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Closure Plan – Ash Pond Area
Closure Plan - Addendum No. 1 - Ash Pond Area
Closure Plan - PDP-5
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Post-Closure Plan - PDP-5
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Demonstration for a Site-Specific Alternative to Initiation of Closure Deadline
Alternative Closure Demonstration Completeness Determination Letter

CCR CLOSURE PLAN
MARTIN LAKE STEAM ELECTRIC STATION
A-1 AREA LANDFILL
PANOLA COUNTY, TEXAS

OCTOBER 2016

PREPARED FOR:

LUMINANT GENERATION COMPANY, LLC
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Dallas, Texas 75201

PREPARED BY:

PASTOR, BEHLING & WHEELER, LLC
5416 Plaza Drive
Texarkana, Texas 75503
Texas Engineering Firm No. 4760

PBW Project No. 5196B

PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by Pastor, Behling & Wheeler, LLC under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I hereby certify that the conceptual closure plan was developed in accordance with the requirements of 40 CFR 257.102(b) of the CCR Rule.

STATE OF TEXAS
BRIAN D. THOMAS
91192
LICENSED
PROFESSIONAL ENGINEER
10/5/16

10/5/16

Brian Thomas, P.E.
Principal Engineer
PASTOR, BEHLING & WHEELER, LLC

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1.0 INTRODUCTION

Luminant Generation Company, LLC (Luminant) owns and operates the Martin Lake Steam Electric Station (MLSES) located approximately five miles southwest of Tatum in Rusk County, Texas. The power plant and related support areas occupy approximately 700 acres on a peninsula on the southwest side of Martin Lake (Figure 1) The MLSES consists of three coal/lignite-fired units with a combined operating capacity of approximately 2,250 megawatts. Coal Combustion Residuals (CCR) including fly ash, bottom ash, gypsum are generated as part of MLSES unit operation. The CCRs are transported off-site for beneficial use by third-parties, are managed by Luminant on-site at one of several CCR surface impoundments or are disposed at Luminant's A-1 Area Landfill. The landfill is located within a reclaimed portion of Luminant's Beckville Mine in Panola County (Figure 2).

The CCR Rule (40 CFR 257 Subpart D - *Standards for the Receipt of Coal Combustion Residuals in Landfills and Surface Impoundments*) has been promulgated by EPA to regulate the management and disposal of CCRs as solid waste under Resource Conservation and Recovery Act (RCRA) Subtitle D. The final CCR Rule was published in the Federal Register on April 17, 2015. The effective date of the CCR Rule was October 19, 2015.

The CCR Rule establishes national operating criteria for existing CCR surface impoundments and landfills, including development of closure plans for all CCR impoundments and landfills. Pastor, Behling & Wheeler, LLC (PBW) was retained by Luminant to develop this closure plan for the A-1 Area Landfill at the MLSES.

1.1 CCR Unit Closure Plan Requirements

40 CFR 257.102(b) of the CCR Rule specifies that a written closure plan must be prepared for each existing CCR landfill that describes the steps necessary to close the unit at any point during the active life of the unit consistent with recognized and generally accepted good engineering practices. The closure plan must include, at a minimum, the following information:

- A narrative description of how the CCR landfill will be closed in accordance with 40 CFR 257.102;
- If closure of the CCR unit will be accomplished by leaving CCR in place, the closure plan will provide a description of the final cover system designed in accordance with 40 CFR 257.102(d) of the CCR Rule, including details concerning the methods and procedures used to install the final cover. The closure plan must also discuss how the final cover system will achieve the following performance standards specified in 40 CFR 257.102(d):
  - Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration

of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere;

- Preclude the probability of future impoundment of water, sediment, or slurry;

- Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during the closure and post-closure care period;

- Minimize the need for further maintenance of the unit; and

- Be completed in the shortest amount of time consistent with recognized and generally accepted good engineering practices.

The final cover system must be designed and constructed to meet the following criteria:

- The permeability of the final cover system must be less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1 X 10^{-5} cm/sec, whichever is less.

- The infiltration of liquids through the closed CCR unit must be minimized by the use of an infiltration layer that contains a minimum of 24 inches of earthen material.

- The erosion of the final cover system must be minimized by the use of an erosion layer that contains a minimum of six inches of earthen material that is capable of sustaining native plant growth.

- The disruption of the integrity of the final cover system must be minimized through a design that accommodates settling and subsidence.

An alternative final cover system design may also be used, provided the alternative final cover system is designed and constructed to meet the following criteria:

- The alternative final cover system must include an infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified above.

- The alternative final cover system must include an erosion layer that provides equivalent protection from wind or water erosion as the erosion layer specified above

- The disruption of the integrity of the alternative final cover system must be minimized through a design that accommodates settling and subsidence.

- An estimate of the maximum inventory of CCR ever on-site over the active life of the landfill and an estimate of the largest area of the landfill ever requiring a final cover at any time during the active life of the unit.

- A schedule for completing all activities necessary to satisfy the closure criteria, including an estimate of the year in which all closure activities for the landfill will be completed. The schedule should provide sufficient information to describe the sequential steps that will be taken to close the unit, including identification of major milestones such as coordinating with and obtaining necessary approvals and permits from other agencies, installation of the final cover system, and the estimated timeframes to complete each step or phase of unit closure.

- In accordance with 40 CFR 257.102(e)(1) of the CCR Rule, closure of a CCR unit must be initiated no later than 30 days after the date on which the landfill receives the known final receipt of CCR or non-CCR waste. Alternatively, under 40 CFR 257.102(e)(2), closure of the landfill must be initiated if the landfill has been idle and has not received CCR or non-CCR waste for two years. Additional two year extensions to initiate closure may be obtained with appropriate documentation.

- In accordance with 40 CFR 257.102(f)(i) of the CCR Rule, closure of a landfill must be completed within six months of commencing closure activities. Additional extensions to complete closure may be obtained with appropriate documentation.

The landfill closure plan must be certified by a qualified professional engineer and must document how the closure plan has been designed and constructed to comply with the requirements of 40 CFR 257.102(b)(4) of the CCR Rule.

In accordance with 40 CFR 257.102(b)(2) of the CCR Rule, the initial written closure plan for an existing CCR landfill must be completed and placed in the facility operating record no later than October 17, 2016.

1.2 MLSES Landfills Subject to CCR Closure Plan Requirements

The only CCR Unit at the MLSES that meets the definition of a CCR Landfill is the A-1 Area Landfill. This closure plan was prepared for the A-1 Area Landfill. In accordance with 40 CFR 257.104 of the CCR Rule, the closure plan must be amended when future landfill construction and/or lateral expansions are constructed at the A-1 Area Landfill.

1.3 Description of A-1 Area Landfill

The A-1 Area Landfill is located approximately 2.5 miles southeast of the MLSES in Panola County (Figure 2). An existing site plan for the A-1 Area Landfill is shown on Figure 3. CCR is transported to the landfill in train cars, off loaded and placed within the active disposal areas at the landfill. The registered boundary of the A-1 Area Landfill covers an area of approximately 986 acres and is located entirely within the reclaimed section of the Luminant Beckville Mine. The A-1 Area Landfill is registered with the Texas Commission on Environmental Quality under SWR31277 (WMU 002) and began receiving CCR in 1980.

The active portion of the A-1 Area Landfill is surrounded by earthen embankments constructed of mine spoil that extend approximately 10 to 20 feet or more above surrounding grade. Prior to the placement of CCR, a 1-foot thick compacted clay bottom liner is constructed over prepared subgrade (clay-rich mine spoil 70-100 feet in thickness). The bottom liner consists of clay scarified and re-compacted to achieve the design specification of 95 percent of maximum density and an in-place permeability of $1x10^{-7}$ cm/sec or less. Continuous construction of the existing clay liner commenced prior to effective date of the CCR Rule, and the approximate current extent of the completed clay liner is illustrated on Figure 3. Specifications for the construction of the perimeter embankments include placement of a 3-foot thick compacted clay liner on the interior slope of the embankment, which was specified not to exceed a 3:1 (horizontal:vertical) sideslope.

Final cover has been placed over approximately 450-acres of the A-1 Area landfill, which consists of the placement of a 3-foot thick compacted clay cap to achieve the design specification of 95 percent of maximum density and an in-place permeability of $1x10^{-7}$ cm/sec or less with a minimum 2-foot thick vegetative cover layer. Progressive capping/closure of the A-1 Area Landfill is performed as placement of CCR reaches the target cap subgrade elevations.

2.0 CLOSURE PLAN FOR A-1 AREA LANDFILL

Although the closure plan presented herein for the A-1 Area Landfill was developed in accordance with the requirements of 40 CFR 257.102 of the CCR Rule, this plan should be considered conceptual in nature given the fundamental assumptions used as the basis of the closure plan. As part of the initiation of final CCR unit closure activities, the conceptual closure plan should be reviewed and revised as needed to ensure appropriate modifications are incorporated into the final design plans and specifications prior to release for bidding and construction.

2.1 Description of A-1 Area Landfill Closure

As described in Section 1, Luminant plans to continue the on-going progressive capping/closure of the A-1 Area Landfill and final closure will comply with 40 CFR 257.102(d) of the CCR Rule, which specifies criteria for leaving CCR in-place and constructing a final cover system over the CCR located within the landfill. The cover system for the A-1 Area Landfill will be designed to achieve the performance standards listed in Section 1.1.

2.2 Removal of Run-off Collection Areas

Although the A-1 Area Landfill operates as a dry CCR unit, run-off collection areas are present within the registered boundary of the landfill. These areas allow for runoff from active disposal areas to be retained prior to discharge or treatment, if needed. Collected run-off in these areas will be removed from the landfill and managed in accordance with applicable state regulations or discharge permits. These areas will be reclaimed to remove sediment and either re-graded to convey stormwater away from the landfill cover system, allowed to remain as reclaimed ponds (beyond the limits of the cover system), or capped as part of the progressive installation of the landfill cover system.

Luminant currently anticipates that the North Run-off Collection Area (NROCA) will be capped or reclaimed within the next five years as placement of the final cover system progresses. The South Run-off Collection Area (SROCA), the Former South Run-off Collection Area (FSROCA), the South Treatment Pond (STP), and the North Treatment Pond (NTP) will remain in-service while active placement of CCR is occurring within the landfill. With exception of the NROCA and NTP, Luminant currently anticipates that these areas will be reclaimed. The NTP and NROCA will be dewatered and accumulated sediment will be stabilized prior to placement of the final cover system in this area.

2.3 Final Cover System – A-1 Area Landfill

The proposed final grading plan for the final cover system is illustrated in Figure 4 and a conceptual surface water control plan is included as Figure 5. In accordance with 40 CFR 257.102(d) of the CCR Rule, the permeability of the final cover system will be less than or equal to the permeability of the existing bottom liner in the A-1 Area Landfill (i.e. 1 foot clay liner with a permeability of <1 X 10^{-7} cm/sec). Given the status of the on-going progressive construction of the final cover system for the landfill and availability of suitable clay soil, placement of a compacted cap will continue as a preferred means of in-place closure of CCR. Typical construction details and surface water drainage controls for the final cover system are provided in Figures 6 and 7.

Technical Specifications for material selection and placement of the proposed final cover system and the associated cap subgrade have been developed to minimize potential for differential settlement and subsidence. Post-closure monitoring activities will be performed to ensure the cover system complies with the requirements of the CCR Rule. Furthermore, an evaluation of infiltration through the proposed cover systems was developed using the U.S. Army Corps of Engineers – Hydrologic Evaluation of Landfill Performance (HELP) model (Appendix B). As demonstrated by the HELP model results, the permeability of the clay cap (infiltration layer) final cover system will be less than or equal to the permeability of the bottom liner system. The final cover option is designed to minimize impounding of water on the cap and associated long-term care activities.

2.3.1 Compacted Clay Cap

Select fill and/or CCR deemed suitable for beneficial use will be placed within the proposed limits of the landfill cover system to the lines and grades specified for the cap subgrade (Figure 4). Upon placement of cap subgrade to within approximately five feet of proposed finished grade, approved select fill material (i.e. stockpiled suitable fill) will be placed in accordance with the specifications for cap subgrade. A three-foot thick compacted clay liner with permeability of no greater than $1x10^{-7}$ cm/sec will be placed on the prepared cap subgrade material. Cap subgrade and clay cap material selection, placement, compaction and testing will conform to the Technical Specifications in Section 02320 and 02330, respectively (Appendix A). The vegetative soil layer is placed in a single loose lift over the prepared clay cap to allow for establishment of permanent vegetative cover.

2.4 Final Cover System Slope Stability

Selection of suitable construction materials, proper material placement, and quality assurance testing of both the subgrade preparation and cover system installation in accordance with the Technical Specifications (Appendix A) will ensure stability of the final cover system. The SLIDE 7.0 equilibrium slope stability model was used to demonstrate that the proposed cover system is stable at the slopes specified in the conceptual closure plan (see Appendix C).

2.5 Stormwater Run-off Control

Surface drainage of the cap covering CCR will generally consist of sheet flow or shallow concentrated flow along stormwater diversion berms that will convey run-off to reinforced stormwater let-down structures. The final cover system will allow for lateral drainage of infiltration off the capped area to prevent saturation of the vegetative layer and/or ponding on the cover system.

Existing areas of the landfill where the final cover system is in-place are typically sloped from one to five percent from the landfill crest to the perimeter embankments. The existing perimeter exterior embankments are typically 5:1 (horizontal:vertical) or less steep. The proposed final cover system for the active portion of the existing landfill varies from three to five percent from the crest to perimeter areas where the cap slopes more steeply to match surrounding grades. These steeper portions of the capped area vary between 3:1 and 5:1 with slope lengths less than 250 feet. Stormwater let-down structures will be constructed at intervals on these steeply sloped faces to convey run-off from the limits of the capped area away from the landfill. Slope stabilization material (Geocells, or approved equivalent) will be placed across the cross-section of the stormwater let-down structures to control erosion in these areas.

A surface water control plan for the A-1 Area Landfill is shown on Figure 5. A conceptual run-off control plan that includes estimated peak discharges based on the 25-year/24-hour storm event (8.6 inches) for the capped area is presented in Appendix D. Typical construction details for the stormwater let-down structures and related appurtenances are provided on Figures 6 and 7. Technical Specifications for the stormwater let-down structures and related appurtenances are included in Appendix A.

2.6 CCR Inventory and Area to Be Capped

For the purposes of this conceptual closure plan, in-place closure of CCR within the A-1 Area Landfill is based on the CCR contained in the landfill achieving the particular lines and grades associated with each distribution area outlined in the attached grading plan (Figure 5). To date, Luminant estimates that over

40,000,000 cubic yards of CCR has been placed in the landfill. Based on this assumption, the landfill will contain over 50,000,000 cubic yards of CCR at time of closure. The registered total surface area of the A-1 Area Landfill is 986 acres. To date approximately 450 acres has previously been permanently closed by the placement of a compacted clay cap. The remaining active disposal area (approximately 370 acres) will be progressively closed as various sections of the landfill reach the target cap subgrade elevations.

2.7 Closure Schedule

The timing of the closure of the A-1 Area Landfill will be in accordance with the CCR rules. The assumption is that final closure of the A-1 Area Landfill will be triggered by inactivity (i.e. inactive for 2-years), which will require final closure of the landfill to be completed within 6 months of start of closure. However, Sections 257.102(f)(2) and 257.103 of the CCR Rule allow for extension of the closure schedule under certain circumstances or demonstration that alternative closure requirements should apply to the CCR units. A Gantt chart illustrating the sequential steps of the CCR closure process, including pre-construction activities (i.e. necessary notifications and permitting) as well as closure milestones, is included as Appendix E.

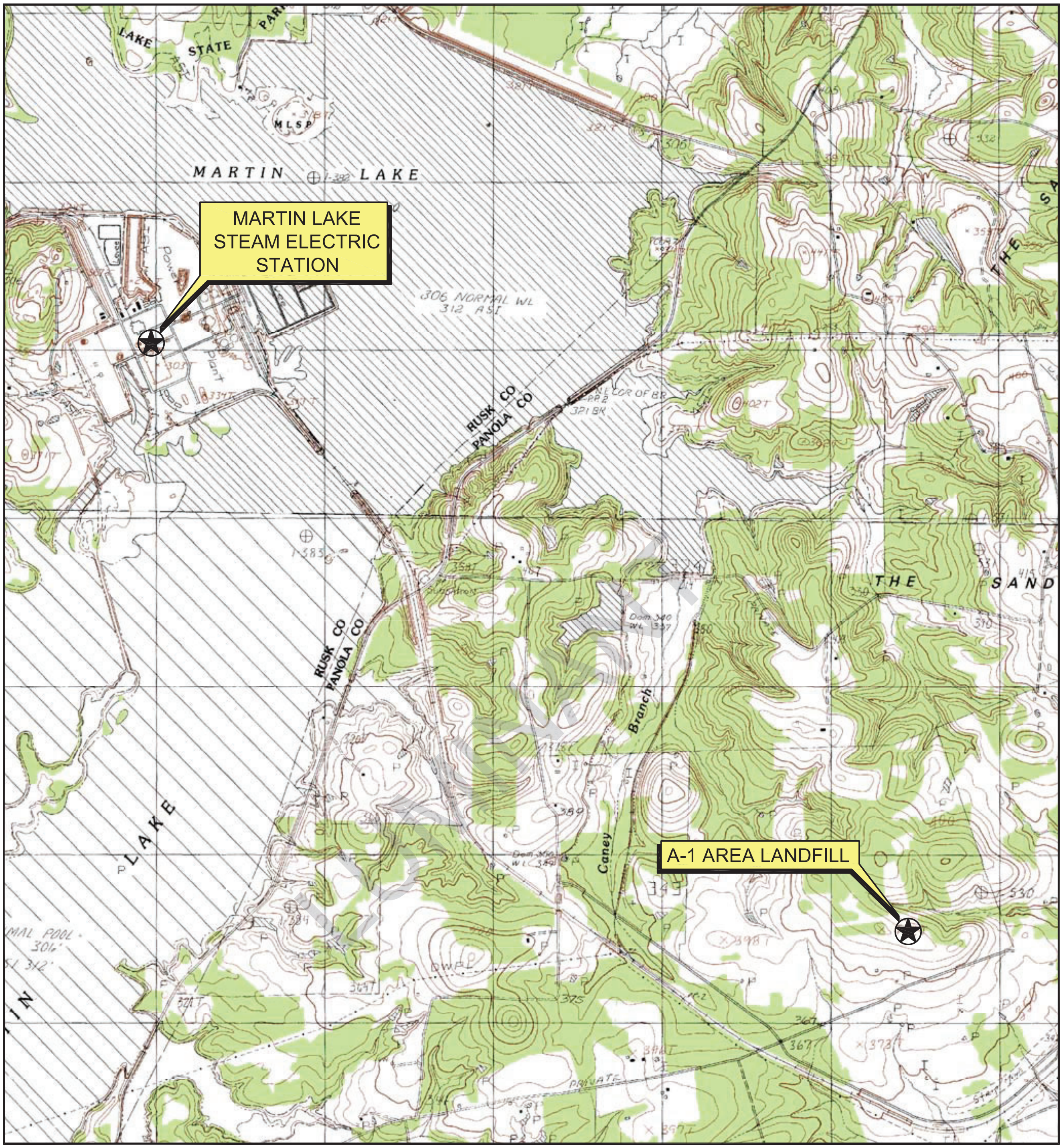
3.0 REFERENCES

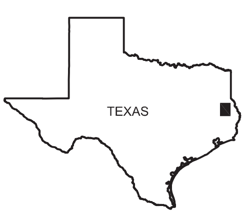
Hershfield, OM. 1961. Rainfall Frequency Atlas of the United States for Durations from 30 minutes to 24 hours and Return Periods from 1 to 100 Years, U.S. Dept. Commerce, Weather Bureau. Technical Paper No. 40. Washington, DC.

U.S. Army Corps of Engineer, 1997*, Hydrologic Evaluation of Landfill Performance (Version 3.07), November 1.*

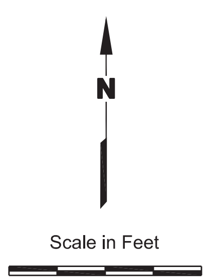
United States Department of Agriculture, Natural Resources Conservation Service (USDA-NRCS), 1986. *Urban Hydrology for Small Watersheds - TR-55*, June.

FIGURES





QUADRANGLE LOCATION



SOURCE:
Base map from www.tnris.gov, Tatum, TX 7.5 min. USGS quadrangle dated 1983.

LUMINANT GENERATION COMPANY, LLC
MARTIN LAKE STEAM ELECTRIC STATION

Figure 1

SITE LOCATION MAP

PROJECT: 5196B	BY: AJD	REVISIONS
DATE: SEPT., 2016	CHECKED: BDT	

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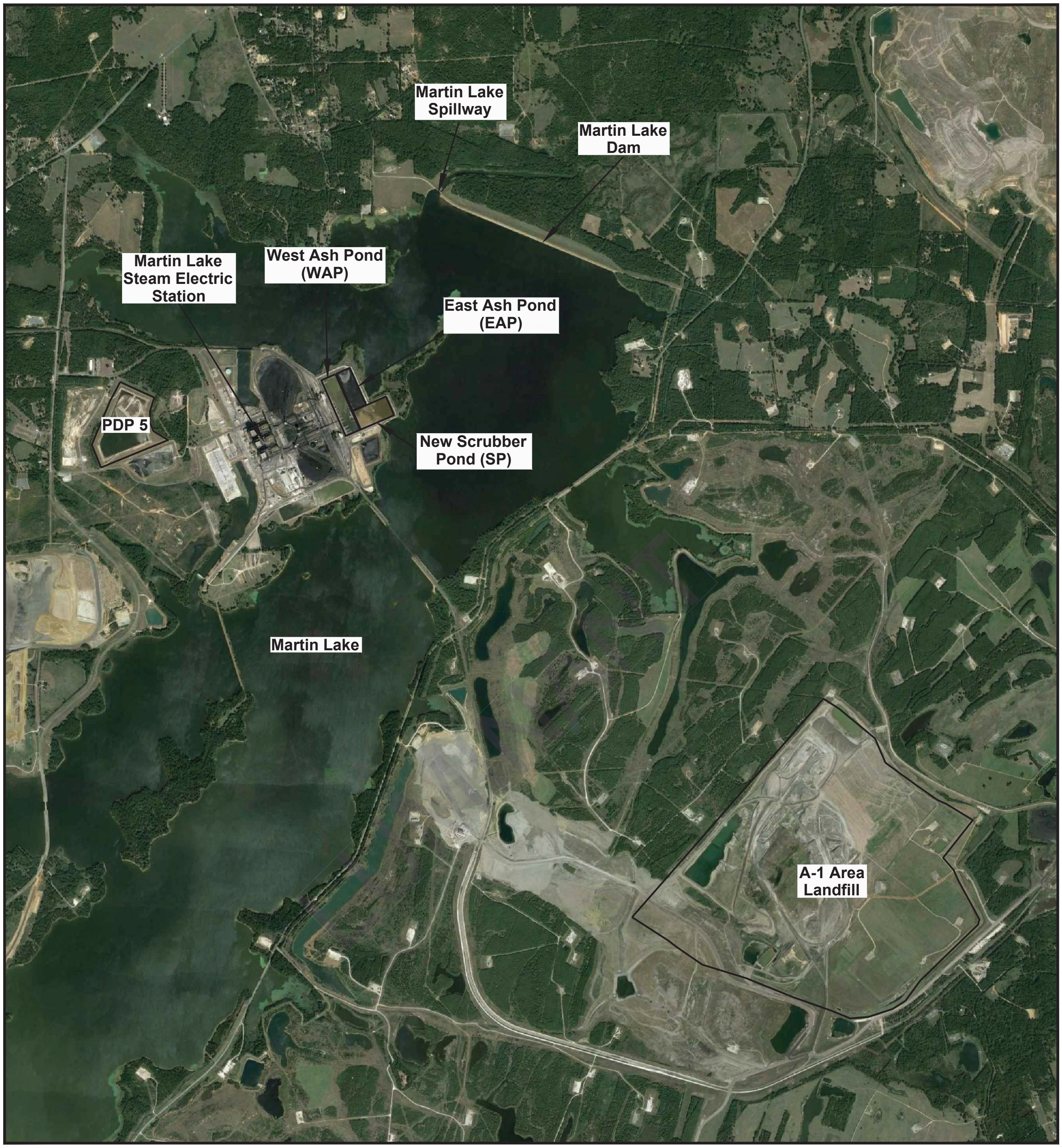
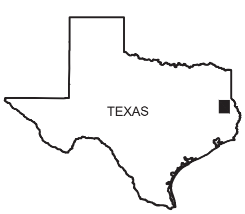
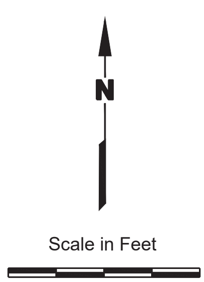
CONSULTING ENGINEERS AND SCIENTISTS





PHOTOGRAPH LOCATION



SOURCE:
Imagery from Google Earth, photography dated October 1, 2015.

LUMINANT GENERATION COMPANY, LLC
MARTIN LAKE STEAM ELECTRIC STATION

Figure 2

SITE VICINITY MAP

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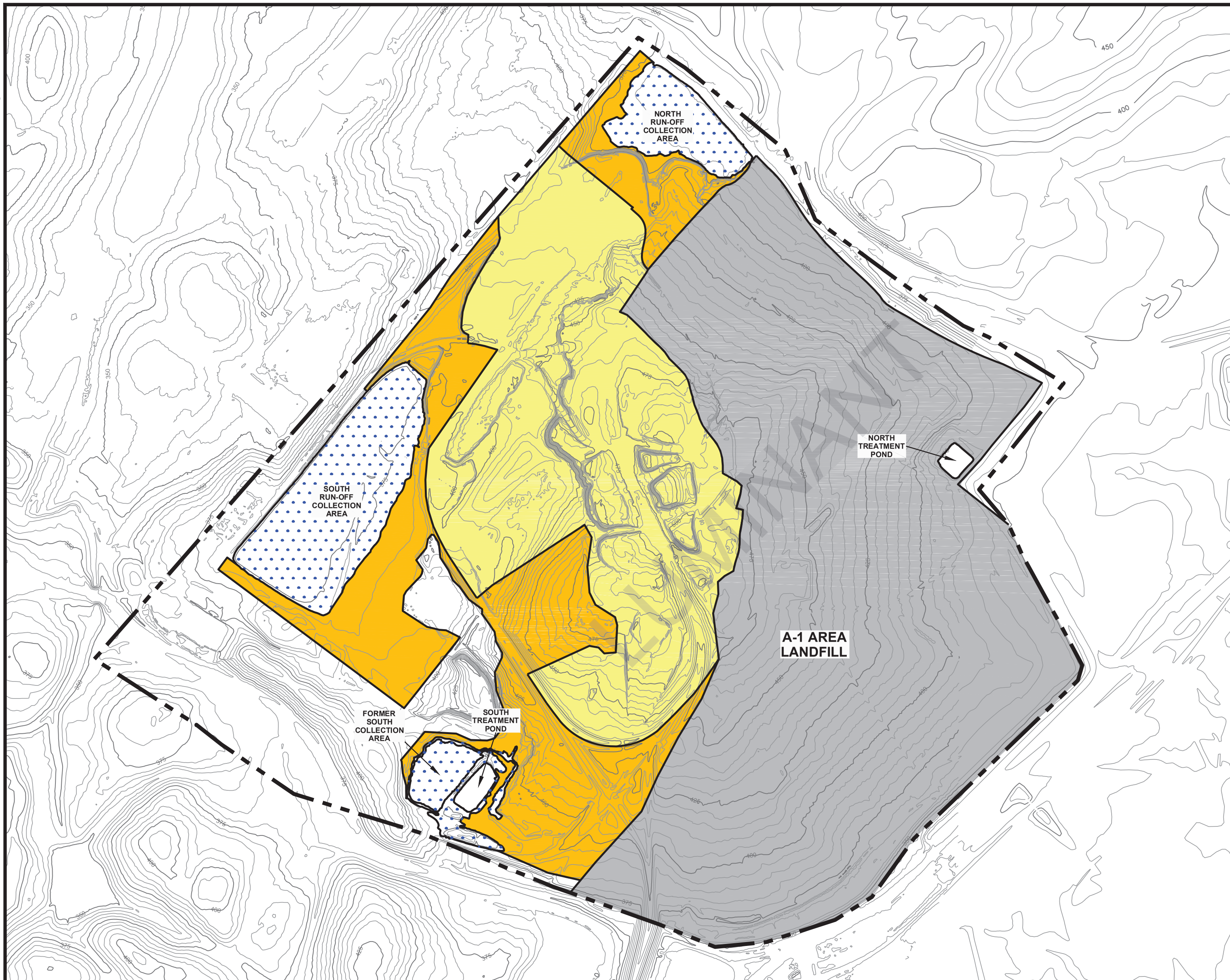

EXPLANATION

- Landfill Registration Boundary
- Existing Grade Contour 5 ft Interval
- Existing Grade Contour 25 ft Interval
- Capped Area (Existing)
- Active CCR Disposal/ Disturbed Area
- Existing Compacted Clay Liner
- Run-off Collection Area

Notes:
1. Extent of Capped Areas based on October 2016 site conditions.
2. Run-Off Collection Areas and Treatment Ponds are lined with compacted clay.

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MARTIN LAKE STEAM ELECTRIC STATION

Figure 3

EXISTING SITE PLAN

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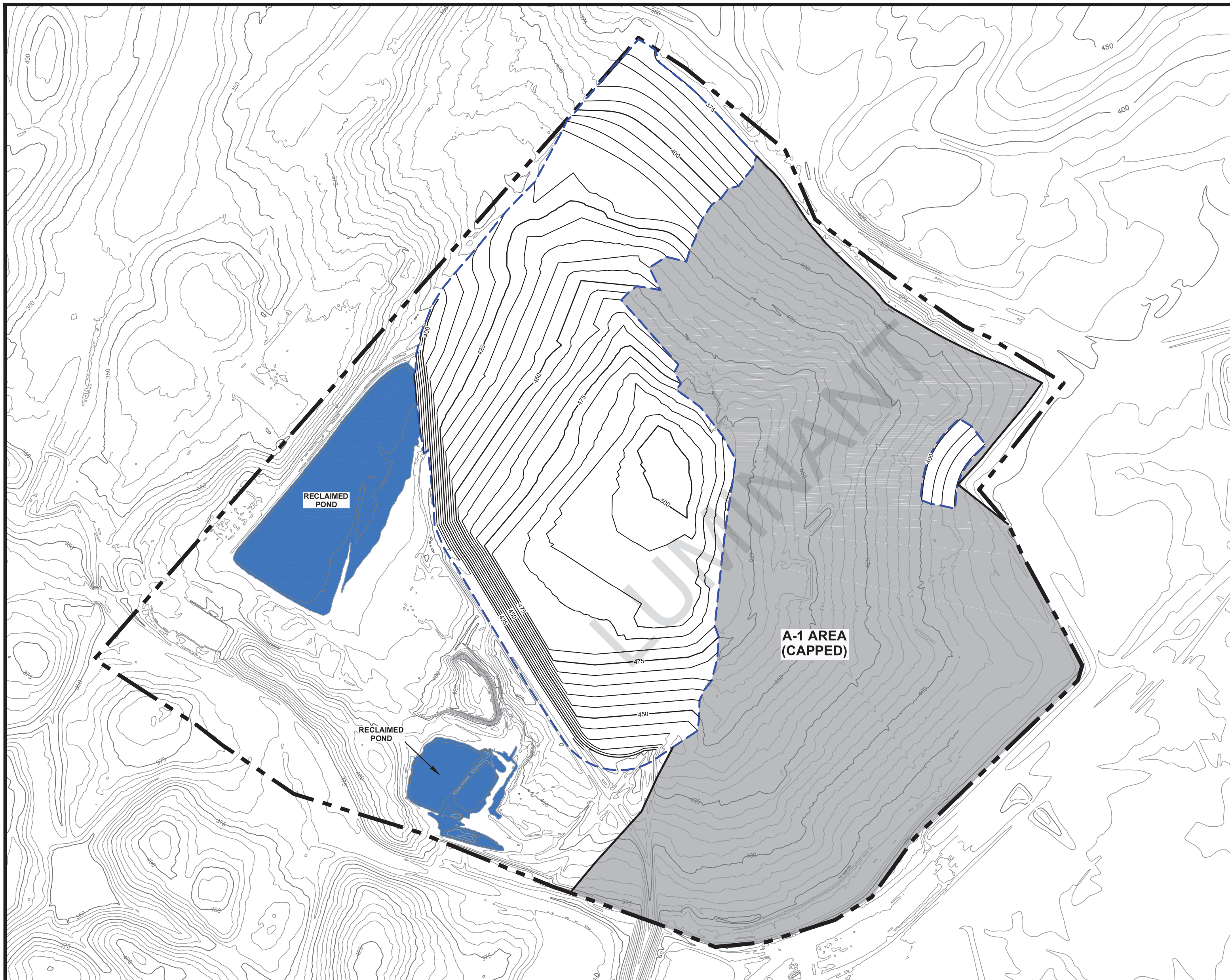

EXPLANATION

- Landfill Registration Boundary
- Existing Grade Contour 5 ft Interval
- Existing Grade Contour 25 ft Interval
- Proposed Finished Grade Contour 5 ft Interval
- Proposed Finished Grade Contour 25 ft Interval
- Proposed Limits of CAP
- Capped Area (Existing)

Scale in Feet
0 450 900

LUMINANT GENERATION COMPANY, LLC
MARTIN LAKE STEAM ELECTRIC STATION

Figure 4

PROPOSED GRADING PLAN

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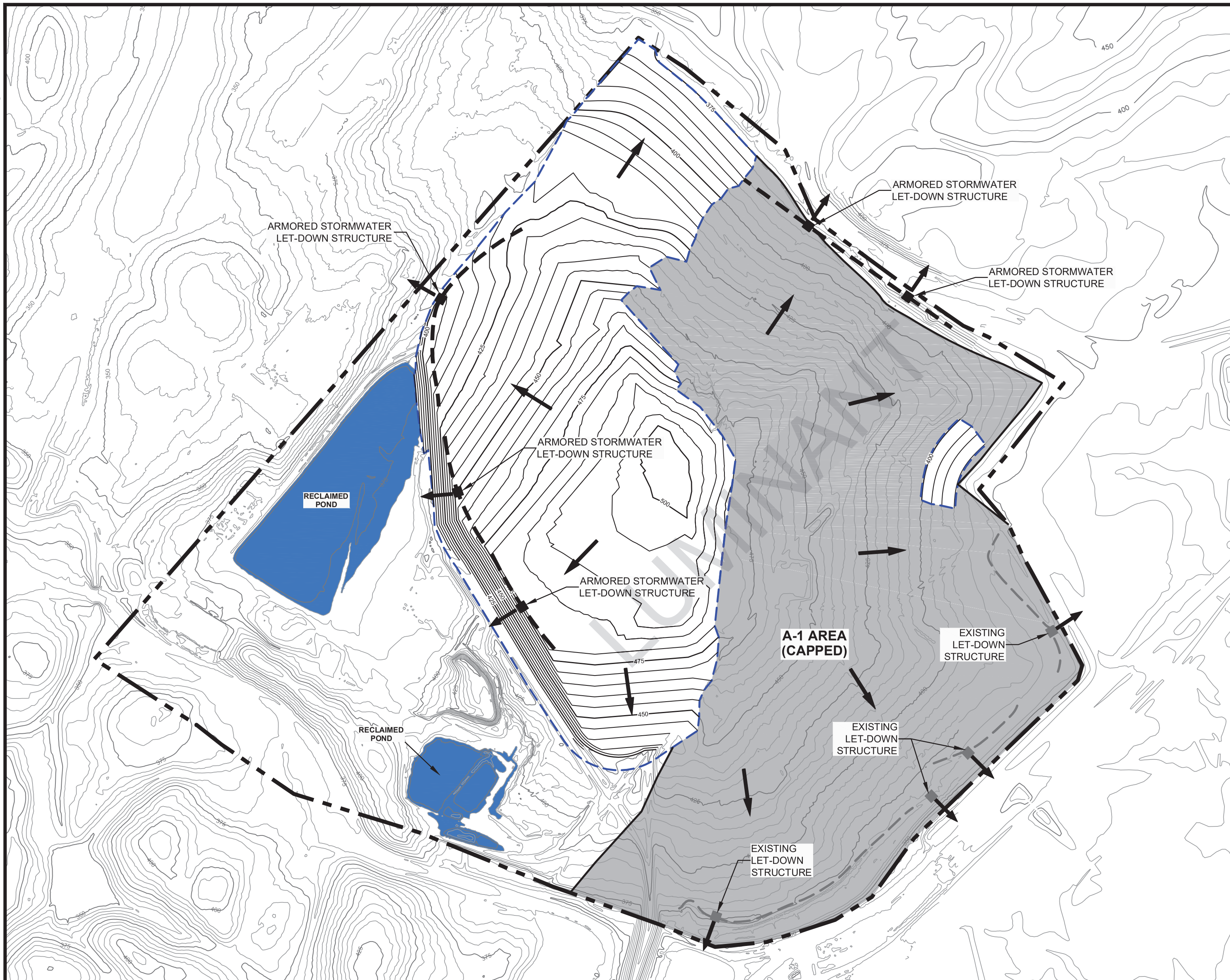

EXPLANATION

- Landfill Registration Boundary
- Existing Grade Contour 5 ft Interval
- Existing Grade Contour 25 ft Interval
- Proposed Finished Grade Contour 5 ft Interval
- Proposed Finished Grade Contour 25 ft Interval
- Proposed Limits of CAP
- Sheet Flow
- Approximate Alignment Stormwater Diversion Berm
- Approximate Alignment Existing Stormwater Diversion Berm
- Capped Area (Existing)

N

Scale in Feet
0 450 900

LUMINANT GENERATION COMPANY, LLC
MARTIN LAKE STEAM ELECTRIC STATION

Figure 5

SURFACE WATER CONTROL PLAN

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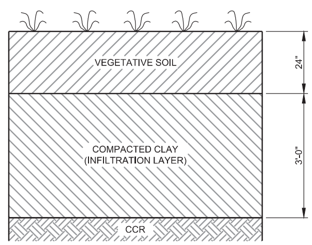
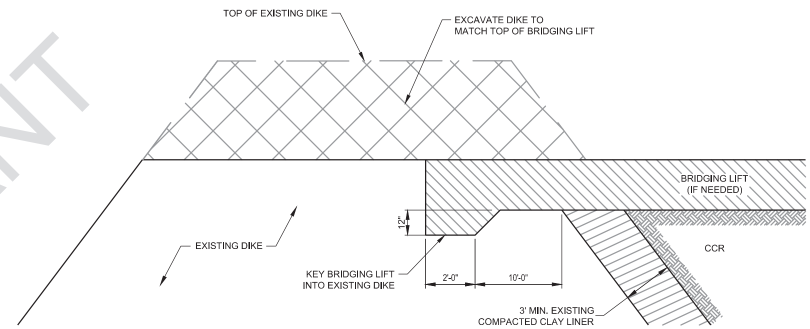


1/6 CLAY CAP DETAIL
NOT TO SCALE



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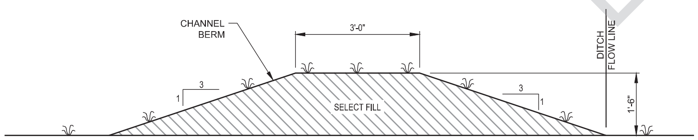

3/6 CHANNEL BERM
NOT TO SCALE

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MARTIN LAKE STEAM ELECTRIC STATION

Figure 6

TYPICAL CONSTRUCTION DETAILS - CCR COVER SYSTEM

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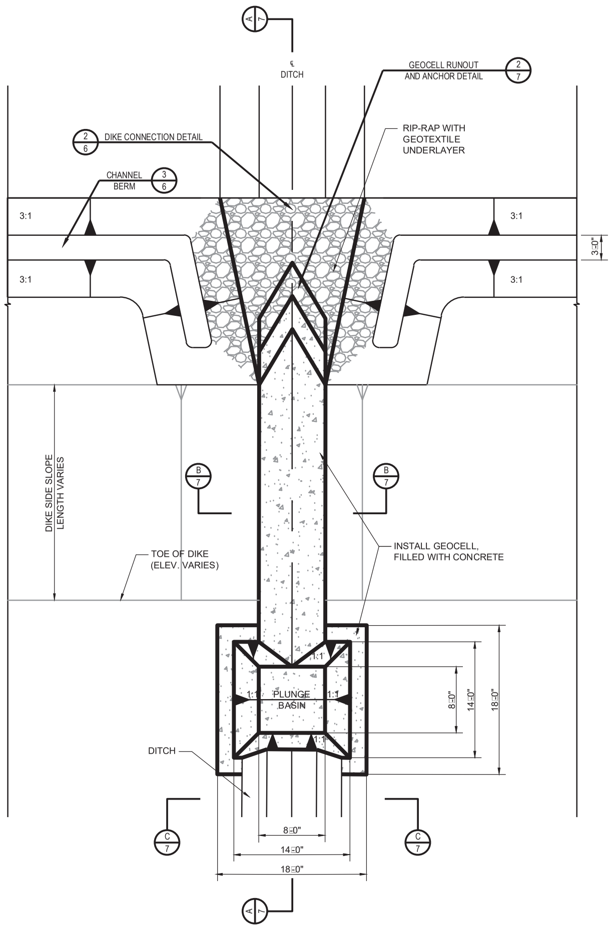
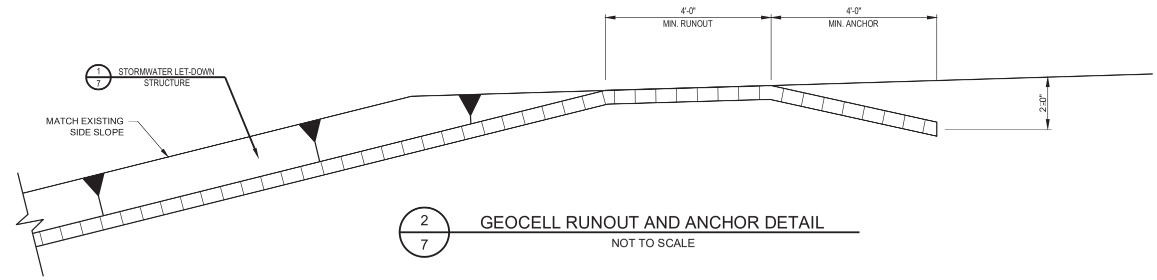


1/7 STORMWATER LET-DOWN STRUCTURE

SCALE: 1"=20'



2/7 GEOCELL RUNOUT AND ANCHOR DETAIL

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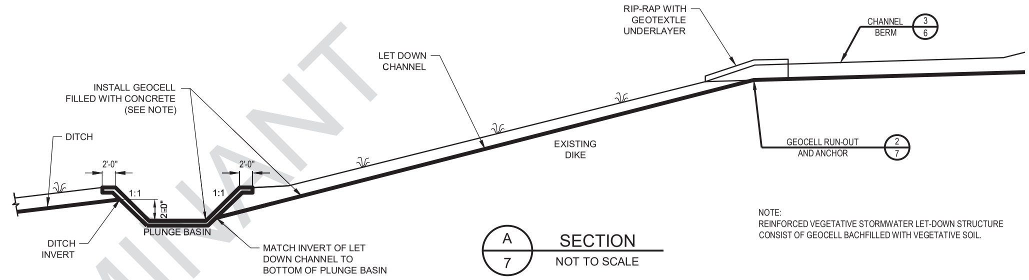
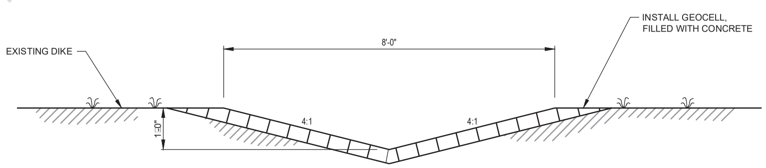


NOTE:
REINFORCED VEGETATIVE STORMWATER LET-DOWN STRUCTURE CONSIST OF GEOCELL BACHFILLED WITH VEGETATIVE SOIL.

A/7 SECTION

NOT TO SCALE



B/7 SECTION

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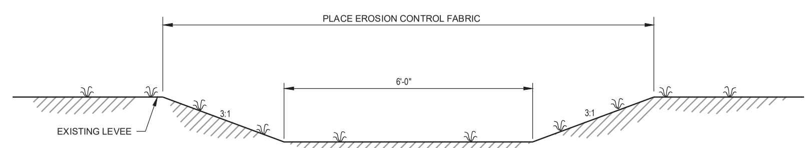

C/7 SECTION

NOT TO SCALE

LUMINANT

LUMINANT GENERATION COMPANY, LLC
MARTIN LAKE STEAM ELECTRIC STATION

Figure 7

TYPICAL DRAINAGE CONTROL DETAILS

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PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS

APPENDIX A

TECHNICAL SPECIFICATIONS

A-1 AREA LANDFILL
TECHNICAL SPECIFICATIONS

A-1 AREA LANDFILL
TECHNICAL SPECIFICATIONS
TABLE OF CONTENTS

SECTION 01100

EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section consists of furnishing, placing, and maintaining erosion and sedimentation control measures as shown on the Drawings, as directed by the COMPANY, and where necessary to reduce sediment content of runoff prior to establishment of permanent vegetation.

1.2 PERFORMANCE REQUIREMENTS

A. CONTRACTOR shall provide erosion and sedimentation control measures to control erosion and sediment runoff in any location where erosion and sediment runoff is likely to occur and as required by the COMPANY. Erosion and sedimentation control measures shall remain in place until removal is approved by the COMPANY.

B. Clearing and stripping of vegetation, regrading and other construction activities shall be conducted in a manner to minimize erosion. Existing drainage patterns and vegetation shall be protected and retained to the greatest extent practicable.

C. The size and duration of exposure of disturbed areas shall be kept to a minimum and all disturbed soil shall be stabilized as quickly as practicable. Diversion channels/berms shall be located upstream from disturbed areas to minimize the amount of run-on to the disturbed areas.

D. In the event that erosion and sedimentation control measures used by CONTRACTOR prove to be inadequate as determined by COMPANY, CONTRACTOR shall be required to adjust his operations to the extent necessary to control sedimentation and shall repair areas impacted by sedimentation as directed by COMPANY at no additional cost to COMPANY.

1.3 SUBMITTALS

A. CONTRACTOR shall submit the following to COMPANY a minimum of 14 days prior to initiating field activities:

1. A copy of the construction Storm Water Pollution Prevention Plan (SWPPP) developed for the Work.
2. An installation schedule for erosion and sedimentation control measures. This schedule shall cover all ground disturbance activities including material staging areas and planned excavation and grading areas.
3. Certification that all proposed erosion and sedimentation control products comply with the requirements of these specifications.

PART 2 - PRODUCTS

2.1 SILT FENCE

A. Silt fence fabric material shall be a woven geotextile conforming to the following requirements:

Physical Property	Test Method	Requirement
Tensile Strength, lb.	ASTM D4632	100 Minimum
Elongation @ Yield, %	ASTM D4632	10-40
Trapezoidal Tear, N (lb.)	ASTM D4533	50 Minimum
Apparent Opening Size	ASTM D4751	20-50
Permittivity, 1/sec	ASTM D4491	0.1 Minimum
UV Stability, 500 hr.	ASTM D4355	80 Minimum

B. Posts shall be essentially straight wood or steel posts with a minimum length of 48 inches. Soft wood posts must be at least 3 in. in diameter or nominal 2 x 4 in. Hardwood posts must have a minimum cross-section of 1-1/2 x 1-1/2 inches. T- or L-shaped steel posts must have a minimum weight of 1.3 pounds per foot.

2.2 EROSION CONTROL FABRIC

A. Erosion Control Fabric shall be North American Green S150 or COMPANY-approved equal.

B. Erosion control fabric blanket shall have a minimum width of 6 feet. The fabric mat shall be machine-produced of 100 percent coconut fiber with colored line or thread along outer edges to indicate material overlap limits and shall have a minimum weight of 0.50lb./sq.yd.

C. The top and bottom cover of the fabric shall be heavy-weight polypropylene netting with ultraviolet additives to delay breakdown. The mesh size shall be a minimum of 0.5 inch by 0.5 inch.

D. The blanket and top/bottom covers shall be sown together on 1.5 inch center at 50 stitches per roll width with UV stable polypropylene thread.

E. Erosion Control Fabric shall be installed using 6-in. wooden stakes or metal staples of sufficient material quality, cross-section, and strength to anchor the erosion control blanket against loads imposed by surface runoff and sediment.

2.3 HAY BALES

A. Hay bales may be obtained from local sources and shall weigh 40 to 120 pounds per bale. Only grain hay bales, free of noxious weeds, shall be used. Bales shall be tightly and securely bound with wire to provide a stable bale and to extend the functional life of the bale to the extent practicable. Bales shall be free from rot and mold.

B. Stakes for hay bales shall be wooden stakes or metal rebar of sufficient material quality, cross-section, and strength to secure the hay bales.

2.4 TEMPORARY VEGETATION

A. Temporary Vegetation shall be applied on areas left exposed for greater than 30 days. CONTRACTOR shall use temporary vegetation seed mixture and application rate as specified in Section 02350, "Vegetation," or CONTRACTOR may alternatively submit proposed temporary vegetation seed mix and application rate to COMPANY for approval no later than 7 days prior to use.

B. Mulch shall be applied after temporary vegetation seeding at a rate of 1.5 tons/acre for straw mulch, or at the rate recommended by the manufacturer if wood fiber mulch is used.

CONTRACTOR shall ensure that mulch does not redistribute after application. CONTRACTOR shall reapply mulch as necessary to maintain uniform coverage. Straw mulch shall include dry oat or wheat straw, native hay, or chopped corn stalks. The mulch shall be free from weeds and foreign matter detrimental to plant life. Wood fiber mulch shall include approved wood cellulose fiber in chip form and be free of ingredients that could inhibit germination and growth.

PART 3 - EXECUTION

3.1 GENERAL

A. Delivery, Storage, and Handling. Product delivery, storage and handling shall comply with manufacturer's recommendations. All erosion and sedimentation control products shall be delivered in manufacturer's wrapping and shall be stored in a manner to prevent damage. Damaged or unsuitable products shall be promptly removed from the job site and replaced with products meeting these specifications.

B. All erosion and sedimentation control measures shall be installed in accordance with manufacturer’s recommendations and approved by the COMPANY prior to initiating any clearing, demolition or construction activities.

C. Cut Areas. Establish an erosion control line (hay bales or filter fabric) at toe of slope in all cut areas prior to beginning cut operations.

D. Fill Areas. Establish an erosion control line (hay bales or filter fabric) approximately 10 feet from toe of slope of proposed fill areas prior to beginning fill operations.

E. Stockpiles. Sides of soil stockpiles shall have a maximum slope of 2:1. All stockpiles shall be surrounded by a sediment barrier (hay bales or filter fabric) unless other wise approved by the COMPANY. All stockpiles left bare for more than 30 days shall be stabilized with temporary vegetation and/or mulch.

3.2 SILT FENCE

A. Silt fence shall be installed along the downstream perimeter of all disturbed areas to intercept sediment from sheet flow.

B. Posts shall be embedded into the ground at least 18 inches deep and shall be spaced a maximum of 8 feet apart.

C. Filter fabric shall be installed by digging a 6 inch wide by 6 inch deep trench along the upstream side of the fence. Place approximately 6 to 8 inches of the fabric in the trench and backfill the trench.

D. Unless otherwise shown on the Drawings, attach the wire mesh to wooden posts with staples, or to steel posts with T-clips, in at least 4 places equally spaced. Sewn vertical pockets may be used to attach wire mesh or fabric to end posts.

E. Fasten the fabric to the top strand of the reinforcement by rings or cord every 15 inches or less. Locate fabric splices at a fence post with a minimum overlap of 6 inches attached in at least 4 places equally spaced. Do not locate fabric splices in concentrated flow areas.

3.3 EROSION CONTROL FABRIC

A. Erosion control fabric shall be installed following completion of final grading activities in the following disturbed earth areas unless otherwise approved by the COMPANY:

1. All exterior slopes 4(H) to I(V) and steeper; and
2. All drainage ditches, channels and swales.

B. Erosion control fabric shall be anchored at the top of the slope using an anchor trench and shall be rolled down the slope so as to maintain tension to preclude folds and wrinkles. Any folds or wrinkles shall be removed by hand.

C. The erosion control fabric anchor trench shall be 6 inches wide by 6 inches deep. The trench fabric shall be connected to the vertical face of the trench using stakes or staples spaced at 12 inches on center. The trench shall be backfilled and compacted upon completion of stapling.

D. Successive erosion control fabric panels shall be overlapped in such a manner that the upstream and upslope panel is placed over the downstream and downslope panel. Panels shall overlap a minimum of 6 inches at end joints and on sideslopes.

E. Stake or staple through both panels with stakes/staples driven flush with the soil surface. Stake/staple spacing shall be in accordance with manufacturer's recommendations.

3.4 HAY BALES

A. Hay bales shall be installed to form water stops, filtration dams, diversions, etc. as required for erosion and sedimentation control. On sloping terrain, hay bales may be used to trap sediment until vegetation has become established.

B. Place bales lengthwise with ends tight, abutting one another. Install bales with bindings located on the sides.

C. Entrench hay bales a minimum of 4 inches and backfill. Place backfill on the upstream side of the bales.

D. Secure the bale in place with two stakes per bale and insert straw in voids between bales.

3.5 MAINTENANCE

A. All erosion and sedimentation controls shall be maintained in a structurally sound and functional manner. All erosion and sedimentation controls shall be inspected at least on a weekly basis, immediately after each rainfall and daily during prolonged rainfall.

B. Any damaged or deteriorating systems shall be replaced immediately upon discovery or as directed by COMPANY.

C. Sediment deposits shall be removed when the deposit reaches 1/3 the height of the fence or sooner to provide a functional and stable system. Sediment retained by sedimentation and erosion control systems shall be removed by CONTRACTOR and may be used on the project as fill as approved by COMPANY.

D. Areas where temporary vegetation or mulch has been applied shall be inspected to ensure proper growth and coverage. Temporary vegetation or mulch shall be reapplied as necessary to minimize erosion.

3.6 REMOVAL

A. Erosion and sedimentation controls shall remain in-place until the COMPANY directs their removal. Upon removal CONTRACTOR shall dispose of any sediment accumulations, dress the area to the satisfaction of COMPANY, and shall vegetate all bare areas in accordance with the Contract Documents. Temporary erosion control blanket materials specified are biodegradable and will remain in place after establishment of permanent vegetation.

++END OF SECTION++

SECTION 01200

DUST CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section consists of performance of dust control measures as necessary to prevent fugitive dust during construction activities or as directed by the ENGINEER.

1.2 PERFORMANCE REQUIREMENTS

A. CONTRACTOR shall implement all necessary dust control measures to prevent fugitive dust during all construction activities.

B. The need for dust control measures will be based on visual observation of airborne dust. CONTRACTOR shall implement dust control measures on a regular basis throughout the duration of the work unless other wise authorized by the ENGINEER. CONTRACTOR shall adjust operations and/or dust controls as necessary, at no additional cost to OWNER, if directed by ENGINEER to mitigate dust.

1.3 SUBMITTALS

A. CONTRACTOR shall submit the following to ENGINEER a minimum of 5 days prior to initiating dust control measures:

1. Source of dust control water;
2. List of dust control equipment; and
3. Manufacturer specification sheets and material safety data sheets (MSDS) for chemical additives used for dust control.

PART 2 - PRODUCTS

2.1 WATER

A. Water used for dust control need not be potable, but must not be contaminated. Proposed source of dust control water must be approved by ENGINEER prior to initiating dust control measures.

2.2 CHEMICAL ADDITIVES

A. Chemical additives shall be incorporated into dust control measures only if approved by the ENGINEER.

B. Calcium Chloride for dust control shall conform to the requirements of ASTM D98, Type 1 or Type 2.

C. Alternative chemical additives for dust control may be used if approved by the ENGINEER.

2.3 EQUIPMENT

A. Dust control water shall be applied using tank trucks equipped with water cannon capable of delivering water through either front- or rear-mounted nozzles. Tank trucks shall be of sufficient size and mobility and carry a sufficient quantity of water to control dust generated by CONTRACTOR’s activities.

B. More than one water tank truck may be required during construction activities to sufficiently suppress dust.

PART 3 - EXECUTION

3.1 IMPLEMENTATION OF DUST CONTROL MEASURES

A. Vehicular traffic in disturbed areas shall be limited to the extent practicable. Construction vehicles shall maintain low speeds to minimize the amount of dust created. Adequate freeboard in loaded trucks shall be maintained to prevent spillage during operations. Roadway surfaces shall be kept free of spilled/tracked soil.

B. Soil stockpiles shall be graded and shaped to minimize surface area. Water or covers shall be applied to stockpiles as needed to control dust.

C. Apply dust control water uniformly over roads and disturbed areas from trucks capable of uniform distribution. Provide suitable devices for positive shut-off and for regulating flow of water.

D. Apply calcium chloride or other chemical additives at locations only when directed by ENGINEER. Spread calcium chloride or other chemical additives by approved devices and methods for uniform distribution.

E. Dust control water and/or chemical additives shall be applied so as to limit and/or prevent formation of standing water and mud; over spray of chemical dust suppressants in areas adjacent to surface water bodies or sensitive habitats; and/or flushing of materials off of the work area.

++END OF SECTION++

SECTION 02200

SITE PREPARATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section consists of all work associated with clearing and preparing the work area, borrow areas, and other work areas for earthwork and other construction activities, including removal of existing vegetation and verification of existing site conditions.

1.2 EXISTING SITE CONDITIONS

A. CONTRACTOR shall verify that existing topographic conditions in the Work Area as shown on the Drawings are an accurate representation of existing site conditions prior to initiating construction activities.

B. If CONTRACTOR contends that existing topographic conditions are different from that shown on the Drawings, Contractor shall submit survey data from a Texas-registered land surveyor to document actual topographic conditions, and shall identify with such submission additional work required which was not accounted for in CONTRACTOR's bid. There shall be no opportunity for a Claim for extra work due to differing topographic conditions once stripping or excavation work has started.

C. Existing site improvements (utilities, monitoring wells, and similar items) shall be located and protected by CONTRACTOR before CONTRACTOR begins clearing operations.

1.3 SUBMITTALS

A. Clearing and grubbing and solid waste generated during cap subgrade preparation shall be placed within the active portion of the landfill unless otherwise approved by the ENGINEER. CONTRACTOR shall submit name and address of the alternate disposal facility proposed for management of trash and rubbish generated in connection with site preparation at least 5 days prior to beginning clearing operations.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 CLEARING

A. Clearing shall consist of the cutting, shredding, and stockpiling of all trees and shrubs and the stripping of all grass and similar surface vegetation within the limits of the landfill and borrow areas. Clearing shall be limited to the areas required to perform the work.

B. CONTRACTOR shall segregate material removed as part of clearing from soils to be incorporated into subsequent earthwork activities.

3.2 VEGETATIVE SOIL STRIPPING AND STOCKPILING

A. After completion of clearing activities, CONTRACTOR shall strip the uppermost approximately 12 inches of existing vegetative soil from the cleared areas. Material identified as vegetative soil shall be subject to ENGINEER's approval.

B. CONTRACTOR shall stockpile stripped vegetative soil in the work area in a location acceptable to the ENGINEER.

3.3 DISPOSAL OF BRUSH AND OTHER VEGETATIVE MATERIAL

A. CONTRACTOR shall dispose of all brush and other vegetative materials generated during site clearing in accordance with all applicable regulations and as approved by the ENGINEER.

B. If approved by the ENGINEER, CONTRACTOR may burn brush and other vegetative material in accordance with the requirements of TCEQ Publication RG-049 "Outdoor Burning in Texas", as modified to comply with OWNER requirements. Specific requirements for burning of brush and other vegetative material include, but are not limited to, the following:

1. Commence or continue burning only when the wind direction and other weather conditions are such that the smoke and other pollutants will not present a hazard to any public road, landing strip, or water body or have an adverse effect on any off-site structure.

2. Don't start burning unless weather conditions are such that the smoke will dissipate (winds of at least 6 miles per hour; no temperature inversions) while still allowing the fire to be contained and controlled (winds no faster than 23 miles per hour).

3. Post someone to flag traffic if at any time the burning causes or may tend to cause smoke to blow onto or across a road or highway.

4. Begin burning no earlier than one hour after sunrise, end it the same day and no later than one hour before sunset, and make sure that a responsible party is present while the burn is active and the fire is progressing.

5. At the end of the burn, extinguish isolated residual fires or smoldering objects if the smoke they produce can be a nuisance or a traffic hazard.

C. CONTRACTOR will be responsible for controlling fires in compliance with all Federal, State, and Local laws and regulations. The securing of necessary burning permits shall be the responsibility of the CONTRACTOR. All burning shall be under the constant care of competent watchmen. All materials resulting from clearing and grubbing operations and disposed of by burning on the site shall be thoroughly and completely reduced to ashes.

D. CONTRACTOR shall be responsible for providing a suitable location (subject to ENGINEER and OWNER approval) for off-site disposal of cleared material not burned on-site. Once ENGINEER and OWNER have approved the disposal location, CONTRACTOR shall transport and dispose the material in accordance with all applicable regulations.

++END OF SECTION++

SECTION 02300

EARTHWORK

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section consists of all activities associated with earthwork construction, including, but not necessarily limited to:

1. Excavation, loading, transportation, unloading and stockpiling of soil from COMPANY-designated locations;
2. Placement, compaction, and grading of various earthen materials;
3. Ditch grading; and
4. All other activities required to complete earthwork construction as shown on the Drawings, specified herein and or required by the COMPANY.

1.2 REFERENCES

A. American Society of Testing Materials (ASTM) Standards/Publications (Latest version):

C33	Standard Specification for Concrete Aggregates
D422	Method of Particle Size Analysis of Soils
D698	Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3)
D1557	Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3)
D1587	Standard Practice for Thin-walled Tube Sampling of Soils
D2487	Classification of Soils for Engineering Purposes
D2922	Density of Soil In Place by Nuclear Density Gage
D3080	Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions
D4318	Liquid Limit, Plastic Limit and Plasticity Index of Soils
D5084	Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.3 DEFINITIONS

A. Select Fill: Soil material suitable for use as cap fill, for dike construction or other areas identified by the COMPANY.

B. General Fill: Any non-classified soil deemed suitable by the COMPANY.

C. Liner Subgrade: Soil complying with the specified requirements located immediately beneath the geosynthetic clay liner (GCL).

D. Compacted Clay: Low-permeability soil layer of liner system.

E. Vegetative Soil: Growth medium used along with any necessary admixtures to support vegetation.

F. Gravel: Granular crushed stone material used as erosion protection in ditches.

G. Road Base: Granular material placed on the surface of haul roads, access roads and other areas designated on the Drawings, identified in the Specifications or required by the COMPANY.

H. Rip Rap: Stone armor material used in drainage features for erosion control and energy dissipation.

1.4 SUBMITTALS

A. CONTRACTOR shall identify all earthwork material suppliers and shall submit written verification from his material suppliers that all earthwork materials to be used for the work comply with the requirements of this Section.

B. CONTRACTOR shall submit copies of all geotechnical laboratory reports within 10 working days after sample collection.

1.5 QUALITY CONTROL

A. CONTRACTOR shall perform construction surveys, as needed, to ensure that the lines and grades of all excavations, embankments, ditches, pipe trenches, pipe inverts, and graded surfaces are in accordance with the drawings and specifications.

B. COMPANY may perform pre-construction and post-construction topographic surveys of the work area and related areas and may perform additional quality assurance surveys. CONTRACTOR shall coordinate his activities with COMPANY's surveyor and provide safe access to all excavation areas for survey and/or verification sampling activities.

1.6 TESTING

A. The number and type of testing required for each type of earthwork shall be as specified in the specific section related to the type of earthwork.

B. COMPANY will select the locations for all tests. Tests performed at locations not approved by the COMPANY will not be accepted.

C. All undisturbed earthwork samples shall be collected using a thin-walled sampler complying with ASTM D1587. The length of the sampler shall be suitable for collection of an undisturbed sample over the specified sampling interval.

D. Unless otherwise specified, testing shall be performed in accordance with the following methods:

1. Soil classification shall be performed using ASTM D2487. Liquid Limits, Plastic Limits and Plasticity Indices shall be determined using ASTM D4318.

2. Moisture-Density Relationships shall be determined using ASTM D698. Unless otherwise directed by COMPANY. ASTM D1557 may be used only where specified.

3. In-place density and moisture content shall be determined using ASTM D6938 (Nuclear Density Gage). Other methods for determining in-place density and moisture may not be used unless approved by the COMPANY.

4. Hydraulic conductivity shall be determined using ASTM D5084.

5. Direct shear testing shall be performed in accordance with ASTM D3040.

1.7 TOLERANCES

A. Grades and slopes of all earthwork shall be straight and true. Unless otherwise specified, CONTRACTOR shall complete all earthwork within the dimensional tolerances presented below.

B. Elevation Tolerances:

1.	Compacted Clay Surface:	plus 0.1 foot, minus 0.0 foot.
2.	Liner Subgrade Surface:	plus 0.1 foot, minus 0.0 foot.
3.	Gravel Surface:	plus 0.1 foot, minus 0.0 foot.
4.	All Other Surfaces:	plus 0.2 foot, minus 0.0 foot.

C. Thickness Tolerances:

1.	Compacted Clay Subgrade:	plus 0.2 foot, minus 0.0 foot.
2.	Liner Subgrade:	plus 0.2 foot, minus 0.0 foot.
3	All Other Surfaces:	plus 0.1 foot, minus 0.0 foot.

D. Grade Tolerances: All grades/slopes shall be completed within

1.	Compacted Clay Surface:	plus or minus 0.1 percent of design slope.
2.	Liner Subgrade Surface:	plus or minus 0.1 percent of design slope.
3.	Gravel and Drainage Features:	plus or minus 0.1 percent of design slope.
4.	All Other Surfaces:	plus or minus 0.2 percent of design slope.

E. Horizontal Coordinates and/or Earthwork Dimensions: plus or minus 0.5 feet

1.8 UTILITIES

A. COMPANY will attempt to deactivate electrical and other utilities in areas to be excavated; however, CONTRACTOR shall be ultimately responsible for ensuring that no energized equipment or utilities are present prior to initiating excavation activities. If CONTRACTOR identifies energized or active equipment or utilities, CONTRACTOR shall cease work and notify COMPANY so that the equipment/utilities may be deactivated. CONTRACTOR shall again check the equipment and utilities to ensure they are deactivated prior to proceeding with excavation activities.

B. CONTRACTOR shall note that underground and aboveground utilities may be located in the area of the Work. CONTRACTOR shall be ultimately responsible for protecting the utilities during earthwork and related activities.

1.9 EARTHWORK SAFETY

A. As discussed in other areas of these specifications, CONTRACTOR shall be fully responsible for the health and safety of all personnel in the work area, at all times, and shall take all necessary precautions to protect personnel.

B. In addition to general health and safety responsibilities, CONTRACTOR shall be fully responsible for complying with all applicable OSHA and related regulations regarding earthwork, including, but not limited to, the requirements of 40 CFR Part 126.

PART 2 - PRODUCTS

2.1 SELECT FILL

A. Select fill shall consist of soil excavated during foundation soil grading. CONTRACTOR shall be responsible for loading, transporting, placement and compaction of select fill.

B. Select fill shall classify as CH, CL or SC using ASTM D2487, shall have a plasticity index between 15 and 40, and shall be free of roots, brush, sod, or other perishable materials and debris.

2.2 GENERAL FILL

A. General fill shall be any non-classified soil deemed suitable by the COMPANY. General fill shall be free of trash, rubbish or other deleterious substances. The maximum particle size of general fill shall be 6 inches.

2.3 LINER SUBGRADE

A. Liner Subgrade shall consist of soil excavated from the site during foundation grading. CONTRACTOR shall be responsible for loading, transporting, placement and compaction of Liner Subgrade.

B. Liner Subgrade shall classify as CH or CL using ASTM D2487 and shall contain no organic material, sticks, or other deleterious material.

C. The maximum particle size of liner subgrade shall be 3 inches. Particles larger than 1 inch shall be subrounded to rounded.

2.4 COMPACTED CLAY

A. Compacted Clay shall consist of soil excavated from the COMPANY-designated Borrow Area or other COMPANY-approved off-site source. CONTRACTOR shall be responsible for loading, transporting, placement and compaction of Compacted Clay.

B. Compacted Clay shall classify as CH or CL using ASTM D2487 and shall contain no organic material, sticks, or other deleterious material.

C. Compacted Clay shall conform to the following:

Parameter	Specification
Plasticity Index	15 Minimum
Liquid Limit	30 Minimum
Percent Passing No. 200 Sieve	30% Minimum
Percent Passing 1.5-inch Sieve	100%
Hydraulic Conductivity	1×10^{-7} cm/s Maximum
In-Place Density	95% Standard Proctor Minimum
In-Place Moisture Content	-1% to +3% Optimum Moisture Content

2.5 VEGETATIVE SOIL

A. Vegetative soil shall consist of soil stripped from the work area and stockpiled by the CONTRACTOR. Vegetative soil shall be free of deleterious material, materials toxic to plant growth, noxious weed seeds, rhizomes, roots, subsoil, rocks, or other debris.

2.6 GRAVEL

A. Gravel shall be washed, angular crushed gravel or crushed limestone, free of mud, clay, vegetation or other debris, conforming to ASTM C33 for stone quality.

B. Gravel shall have the following size gradation:

U.S. Sieve Size	Percent Passing
1.5 Inch	100
1 Inch	90 to 100
0.5 Inch	15 to 60
No. 4	0 to 10
No. 8	0 to 5

C. Gravel shall conform to the following:

1. Liquid Limit (LL) less than or equal to 35.

2. Plasticity Index (PI) less than or equal to 10.

2.7 ROAD BASE

A. Road base shall consist of crushed stone, free of mud, clay, vegetation or other debris, conforming to the requirements of TXDOT Item 248, Type A (Grade I). Size Gradation shall comply with the following:

U.S. Sieve Size	Percent Passing
2.5 inch	100
1.75 inch	100
0.875 inch	65 to 90
0.375 inch	50 to 70
No. 4	35 to 55
No. 40	15 to 30
No. 200	0

B. Road Base shall conform to the following:

1. Liquid Limit (LL) less than or equal to 35.

2. Plasticity Index (PI) less than or equal to 10.

2.8 RIPRAP

A. Riprap shall be clean, well-graded durable natural stone with a minimum specific gravity of 2.4.

Unless other wise approved by the COMPANY, riprap shall comply with the following:

1. No deleterious material, noxious weed seeds, roots, subsoil, or other debris shall be present.

2. Riprap shall consist of stone conforming to the following gradation:

Stone Weight (pounds)	Percent Lighter Than
700	100
300	50 to 100
150	15 to 50
45	0 to 15

3. Stones shall be at least 3 inches in their least dimension. The breadth or thickness of each stone shall not be less than one-third the length of the stone.

PART 3 - EXECUTION

3.1 GENERAL

A. All earthwork shall be completed to the lines and grades shown on the Drawings and as required by the COMPANY.

B. CONTRACTOR shall not place material in the presence of water unless approved by the COMPANY. Saturated areas shall be dewatered by CONTRACTOR as specified herein prior to initiating earthwork activities. CONTRACTOR shall remove all saturated soils, muck, organic matter and other materials not suitable for compaction or proof-rolling from dewatered areas prior to placing fill materials.

C. All proof rolling shall be performed as follows unless another method is approved by the COMPANY:

1. Proof rolling equipment shall be approved by the COMPANY. Proof rolling equipment may be self-propelled or towed by a suitable tractor.

2. Proof rolling equipment shall have a rolling width of 8 to 10 feet and shall be capable of operating under various contact pressures.

3. Contact pressure of proof rolling equipment shall be a minimum of 2000 pounds per square foot.

4. A minimum of two passes with the proof rolling equipment shall be completed across the entire native soil surface prior to placement of any material.

5. Any area shown to be unstable or non-uniform after proof rolling shall be recompacted and/or reworked until proof rolled to the satisfaction of the COMPANY.

D. Compaction of all materials shall be performed with an appropriately heavy, properly ballasted penetrating-foot compactor. A minimum of four passes of the compactor shall be performed on each material lift regardless of whether the lift complies with specified density requirements within less than four passes.

E. When target compaction/density is specified using ASTM D698 (Standard Proctor), the minimum weight of the compacting equipment shall be 1500 pounds per linear foot of drum length.

F. The daily work area shall extend a distance no greater than necessary to maintain moist conditions and continuous operations. Desiccation and crusting of the lift surface shall be avoided as much as possible.

G. Water added to soils shall be clean and shall not have come into contact with waste or any objectionable material. Source of water shall be approved by COMPANY prior to application.

H. Unless otherwise specified or approved by the COMPANY, the maximum clod size in each lift prior to compaction shall be 2 inches in diameter. Clod size shall be reduced through discing, pulverizing or similar methods. Unless otherwise approved by the COMPANY, a minimum of 4 passes with discing or pulverizing equipment shall be made across each lift prior to beginning compaction. A pass is defined as one trip across the lift surface. Passes shall be made at alternating right angles across the lift surface.

I. Finished, compacted lifts of all material shall be sprayed with clean water as necessary to prevent drying and desiccation.

J. At the end of each construction day's activities, completed lifts shall be sealed by rolling with a rubber-tired or smooth drum roller. Prior to resuming placement of overlying material, the surface of the previous lift shall be scarified to a minimum depth of 2 inches.

3.2 DEWATERING

A. CONTRACTOR shall note that some of the work may be performed in areas exhibiting saturated conditions at and below the groundwater table. CONTRACTOR shall not place material in the presence of water unless approved by the COMPANY.

B. CONTRACTOR shall dewater the work area using pumps or other method approved by the COMPANY. Dewatering measures shall be implemented by the time the excavation reaches the water level in order to maintain the integrity of the in-situ material. Dewatering water shall be discharged in accordance with COMPANY requirements in a manner that minimizes erosion and other disturbances to existing drainage features and adjacent areas.

C. All dewatering system components, including cofferdams, pumps, piping and related equipment shall be removed by the CONTRACTOR at the completion of the work.

3.3 COMPACTED CLAY

A. Construction of the Compacted Clay layer will begin after the underlying native soil has been finished to the proper lines and grade. The depth of the top of the underlying native soil prior to compacted clay construction shall coincide with the bottom of the Compacted Clay layer. The Compacted Clay layer shall be keyed into the underlying native soil or otherwise constructed to ensure stability.

B. Compacted Clay shall be placed and compacted in lifts. Maximum loose lift thickness shall be 8 inches. Maximum compacted lift thickness shall be 6 inches.

C. New Compacted Clay lifts shall be properly tied back into previous clay sections to ensure continuous clay layer coverage. Compacted Clay layers shall be tied into previously placed Compacted Clay layers using a stair-step construction method with benches, no steeper than a five horizontal to one vertical face.

D. For excavation surfaces with a slope of 3(H):1(V) or flatter, Compacted Clay layer construction may utilize lifts parallel to the finished surface. For excavation surfaces that have steeper than 3(H):1(V) slopes, Compacted Clay lifts shall be placed in successive horizontal lifts. All horizontal lifts shall be sufficiently wide to safely accommodate construction equipment.

E. Testing requirements for lifts placed on all sloped surfaces shall be the same as specified for non-sloped surfaces. Lift areas on sloped surfaces shall be measured parallel to the surface of the excavation.

F. Prior to compaction of each lift, the moisture content of the Compacted Clay shall comply with the requirements of these specifications. If the moisture content is above the specified maximum, the Compacted Clay shall be pulverized, disced or similarly reworked to air dry the material and decrease the moisture content.

G. Each lift shall be compacted to a minimum of 95 percent maximum dry density as determined by ASTM D698 (Standard Proctor). Material with densities less than the specified density shall be recompacted and/or reworked as necessary to achieve the specified density.

H. Each lift shall be thoroughly compacted and shall satisfy all specified requirements before a subsequent lift is placed.

I. After the final lift has been compacted and tested, the surface of the Compacted Clay shall be rolled and sealed with a smooth drum roller. A minimum of four passes of the roller shall be performed on the Compacted Clay. A pass is defined as one trip across the entire Compacted Clay surface.

J. COMPANY will test Compacted Clay per the following guidelines:

1. Pre-Construction Testing. Prior to beginning placement of the Compacted Clay, CONTRACTOR shall collect composite samples from the prospective clay source(s) and test the samples as described below. All composite samples shall consist of equal volumes of soil collected from a minimum of four locations within the prospective clay source.

   a. Two soil classifications in accordance with ASTM D2487 shall be performed from each clay source. Plasticity Index (PI) shall be included in the soil classification.

   b. Two moisture-density relationship tests in accordance with ASTM D698 (Standard Proctor) shall be performed from each clay source.

   c. Two hydraulic conductivity tests by ASTM D5084 shall be performed from each clay source. Each sample shall be compacted to 95 percent maximum dry density as determined by ASTM D698 (Standard Proctor) prior to performing the hydraulic conductivity test.

2. In-Place Testing. After each Compacted Clay lift has been placed, COMPANY will perform the following in-place tests:

   a. One in-place density test in accordance with ASTM D6938 shall be performed per each 4,000 square feet for each lift.

   b. One in-place moisture density relationship shall be reported for every in-place density test performed.

K. After completion of the Compacted Clay layer, but before beginning installation of the overlying materials, CONTRACTOR shall survey the finished elevations of the Compacted Clay to ensure that the top of the Compacted Clay is at the grades and elevations specified on the Drawings. There shall be a minimum of one survey point for every 5,000 square feet of Compacted Clay surface area.

3.4 SELECT FILL

A. Select fill shall be placed and compacted in lifts. Maximum loose lift thickness shall be 8 inches. Maximum compacted lift thickness shall be 6 inches.

B. Prior to compaction, the moisture content of the select fill shall be no greater than plus 3 percent of the optimum moisture content as determined by ASTM D698 (Standard Proctor). If the moisture content is above the specified maximum, select fill shall be pulverized, disced or similarly reworked to air dry the material and decrease the moisture content.

C. Each select fill lift shall be compacted to a minimum of 90 percent maximum dry density as determined by ASTM D698 (Standard Proctor). Material with densities less than the specified density shall be recompacted and/or reworked as necessary to achieve the specified density.

D. Each lift shall be thoroughly compacted and shall satisfy all moisture and density requirements before a subsequent lift is placed.

E. COMPANY will test select fill per the following guidelines:

1. One moisture density relationship test in accordance with ASTM D698 (Standard Proctor) shall be performed for every 50,000 cubic yards placed.

2. One in-place density test in accordance with ASTM D6938 shall be performed for every 20,000 square feet of surface area for each lift. Surface area shall be measured in the horizontal plane.

3. One soil classification in accordance with ASTM D2487 shall be performed for every 50,000 cubic yards placed.

4. Plasticity Index (PI) shall be included in the soil classification. One moisture-density relationship test in accordance with ASTM D698 (Standard Proctor) shall be performed any time a PI change greater than 10 is observed in the soil classification tests.

F. After completion of the select fill, but before beginning installation of the overlying materials, CONTRACTOR shall survey the finished elevations of the select fill to ensure that the top of the select fill is at the grades and elevations specified on the Drawings. There shall be a minimum of one survey point for every 5,000 square feet of select fill surface area.

3.5 SELECT FILL ON STEEP SLOPES

A. Steep slopes are defined as surfaces with slopes steeper than 5 horizontal to 1 vertical.

B. Construction of select fill on steep slopes shall comply with all other requirements for select fill, in addition to those specified herein.

C. Select fill shall be placed and compacted in benched, horizontal lifts. Maximum loose lift thickness shall be 8 inches. Maximum compacted lift thickness shall be 6 inches.

D. Lifts shall be placed and compacted horizontally (benched parallel to the toe of the slope) rather than vertically (up and down the slope). Each lift shall be wide enough to permit passage of compacting equipment.

E. Lifts shall extend horizontally beyond the required final elevations of select fill to permit grading back to the required slopes after compaction and testing.

F. After each lift has been compacted, tested and accepted by the COMPANY, Contractor shall grade the slope to the required elevations

3.6 LINER SUBGRADE

K. Liner Subgrade shall be placed and compacted in lifts. Maximum loose lift thickness shall be 8 inches. Maximum compacted lift thickness shall be 6 inches. A total of 2 lifts will be placed to construct the 12 inch Liner Subgrade thickness.

L. Prior to compaction of each of the lifts, CONTRACTOR shall manually remove all visible rock 3 inches or greater in size from the lift. After the visible rocks have been removed, CONTRACTOR shall compact each lift as discussed below.

C. Prior to compaction of each lift, the moisture content of the Liner Subgrade shall be no greater than plus 4 percent of the optimum moisture content as determined by ASTM D698 (Standard Proctor). If the moisture content is above the specified maximum, Liner Subgrade shall be pulverized, disced or similarly reworked to air dry the material and decrease the moisture content.

D. Each lift shall be compacted to a minimum of 90 percent maximum dry density as determined by ASTM D698 (Standard Proctor). Material with densities less than the specified density shall be recompacted and/or reworked as necessary to achieve the specified density.

E. Each lift shall be thoroughly compacted and shall satisfy all specified requirements before a subsequent lift is placed.

F. After the second lift has been compacted and tested, the surface of the Liner Subgrade shall be rolled and sealed with a smooth drum roller. A minimum of four passes of the roller shall be performed on the Liner Subgrade. A pass is defined as one trip across the entire Liner Subgrade surface.

H. CONTRACTOR shall test Liner Subgrade as specified herein:

1. One moisture density relationship test in accordance with ASTM D698 (Standard Proctor) shall be performed for every 10,000 cubic yards placed.

2. One in-place density test in accordance with ASTM D6938 shall be performed for every 20,000 square feet of surface area for each lift. Surface area shall be measured in the horizontal plane.

3. One soil classification in accordance with ASTM D2487 shall be performed for every 10,000 cubic yards placed.

4. Plasticity Index (PI) shall be included in the soil classification. One moisture-density relationship test in accordance with ASTM D698 (Standard Proctor) shall be performed any time a PI change greater than 10 is observed in the soil classification tests.

5. One hydraulic conductivity test by ASTM D5084 for every 10,000 cubic yards of Liner Subgrade. Each test shall be performed on a composite Liner Subgrade sample collected from the Liner Subgrade stockpile as approved by COMPANY. The composite sample shall be compacted to 90 percent maximum dry density as determined by ASTM D698 (Standard Proctor) prior to performing the hydraulic conductivity test.

I. After completion of the Liner Subgrade, but before beginning installation of the overlying materials, CONTRACTOR shall survey the finished elevations of the Liner Subgrade to ensure that the top of the Liner Subgrade is at the grades and elevations specified on the Drawings. There shall be a minimum of one survey point for every 10,000 square feet of Liner Subgrade surface area.

3.7 VEGETATIVE SOIL

A. Vegetative Soil shall not be placed until the underlying soil has been approved by the COMPANY.

B. Vegetative Soil shall be placed in one 12 inch lift without damaging the underlying soil. Vegetative Soil shall be tracked in and smoothed out using tracked equipment. No direct compactive effort shall be used on vegetative soil.

C. After completion of the Vegetative Soil layer, CONTRACTOR shall survey the finished elevations of the Vegetative Soil to ensure that the top of the vegetative soil is at the grades and elevations specified on the Drawings. There shall be a minimum of one survey point for every 5,000 square feet of Vegetative Soil surface area.

3.8 ROAD BASE

A. Road Base shall be placed on access ramps, on the top of the dike and as required by the COMPANY.

B. Geotextile shall be placed beneath all Road Base in accordance with Section 2430 of these specifications.

C. Road Base shall be placed and compacted in lifts, with a maximum loose lift thickness of 8 inches. Each fill lift shall be compacted using a minimum of four passes of the compactor. A pass is defined as one trip across the lift surface. There is no target maximum density requirement for road base.

D. After completion of the road base, but before beginning installation of the overlying materials, CONTRACTOR shall survey the finished elevations of the road base to ensure that the top of the road base is at the grades and elevations specified on the Drawings. There shall be a minimum of one survey point for every 5,000 square feet of road base surface area.

3.9 RIPRAP

A. Riprap shall be placed on geotextile conforming to the requirements of Section 02300 of these specifications. Place geotextile with the length running up and down the slope. Ensure geotextile has a minimum overlap of 2 feet at all seams.

B. Riprap shall be placed in such manner as to produce a well graded mass of rock with the minimum practicable percentage of voids, and shall be constructed within a tolerance of plus 4 inches or minus 2 inches from the lines and grades shown on the Drawings. Placement shall begin at the bottom of the area to be covered and continue up slope. Subsequent loads of material shall be placed against previously placed material in such a manner as to ensure a relatively homogenous mass. Open joints shall be filled with spalls or small rocks. Rocks shall be arranged to present a uniform finished top surface such that the variation between tops of adjacent rocks shall not exceed 3 inches.

C. No stone shall be dropped through air from a height greater than 3 feet on top of the geotextile. The larger stones shall be well distributed and the entire mass of stones in their final position shall be roughly graded to conform to the gradation specified in this specification. The finished riprap shall be free from objectionable pockets of small stones and clusters of larger stones. Placing riprap by dumping into chutes or by similar methods likely to cause segregation of the various sizes will not be permitted. Placing riprap by dumping it at the top of the slope and pushing it down the slope will not be permitted. Rearranging of individual stones will be required to the extent necessary to obtain a well-graded distribution of stone sizes as specified above.

++END OF SECTION++

SECTION 02320

CAP SUBGRADE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section shall govern work associated with grading, excavation, supply, hauling, placement and compaction of cap subgrade material.

B. Work associated with the cap subgrade shall also conform to Section 02300 – Earthwork of the Specifications.

1.2 MATERIALS INCLUDED IN THIS SECTION

A. Existing Coal Combustion By-Products used as cap subgrade

B. Contractor-supplied material used as cap subgrade

1.3 RELATED SECTIONS

A. Section 02300 Earthwork

B. Section 02330 Clay Cap

1.4 REFERENCES

A. Reference Standards for cap subgrade shall be as referenced in Section 02300 – Earthwork

1.5 SUBMITTALS

A. Submittals for cap subgrade shall be as specified in Section 02300 – Earthwork

PART 2 - PRODUCTS

2.1 COAL COMBUSTION BY-PRODUCTS AS CAP SUBGRADE

A. OWNER will supply CCBs or existing CCBs within the landfill may be re-graded for use as cap subgrade.

B. OWNER will identify the location of CCBs outside of the landfill that may be used to supplement existing landfilled materials. Contractor shall be responsible for loading, transporting, placement, and compaction of CCBs used as cap subgrade.

C. Cap subgrade shall be free of roots, brush, sod, or other perishable materials and debris.

2.2 CONTRACTOR-SUPPLIED MATERIAL AS CAP SUBGRADE

A. Contractor-supplied cap subgrade material shall be as specified herein.

B. Cap subgrade material shall be approved by the Engineer prior to delivery to the Site.

C. Contractor shall provide written Certification to Engineer that material to be supplied conforms to the requirements of this specification.

D. Cap subgrade shall be clean fill material free of waste material, organic material, sticks, or other deleterious material.

E. Cap subgrade may include crushed rock, broken rock, broken concrete and similar materials provided these materials do not exceed 30 percent (by weight) of the total material in the cap subgrade lift of which they are part.

F. Contractor-supplied cap subgrade shall be soil class “CL” or “CH” according to ASTM D2487 and shall conform to the following:

1. No material larger than 3-inch diameter.
2. Plasticity Index (PI) greater than or equal to 7.
3. Particle size distribution shall conform to the following:

U.S. Sieve Size	Percent Passing
No. 4	80-95
No. 40	55-75
No. 200	Greater than 50

PART 3 – EXECUTION

3.1 GENERAL

A. Compaction of all materials shall be performed with an appropriately heavy, properly ballasted penetrating foot compactor. A minimum of four passes of the compactor shall be performed on each material lift. A pass is defined as one trip of the compactor over the lift and back to the starting point by a single drum roller or one trip across the lift surface from one side to the other if the compacting equipment has front and back compacting rollers.

B. The minimum weight of the compacting equipment shall be 1,500 pounds per linear foot of drum length.

C. The daily work area shall extend a distance no greater than necessary to maintain moist conditions and continuous operations. Desiccation and crusting of the lift surface shall be avoided as much as possible.

D. Water added to soils shall be clean and shall not have come into contact with waste or any objectionable material.

3.2 CONSTRUCTION OF CAP SUBGRADE

A. All existing vegetation on areas to be capped or regraded shall be stripped or otherwise removed prior to placing cap subgrade or regarding. Contractor shall be responsible for disposal of all debris resulting from vegetation removal in accordance with applicable laws and regulations.

B. After existing vegetation has been removed, material underlying the cap subgrade shall be scarified to a minimum depth of 2-inches prior to placement of cap subgrade. Areas that only require regarding may not require scarifiying and compaction provided that such areas meet that are regarded to meet the requirements of Subsection 3.2.C of this Specification.

C. Cap subgrade underlying the clay cap shall conform to the following:

1. Cap subgrade shall be placed in compacted lifts. Maximum loose lift thickness shall be 12 inches and a minimum of four passes of the compacting equipment shall be required for each lift.

2. After the final lift has been placed and compacted to the required elevations, the cap subgrade shall be proof rolled using the methods specified herein or other method approved by the Engineer:

   a. Proof rolling equipment shall consist of not less than four pneumatic tired wheels, arranged so that the wheels carry approximately equal loads when operating on uneven surfaces. Proof rolling equipment may be self-propelled or towed by a suitable tractor.

   b. Proof rolling equipment shall have a rolling width of 8 to 10 feet and shall be capable of operating under various contact pressures.

   c. Contact pressure of proof rolling equipment shall be a minimum of 2,000 pounds per square foot.

   d. A minimum of two passes with proof rolling equipment shall be completed across the entire prepared cap subgrade surface.

3. Any area of the cap subgrade shown to be unstable or non-uniform after proof rolling shall be recompacted and/or reworked until proof rolled to the satisfaction of the ENGINEER.

D. Finished lifts of cap subgrade shall be sprayed with clean water as necessary to prevent drying and desiccation.

E. At the end of each construction day's activities, completed lifts shall be sealed by rolling with a rubber-tired or smooth drum roller. Prior to resuming placement of material the surface of the cap subgrade shall be scarified to a minimum depth of 2 inches.

F. After completion of the cap subgrade, but before beginning installation of the overlying clay cap, Contractor shall survey the finished elevations of the cap subgrade to ensure that the top of the cap subgrade is at the specified grades and elevations presented in the Conceptual Closure Plan. There shall be a minimum of one survey point for every 10,000 square feet of cap surface area.

++END OF SECTION++

SECTION 02330

CLAY CAP

PART 1 - GENERAL

3.3 DESCRIPTION

A. This section shall govern work associated with grading, excavation, supply, hauling, placement and compaction of the clay cap material.

B. Work associated with the cap subgrade shall also conform to Section 02300 – Earthwork of the Specifications.

3.4 MATERIALS INCLUDED IN THIS SECTION

A. OWNER-supplied material used as clay cap

B. Contractor-supplied material used as cap subgrade

3.5 RELATED SECTIONS

A. Section 02300 Earthwork

B. Section 02330 Clay Cap

3.6 REFERENCES

A. Reference Standards for cap subgrade shall be as referenced in Section 02300 – Earthwork

1.5 SUBMITTALS

A. Submittals for cap subgrade shall be as specified in Section 02300 – Earthwork

PART 2 - PRODUCTS

2.1 COAL COMBUSTION BY-PRODUCTS AS CAP SUBGRADE

A. OWNER may identify a suitable on-site borrow area for supplying clay cap material.

B. OWNER will identify the location of suitable material that may be used as clay cap. Contractor shall be responsible for loading, transporting, placement, and compaction of material used as the clay cap.

C. Clay cap material shall be free of roots, brush, sod, or other perishable materials and debris.

2.2 CONTRACTOR-SUPPLIED MATERIAL AS CLAY CAP

A. Contractor-supplied clay cap material shall be as specified herein.

B. Cap material shall be approved by the Engineer prior to delivery to the Site.

C. Contractor shall provide written Certification to Engineer that material to be supplied conforms to the requirements of this specification.

D. Clay cap shall be clean fill material free of waste material, organic material, sticks, or other

deleterious material.

E. Contractor-supplied clay cap shall be soil class “CL” or “CH” according to ASTM D2487 and shall conform to the following:

1. No material larger than 3-inch diameter.

2. Plasticity Index (PI) greater than or equal to 15.

3. In-place permeability by ASTM D5084 no greater than 1×10^{-7} cm/sec

4. All material retained on the No. 4 Sieve shall be subrounded to rounded.

5. Particle size distribution shall conform to the following:

U.S. Sieve Size	Percent Passing
No. 4	80-95
No. 40	55-75
No. 200	Greater than 50

PART 3 – EXECUTION

3.1 GENERAL

A. Compaction of all materials shall be performed with an appropriately heavy, properly ballasted penetrating foot compactor. A minimum of four passes of the compactor shall be performed on each material lift. A pass is defined as one trip of the compactor over the lift and back to the starting point by a single drum roller or one trip across the lift surface from one side to the other if the compacting equipment has front and back compacting rollers.

B. The minimum weight of the compacting equipment shall be 1,500 pounds per linear foot of drum length.

C. The daily work area shall extend a distance no greater than necessary to maintain moist conditions and continuous operations. Desiccation and crusting of the lift surface shall be avoided as much as possible.

D. Water added to soils shall be clean and shall not have come into contact with waste or any objectionable material.

3.2 CONSTRUCTION OF CAP SUBGRADE

A. Clay cap shall be placed and compacted with a maximum loose lift thickness of 8 inches and a maximum compacted lift thickness of 6 inches.

B. The clay cap shall be compacted as necessary to achieve an in-place permeability of no greater than 1×10^{-7} cm/second. At a minimum, four passes of the compacting equipment shall be required for each lift.

G. Contractor shall test the clay cap as specified herein:

1. Two soil classifications in accordance with ASTM D2487 shall be performed for each lift.

2. One in-place density test in accordance with ASTM D2922 shall be performed for every 20,000 square feet of cap subgrade placed for each 12 inches of compacted thickness.

3. One permeability test in accordance with ASTM D5084 shall be performed for every 4 acres of cap subgrade placed for each 12 inches of compacted thickness.

H. Finished lifts of cap subgrade shall be sprayed with clean water as necessary to prevent drying and desiccation.

I. At the end of each construction day's activities, completed lifts shall be sealed by rolling with a rubber-tired or smooth drum roller. Prior to resuming placement of material the surface of the cap subgrade shall be scarified to a minimum depth of 2 inches.

J. After completion of the cap subgrade, but before beginning installation of the overlying clay cap, Contractor shall survey the finished elevations of the cap subgrade to ensure that the top of the cap subgrade is at the specified grades and elevations presented in the Conceptual Closure Plan. There shall be a minimum of one survey point for every 10,000 square feet of cap surface area.

++END OF SECTION++

SECTION 02340

VEGETATIVE SOIL LAYER

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section shall govern work associated with grading, excavation, supply, hauling, placement and compaction of the vegetative soil material.

B. Work associated with the vegetative soil layer shall also conform to Section 02300 – Earthwork of the Specifications.

1.2 MATERIALS INCLUDED IN THIS SECTION

A. OWNER-supplied material used as vegetative soil

B. Contractor-supplied material used as vegetative soil

1.3 RELATED SECTIONS

A. Section 02300 Earthwork

B. Section 02330 Clay Cap

C. Vegetation

1.4 REFERENCES

A. Reference Standards for vegetative soil layer shall be as referenced in Section 02300 – Earthwork

1.5 SUBMITTALS

A. Submittals for cap subgrade shall be as specified in Section 02300 – Earthwork

PART 2 - PRODUCTS

2.1 OWNER-SUPPLIED MATERIAL AS VEGETATIVE SOIL LAYER

A. OWNER will supply Contractor with material for use as vegetative soil layer.

B. OWNER will identify the location of material for Contractor. Contractor shall be responsible for loading, transporting, placement, and compaction of material used as the vegetative soil layer.

2.2 CONTRACTOR-SUPPLIED MATERIAL AS VEGETATIVE SOIL LAYER

A. Vegetative soil layer shall be a clay loam or silty clay loam as classified by the United States Department of Agriculture and shall comply with all of the following:

1. Free of deleterious material, materials toxic to plant growth, noxious weed seeds, rhizomes, roots, subsoil, rocks, or other debris.
2. Maximum sodium adsorption ration (SAR): 8
3. Maximum electrical conductivity (EC): 2 mmhos/cm

4. Maximum particle dimension: 2 inches.
5. The pH shall be between 6.0 and 8.5 standard units. If approved by the Engineer, Contractor may amend soil as necessary to achieve the specified pH.

PART 3 - EXECUTION

3.1 VEGETATIVE SOIL LAYER PLACEMENT

A. Vegetative Soil shall not be placed until the underlying soil has been approved by the ENGINEER.

B. Vegetative Soil shall be placed in one 18 inch lift without damaging the underlying soil. Vegetative Soil shall be tracked in and smoothed out using tracked equipment. No direct compactive effort shall be used on vegetative soil.

C. After completion of the Vegetative Soil layer, CONTRACTOR shall survey the finished elevations of the Vegetative Soil to ensure that the top of the protective soil is at the grades and elevations specified on the Drawings. There shall be a minimum of one survey point for every 10,000 square feet of Vegetative Soil surface area.

++END OF SECTION++

SECTION 02350

VEGETATION

PART 1 – GENERAL

1.1 SUMMARY

A. This Section describes the requirements for vegetation establishment in areas disturbed during construction activities.

1.2 SUBMITTALS

A. CONTRACTOR shall submit information regarding proposed seed, fertilizer, mulch, tackifier and any other materials to be used to establish vegetation at least 10 days prior to delivery.

PART 2 – PRODUCTS

2.1 SEED SUPPLIERS

A. Seed suppliers must provide labeling of variety, purity, and germination. The supplier must satisfy State of Texas seed quality laws. The COMPANY must approve seed supplier.

2.2 SEED DELIVERY, STORAGE, AND HANDLING

A. Grass seed mixture shall be delivered in sealed containers. Seed in damaged packaging will not be accepted. CONTRACTOR shall provide seed mixture in containers showing the percentage of each species in the seed mix, year of production, net weight, date of packaging, name and address of supplier, percent of weed seed content, and guaranteed percentage of purity and germination.

B. Fertilizer shall be delivered in appropriate waterproof containers showing weight, chemical analysis, and name of manufacturer.

2.3 SEED MIXTURE

A. Seed mixture shall be appropriate for the season in which it is planted and shall be approved by the COMPANY prior to placement.

B. Seed shall be hulled, extra-fine grade, treated with fungicide, and shall have a germination and purity that will produce, after allowance for Federal Seed Act tolerances, a pure live seed (PLS) content of not less than 85 percent. Seed shall be labeled in accordance with U.S. Department of Agriculture rules and regulations.

C. Unless otherwise approved by the COMPANY, vegetation seed mixture shall consist of the following grasses at the application rates specified:

Grass Species	Application Rate (pounds PLS per acre)
Gulf Rye	30
Common Bermudagrass	20
Total:	50

D. Alternative seed mixtures may be submitted in writing to the COMPANY and must be approved by the COMPANY prior to seed application.

2.4 ACCESSORIES

A. Mulching materials shall consist of dry oat, wheat, or Bermuda straw, free from weeds and foreign matter detrimental to plant life. Native hay or chopped cornstalks are acceptable. Also acceptable is approved chip-form wood cellulose fiber that is free of ingredients that could inhibit growth or germination.

B. Compost, if used as an organic admixture, shall be applied per TXDOT Special Specification; Item 1027 "Furnishing and Placing Compost." Compost application is optional and subject to the approval of the COMPANY, which must be obtained at least 10 days prior to use.

C. Fertilizer shall be applied to vegetative soil layer material and shall be inorganic chemical fertilizer consisting of 20-5-5 fertilizer applied at 200 pounds per acre.

D. Stakes shall be softwood lumber, chisel pointed.

E. Water shall be from fresh water sources and shall be free from soil, acids, alkalis, salt, or any other substance injurious to growth of grass.

PART 3 – EXECUTION

3.1 INSPECTION OF VEGETATIVE SOIL

A. CONTRACTOR shall verify that vegetative soil and areas disturbed during construction activities are ready to receive the work covered by this section.

3.2 FERTILIZER

A. All fertilizer shall be applied in accordance with manufacturer's instructions.

B. Manure, if used, may be applied at a rate of up to 10 tons/acre. Manure application is optional subject to the approval of the COMPANY, which must be obtained at least 10 days prior to use.

C. Pre-planting fertilizer shall be mixed thoroughly into the upper 3 in. of vegetative-soil layer prior to applying seed.

3.3 SEEDING

A. Drill seed application is acceptable for slopes equal to or flatter than 4(H):1(V).

B. Seed shall be applied evenly by broadcast or hydroseed application at the rate specified in this Section. Adjustment to rate shall be made for variations in seed purity and germination to achieve the PLS equivalent rate. Hydroseeding is acceptable as a broadcast method of seeding and fertilizing. If dry broadcasting is done, seeds must be raked into the upper soil surface and seed must be applied at half of the specified broadcast rate. Designated areas for erosion control may not be seeded in excess of that which can be covered with erosion control material on the same day.

C. CONTRACTOR shall not sow immediately following rain, when ground is too dry, or during windy periods.

3.4 SEED PROTECTION/EROSION CONTROL

A. Straw/hay mulch shall be applied to all seeded areas, with slopes less than 4(H) to 1(V), within 24 hours after seeding operations. Straw or hay mulch shall be applied at a rate of approximately 150 pounds per 1000 square feet (6,500 pounds per acre) and crimped in place. Cellulose fiber

mulch shall be applied at a rate of approximately 75 pounds per 1,000 square feet (3,200 pounds per acre).

B. Seeded sloped areas shall be covered with erosion control fabric on all exterior slopes of 4(H) to I(V) and steeper; and in all drainage channels and swales in accordance with Section 1100, "Erosion and Sedimentation Control."

3.5 IRRIGATION

A. CONTRACTOR shall irrigate seeded areas if and as necessary to comply with the Uniform Grass Coverage (UGC) requirements of this Section.

B. Irrigation may be performed by water truck or by temporary irrigation system. If a temporary irrigation system is used, CONTRACTOR shall remove temporary irrigation system once COMPANY has accepted vegetated areas.

C. Irrigation shall be performed for a minimum of thirty days after initial planting and for as long as necessary to establish UGC across the entire seeded area.

3.6 ESTABLISHMENT AND ACCEPTANCE OF PERMANENT VEGETATION

A. It shall be solely the CONTRACTOR's responsibility to establish UGC across all application areas, regardless of unseasonable climatic conditions or other adverse conditions affecting planting operations and growth of vegetation.

B. Uniform Grass Coverage (UGC) shall be defined as a uniform stand of the specified grass with not less than 12 growing plants per square foot of seeded areas.

C. COMPANY will consider application areas acceptable only when:

1. A statistically significant number of randomly sampled plots have an average of 12 growing plants per square foot.
2. A minimum of one mowing has been performed in the seeded areas.
3. UGC has been deemed to have been achieved by the COMPANY.

D. Any application areas, which are not determined to be acceptable by the COMPANY, shall be replanted, refertilized, and reirrigated at no additional cost to the COMPANY.

E. The life and satisfactory condition of all plants (including grass) shall be guaranteed by CONTRACTOR for a period of up to one calendar year after written notice of first acceptance of vegetation by COMPANY. The guarantee period shall include one complete growing season and dormant period.

++END OF SECTION++

SECTION 02450

GEOCELLS

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section shall govern work associated with furnishing and installing geocells (cellular confinement system) including, but not limited to, layout, installation, and testing.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM)

D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
D1603	Standard Test Method for Carbon Black In Olefin Plastics
D1693	Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
D5199	Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
D5397	Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test

B. US Army Corps of COMPANYs (USACE)

Technical Report GL-86-19, Appendix A.

1.4 QUALIFICATIONS

A. Geocell Manufacturer's Field Representative shall have worked in a similar capacity on at least 5 geocell projects similar in complexity to the project described in the contract documents.

B. Geocell Installer shall have worked in a similar capacity on at least 5 geocell projects similar in complexity to the project described in the contract documents.

1.5 SUBMITTALS

A. At least 14 days prior to installation of the geocells, CONTRACTOR shall submit for approval the following information:

1. Manufacturer‘s Literature. Submit manufacturer’s literature for proposed geocells, including catalog cut sheets, material samples and, written instructions for delivery, storage, handling, installation, seaming, and repair.

2. Manufacturer Certification. Written certification from the manufacturer that the geocells comply with the requirements of these specifications and is appropriate for the intended application.

1. 6 WARRANTY

A. Material shall include one-year warranty against defects.

B. Installation shall be warranted against defects in workmanship for a period of 1-year from the date of geocell completion.

PART 2 - PRODUCTS

2.1 GEOCELL PRODUCT STANDARD

A. Geocells shall be black Terracell 140 perforated, textured high-density polyethylene (HDPE) geocell as manufactured by Hanes Geo Components, or approved equal.

B. Geocells shall be manufactured to meet the values listed as follows:

Property	Values
Cell Depth	4 in
Nominal Expanded Cell Size	10.2 in X 8.8 in
Nominal Expanded Cell Area	44.8 in
Nominal Expanded Section (L X W)	21.4 ft X 8.4 ft
Cells per Section (L X W)	29 cells X 10 cells
Nominal Expanded Section Area	180 sf
Weld Spacing	14 in

C. Geocells shall be constructed using virgin, non-thermally degraded HDPE with material properties that meet or exceed the following values:

Property	ASTM	Unit	Minimum Values
Polymer Density	D1505	g/cm3	0.935-0.965
Environmental Stress Crack Resistance	D5397	hours	>400
Environmental Stress Crack Resistance	D1693	hours	>6000
Minimum Carbon Black Content	D1603	%	1.5
Nominal Sheet Thickness	D5199	mil	60 (+10%, -5%)
Seam Peel Strength	USACE	lb	320

D. Geocell weld joints shall have a Seam Hang Strength able to support a load of 160 pounds for 30 days minimum or for 7 days minimum while undergoing temperature change from 74 degrees F to 130 degrees F on 1-hour cycle.

E. The HDPE strips used to construct the Geocell shall be textured with diamond shaped indentations. The rhomboidal indentations shall have a surface density of 140 to 200 per in^2.

F. Geocells shall be perforated with10 mm diameter holes spaced at 16.6 mm on center. The holes shall be placed in horizontal rows staggered 8.3 mm on relative to hole centers.

G. Geocell section length shall be in accordance with manufacturer recommendations for intended application.

2.2 ACCESSORIES

A. J-Hooks:

1. J-Hooks shall be uncoated steel reinforcing bars as follows:

   a. Diameter: 0.5 inch
   b. Length: 12 inches minimum.
   c. Hook: 180-degree bend

2.3 INFILL MATERIAL

A. Infill Material shall be concrete. Concrete shall at a minimum be Class A, 3,000-psi concrete with three-quarter inch diameter aggregate.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE and HANDLING

A. Comply with the Manufacturer's recommendations regarding product handling and protection.

B. Deliver products to the job site in their manufacturer's original packaging, with labels intact and legible.

C. Maintain packaged materials with seals unbroken and labels intact until time of use. Maintain in a manner that keeps product clean, dry and free of damage. Promptly remove damaged or unsuitable products from the job site and promptly replace with products meeting the required specifications.

D. Comply with Manufacturer's recommendations when hauling, unloading, deploying, and installing geotextile. Inspect for defects before installing.

3.2 FAMILIARIZATION

A. Inspection

1. Prior to beginning geocell installation, Geocell Installer and Geocell Manufacturer's Field Representative shall carefully inspect and approve the area to receive geocells.

2. If Geocell Installer or Geocell Manufacturer's Field Representative have any concerns regarding the proposed geocell area, they shall immediately notify COMPANY.

3.3 PREPARATION

A. Prepare site by removing vegetative cover, debris, and unacceptable soils from area where geocells will be installed.

B. Replace removed soils with acceptable materials.

3.4 INSTALLATION

A. Install geocells in accordance with manufacturer's instructions at locations indicated on the drawings.

B. Anchor geocell sections as necessary to resist sliding due to gravitational forces and sheet flow. The upper edge of the geocell shall be buried in an anchor trench as recommended by the Manufacturer and shown on the Drawings. Geocells shall also be anchored using J-Hooks in

accordance with manufacturer recommendations.

C. Ensure top edges of adjoining cell walls are flush with each other and in proper alignment.

D. Geocells shall be infilled with concrete. Deliver infill material to geocells from top of slope or channel to bottom in accordance with manufacturer's instructions.

E. Limit drop height of infill material to a maximum of 3 feet to prevent damage to geocells.

F. Manually rake and machine finish concrete infill material.

++END OF SECTION++

APPENDIX B

HELP MODEL OUTPUT

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******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
** HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE **
**        HELP MODEL VERSION 3.07 (1 November 1997)          **
**       DEVELOPED BY ENVIRONMENTAL LABORATORY           **
**           USAE WATERWAYS EXPERIMENT STATION             **
**FOR USEPA RISK REDUCTION ENGINEERING LABORATORY**
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************


PRECIPITATION DATA FILE:      C:\WHI\VHELP22\data\P8054.VHP\_weather1.dat
TEMPERATURE DATA FILE:         C:\WHI\VHELP22\data\P8054.VHP\_weather2.dat
SOLAR RADIATION DATA FILE:   C:\WHI\VHELP22\data\P8054.VHP\_weather3.dat
EVAPOTRANSPIRATION DATA:      C:\WHI\VHELP22\data\P8054.VHP\_weather4.dat
SOIL AND DESIGN DATA FILE:   C:\WHI\VHELP22\data\P8054.VHP\I_394356.inp
OUTPUT DATA FILE:                C:\WHI\VHELP22\data\P8054.VHP\O_394356.prt


TIME:   10:43       DATE:    9/21/2016


******************************************************************************

      TITLE:   A1 Landfill Compacted Clay Cap

******************************************************************************


      NOTE:   INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER   1
                                   --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                          MATERIAL TEXTURE NUMBER    6
           THICKNESS                       =       60.96    CM
           POROSITY                        =        0.4530 VOL/VOL
           FIELD CAPACITY                  =        0.1900 VOL/VOL
           WILTING POINT                   =        0.0850 VOL/VOL
           INITIAL SOIL WATER CONTENT   =        0.4275 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =   0.720001612800E-03 CM/SEC
         NOTE:   SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY   5.00
                 FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                   LAYER   2
                                   --------

                          TYPE 3 - BARRIER SOIL LINER
                          MATERIAL TEXTURE NUMBER   29
           THICKNESS                       =       91.44     CM
           POROSITY                        =        0.4510 VOL/VOL
           FIELD CAPACITY                  =        0.4190 VOL/VOL
           WILTING POINT                   =        0.3320 VOL/VOL
           INITIAL SOIL WATER CONTENT   =        0.4510 VOL/VOL
           EFFECTIVE SAT. HYD. COND.    =   0.100000000000E-06 CM/SEC


                    GENERAL DESIGN AND EVAPORATIVE ZONE DATA
                    ----------------------------------------

         NOTE:   SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
                 SOIL DATA BASE USING SOIL TEXTURE # 6 WITH A
```

FAIR STAND OF GRASS, A SURFACE SLOPE OF 4.%
AND A SLOPE LENGTH OF 536. METERS.

SCS RUNOFF CURVE NUMBER = 66.18
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 27.5186 HECTARES
EVAPORATIVE ZONE DEPTH = 25.4 CM
INITIAL WATER IN EVAPORATIVE ZONE = 9.953 CM
UPPER LIMIT OF EVAPORATIVE STORAGE = 11.506 CM
LOWER LIMIT OF EVAPORATIVE STORAGE = 2.159 CM
INITIAL SNOW WATER = 0.000 CM
INITIAL WATER IN LAYER MATERIALS = 67.301 CM
TOTAL INITIAL WATER = 67.301 CM
TOTAL SUBSURFACE INFLOW = 0.00 MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Martin Lake (Shreveport)LA

STATION LATITUDE = 32.47 DEGREES
MAXIMUM LEAF AREA INDEX = 4.50
START OF GROWING SEASON (JULIAN DATE) = 58
END OF GROWING SEASON (JULIAN DATE) = 331
EVAPORATIVE ZONE DEPTH = 10.0 INCHES
AVERAGE ANNUAL WIND SPEED = 8.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 70.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 72.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 72.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Martin Lake (Shreveport)LA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.02	3.46	3.77	4.71	4.70	3.54
3.56	2.52	3.29	2.63	3.77	3.87

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Martin Lake (Shreveport)LA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
46.00	49.80	57.00	65.70	73.00	79.80
82.90	82.40	77.10	66.70	55.70	48.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Martin Lake (Shreveport)LA
AND STATION LATITUDE = 30.56 DEGREES

****

MONTHLY TOTALS (IN INCHES) FOR YEAR 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION	0.84	2.07	1.98	2.47	8.45	2.54
	3.24	1.72	3.02	3.65	3.89	3.18
RUNOFF	0.000	0.000	0.000	0.000	3.584	0.000
	0.000	0.000	0.000	0.000	0.780	1.785
EVAPOTRANSPIRATION	1.614	1.745	3.186	3.700	4.537	1.580

	3.644	2.284	1.923	2.535	1.086	1.486
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.1684	0.1456	0.1629	0.1438	0.1537	0.1410
	0.1487	0.1447	0.1385	0.1537	0.1601	0.1733

MONTHLY SUMMARIES FOR DAILY HEADS (INCHES)

AVERAGE DAILY HEAD ON TOP OF LAYER 2	21.488	19.050	19.619	14.723	16.477	13.740
	14.762	13.387	12.875	16.458	20.477	23.163
STD. DEVIATION OF DAILY HEAD ON TOP OF LAYER 2	0.980	0.379	1.017	1.270	3.494	0.160
	1.668	0.156	0.155	1.401	2.754	0.639

****

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ANNUAL TOTALS FOR YEAR 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	37.05	9145222.668	100.00
RUNOFF	6.149	1517733.345	16.60
EVAPOTRANSPIRATION	29.319	7236958.372	79.13
PERC./LEAKAGE THROUGH LAYER 2	1.834348	452780.602	4.95
AVG. HEAD ON TOP OF LAYER 2	17.1849		
CHANGE IN WATER STORAGE	-0.252	-62249.515	-0.68
SOIL WATER AT START OF YEAR	26.972	6657733.258	
SOIL WATER AT END OF YEAR	26.720	6595483.743	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.137	0.00

****

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.60	2.99	3.85	4.96	4.51	3.71
	3.53	2.17	3.08	2.64	3.69	3.58
STD. DEVIATIONS	2.46	1.49	1.64	2.11	2.06	2.37
	1.79	1.84	1.72	1.45	1.20	2.26
RUNOFF						
TOTALS	1.957	1.027	0.821	0.812	0.350	0.201
	0.082	0.000	0.090	0.120	0.669	1.862
STD. DEVIATIONS	2.245	1.144	1.148	1.010	0.848	0.791
	0.411	0.000	0.295	0.444	1.033	2.055
EVAPOTRANSPIRATION						
TOTALS	1.679	2.116	3.151	4.846	4.872	3.792
	3.455	2.086	2.474	1.663	1.068	1.260
STD. DEVIATIONS	0.174	0.297	0.584	0.659	1.420	2.180
	1.629	1.532	1.238	0.830	0.206	0.203

PERCOLATION/LEAKAGE THROUGH LAYER 2

TOTALS	0.1708	0.1537	0.1662	0.1571	0.1526	0.1444
	0.1473	0.1458	0.1414	0.1495	0.1557	0.1707
STD. DEVIATIONS	0.0037	0.0047	0.0038	0.0050	0.0056	0.0043
	0.0038	0.0027	0.0046	0.0070	0.0112	0.0061

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	22.3261	21.6228	20.7545	19.4343	16.0974	14.9359
	14.2927	13.7858	13.8841	15.0423	18.9221	22.2857
STD. DEVIATIONS	1.2528	1.4403	1.2917	1.7502	1.9106	1.5274
	1.3042	0.9131	1.6268	2.4005	3.9594	2.0719

****
****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES		CU. FEET	PERCENT
PRECIPITATION	42.31	(7.468)	10444395.6	100.00
RUNOFF	7.990	(4.7750)	1972313.97	18.884
EVAPOTRANSPIRATION	32.460	(4.3675)	8012269.82	76.714
PERCOLATION/LEAKAGE THROUGH LAYER 2	1.85537	(0.02814)	457970.335	4.38484
AVERAGE HEAD ON TOP OF LAYER 2	17.782	(0.810)		
CHANGE IN WATER STORAGE	0.007	(0.6000)	1841.58	0.018

****
****

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30 and their dates (DDDYYYY)

	(INCHES)	(CU. FT.)	
PRECIPITATION	4.10	1012021.94161	1980021
RUNOFF	3.750	925585.11065	130016
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.005669	1399.35021	110002
AVERAGE HEAD ON TOP OF LAYER 2	24.000		
SNOW WATER	2.84	701139.9388	130002
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4530		
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0850		

****
****

FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	10.4843	0.4368
2	16.2360	0.4510
SNOW WATER	0.000	

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APPENDIX C

SLIDE 7.0 – CAP/COVER SYSTEM SLOPE STABILITY MODEL OUTPUT

Bullock, Bennett & Associates, LLC ∗ 165 N. Lampasas Street ∗ Bertram, Texas 78605
Telephone: 512.355.9198 ∗ Fax: 512.355.9197

September 30, 2016

Mr. Pat Behling
Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664

Re: Evaluation of Landfill Cap Slope Stability, A1 LF – Martin Lake Steam Electric Station, near Beckville, Texas

Dear Mr. Behling:

As requested by Pastor, Behling & Wheeler, LLC (PBW), Bullock, Bennett & Associates, LLC (BBA) has completed evaluation of slope-stability of the proposed cap for the A1 ash disposal facility at the Martin Lake Steam Electric Station (MLSES) located near Beckville, Texas. This analysis is based on the most recent preliminary design drawings dated August 2016, provided to BBA by PBW. No site specific geotechnical data was provided to BBA for this analysis, therefore, assumptions regarding typical soil properties are made in this evaluation. It is recommended that site-specific soils be tested for engineering strength properties, and slope stability analysis using the on-site data and final design criteria be completed prior to construction activities.

The PBW design includes use of a compacted clay liner system, as further discussed below.

Slope Stability Analysis of Clay Cap

The clay cap system consists of the following, bottom to top:

- 1.0 foot-thick subgrade soil;
- 3.0 foot-thick compacted clay liner; and,
- 1.5 foot-thick protective cover/vegetative soil.

A unit weight and internal friction angle of 115 pounds per cubic foot (pcf) and 15 degrees, respectively, were used for the soil and are generally representative of commonly available soils in Texas, including a wide range of silty, sandy, and lean to fat clays commonly used as cover soil.

This slope stability analysis includes evaluation of the clay cap system using Rocscience Slide 7.0 software. The Simplified Bishop and Morgenstern-Price methods of analysis were conducted on over 400 potential failure surfaces, with the lowest calculated safety factor reported. Slope stability evaluation of the cap was performed for assumed short- and long-term conditions. Site specific geotechnical test data is not available; therefore assumptions regarding soil strength properties (for each soil layer) were made as follows:

Short-Term Conditions:

Cohesion, C:	500 pcf
Friction Angle:	0

Long-Term Conditions:

Cohesion, C:	250 pcf
Friction Angle:	15

The unit weight of soil was assumed to be 115 pcf for each soil layer. Coal combustion residual (ash) material underlies the cap. It is assumed the ash is non-cohesive, well drained and has been in place for a long time prior to capping. For ash the following properties were assumed for both short and long-term cap analysis:

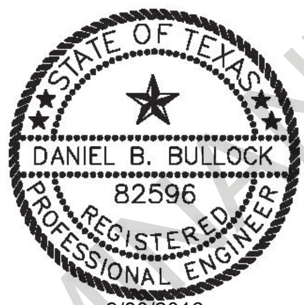
Dry Unit Weight of Ash:	90 pcf
Saturated Unit Weight of Ash:	95 pcf
Cohesion, C:	0 pcf
Friction Angle:	20 deg

The calculated factor of safety for the short- and long-term conditions were both determined to be approximately 1.5.

Please find attached the landfill cap slope stability analysis and supporting notes, assumptions, and documentation, and please feel free to contact me at (512) 355-9198 if you have any questions about this submittal, or if I can be of any further assistance.

Sincerely,

BBA, LLC



9/30/2016

Dan Bullock, P.E.
Principal Engineer

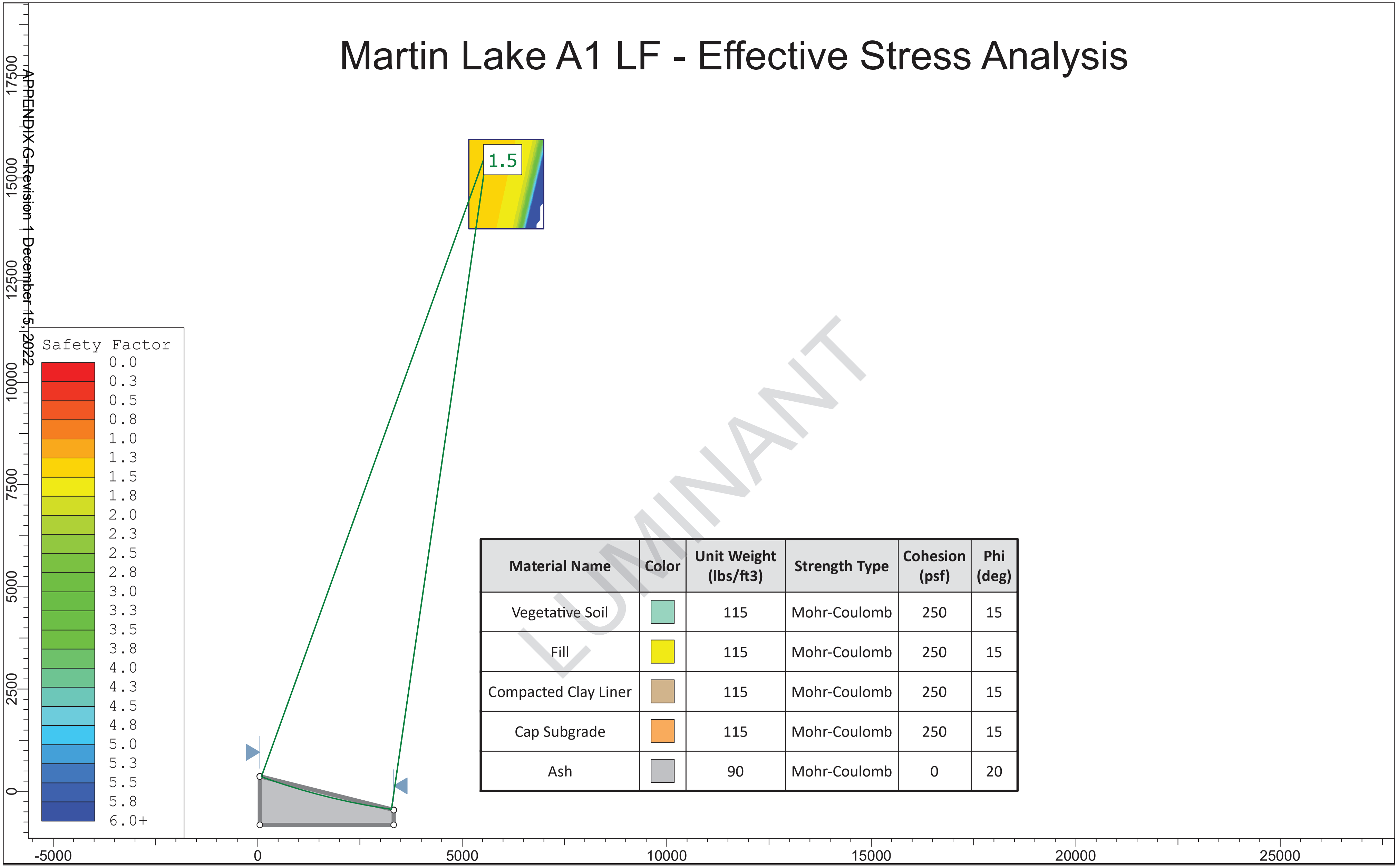
Attachments

ATTACHMENT 1

Landfill Cover Slope Stability Analysis

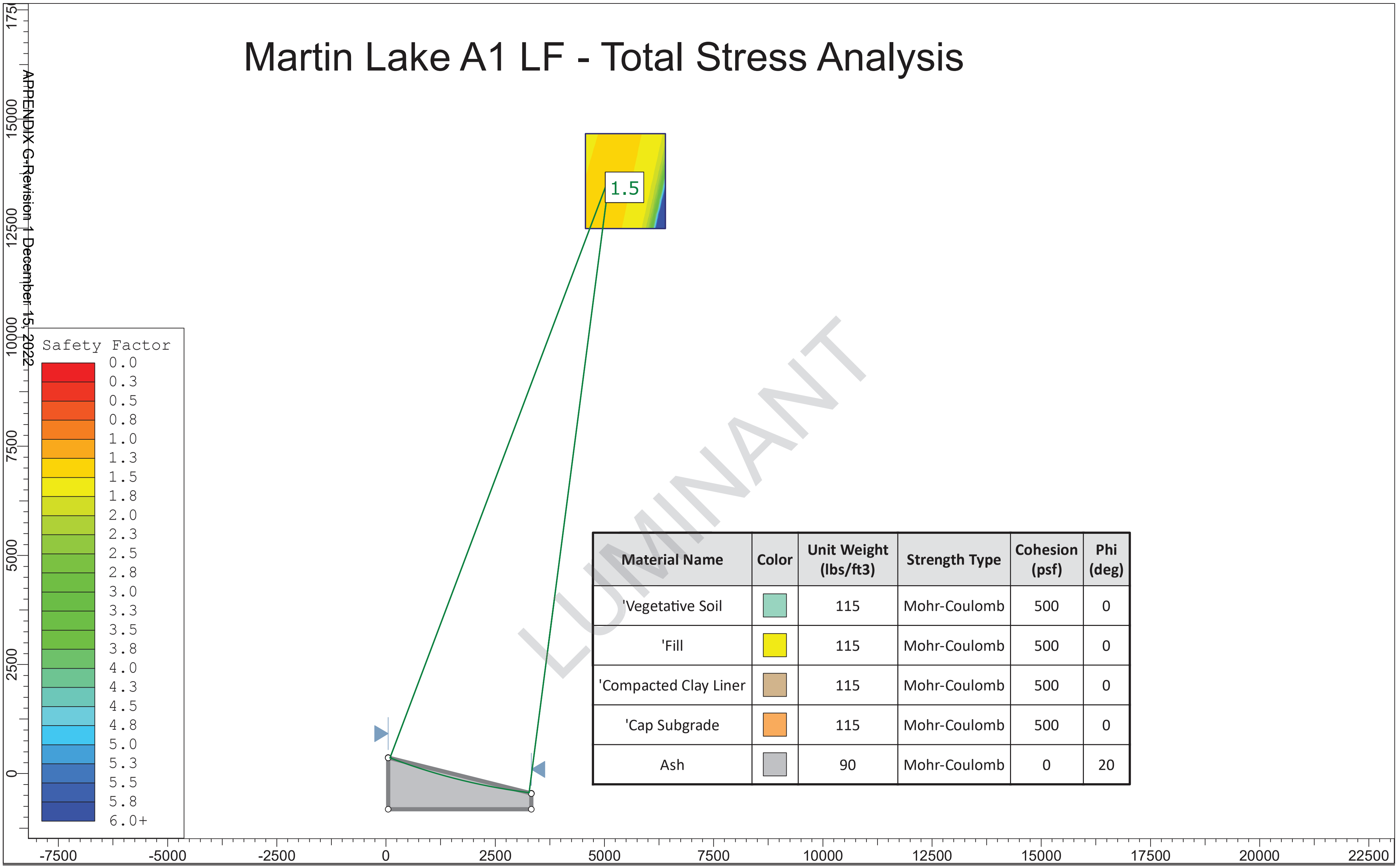
Slide 7.0 Analysis of Clay Cap

Martin Lake A1 LF - Effective Stress Analysis



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Vegetative Soil		115	Mohr-Coulomb	250	15
Fill		115	Mohr-Coulomb	250	15
Compacted Clay Liner		115	Mohr-Coulomb	250	15
Cap Subgrade		115	Mohr-Coulomb	250	15
Ash		90	Mohr-Coulomb	0	20

Martin Lake A1 LF - Total Stress Analysis



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
'Vegetative Soil		115	Mohr-Coulomb	500	0
'Fill		115	Mohr-Coulomb	500	0
'Compacted Clay Liner		115	Mohr-Coulomb	500	0
'Cap Subgrade		115	Mohr-Coulomb	500	0
Ash		90	Mohr-Coulomb	0	20

ML A1_LF total.slmd

Bullock, Bennett & Associates, LLC

APPENDIX D

STORMWATER HYDROLOGY CALCULATIONS

Summary of Peak Flow Estimate - SCC TR-55 Method
Luminant A-1 Area Landfill - Beckville Mine

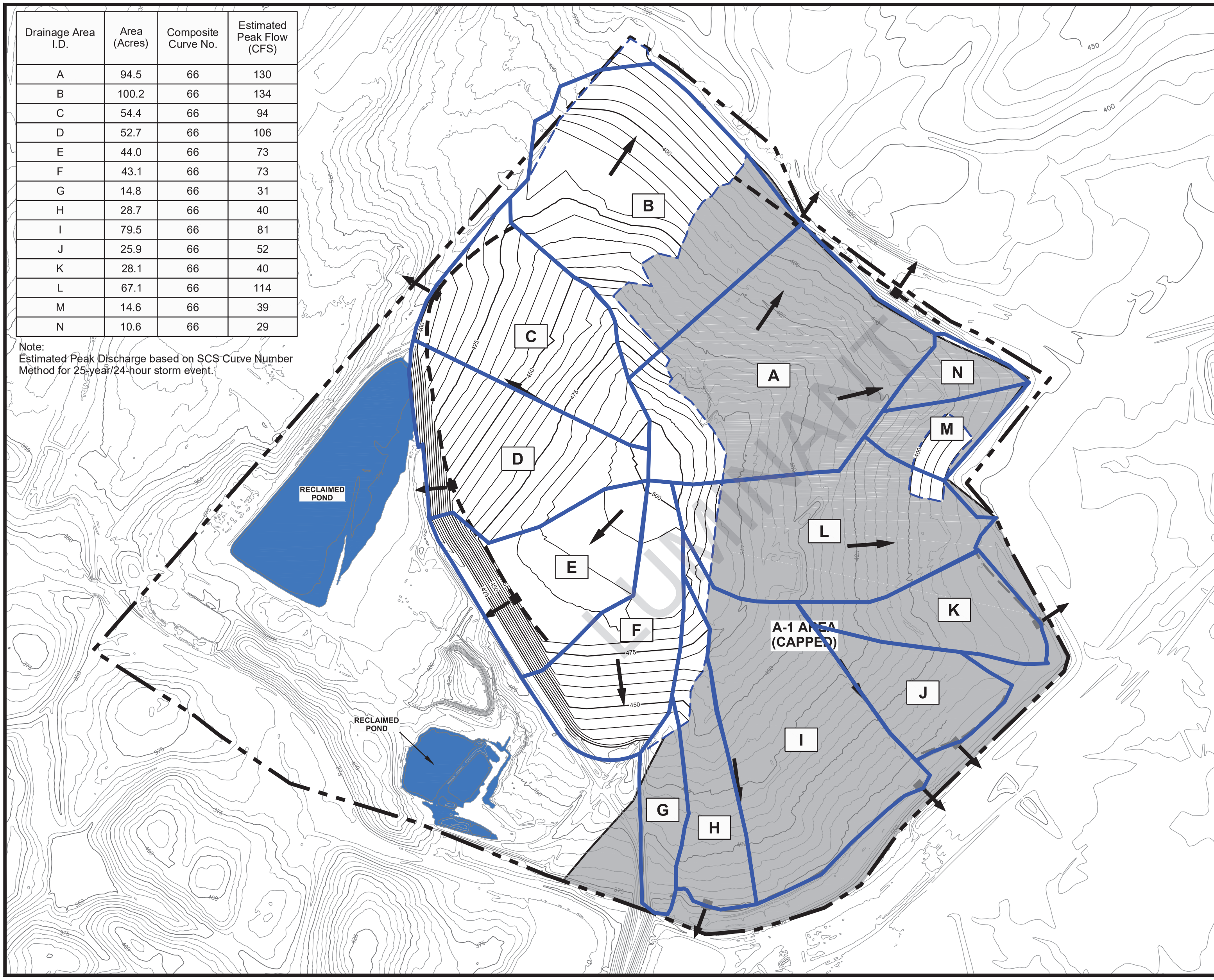
SCS TR-55 Equation & Variables

Q_p= Qu*Area (miles2)* Q*Fp	
Q_p= Estimated Peak Discharge (cfs)	Q= $(P-I_a)^2/(P-I_a) + S)$
Q_u=Unit Peak Discharge (cfs/mile2-inch)	P= Design Storm Rainfall (inches)
A= Area (square miles)	Ia=0.2S (Initial abstractions; inches)
Q= Rainfall Excess (Depth of Runoff Over Watershed)	S= 1000/CN-10
F_p= Ponding Factor (% of ponds/swamps)	CN= SCS Curve Number

Drainage Area I.D.	Area (acres)	Area (mi^2)	Composite Curve Number	Estimated Peak Flow (CFS) Q_p	P (25yr,24hr)	S	I_a	Q	I_a/P	TIME OF CONCENTRATION ESTIMATE v1=aS^.5 fps	v2	Estimated Time of Concen. (Min.)	CAP Roughness Coeff (Table 3.20)	Cap Slope (ft/ft)	Conc. Flow Slope (ft/ft)	Q_u	F_p
A1-A	94.5	0.1477	66	130.4	8.6	5.15	1.03	4.50	0.12	0.54	0.18	124	2.5	0.047	0.005	196.0	1
A1-B	100.2	0.1566	66	134.1	8.6	5.15	1.03	4.50	0.12	0.56	0.18	130	2.5	0.05	0.005	190.2	1
A1-C	54.4	0.085	66	93.8	8.6	5.15	1.03	4.50	0.12	0.49	-	85	2.5	0.038	-	245.1	1
A1-D	52.7	0.0823	66	105.6	8.6	5.15	1.03	4.50	0.12	0.57	-	65	2.5	0.052	-	284.6	1
A1-E	44	0.0688	66	72.6	8.6	5.15	1.03	4.50	0.12	0.29	0.18	92	2.5	0.0137	0.005	234.6	1
A1-F	43.1	0.0673	66	73.1	8.6	5.15	1.03	4.50	0.12	0.45	-	88	2.5	0.033	-	241.0	1
A1-G	14.8	0.0231	66	30.7	8.6	5.15	1.03	4.50	0.12	0.54	-	61	2.5	0.047	-	295.0	1
A1-H	28.7	0.0448	66	40.4	8.6	5.15	1.03	4.50	0.12	0.51	0.18	120	2.5	0.041	0.005	200.0	1
A1-I	79.5	0.1242	66	80.5	8.6	5.15	1.03	4.50	0.12	0.49	0.18	198	2.5	0.038	0.005	143.9	1
A1-J	25.9	0.0405	66	51.9	8.6	5.15	1.03	4.50	0.12	0.62	0.18	65	2.5	0.062	0.005	284.6	1
A1-K	28.1	0.0439	66	40.1	8.6	5.15	1.03	4.50	0.12	0.59	0.18	118	2.5	0.055	0.005	202.8	1
A1-L	67.1	0.1048	66	113.7	8.6	5.15	1.03	4.50	0.12	0.55	-	88	2.5	0.048	-	240.7	1
A1-M	14.6	0.0228	66	38.8	8.6	5.15	1.03	4.50	0.12	0.58	-	36	2.5	0.053	-	377.7	1
A1-N	10.6	0.0166	66	29.1	8.6	5.15	1.03	4.50	0.12	0.49	-	34	2.5	0.038	-	390.4	1

Drainage Area I.D.	Area (Acres)	Composite Curve No.	Estimated Peak Flow (CFS)
A	94.5	66	130
B	100.2	66	134
C	54.4	66	94
D	52.7	66	106
E	44.0	66	73
F	43.1	66	73
G	14.8	66	31
H	28.7	66	40
I	79.5	66	81
J	25.9	66	52
K	28.1	66	40
L	67.1	66	114
M	14.6	66	39
N	10.6	66	29

Note:
Estimated Peak Discharge based on SCS Curve Number Method for 25-year/24-hour storm event.



EXPLANATION

- Landfill Registration Boundary
- Existing Grade Contour 5 ft Interval
- Existing Grade Contour 25 ft Interval
- Proposed Finished Grade Contour 5 ft Interval
- Proposed Finished Grade Contour 25 ft Interval
- Proposed Limits of CAP
- Sheet Flow
- Storm Water Drainage Divide
- Capped Area (Existing)

LUMINANT GENERATION COMPANY, LLC
MARTIN LAKE STEAM ELECTRIC STATION

Appendix D

CCR COVER SYSTEM DRAINAGE AREAS AND ESTIMATED PEAK DISCHARGE

PROJECT: 5196B	BY: AJD	REVISIONS
DATE: SEPT., 2016	CHECKED: BDT	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS

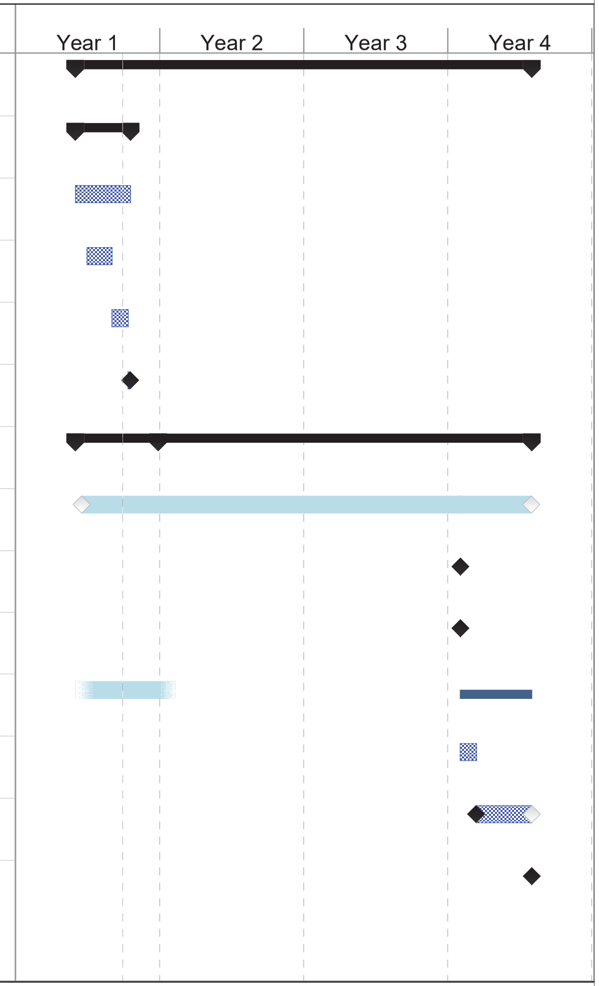
APPENDIX E

PROJECT SCHEDULE – CCR CLOSURE PROCESS

APPENDIX E
PROJECT SCHEDULE - CCR UNIT CLOSURE PROCESS

Thu 9/29/16

ID	Task Name
1	**MLSES A-1 AREA LANDFILL - CLOSURE PLAN**
2	**TASK-1 257.102 Closure Planning for CCR Units**
3	**Preparation of Closure Plan**
4	Review Draft Closure Plan
5	Revise Draft Closure Plan
6	Finalize Closure Plan
7	**Task 2 - 257.102 (d) Closure In-Place of CCR Unit**
8	**Closure Triggers**
9	Closure Initiated within 2-years of Last Receipt of Waste
10	Closure Initiated within 2-years of Last Beneficial Use of CCR
11	**Closure Sequence**
12	TPDES Storm Water Construction General Permit NOI
13	Construct Final Cover System
14	Closure Completion Deadline or 2-year Extension Note - Extension requires demonstration of infeasibility 257.102(f)(2))



Page 1

Task
Split
Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Progress
Deadline

Notes: Schedule does not include administrative/legal/receiver activities. Closure initiation will be determined in accordance with the CCR Rule and this timeline only illustrates the anticipated construction sequencing following closure initiation.

REPORT

CLOSURE PLAN ADDENDUM NO. 1

Martin Lake Steam Electric Station - A1 Area Landfill
Panola County, Texas

Submitted to:

Luminant Generation Company LLC

Submitted by:

WSP GOLDER

1601 S MoPac Expressway
Suite 325D
Austin, Texas, USA 78746
+1 737 703 3900

31404097.007

December 2022

PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by WSP Golder under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I hereby certify that Addendum No.1 to the Closure Plan for the A1 Area Landfill at the Martin Lake Steam Electric Station has been prepared in accordance with the requirements of 40 C.F.R. §257.102(b).

Patrick J. Behling, P.E.
Principal Engineer
WSP Golder
Texas Firm Registration No. 22771

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DOCUMENT REVISION RECORD

Issue No.	Date	Details of Revisions
Revision 0	October 2016	Original Document
Addendum 1	December 2022	Revised configuration of final cap/cover system for A1 Area Landfill, added cap settlement evaluation, added confirmation that cap slope stability will be modeled using site-specific geotechnical data during final closure design, removal of HELP Modeling from Closure Plan, revised closure schedule to state closure will be completed within six months and add estimated completion year, added section addressing the initiation of closure, and added section to address notification citations.

1.0 INTRODUCTION

On behalf of Luminant Generation Company LLC (Luminant), WSP Golder (Golder) has prepared this Addendum No. 1 to the Closure Plan for the A1 Area Landfill (A1 LF) located at the Martin Lake Steam Electric Station (MLSES) in Panola County, Texas (hereafter, the “Site”). Coal Combustion Residuals (CCR) including fly ash, bottom ash, and gypsum generated as part of MLSES operation are disposed in the A1 LF. The A1 LF is regulated as an Existing CCR Landfill under 40 C.F.R. § 257, Subpart D (the “CCR Rule”).

The original Closure Plan for the A1 LF was prepared in October 2016 in accordance with 40 C.F.R. §257.102(b) and placed in the MLSES operating record in accordance with 40 C.F.R. §257.105(h)(10) (PBW, 2016). This Addendum No. 1 updates the Closure Plan to reflect the following:

- Revisions to the configuration of the A1 LF cap/cover system to be consistent with recent Texas Commission on Environmental Quality (TCEQ) approved cap modifications;
- Addition of cap settlement evaluation;
- Confirmation that the slope stability of the A1 LF cap/cover system will be modeled using site-specific geotechnical data during design of the final closure of the landfill;
- removal of HELP Modeling from Closure Plan;
- Revisions to the A1 LF closure schedule to state closure will be completed within six months and add estimated completion year;
- Addition of section addressing the initiation of A1 LF closure; and
- Addition of section to address notification citations.

2.0 A1 AREA LANDFILL FINAL CAP/COVER SYSTEM

The A1 LF is the primary disposal facility for CCR generated at the MLSES and is located within a reclaimed section of the nearby Luminant Beckville Mine. The A1 LF is an above grade landfill surrounded by earthen embankments constructed of mine spoil that extend approximately 10 to 20 feet or more above surrounding grade. The bottom of the A1 LF is lined with a 1-foot thick compacted bottom liner consisting of clay-rich mine spoil scarified and re-compacted to achieve an in-place permeability of 1 x 10^{-7} cm/sec or less. The interior faces of the earthen embankments are constructed with a 3-foot thick compacted mine spoil liner designed to achieve an in-place permeability of 1x10^{-7} cm/sec or less.

The A1 LF has been in operation since 1980 and progressive capping/closure of the A1 LF has been performed as placement of CCR in the landfill reached design elevations. Through 2019, capped/closed areas of the landfill have been covered with a 3-foot thick compacted mine spoil cap (in-place permeability of 1x10^{-7} cm/sec or less) covered with a 2-foot thick vegetative cover layer. This cap configuration was included in the 2016 A1 LF Closure Plan (PBW, 2016).

In 2019, Luminant proposed a modification of the A1 LF cap/cover configuration to close future landfill areas to TCEQ (Golder, 2019). The proposed cap modification consisted of the following (from bottom to top):

- a 2-foot thick compacted mine spoil liner layer (in-place permeability of 1x10^{-7} cm/sec or less); and
- a 1.5-foot thick vegetative soil cover layer.

TCEQ approved the proposed cap modification in 2020 and a copy of the TCEQ approval letter is reproduced in Appendix A.

The Closure Plan for the A1 LF is hereby modified to reflect that future landfill areas will be closed using the following final cap/cover system (from bottom to top):

- a 2-foot thick compacted mine spoil liner layer (in-place permeability of 1x10^{-7} cm/sec or less); and
- a 1.5-foot thick vegetative soil cover layer.

The proposed final cap/cover system for the A1 LF must comply with the final cover system requirements of 40 C.F.R. §257.102(d)(3)(i)(A) through (D):

(A) The permeability of the final cover system must be less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1 X 10^{-5} cm/sec, whichever is less.

(B) The infiltration of liquids through the closed CCR unit must be minimized by the use of an infiltration layer that contains a minimum of 18 inches of earthen material.

(C) The erosion of the final cover system must be minimized by the use of an erosion layer that contains a minimum of 6 inches of earthen material that is capable of sustaining native plant growth.

(D) The disruption of the integrity of the final cover system must be minimized through a design that accommodates settling and subsidence.

2.1 Equivalent Infiltration Reduction – A1 Area Landfill Cap/Cover System

The final cap/cover system for the A1 LF must include an infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified in paragraphs 40 C.F.R. §257.102(d)(3)(i)(A) and (B):

(A) The permeability of the final cover system must be less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1×10^{-5} cm/sec, whichever is less.

(B) The infiltration of liquids through the closed CCR unit must be minimized by the use of an infiltration layer that contains a minimum of 18 inches of earthen material.

2.1.1 Permeability Comparison Between Landfill Cap and Liner

Compliance of the final cap/cover system to the requirements of 40 C.F.R. §257.102(d)(3)(i)(A) was determined by comparing the estimated liquid flow rate through the A1 LF cap to the estimated liquid flow rate through the A1 LF liner system (The permeability of the clay component of the A1 LF cap is less than 1×10^{-5} cm/sec, so this criterion is not applicable). The results of the comparison are presented below.

- Estimated Liquid Flow Through A1 LF Final Cap/Cover System

  The A1 LF will be capped with a 2-feet thick compacted clay layer with a maximum hydraulic conductivity of 1×10^{-7} cm/sec. Flow rate through the A1 LF cap/cover system (per acre of cap area) was estimated using Darcy's Law for gravity flow through porous media as follows:

  - Darcy Equation: Q=A X k X (h/t+1)

    Where:

    Q = flow rate through the clay layer (m^3/s)

    A = cap area perpendicular to the flow (m^2)

    h = head above cap clay layer (m)

    t = thickness of cap clay layer (m)

    k = hydraulic conductivity of cap clay layer (m/s)

  - Assumptions:

    1) The 2-feet thick cap clay layer is assumed to have a maximum hydraulic conductivity of 1×10^{-7} cm/sec.

    2) The hydraulic head above the CCL was assumed to be 12 inches (30.48 cm). This is a conservative assumption for the cap, since the final cap/cover system will be sloped to divert water that infiltrates through the overlying erosion soil layer away from the cap.

    3) A unit cap area of 1 acre was assumed for the evaluation.

  - Flow Rate Through 2-feet Thick Compacted Clay Layer

    A = 1 acre (4046.86 m^2)

    k = 1×10^{-7} cm/sec (1×10^{-9} m/sec)

    h = 1 foot x 30.48 cm/ft = 30.48 cm (0.3048 m)

t = 2 feet X 30.48 cm/ft = 60.96 cm (0.6096 m)

Q = (4046.86 m^2) x (1x10^{-9} m/sec) x ((0.3048 m / 0.6096 m) + 1)

= 6.07x10^{-6} m^3/s per acre of cap or 138 gallons per day per acre of cap

- Estimated Liquid Flow Through A1 LF Liner

  The bottom of the A1 LF is lined with a 1-foot thick compacted bottom liner consisting of clay-rich mine spoil scarified and re-compacted to a maximum hydraulic conductivity of 1x10^{-7} cm/sec. Flow rate through the A1 LF liner (per acre of liner area) was also estimated using Darcy's Law for gravity flow through porous media as follows:

  - Assumptions:

    1) The 1-foot compacted liner is assumed to have a maximum hydraulic conductivity of 1x10^{-7} cm/sec.
    2) The hydraulic head above the liner was assumed to be 12 inches (30.48 cm).
    3) A unit liner area of 1 acre was assumed for the evaluation.

  - Flow Rate Through A1 LF Liner

    A = 1 acre (4046.86 m^2)

    k = 1x10^{-7} cm/sec (1 X 10^{-9} m/sec)

    h = 1 foot x 30.48 cm/ft = 30.48 cm (0.3048 m)

    t = 1 foot X 30.48 cm/ft = 30.48 cm (0.3048 m)

    Q = (4046.86 m^2) x (1x10^{-9} m/sec) x ((0.3048 m / 0.3048 m) + 1)

    = 8.1x10^{-6} m^3/s per acre of liner or 184 gallons per day per acre of liner

The final cap/cover system for the A1 LF complies with the requirements of 40 C.F.R. §257.102(d)(3)(i)(A), since the estimated liquid flow rate through the final cap/cover system (138 gallons per acre per day) is less than the estimated liquid flow rate through the A1 LF liner (184 gallons per acre per day).

2.2.2 Infiltration Comparison of Landfill Cap to 18-Inch Earth Infiltration Layer

The A1 LF cap/cover system includes an infiltration layer consisting of a 2-foot thick compacted mine spoil liner layer with an in-place permeability of 1x10^{-7} cm/sec or less which exceeds the 18 inch minimum specified in 40 C.F.R. §257.102(d)(3)(i)(B).

2.2 Equivalent Erosion Protection – A1 Area Landfill Cap/Cover System

The final cap/cover system for the A1 Landfill includes an 18-inch erosion layer consisting of 12 inches of general fill overlain with 6 inches of soil capable of supporting native vegetation. This complies with the requirements of 40 C.F.R. §257.102(d)(3)(ii)(B), which states that the final cover system must use of an erosion layer that contains a minimum of six inches of earthen material that is capable of sustaining native plant growth.

2.3 Settling and Subsidence – A1 Area Landfill System

40 C.F.R. §257.102(d)(3)(i)(D) states that the disruption of the integrity of the final cover system must be minimized through a design that accommodates settling and subsidence. An evaluation of potential settlement for the final cap/cover systems for the A1 LF is attached as Appendix B to this Addendum. The A1 LF Closure Plan will be updated to include a cap/cover system settlement evaluation using site-specific data during design of the final cap/closure systems for the landfill.

2.4 Slope Stability – A1 Area Landfill Cap/Cover System

The A1 LF Closure Plan will be updated to include cap/cover system slope stability modeling using site-specific geotechnical data during design of the final cap/closure systems for the landfill.

2.5 HELP Modeling in 2016 Closure Plan

The 2016 Closure Plan for the A1 LF included Hydrologic Evaluation of Landfill Performance (HELP) model evaluations to compare the permeability of the then-proposed cap to the landfill liner (PBW, 2016). The HELP model evaluations in the 2016 Closure Plan have been replaced by the infiltration evaluations presented above for the new cap/cover system and have been deleted from this amended Closure Plan.

2.6 Conclusions

The final cap/cover system for the A1 LF described above complies with the final cover system requirements of 40 C.F.R. §257.102(d)(3)(i)(A) through (D).

3.0 A1 AREA LANDFILL CLOSURE SCHEDULE AND NOTIFICATION UPDATES

The closure schedule for the A1 Landfill is described in Section 2.7 and Appendix E of the 2016 Closure Plan (PBW, 2016). The 2016 A1 LF Closure Schedule is updated as follows:

- Initiation of A1 LF Closure. For the purposes of the A1 LF Closure Schedule, Luminant estimates that the MLSES will cease operations in approximately 2045. However, CCR and related waste will continue to be generated after plant operation has terminated as part of facility decommissioning and demolition and the CCR and related waste may be managed in the A1 LF. In accordance with 40 C.F.R. §257.102(e)(2)(i), the A1 LF will commence closure within two years of the date of final receipt of either CCR or non-CCR waste; however, in accordance with 40 C.F.R. §257.102(e)(2)(ii) an additional two years may be required to initiate closure provided Luminant provides written documentation that the A1 LF will continue to accept wastes beyond the original two-year period. For the purposes of the A1 LF Closure Schedule, Luminant estimates that A1 LF Closure will be initiated in approximately 2047.
- Completion of A1 LF Closure. In accordance with 40 C.F.R. §257.102(f)(1)(i), Luminant estimates that final closure of the A1 LF will be completed within 6 months of start of closure or in approximately 2048. It should be noted; however, that 40 CFR §257.102(f)(2) of the CCR Rule allow for extension of the closure schedule in the event that it is not feasible to complete closure of the A1 LF within the required timeframes due to factors beyond the facility's control.

Luminant will provide the following notifications related to closure of the A1 LF:

- In accordance with 40 C.F.R. §257.102(g), Luminant will prepare a notification of intent to close the A1 LF. The notice will be prepared no later than the date of closure initiation, will be sealed by a qualified professional engineer, and will be placed in the MLSES operating record as required by 40 C.F.R. §257.105(i)(7).
- In accordance with 40 C.F.R. §257.102(h), Luminant will prepare a notification of closure of the A1 LF within 30 days of completion of closure. The notice will be sealed by a qualified professional engineer and will be placed in the MLSES operating record as required by 40 C.F.R. §257.105(i)(8).
- In accordance with 40 C.F.R. §257.102(h) Luminant will provide deed notification for the A1 LF Closure.

4.0 REFERENCES

Golder Associates (Golder), 2019. TCEQ Registration Update – A1 Area Landfill, Martin Lake Steam Electric Station. December.

Pastor, Behling & Wheeler, LLC (PBW), 2016. CCR Closure Plan – A1 Area Landfill, Martin Lake Steam Electric Station. October.

APPENDIX A

TCEQ Approval Letter – A1 Area Landfill Cap Modification

REC'D FEB 04 2020

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

January 23, 2020

Ms. Kimberly D. Mireles
Sr. Director, Environmental Services
Luminant Generation Company LLC
6555 Sierra Drive
Irving, TX 75039-2479

Re: Title 30 Texas Administrative Code Section (§) 335.6 Notification
Luminant Generation Company LLC - Irving, Rusk County
Hazardous Waste Permit No. None
Industrial Solid Waste Registration No. 31277
EPA Identification No. TXD000821306
Tracking No. 24891671; RN102583093/CN603256413

Dear Ms. Mireles:

The Industrial and Hazardous Waste Permits Section of the Texas Commission on Environmental Quality hereby acknowledges receipt of your notification letter dated December 20, 2019 which was received on December 23, 2019. The notification was submitted in accordance with Title 30 Texas Administrative Code (TAC) §335.6. Your letter provides an update for the A1 Area Landfill at the Luminant Martin Lake Steam Electric Station (MLSES) in Rusk County, Texas. Luminant Generation Company LLC (Luminant) is proposing to modify the cap configuration for future capped/closed areas of the A1 Area Landfill (NOR Unit No. 002).

Progressive capping/closure for 428 acres of the landfill, when the landfill reached design elevations, included covering the landfill with 3-foot compacted mine spoil cap (in-place permeability ≤ 1x10-7 cm/sec) covered with 2-foot thick vegetative cover layer. Luminant is proposing to modify the cap configuration for future capped/closed areas of the landfill to consist of a 2-foot thick compacted mine spoil layer (in-place permeability ≤ 1x10-7 cm/sec) covered with a 1.5-foot thick vegetative cover layer.

The A1 Area Landfill is an existing landfill where Coal Combustion Residuals (CCR) wastes are disposed. CCR wastes were regulated under 30 TAC 335 until CCR rule became effective on October 19, 2015. Closure of existing CCR landfills must comply with the requirements of 40 CFR 257.102 until State of Texas CCR regulations are promulgated and become effective. The final cover requirements for the CCR landfill are provided under 40 CFR 257.102(d)(3)(i). Based on the information provided in your notification, it appears that the proposed cap configuration for future capped/closed areas of the landfill to consist of a 2-foot thick compacted mine spoil layer (in-place permeability ≤ 1x10-7 cm/sec) covered with a 1.5-foot thick vegetative cover layer will meet the final cover requirements under 40 CFR 257.102(d)(3)(i)(A) -(D). You may begin your proposed waste management activities at your earliest convenience.

Please be aware that your facility may be subject to requirements other than 40 CFR 257 (i.e., requirements of Texas Water Code and Clean Air Act) which may be applicable to your proposed activities.

Please also be aware that it is the continuing obligation of persons associated with a site to ensure that municipal hazardous waste and industrial solid waste are managed in a manner which does not cause the discharge or imminent threat of discharge of waste into or adjacent to waters in the state, a nuisance, or the endangerment of the public health and welfare as required by 30 TAC §335.4. If the waste management activities fail to comply with these requirements, the burden remains upon Luminant Generation Company LLC to take any necessary and authorized action to correct such conditions.

If you have any questions or comments, please contact Mr. Rama S. Yadav, P.E., P.G. at (512) 239-6784. When responding by letter, please include mail code MC-130 in the address.

Sincerely,

Gulay Aki

Gulay Aki, Team Leader
Industrial & Hazardous Waste Permits Section
Waste Permits Division
Texas Commission on Environmental Quality

RSY/GA/gg

APPENDIX B

Evaluation of Potential Cap/Cover System Settlement

December 2, 2022

Mr. Pat Behling
WSP Golder
1601 S MoPac Expressway
Suite 325D
Austin, Texas, USA 78746

Re: Evaluation of Potential for Landfill Cap Settlement, A-1 Landfill – Martin Lake Steam Electric Station, Rusk County, Texas

Dear Mr. Behling:

As requested by WSP Golder, Bullock, Bennett & Associates, LLC (BBA) has evaluated the proposed cap system at the A-1 Landfill (A-1 LF) at the Martin Lake Steam Electric Station (MLSES) located in Rusk County, Texas – specifically in regard to the suitability of the proposed cap system to accommodate anticipated settlement. This evaluation is based on the most recent design drawings dated September 2016, provided to BBA by WSP Golder. No site-specific geotechnical data for the coal combustion residuals (CCR) fill material was provided to BBA for this analysis, and no site-specific consolidation or settlement data for on-site soils were provided; therefore, general assumptions regarding typical soil and CCR properties are made in this evaluation. It is BBA's understanding that site-specific soils and CCRs will be tested for engineering properties and that a detailed engineering settlement analysis using the on-site data and final design criteria will be completed prior to final cap construction activities.

The original Closure Plan for A-1 LF was prepared in October 2016 (PBW, 2016). The 2016 Closure Plan included use of a 3-foot-thick compacted clay liner system. To date, portions of the A-1 LF have been progressively capped using the 3-foot-thick clay system overlain by a 2-foot-thick vegetative soil cover. WSP Golder submitted a TCEQ Registration Update on December 20, 2019 that modified the proposed cap system to be constructed during future capping, to consist of a 2-foot-thick clay cap with an 18-inch-thick vegetative soil cover. This Registration Update was approved by TCEQ in a letter dated January 23, 2020:

The grades, slopes, etc. for the revised A-1 LF final cap/cover system will remain as presented in the 2016 A-1 LF Closure Plan.

The landfill cap will tie into the perimeter earth embankment system constructed of clay-rich mine spoil, which ranges from approximately 10- to 20- feet or more above the surrounding natural grades. The perimeter earth embankment was constructed in thin lifts of compacted embankment fill meeting engineering specifications.

<u>Engineering Properties of CCR Fill Material Underlying the Proposed Cap System</u>:

CCR fill materials for A-1 LF include mostly bottom ash and some flue gas desulfurization material (FGD, or gypsum). These CCRs are non-plastic and moderately to highly permeable (typically drain better than clays and silts) and are well suited as fill materials[1,2,3]. The coefficient of consolidation of bottom ash when compared to typical soils is typically low and decreases with incremental loading and time. This indicates the bottom ash possesses load taking ability and that structures, or in this case a landfill cap, lying above the ash will undergo gradual settling and not suffer large deformation - making ash well suited as a fill material.[1] According to the American Coal Ash Association approximately 3.63. million metric tons (4.0 million tons) of bottom ash were used in structural fill applications in 2006 (ACAA 2007). Structural fill and embankment material is the largest use of bottom ash in the US.[2] FGD material has engineering properties that also make it suitable for use as embankment fill.[3] BBA has experience in capping multiple impoundments and landfills in Texas containing bottom ash and gypsum and has performed annual engineering inspections for years following final capping activities at these facilities and has observed very little cap settlement.

Based upon review of the A-1 LF bottom and proposed cap elevations, it appears there will be a layer of dry-placed CCRs approximately 50 to 100-feet thick under the proposed cap system.

Subsurface Conditions:

The bottom of the A-1 LF is lined with a 1-foot thick layer of clay-rich mine spoil scarified and re-compacted to achieve an in-place permeability of 1×10^{-7} cm/sec or less. Subsurface conditions below the compacted bottom liner consist of up to 150 feet or more of low permeability, clay-rich mine spoil material that has been in place for approximately 40 years.

Based on review of the proposed cap system and technical specifications for materials and placement, evaluation of typical CCR engineering properties, the perimeter embankment system, and the site underlying subsurface conditions, it appears the cap design for A-1 LF is designed appropriately to accommodate settling and subsidence and will minimize the disruption of the integrity of the final capping system. Final cap grade designs include a 3% slope that will promote storm water drainage off the cap system, and these slopes appear sufficient to accommodate anticipated settlement while continuing to maintain positive surface water drainage. In addition, MLSES will conduct regularly scheduled cap inspections during post-closure care, and any settlement identified will be addressed to maintain cap design functions.

Please feel free to contact me at (512) 355-9198 if you have any questions about this submittal, or if I can be of any further assistance.

Sincerely,

Bullock, Bennett & Associates, LLC

Dan Bullock, PE (TX 82596)
Principal Engineer
Texas Professional Engineering Firm No. F-8542

STATE OF TEXAS
DANIEL B. BULLOCK
82596
REGISTERED
PROFESSIONAL ENGINEER
12/2/2022

---

(1) One-Dimensional Consolidation of Sedimented Stowed Pond Ash, Devi Presad Mishra and Samir Kumar Das Document: Geotech Geol Eng (2012) 30:685-695 DOI 10.1007/s10706-011-9486-x
(2) User Guideline for Coal Bottom Ash and Boiler Slag in Green Infrastructure construction, Craig H. Benson and Sabrina Bradshaw. December 2011. Recycled Materials Resource Center, University of Wisconsin-Madison.
(3) User Guideline for Flue Gas Desulfurization Material in Green Infrastructure construction, Craig H. Benson and Sabrina Bradshaw. December 2011. Recycled Materials Resource Center, University of Wisconsin-Madison

CCR CLOSURE PLAN
MARTIN LAKE STEAM ELECTRIC STATION
BOTTOM ASH PONDS AND NEW SCRUBBER POND
RUSK COUNTY, TEXAS

OCTOBER 2016

PREPARED FOR:

LUMINANT GENERATION COMPANY, LLC
1601 Bryan Street (EP-27)
Dallas, Texas 75201

PREPARED BY:

PASTOR, BEHLING & WHEELER, LLC
5416 Plaza Drive
Texarkana, Texas 75503
Texas Engineering Firm No. 4760

PBW Project No. 5196B

PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by Pastor, Behling & Wheeler, LLC under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I hereby certify that the conceptual closure plan was developed in accordance with the requirements of 40 CFR 257.102(b) of the CCR Rule.

STATE OF TEXAS
BRIAN D. THOMAS
91192
LICENSED
PROFESSIONAL ENGINEER
10/5/16

10/5/16
Brian Thomas, P.E.
Principal Engineer
PASTOR, BEHLING & WHEELER, LLC

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1.0 INTRODUCTION

Luminant Generation Company, LLC (Luminant) owns and operates the Martin Lake Steam Electric Station (MLSES) located approximately five miles southwest of Tatum in Rusk County, Texas. The power plant and related support areas occupy approximately 700 acres on a peninsula on the southwest side of Martin Lake (Figure 1). The MLSES consists of three coal/lignite-fired units with a combined operating capacity of approximately 2,250 megawatts. Coal Combustion Residuals (CCR) including fly ash, bottom ash, and gypsum are generated as part of MLSES unit operation. The CCRs are transported off-site for beneficial use by third-parties, are managed by Luminant on-site at Permanent Disposal Pond No. 5 (PDP-5) or are disposed at Luminant's A-1 Area Landfill.

The CCR Rule (40 CFR 257 Subpart D - *Standards for the Receipt of Coal Combustion Residuals in Landfills and Surface Impoundments*) has been promulgated by EPA to regulate the management and disposal of CCRs as solid waste under Resource Conservation and Recovery Act (RCRA) Subtitle D. The final CCR Rule was published in the Federal Register on April 17, 2015. The effective date of the CCR Rule was October 19, 2015.

The CCR Rule establishes national operating criteria for existing CCR surface impoundments and landfills, including development of closure plans for all CCR impoundments and landfills. Pastor, Behling & Wheeler, LLC (PBW) was retained by Luminant to develop this closure plan for the CCR impoundments at the MLSES.

1.1 CCR Surface Impoundment Closure Plan Requirements

40 CFR 257.102(b) of the CCR Rule specifies that a written closure plan must be prepared for each existing CCR surface impoundment that describes the steps necessary to close the impoundment at any point during the active life of the unit consistent with recognized and generally accepted good engineering practices. The closure plan must include, at a minimum, the following information:

- A narrative description of how the CCR impoundment will be closed in accordance with 40 CFR 257.102;

- If closure of the impoundment will be accomplished through removal of CCR from the unit, a description of the procedures to remove the CCR and decontaminate the impoundment in accordance with 40 CFR 257.102(c) of the CCR Rule. CCR removal and decontamination of the impoundment are considered complete when constituent concentrations throughout the impoundment and any areas affected by releases from the unit have been removed and groundwater monitoring concentrations do not exceed applicable groundwater protection standards.

- If closure of the impoundment will be accomplished by leaving CCR in place, the closure plan will provide a description of the final cover system designed in accordance with 40 CFR 257.102(d) of the CCR Rule, including details concerning the methods and procedures used to install the final cover. The closure plan must also discuss how the final cover system will achieve the following performance standards specified in 40 CFR 257.102(d):

  - Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere;

  - Preclude the probability of future impoundment of water, sediment, or slurry;

  - Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during the closure and post-closure care period;

  - Minimize the need for further maintenance of the unit; and

  - Be completed in the shortest amount of time consistent with recognized and generally accepted good engineering practices.

  Prior to installing the final cover system on the closed impoundment, free liquids must be eliminated by removing liquid wastes or solidifying the remaining wastes and waste residues and the remaining wastes must be stabilized sufficiently to support the final cover system.

  The final cover system must be designed and constructed to meet the following criteria:

  - The permeability of the final cover system must be less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1 X 10^{-5} cm/sec, whichever is less.

  - The infiltration of liquids through the closed CCR unit must be minimized by the use of an infiltration layer that contains a minimum of 18 inches of earthen material.

  - The erosion of the final cover system must be minimized by the use of an erosion layer that contains a minimum of six inches of earthen material that is capable of sustaining native plant growth.

  - The disruption of the integrity of the final cover system must be minimized through a design that accommodates settling and subsidence.

  An alternative final cover system design may also be used, provided the alternative final cover system is designed and constructed to meet the following criteria:

  - The alternative final cover system must include an infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified above.

  - The alternative final cover system must include an erosion layer that provides equivalent protection from wind or water erosion as the erosion layer specified above

  - The disruption of the integrity of the alternative final cover system must be minimized through a design that accommodates settling and subsidence.

- An estimate of the maximum inventory of CCR ever on-site over the active life of the impoundment and an estimate of the largest area of the impoundment ever requiring a final cover at any time during the active life of the unit.

- A schedule for completing all activities necessary to satisfy the closure criteria, including an estimate of the year in which all closure activities for the impoundment will be completed. The schedule should provide sufficient information to describe the sequential steps that will be taken to close the unit, including identification of major milestones such as coordinating with and obtaining necessary approvals and permits from other agencies, the dewatering and stabilization phases of impoundment closure, or installation of the final cover system, and the estimated timeframes to complete each step or phase of unit closure.

- In accordance with 40 CFR 257.102(e)(1) of the CCR Rule, closure of a surface impoundment must be initiated no later than 30 days after the date on which the impoundment either receives the known final receipt of CCR or non-CCR waste or the known final volume of CCR is removed from the impoundment for the purpose of beneficial use. Alternatively, under 40 CFR 257.1032(e)(2), closure of the impoundment must be initiated if the impoundment has been idle and has not received CCR or non-CCR waste for two years. Additional two year extensions to initiate closure may be obtained with appropriate documentation.

- In accordance with 40 CFR 257.102(f) of the CCR Rule, closure of a surface impoundment must be completed within five years of commencing closure activities. Additional extensions to complete closure may be obtained with appropriate documentation.

The impoundment closure plan must be certified by a qualified professional engineer and must document how the closure plan has been designed and constructed to comply with the requirements of 40 CFR 257.102(b)(4) of the CCR Rule.

In accordance with 40 CFR 257.102(b)(2) of the CCR Rule, the initial written closure plan for an existing CCR surface impoundment must be completed and placed in the facility operating record no later than October 17, 2016.

1.2 MLSES Impoundments Subject to CCR Closure Plan Requirements

The CCR Rule defines coal combustion residuals such as fly ash, bottom ash, boiler slag, flue gas desulfurization (FGD) materials (gypsum), and related solids generated from burning coal for the purpose of generating electricity by electric utilities and independent power producers. The closure plan requirements of the CCR Rule apply to surface impoundments that dispose or otherwise engage in solid waste management of CCRs. The surface impoundments at the MLSES that meet the definition of an existing CCR unit are the West Ash Pond (WAP), East Ash Pond (EAP), New Scrubber Pond (SP), and Permanent Disposal Pond-5 (PDP-5).

This closure plan addresses the following CCR surface impoundments at the MLSES:

- West Ash Pond (WAP),
- East Ash Pond (EAP), and
- New Scrubber Pond (SP)

Due to their proximity to each other, the BAPs and SP will be considered one CCR surface impoundment (identified as the "CCR Unit Closure Area") for the purposes of this closure plan.

1.3 Description of BAPs

The WAP and EAP (collectively "Bottom Ash Ponds" or "BAPs") are located approximately 2,000 feet east of the MLSES power plant (Figure 2). A site plan for the BAPs is shown on Figure 3.

The BAPs receive recovered overflow from bottom ash dewatering bins and other MLSES process wastewater sources that typically include bottom ash fines. The ponds also act as surge basins for various water streams in the ash-water system. Recovered sluice water, process waters and storm water runoff from the MLSES ash-water system are pumped to each pond through a series of above grade pipes. The BAPs are constructed partially above and partially below grade and all material that enters the ponds is pumped into the impoundments. There are no gravity discharges to the BAPs.

The BAPs share an interior embankment and cover areas of approximately 14.6 acres and 9.6 acres, respectively, and are surrounded by engineered earthen dikes that extend above grade, typically less than 20 feet. The BAPs are constructed partially above and partially below grade and are surrounded by earthen embankments that extend approximately 10 to 20 feet above grade depending on surrounding topography. The exterior slopes of the embankments are vegetated with grasses and similar vegetation.

The BAPs were originally constructed in 1977 with an in-situ compacted clay liner. The WAP was removed from service in March 1988 and re-lined with a double 60-mil high density polyethylene (HDPE) liner system overlain with a concrete revetment mat. The EAP was dredged and removed from service in 1989, and a new south embankment was constructed to allow for an increase in the size of the SP. The EAP remained inactive until the installation of a new double 60-mil HDPE liner system with concrete revetment mat was completed in February 2010. The crest elevation of the BAP embankment is 330 feet above mean sea level (MSL) and the EAP borders Martin Lake. Based on available construction data, the BAPs were constructed to provide 232.6 and 125.8 acre-feet of storage capacity for the WAP and EAP, respectively. The total design capacity of the BAPs is approximately 116,764,000 gallons or approximately 358.4 acre-feet.

1.4 Description of SP

A site plan for the SP is shown on Figure 3. The SP is an approximately 12.5 acre surface impoundment that is used to manage gypsum as well as discharge from the sludge thickener sumps, the plant yard sumps, and storm water management areas. Process wastewater can be transferred from the SP to the BAPs and PDP-5, or used as makeup water to the scrubber systems. The SP is located partially above and partially below grade and all material that enters the ponds is pumped into the impoundment. There are no gravity discharges to the SP.

The west embankment of the SP is an internal/shared embankment with the WAP and a portion of the northern embankment is an internal/shared embankment with the EAP. The SP is constructed partially below grade and is surrounded by engineered earthen embankments that extend above grade (typically less than 20 feet). The exterior slopes of the embankments are vegetated with grass and similar vegetation.

The SP was originally constructed in the 1977 and was expanded to its current size in 1989. The SP was relined in 1989 with a double 60-mil HDPE liner system, overlain with a concrete revetment mat. The crest elevation of the SP embankments is 330 feet MSL and borders Martin Lake on portions of both the north and south embankments. Based on available construction data, the SP was constructed to provide 198.9 acre-feet or approximately 64,800,000 gallons of storage capacity.

Total design capacity of the CCR impoundments located within the CCR Unit Closure Area (WAP, EAP and SP) is 557.3 acre-feet or approximately 181,597,000 gallons. The CCR Unit Closure Area is classified as a low hazard potential impoundment in accordance with the requirements of 40 CFR 257.73(a)(2) of the CCR Rule (PBW, 2016).

2.0 CLOSURE PLAN FOR CCR IMPOUNDMENTS

Although the closure plan presented herein for the CCR Unit Closure Area was developed in accordance with the requirements of 40 CFR 257.102 of the CCR Rule, this plan should be considered conceptual in nature given the fundamental assumptions used as the basis of the closure plan. Upon initiation of final CCR unit closure activities, the conceptual closure plan should be reviewed and revised to ensure appropriate modifications are incorporated into the final design plans and specifications prior to release for bidding and construction.

2.1 Narrative Description of CCR Impoundment Closure

Luminant plans to close the CCR Impoundments in accordance with 40 CFR 257.102(d) of the CCR Rule by leaving CCR in-place and constructing a final cover system over CCR located within the combined footprint of these three surface impoundments.

2.2 Removal of Free Liquids and CCR Stabilization – CCR Unit Closure Area

Free liquids present within the CCR Unit Closure Area will be removed by constructing dewatering sumps within accessible areas of the CCR prior to placement of cap subgrade and the final cover system. Free liquids removed from the impoundments will be managed in accordance with applicable state regulations. Following removal of liquids from the impoundments, the stability of the CCR material should be evaluated to ensure adequate bearing capacity for equipment used to construct the cap. For the purposes of this conceptual closure plan, PBW has assumed that the dewatered CCR will accommodate construction equipment necessary to place a minimum two-foot thick bridging lift of approved fill. To the extent practicable prior to and during placement of the bridging lift, CCR within the impoundments will be progressively graded to achieve a uniform slope (+/- 1%) across the impoundment. The bridging lift will be placed to establish a suitable base for placement of the cap subgrade, and will consist of an initial one-foot thick compacted lift followed by two six-inch compacted lifts. Approved materials for use in the bridging lift and placement methods will conform to the Technical Specifications for general earthwork and CCR stabilization provided in Sections 02300 and 02310, respectively (Appendix A).

2.3 Final Cover System – CCR Unit Closure Area

For the purposes of this conceptual closure plan, two final cover system options for the CCR Unit Closure Area are presented in this section. In accordance with 40 CFR 257.102(d) of the CCR Rule, the permeability of each final cover system option will be less than or equal to the permeability of the existing bottom liner in the CCR impoundments (double 60-mil HDPE liner system). The proposed final grading plan for the final cover system is illustrated in Figure 4, and typical construction details and surface water drainage controls for each the final cover systems are provided in Figures 5-7.

Technical Specifications for material selection and placement of the proposed final cover system alternatives and the associated cap subgrade have been developed to minimize potential for differential settlement and subsidence. Post-closure monitoring activities will be performed to ensure the cover system complies with the requirements of the CCR Rule. Furthermore, an evaluation of infiltration through the proposed cover systems was developed using the U.S. Army Corps of Engineers – Hydrologic Evaluation of Landfill Performance (HELP) model (Appendix B). As demonstrated by the HELP model results, the permeability of the clay cap (infiltration layer) final cover system option will be less than or equal to the permeability of the bottom liner system and the permeability of the linear low density polyethylene cap option will achieve an improved reduction in infiltration compared to the clay cap (infiltration layer) option. Both final cover options will be designed to minimize impounding of water on the cap and associated long-term care activities.

2.3.1 Compacted Clay Cap

Select fill and/or CCR deemed suitable for beneficial re-use will be placed within the proposed limits of the impoundment cover system for the CCR Unit Closure Area to the lines and grades specified for the cap subgrade (Figures 5 and 7). Upon placement of cap subgrade to within approximately five feet of proposed finished grade, only approved select fill material (i.e. embankment spoil material or contactor-supplied select fill) will be placed in accordance with the specifications for cap subgrade. A three foot thick compacted clay liner with permeability of no greater than $1x10^{-7}$ cm/sec will be placed on the prepared cap subgrade material. Cap subgrade and clay cap material selection, placement, compaction and testing will conform to the Technical Specifications in Section 02320 and 02330, respectively (Appendix A). An 18-inch minimum thickness vegetative soil layer will be placed in a single loose lift over the prepared clay cap and permanent vegetative cover will be established in accordance with Sections 02340 and 02350 of the Technical Specification (Appendix A).

2.3.2 Geosynthetic Cap

Select fill and/or CCR deemed suitable for beneficial re-use will be placed within the proposed limits of the impoundment cover system for the CCR Unit Closure Area to the lines and grades specified for the cap subgrade (Figure 4 and 6). Upon placement of cap subgrade to within approximately 2.5 feet of proposed finished grade, only approved select fill material (i.e. embankment spoil material or contactor-supplied select fill) will be placed in accordance with the specifications for cap subgrade. A 40-mil linear low-density polyethylene (LLDPE) liner will be installed over the prepared cap subgrade. LLDPE liner deployment, field seaming, and field quality assurance testing will conform to Section 02420 of the Technical Specifications (Appendix A). A geonet drainage layer will be installed above the LLDPE liner to provide lateral drainage relief of infiltration from the overlying vegetative soil layer. An 18-inch (minimum thickness) vegetative soil layer will be placed in a single loose lift over the prepared geosynthetic cap system and permanent vegetative cover will be established in accordance with Sections 02340 and 02350 of the Technical Specification (Appendix A).

2.4 Final Cover System Slope Stability

Selection of suitable construction materials, proper material placement, and quality assurance testing of both the subgrade preparation and cover system installation in accordance with the Technical Specifications (Appendix A) will ensure stability of the final cover system. The SLIDE 7.0 equilibrium slope stability model was used to demonstrate that the proposed cover system is stable at the slopes specified in the conceptual closure plan (see Appendix C). Previous slope stability modeling performed by Golder and Associates (Burns & McDonnell, 2015) concluded that the existing embankments are stable under both short-term and long-term modeling conditions. Updated slope stability modeling of the existing CCR Unit Closure Area embankments is currently being prepared by others to comply with initial and periodic stability evaluations required by 40 CFR 257.73(f) of the CCR Rule.

2.5 Stormwater Run-off Control

The final grading of the CCR Unit Closure Area cover system will establish uniform slopes of approximately 3 percent on the portion of the cap overlying CCR, and slope lengths will generally not exceed 300 feet. Surface drainage of the portion of the cap covering CCR will generally consist of sheet flow or shallow concentrated flow within perimeter grass-lined channels (located outside the capped area) that will convey run-off to Martin Lake. Both cover system alternatives will allow for lateral drainage of infiltration off the capped area to prevent saturation of the vegetative layer and/or ponding on the cover system. The geosynthetic cover system includes a drainage layer above the impermeable capping system that is designed to collect infiltration from the vegetative layer and control discharge to the limits of the cover system, which also prevents saturation of the vegetative layer and/or ponding on the cover system. A conceptual run-off control plan that includes estimated peak discharges based on the 25-year/24-hour storm event (8.6 inches) for capped area is presented in Appendix D (Hershfield, 1961). Typical construction details for the geocomposite drainage layer and surface water conveyance structures are provided on Figure 7, and Technical Specifications for the geocomposite drainage layer and EnviroGrid™ slope erosion control are provided in Appendix A.

2.6 CCR Inventory and Area to Be Capped

For the purposes of this conceptual closure plan, in-place closure of CCR within the CCR Unit Closure Area is based on the assumed volume of CCR (solids) contained in the ponds being limited to 50 percent of the capacity of the ponds. Based on this assumption, CCR Unit Closure Area will be closed as a single CCR management unit, which will contain approximately 524,809 cubic yards of CCR at time of closure. This estimated volume of CCR does not include decontamination spoil material generated from the decontamination of the interior embankments of the CCR Unit Closure Area above the elevation of the aforementioned 50 percent solids capacity. The combined surface area of the CCR Unit Closure Area is approximately 34-acres. Given that the proposed limits of the cover system extends over the interior embankment between the ponds and extends beyond the historic limits of the CCR impoundments to tie-in with the exterior slope of the existing perimeter embankments, the final surface area of the cover system will slightly exceed 38-acres.

2.7 Closure Schedule

The final closure of the CCR Unit Closure Area will be completed within 5 years of start of closure; however, 40 CFR 257.102(f)(2) and 257.103 of the CCR Rule allow for extension of the closure schedule or demonstration that alternative closure requirements should apply to the CCR unit. A Gantt chart illustrating the sequential steps of the CCR closure process, including pre-construction activities (i.e. necessary notifications and permitting) as well as closure milestones, is included as Appendix E.

3.0 REFERENCES

Burns & McDonnell Engineering Company, Inc., 2015. *Martin Lake Pond Study* – Luminant Energy, Rusk County, TX, November 10.

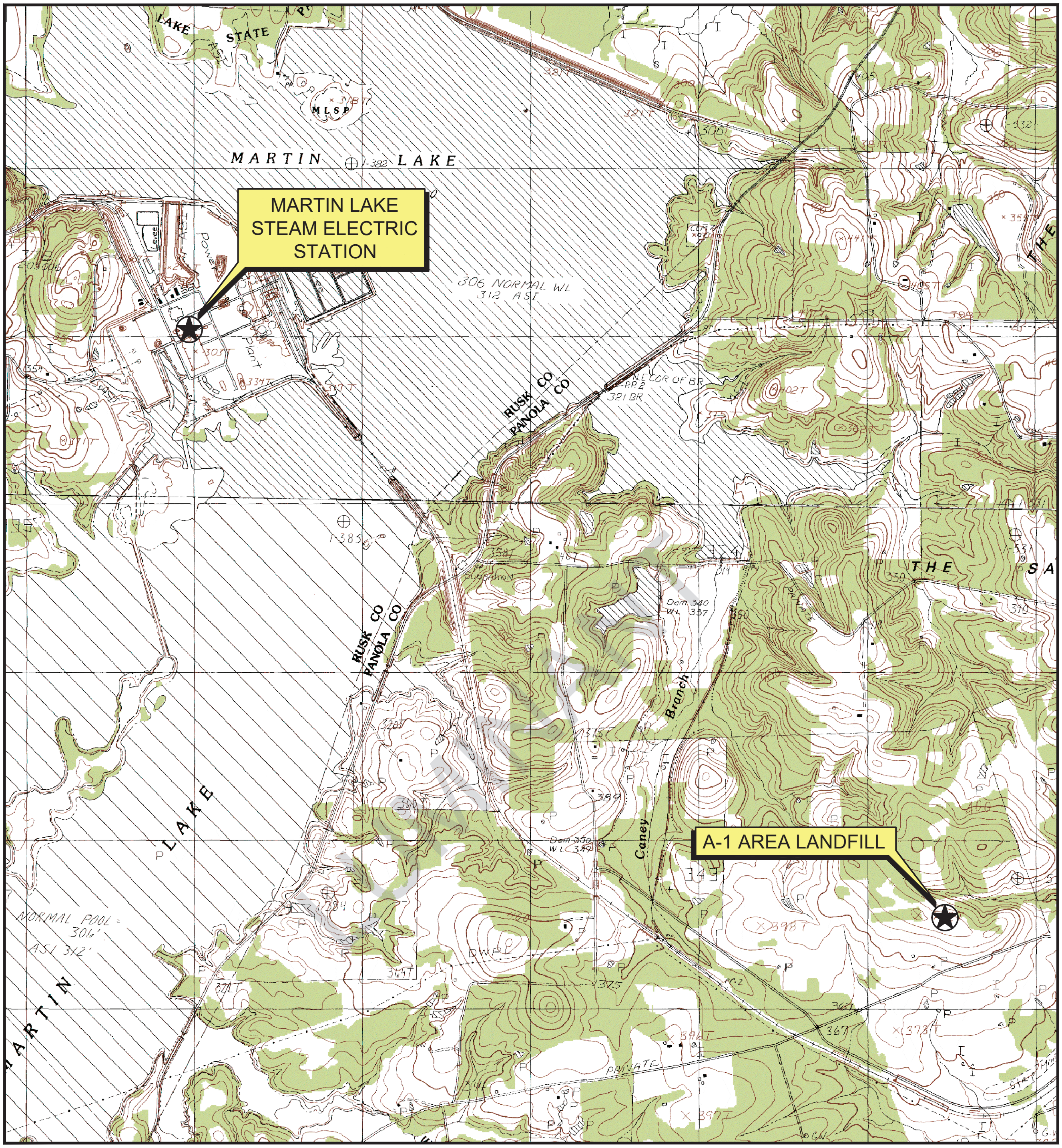
Dewberry Consultants, LLC (Dewberrry), 2014. *Coal Combustion Residue Impoundment Round 12 - Dam Assessment Report, Martin Lake Steam Electric Plant Coal Combustion Residuals Impoundments, Tatum, Texas*, EP-09W001727, March.

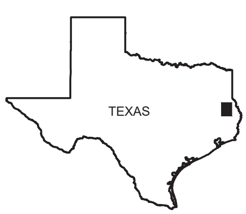
Hershfield, OM. 1961. Rainfall Frequency Atlas of the United States for Durations from 30 minutes to 24 hours and Return Periods from 1 to 100 Years, U.S. Dept. Commerce, Weather Bureau. Technical Paper No. 40. Washington, DC.

Pastor, Behling & Wheeler, LLC (PBW), 2016. Hazard Classification Assessment – Martin Lake Steam Electric Station Ash Pond Area and Permanent Disposal Pond No. 5, Rusk County, Texas. October.

U.S. Army Corps of Engineer, 1997, Hydrologic Evaluation of Landfill Performance (Version 3.07), November 1.

FIGURES





□UADRANGLE LOCATION

N

Scale in Feet

0 1500 3000

SOURCE:
Base map from www.tnris.gov, Tatum, TX 7.5 min. USGS □uadrangle dated 1983.

LUMINANT GENERATION COMPANY, LLC

MARTIN LAKE STEAM ELECTRIC STATION

Figure 1

SITE LOCATION MAP

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DATE: SEPT., 2016	CHECKED: BDT	

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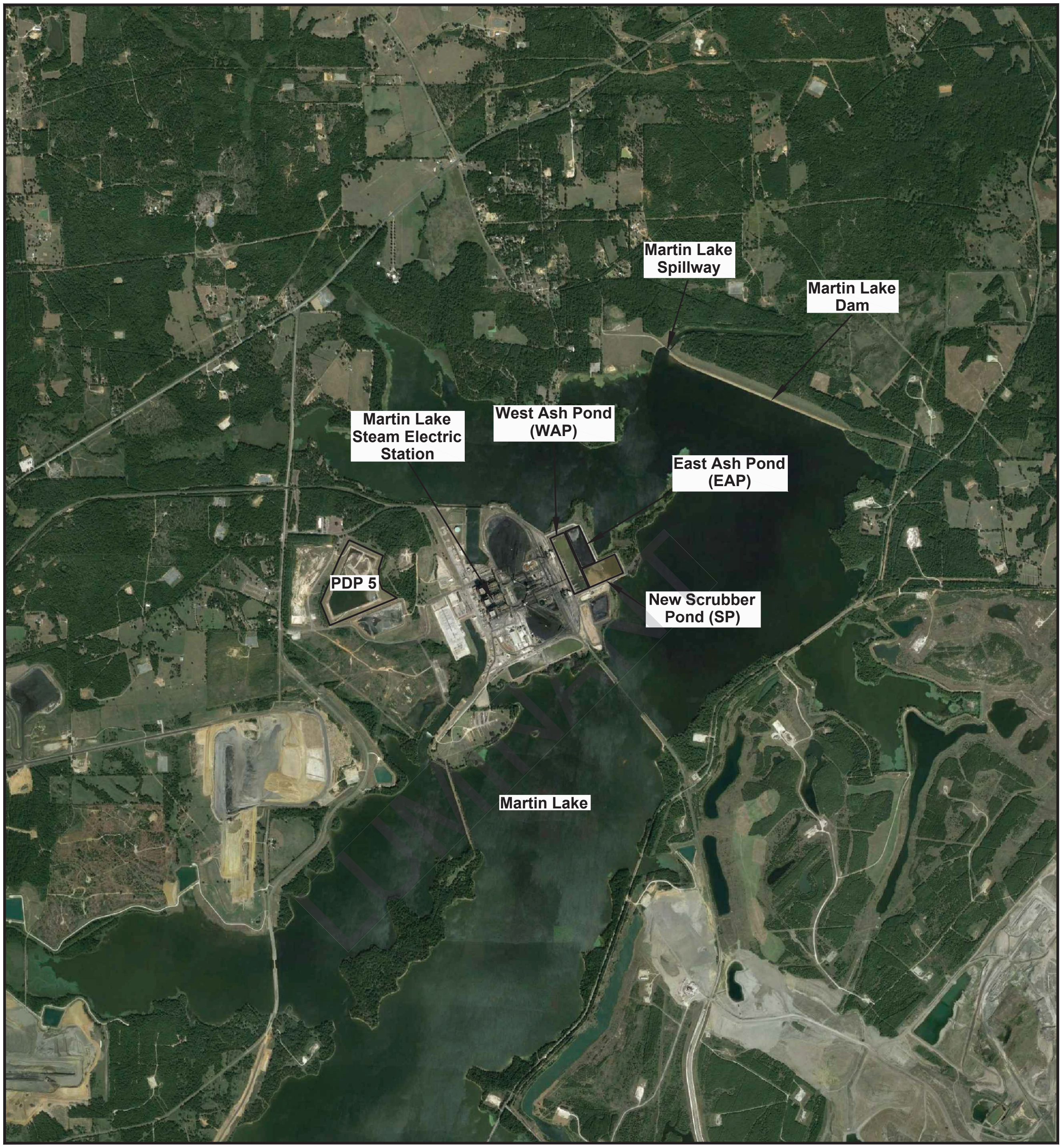

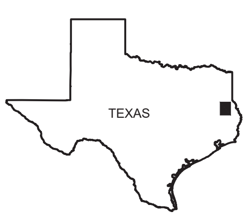

PHOTOGRAPH LOCATION

N

Scale in Feet

0 2000 4000

SOURCE:
Imagery from Google Earth, photography dated October 1, 2015.

LUMINANT GENERATION COMPANY, LLC
MARTIN LAKE STEAM ELECTRIC STATION

Figure 2

SITE VICINITY MAP

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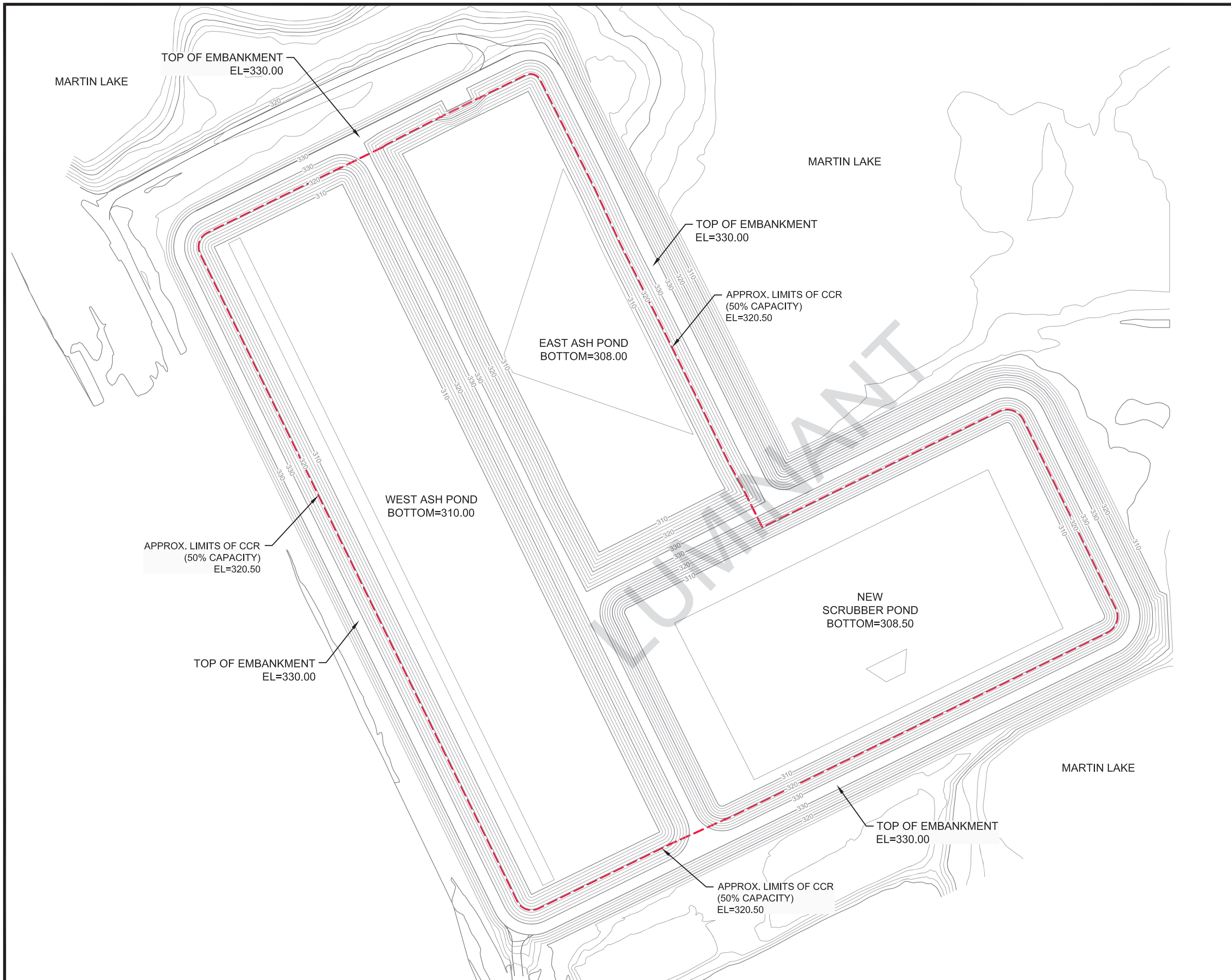

EXPLANATION

Existing Grade Contour 2 ft Interval

Existing Grade Contour 10 ft Interval

50 Percent Solid Fill Limit

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MARTIN LAKE STEAM ELECTRIC STATION

Figure 3

EXISTING SITE PLAN

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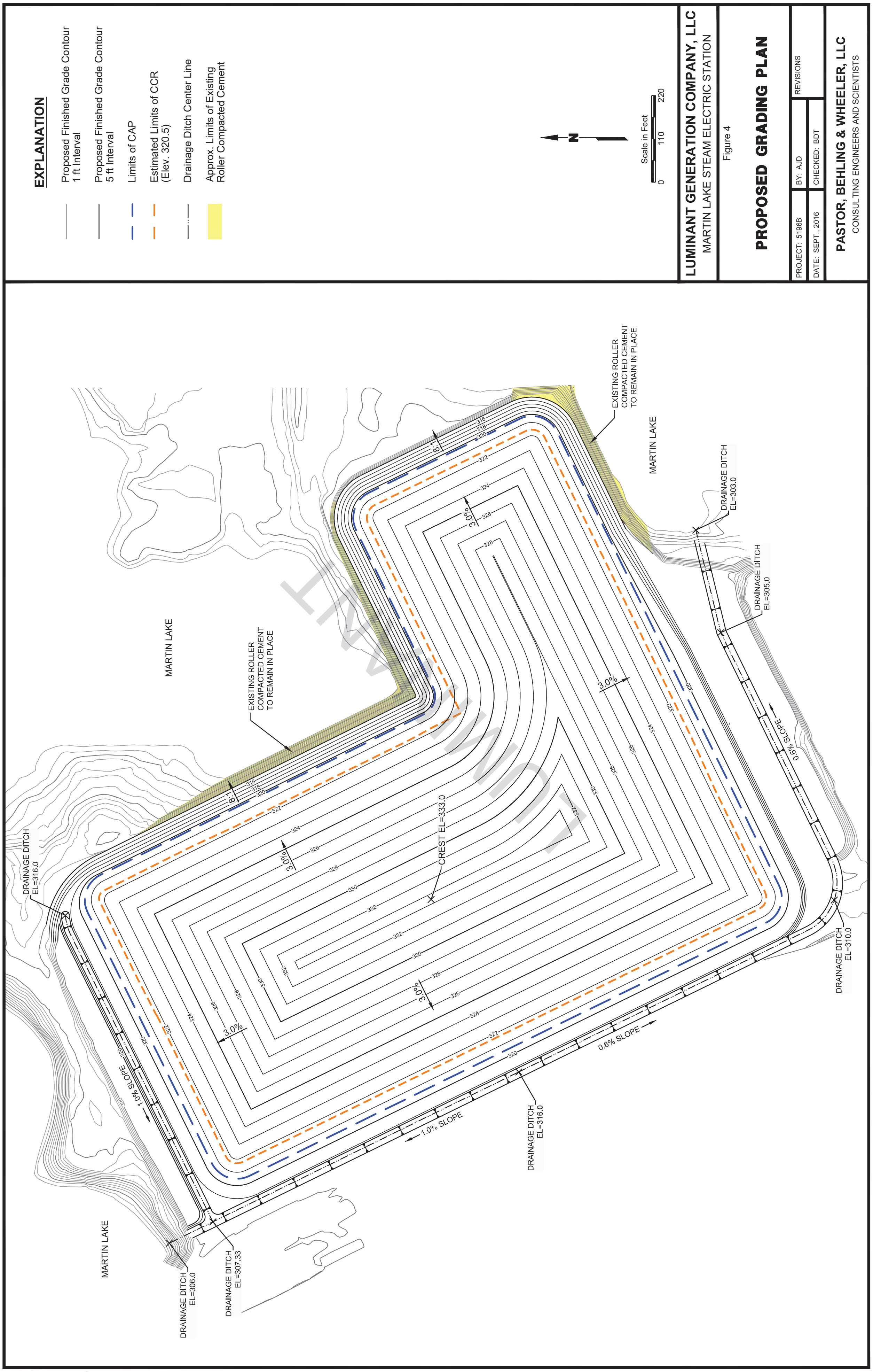
EXPLANATION
Proposed Finished Grade Contour 1 ft Interval
Proposed Finished Grade Contour 5 ft Interval
Limits of CAP
Estimated Limits of CCR (Elev. 320.5)
Drainage Ditch Center Line
Approx. Limits of Existing Roller Compacted Cement
Scale in Feet
0
110
220
N
LUMINANT GENERATION COMPANY, LLC
MARTIN LAKE STEAM ELECTRIC STATION
Figure 4
PROPOSED GRADING PLAN
REVISIONS
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BY: AJD
DATE: SEPT., 2016
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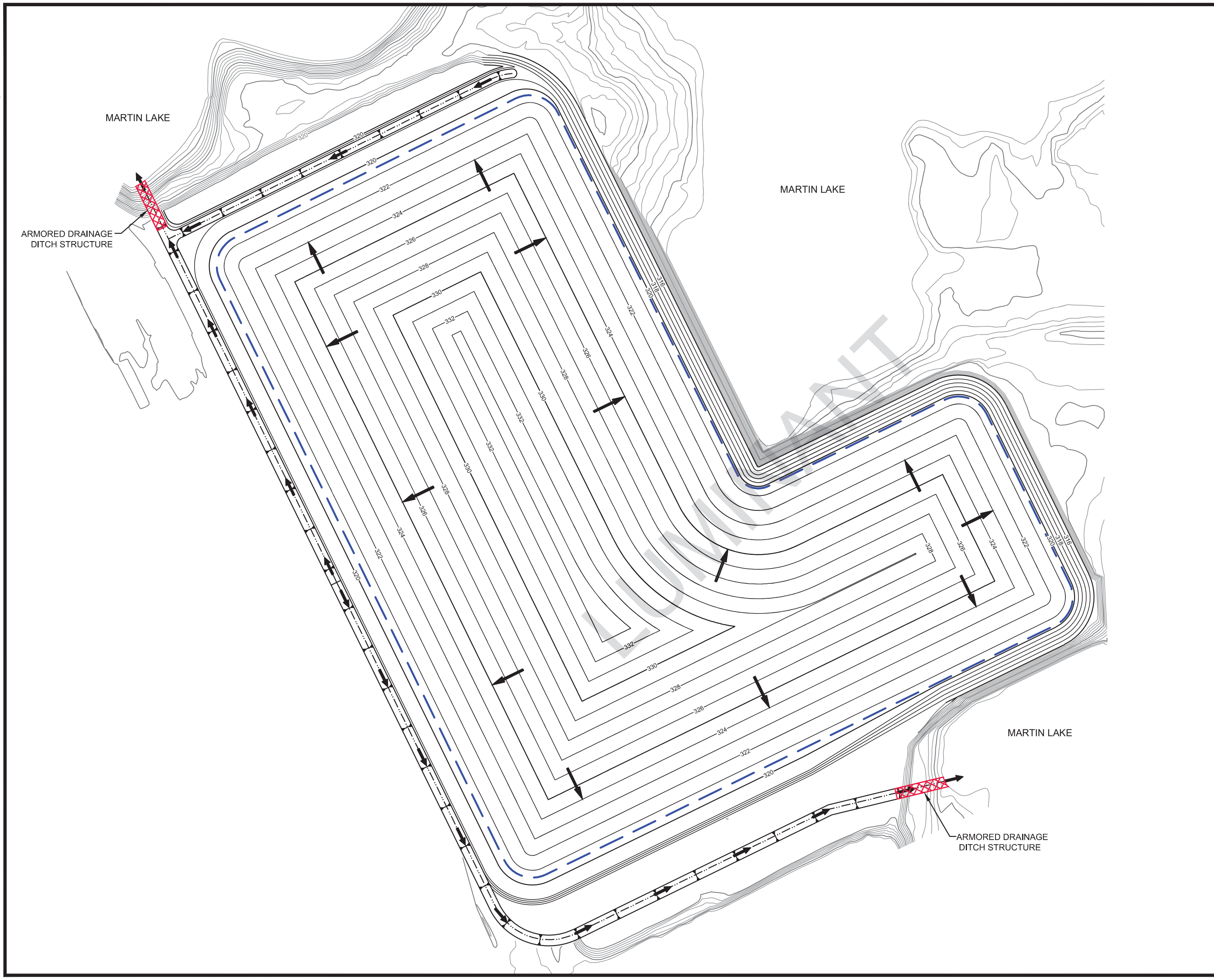
PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS
MARTIN LAKE
EXISTING ROLLER COMPACTED CEMENT TO REMAIN IN PLACE
DRAINAGE DITCH EL=303.0
DRAINAGE DITCH EL=305.0
DRAINAGE DITCH EL=316.0
DRAINAGE DITCH EL=310.0
DRAINAGE DITCH EL=306.0
DRAINAGE DITCH EL=307.33
CREST EL=333.0
3.0%
8:1
0.6% SLOPE
1.0% SLOPE
316
318
320
322
324
326
328
330
332



EXPLANATION

- Proposed Finished Grade Contour 1 ft Interval
- Proposed Finished Grade Contour 5 ft Interval
- Limits of CAP
- Sheet Flow
- Concentration Flow Path

N

Scale in Feet

0 110 220

LUMINANT GENERATION COMPANY, LLC

MARTIN LAKE STEAM ELECTRIC STATION

Figure 5

SURFACE WATER CONTROL PLAN

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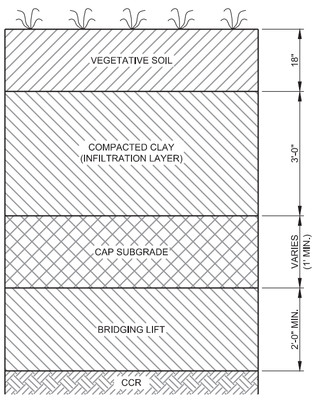
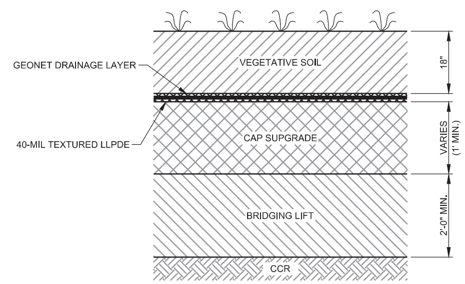


1/7 CLAY CAP DETAIL
NOT TO SCALE



2/7 GEOCOMPOSITE CAP DETAIL
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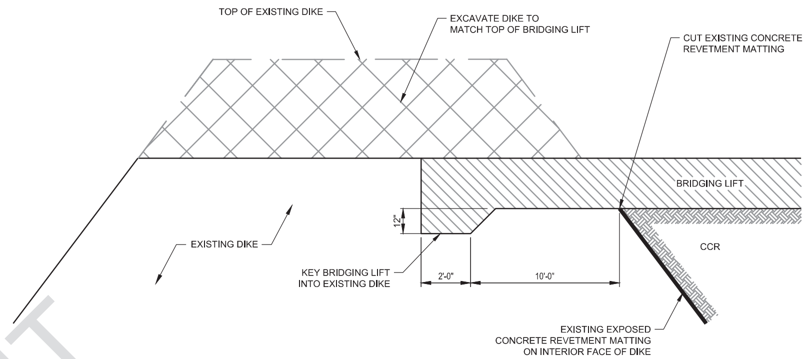
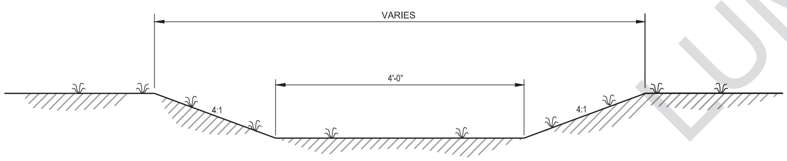
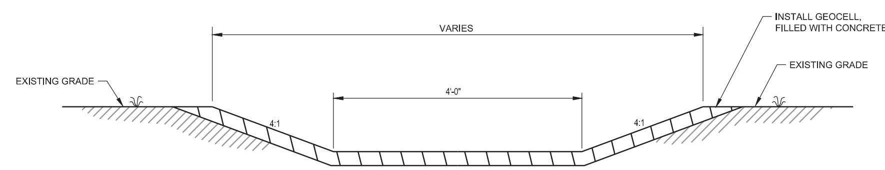


3/7 DIKE CONNECTION DETAIL
NOT TO SCALE



4/7 DRAINAGE DITCH
NOT TO SCALE



5/7 ARMORED DRAINAGE DITCH SECTION
NOT TO SCALE

LUMINANT

LUMINANT GENERATION COMPANY, LLC MARTIN LAKE STEAM ELECTRIC STATION		
Figure 6 **TYPICAL CONSTRUCTION DETAILS - CCR COVER SYSTEM**		
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DATE: SEPT., 2016	CHECKED: BDT	
PASTOR, BEHLING & WHEELER, LLC CONSULTING ENGINEERS AND SCIENTISTS		

APPENDIX A

TECHNICAL SPECIFICATIONS

CCR UNIT CLOSURE AREA
TECHNICAL SPECIFICATIONS

MLSES CCR UNIT CLOSURE AREA
TECHNICAL SPECIFICATIONS
TABLE OF CONTENTS

SECTION 01100

EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section consists of furnishing, placing, and maintaining erosion and sedimentation control measures as shown on the Drawings, as directed by the COMPANY, and where necessary to reduce sediment content of runoff prior to establishment of permanent vegetation.

1.2 PERFORMANCE REQUIREMENTS

A. CONTRACTOR shall provide erosion and sedimentation control measures to control erosion and sediment runoff in any location where erosion and sediment runoff is likely to occur and as required by the COMPANY. Erosion and sedimentation control measures shall remain in place until removal is approved by the COMPANY.

B. Clearing and stripping of vegetation, regrading and other construction activities shall be conducted in a manner to minimize erosion. Existing drainage patterns and vegetation shall be protected and retained to the greatest extent practicable.

C. The size and duration of exposure of disturbed areas shall be kept to a minimum and all disturbed soil shall be stabilized as quickly as practicable. Diversion channels/berms shall be located upstream from disturbed areas to minimize the amount of run-on to the disturbed areas.

D. In the event that erosion and sedimentation control measures used by CONTRACTOR prove to be inadequate as determined by COMPANY, CONTRACTOR shall be required to adjust his operations to the extent necessary to control sedimentation and shall repair areas impacted by sedimentation as directed by COMPANY at no additional cost to COMPANY.

1.3 SUBMITTALS

A. CONTRACTOR shall submit the following to COMPANY a minimum of 14 days prior to initiating field activities:

1. A copy of the construction Storm Water Pollution Prevention Plan (SWPPP) developed for the Work.
2. An installation schedule for erosion and sedimentation control measures. This schedule shall cover all ground disturbance activities including material staging areas and planned excavation and grading areas.
3. Certification that all proposed erosion and sedimentation control products comply with the requirements of these specifications.

PART 2 - PRODUCTS

2.1 SILT FENCE

A. Silt fence fabric material shall be a woven geotextile conforming to the following requirements:

Physical Property	Test Method	Requirement
Tensile Strength, lb.	ASTM D4632	100 Minimum
Elongation @ Yield, %	ASTM D4632	10-40
Trapezoidal Tear, N (lb.)	ASTM D4533	50 Minimum
Apparent Opening Size	ASTM D4751	20-50
Permittivity, 1/sec	ASTM D4491	0.1 Minimum
UV Stability, 500 hr.	ASTM D4355	80 Minimum

B. Posts shall be essentially straight wood or steel posts with a minimum length of 48 inches. Soft wood posts must be at least 3 in. in diameter or nominal 2 x 4 in. Hardwood posts must have a minimum cross-section of 1-1/2 x 1-1/2 inches. T- or L-shaped steel posts must have a minimum weight of 1.3 pounds per foot.

2.2 EROSION CONTROL FABRIC

A. Erosion Control Fabric shall be North American Green S150 or COMPANY-approved equal.

B. Erosion control fabric blanket shall have a minimum width of 6 feet. The fabric mat shall be machine-produced of 100 percent coconut fiber with colored line or thread along outer edges to indicate material overlap limits and shall have a minimum weight of 0.50lb./sq.yd.

C. The top and bottom cover of the fabric shall be heavy-weight polypropylene netting with ultraviolet additives to delay breakdown. The mesh size shall be a minimum of 0.5 inch by 0.5 inch.

D. The blanket and top/bottom covers shall be sown together on 1.5 inch center at 50 stitches per roll width with UV stable polypropylene thread.

E. Erosion Control Fabric shall be installed using 6-in. wooden stakes or metal staples of sufficient material quality, cross-section, and strength to anchor the erosion control blanket against loads imposed by surface runoff and sediment.

2.3 HAY BALES

A. Hay bales may be obtained from local sources and shall weigh 40 to 120 pounds per bale. Only grain hay bales, free of noxious weeds, shall be used. Bales shall be tightly and securely bound with wire to provide a stable bale and to extend the functional life of the bale to the extent practicable. Bales shall be free from rot and mold.

B. Stakes for hay bales shall be wooden stakes or metal rebar of sufficient material quality, cross-section, and strength to secure the hay bales.

2.4 TEMPORARY VEGETATION

A. Temporary Vegetation shall be applied on areas left exposed for greater than 30 days. CONTRACTOR shall use temporary vegetation seed mixture and application rate as specified in Section 02350, "Vegetation," or CONTRACTOR may alternatively submit proposed temporary vegetation seed mix and application rate to COMPANY for approval no later than 7 days prior to use.

B. Mulch shall be applied after temporary vegetation seeding at a rate of 1.5 tons/acre for straw mulch, or at the rate recommended by the manufacturer if wood fiber mulch is used.

CONTRACTOR shall ensure that mulch does not redistribute after application. CONTRACTOR shall reapply mulch as necessary to maintain uniform coverage. Straw mulch shall include dry oat or wheat straw, native hay, or chopped corn stalks. The mulch shall be free from weeds and foreign matter detrimental to plant life. Wood fiber mulch shall include approved wood cellulose fiber in chip form and be free of ingredients that could inhibit germination and growth.

PART 3 - EXECUTION

3.1 GENERAL

A. Delivery, Storage, and Handling. Product delivery, storage and handling shall comply with manufacturer's recommendations. All erosion and sedimentation control products shall be delivered in manufacturer's wrapping and shall be stored in a manner to prevent damage. Damaged or unsuitable products shall be promptly removed from the job site and replaced with products meeting these specifications.

B. All erosion and sedimentation control measures shall be installed in accordance with manufacturer’s recommendations and approved by the COMPANY prior to initiating any clearing, demolition or construction activities.

C. Cut Areas. Establish an erosion control line (hay bales or filter fabric) at toe of slope in all cut areas prior to beginning cut operations.

D. Fill Areas. Establish an erosion control line (hay bales or filter fabric) approximately 10 feet from toe of slope of proposed fill areas prior to beginning fill operations.

E. Stockpiles. Sides of soil stockpiles shall have a maximum slope of 2:1. All stockpiles shall be surrounded by a sediment barrier (hay bales or filter fabric) unless other wise approved by the COMPANY. All stockpiles left bare for more than 30 days shall be stabilized with temporary vegetation and/or mulch.

3.2 SILT FENCE

A. Silt fence shall be installed along the downstream perimeter of all disturbed areas to intercept sediment from sheet flow.

B. Posts shall be embedded into the ground at least 18 inches deep and shall be spaced a maximum of 8 feet apart.

C. Filter fabric shall be installed by digging a 6 inch wide by 6 inch deep trench along the upstream side of the fence. Place approximately 6 to 8 inches of the fabric in the trench and backfill the trench.

D. Unless otherwise shown on the Drawings, attach the wire mesh to wooden posts with staples, or to steel posts with T-clips, in at least 4 places equally spaced. Sewn vertical pockets may be used to attach wire mesh or fabric to end posts.

E. Fasten the fabric to the top strand of the reinforcement by rings or cord every 15 inches or less. Locate fabric splices at a fence post with a minimum overlap of 6 inches attached in at least 4 places equally spaced. Do not locate fabric splices in concentrated flow areas.

3.3 EROSION CONTROL FABRIC

A. Erosion control fabric shall be installed following completion of final grading activities in the following disturbed earth areas unless otherwise approved by the COMPANY:

1. All exterior slopes 4(H) to I(V) and steeper; and
2. All drainage ditches, channels and swales.

B. Erosion control fabric shall be anchored at the top of the slope using an anchor trench and shall be rolled down the slope so as to maintain tension to preclude folds and wrinkles. Any folds or wrinkles shall be removed by hand.

C. The erosion control fabric anchor trench shall be 6 inches wide by 6 inches deep. The trench fabric shall be connected to the vertical face of the trench using stakes or staples spaced at 12 inches on center. The trench shall be backfilled and compacted upon completion of stapling.

D. Successive erosion control fabric panels shall be overlapped in such a manner that the upstream and upslope panel is placed over the downstream and downslope panel. Panels shall overlap a minimum of 6 inches at end joints and on sideslopes.

E. Stake or staple through both panels with stakes/staples driven flush with the soil surface. Stake/staple spacing shall be in accordance with manufacturer's recommendations.

3.4 HAY BALES

A. Hay bales shall be installed to form water stops, filtration dams, diversions, etc. as required for erosion and sedimentation control. On sloping terrain, hay bales may be used to trap sediment until vegetation has become established.

B. Place bales lengthwise with ends tight, abutting one another. Install bales with bindings located on the sides.

C. Entrench hay bales a minimum of 4 inches and backfill. Place backfill on the upstream side of the bales.

D. Secure the bale in place with two stakes per bale and insert straw in voids between bales.

3.5 MAINTENANCE

A. All erosion and sedimentation controls shall be maintained in a structurally sound and functional manner. All erosion and sedimentation controls shall be inspected at least on a weekly basis, immediately after each rainfall and daily during prolonged rainfall.

B. Any damaged or deteriorating systems shall be replaced immediately upon discovery or as directed by COMPANY.

C. Sediment deposits shall be removed when the deposit reaches 1/3 the height of the fence or sooner to provide a functional and stable system. Sediment retained by sedimentation and erosion control systems shall be removed by CONTRACTOR and may be used on the project as fill as approved by COMPANY.

D. Areas where temporary vegetation or mulch has been applied shall be inspected to ensure proper growth and coverage. Temporary vegetation or mulch shall be reapplied as necessary to minimize erosion.

3.6 REMOVAL

A. Erosion and sedimentation controls shall remain in-place until the COMPANY directs their removal. Upon removal CONTRACTOR shall dispose of any sediment accumulations, dress the area to the satisfaction of COMPANY, and shall vegetate all bare areas in accordance with the Contract Documents. Temporary erosion control blanket materials specified are biodegradable and will remain in place after establishment of permanent vegetation.

++END OF SECTION++

SECTION 01200

DUST CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section consists of performance of dust control measures as necessary to prevent fugitive dust during construction activities or as directed by the ENGINEER.

1.2 PERFORMANCE REQUIREMENTS

A. CONTRACTOR shall implement all necessary dust control measures to prevent fugitive dust during all construction activities.

B. The need for dust control measures will be based on visual observation of airborne dust. CONTRACTOR shall implement dust control measures on a regular basis throughout the duration of the work unless other wise authorized by the ENGINEER. CONTRACTOR shall adjust operations and/or dust controls as necessary, at no additional cost to OWNER, if directed by ENGINEER to mitigate dust.

1.3 SUBMITTALS

A. CONTRACTOR shall submit the following to ENGINEER a minimum of 5 days prior to initiating dust control measures:

1. Source of dust control water;
2. List of dust control equipment; and
3. Manufacturer specification sheets and material safety data sheets (MSDS) for chemical additives used for dust control.

PART 2 - PRODUCTS

2.1 WATER

A. Water used for dust control need not be potable, but must not be contaminated. Proposed source of dust control water must be approved by ENGINEER prior to initiating dust control measures.

2.2 CHEMICAL ADDITIVES

A. Chemical additives shall be incorporated into dust control measures only if approved by the ENGINEER.

B. Calcium Chloride for dust control shall conform to the requirements of ASTM D98, Type 1 or Type 2.

C. Alternative chemical additives for dust control may be used if approved by the ENGINEER.

2.3 EQUIPMENT

A. Dust control water shall be applied using tank trucks equipped with water cannon capable of delivering water through either front- or rear-mounted nozzles. Tank trucks shall be of sufficient size and mobility and carry a sufficient quantity of water to control dust generated by CONTRACTOR’s activities.

B. More than one water tank truck may be required during construction activities to sufficiently suppress dust.

PART 3 - EXECUTION

3.1 IMPLEMENTATION OF DUST CONTROL MEASURES

A. Vehicular traffic in disturbed areas shall be limited to the extent practicable. Construction vehicles shall maintain low speeds to minimize the amount of dust created. Adequate freeboard in loaded trucks shall be maintained to prevent spillage during operations. Roadway surfaces shall be kept free of spilled/tracked soil.

B. Soil stockpiles shall be graded and shaped to minimize surface area. Water or covers shall be applied to stockpiles as needed to control dust.

C. Apply dust control water uniformly over roads and disturbed areas from trucks capable of uniform distribution. Provide suitable devices for positive shut-off and for regulating flow of water.

D. Apply calcium chloride or other chemical additives at locations only when directed by ENGINEER. Spread calcium chloride or other chemical additives by approved devices and methods for uniform distribution.

E. Dust control water and/or chemical additives shall be applied so as to limit and/or prevent formation of standing water and mud; over spray of chemical dust suppressants in areas adjacent to surface water bodies or sensitive habitats; and/or flushing of materials off of the work area.

++END OF SECTION++

SECTION 02200

SITE PREPARATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section consists of all work associated with clearing and preparing the work area, borrow areas, and other work areas for earthwork and other construction activities, including removal of existing vegetation and verification of existing site conditions.

1.2 EXISTING SITE CONDITIONS

A. CONTRACTOR shall verify that existing topographic conditions in the Work Area as shown on the Drawings are an accurate representation of existing site conditions prior to initiating construction activities.

B. If CONTRACTOR contends that existing topographic conditions are different from that shown on the Drawings, Contractor shall submit survey data from a Texas-registered land surveyor to document actual topographic conditions, and shall identify with such submission additional work required which was not accounted for in CONTRACTOR's bid. There shall be no opportunity for a Claim for extra work due to differing topographic conditions once stripping or excavation work has started.

C. Existing site improvements (utilities, monitoring wells, and similar items) shall be located and protected by CONTRACTOR before CONTRACTOR begins clearing operations.

1.3 SUBMITTALS

A. Clearing and grubbing and solid waste generated during cap subgrade preparation shall be placed within the active portion of the landfill unless otherwise approved by the ENGINEER. CONTRACTOR shall submit name and address of the alternate disposal facility proposed for management of trash and rubbish generated in connection with site preparation at least 5 days prior to beginning clearing operations.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 CLEARING

A. Clearing shall consist of the cutting, shredding, and stockpiling of all trees and shrubs and the stripping of all grass and similar surface vegetation within the limits of the landfill and borrow areas. Clearing shall be limited to the areas required to perform the work.

B. CONTRACTOR shall segregate material removed as part of clearing from soils to be incorporated into subsequent earthwork activities.

3.2 VEGETATIVE SOIL STRIPPING AND STOCKPILING

A. After completion of clearing activities, CONTRACTOR shall strip the uppermost approximately 12 inches of existing vegetative soil from the cleared areas. Material identified as vegetative soil shall be subject to ENGINEER’s approval.

B. CONTRACTOR shall stockpile stripped vegetative soil in the work area in a location acceptable to the ENGINEER.

3.3 DISPOSAL OF BRUSH AND OTHER VEGETATIVE MATERIAL

A. CONTRACTOR shall dispose of all brush and other vegetative materials generated during site clearing in accordance with all applicable regulations and as approved by the ENGINEER.

B. If approved by the ENGINEER, CONTRACTOR may burn brush and other vegetative material in accordance with the requirements of TCEQ Publication RG-049 "Outdoor Burning in Texas", as modified to comply with OWNER requirements. Specific requirements for burning of brush and other vegetative material include, but are not limited to, the following:

1. Commence or continue burning only when the wind direction and other weather conditions are such that the smoke and other pollutants will not present a hazard to any public road, landing strip, or water body or have an adverse effect on any off-site structure.

2. Don't start burning unless weather conditions are such that the smoke will dissipate (winds of at least 6 miles per hour; no temperature inversions) while still allowing the fire to be contained and controlled (winds no faster than 23 miles per hour).

3. Post someone to flag traffic if at any time the burning causes or may tend to cause smoke to blow onto or across a road or highway.

4. Begin burning no earlier than one hour after sunrise, end it the same day and no later than one hour before sunset, and make sure that a responsible party is present while the burn is active and the fire is progressing.

5. At the end of the burn, extinguish isolated residual fires or smoldering objects if the smoke they produce can be a nuisance or a traffic hazard.

C. CONTRACTOR will be responsible for controlling fires in compliance with all Federal, State, and Local laws and regulations. The securing of necessary burning permits shall be the responsibility of the CONTRACTOR. All burning shall be under the constant care of competent watchmen. All materials resulting from clearing and grubbing operations and disposed of by burning on the site shall be thoroughly and completely reduced to ashes.

D. CONTRACTOR shall be responsible for providing a suitable location (subject to ENGINEER and OWNER approval) for off-site disposal of cleared material not burned on-site. Once ENGINEER and OWNER have approved the disposal location, CONTRACTOR shall transport and dispose the material in accordance with all applicable regulations.

++END OF SECTION++

SECTION 02300

EARTHWORK

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section consists of all activities associated with earthwork construction, including, but not necessarily limited to:

1. Excavation, loading, transportation, unloading and stockpiling of soil from COMPANY-designated locations;

2. Placement, compaction, and grading of various earthen materials;

3. Ditch grading; and

4. All other activities required to complete earthwork construction as shown on the Drawings, specified herein and or required by the COMPANY.

1.2 REFERENCES

A. American Society of Testing Materials (ASTM) Standards/Publications (Latest version):

C33	Standard Specification for Concrete Aggregates
D422	Method of Particle Size Analysis of Soils
D698	Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3)
D1557	Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3)
D1587	Standard Practice for Thin-walled Tube Sampling of Soils
D2487	Classification of Soils for Engineering Purposes
D2922	Density of Soil In Place by Nuclear Density Gage
D3080	Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions
D4318	Liquid Limit, Plastic Limit and Plasticity Index of Soils
D5084	Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.3 DEFINITIONS

A. Select Fill: Soil material suitable for use as cap fill, for dike construction or other areas identified by the COMPANY.

B. General Fill: Any non-classified soil deemed suitable by the COMPANY.

C. Liner Subgrade: Soil complying with the specified requirements located immediately beneath the geosynthetic clay liner (GCL).

D. Compacted Clay: Low-permeability soil layer of liner system.

E. Vegetative Soil: Growth medium used along with any necessary admixtures to support vegetation.

F. Gravel: Granular crushed stone material used as erosion protection in ditches.

G. Road Base: Granular material placed on the surface of haul roads, access roads and other areas designated on the Drawings, identified in the Specifications or required by the COMPANY.

H. Rip Rap: Stone armor material used in drainage features for erosion control and energy dissipation.

1.4 SUBMITTALS

A. CONTRACTOR shall identify all earthwork material suppliers and shall submit written verification from his material suppliers that all earthwork materials to be used for the work comply with the requirements of this Section.

B. CONTRACTOR shall submit copies of all geotechnical laboratory reports within 10 working days after sample collection.

1.5 QUALITY CONTROL

A. CONTRACTOR shall perform construction surveys, as needed, to ensure that the lines and grades of all excavations, embankments, ditches, pipe trenches, pipe inverts, and graded surfaces are in accordance with the drawings and specifications.

B. COMPANY may perform pre-construction and post-construction topographic surveys of the work area and related areas and may perform additional quality assurance surveys. CONTRACTOR shall coordinate his activities with COMPANY's surveyor and provide safe access to all excavation areas for survey and/or verification sampling activities.

1.6 TESTING

A. The number and type of testing required for each type of earthwork shall be as specified in the specific section related to the type of earthwork.

B. COMPANY will select the locations for all tests. Tests performed at locations not approved by the COMPANY will not be accepted.

C. All undisturbed earthwork samples shall be collected using a thin-walled sampler complying with ASTM D1587. The length of the sampler shall be suitable for collection of an undisturbed sample over the specified sampling interval.

D. Unless otherwise specified, testing shall be performed in accordance with the following methods:

1. Soil classification shall be performed using ASTM D2487. Liquid Limits, Plastic Limits and Plasticity Indices shall be determined using ASTM D4318.

2. Moisture-Density Relationships shall be determined using ASTM D698. Unless otherwise directed by COMPANY. ASTM D1557 may be used only where specified.

3. In-place density and moisture content shall be determined using ASTM D6938 (Nuclear Density Gage). Other methods for determining in-place density and moisture may not be used unless approved by the COMPANY.

4. Hydraulic conductivity shall be determined using ASTM D5084.

5. Direct shear testing shall be performed in accordance with ASTM D3040.

1.7 TOLERANCES

A. Grades and slopes of all earthwork shall be straight and true. Unless otherwise specified, CONTRACTOR shall complete all earthwork within the dimensional tolerances presented below.

B. Elevation Tolerances:

1.	Compacted Clay Surface:	plus 0.1 foot, minus 0.0 foot.
2.	Liner Subgrade Surface:	plus 0.1 foot, minus 0.0 foot.
3.	Gravel Surface:	plus 0.1 foot, minus 0.0 foot.
4.	All Other Surfaces:	plus 0.2 foot, minus 0.0 foot.

C. Thickness Tolerances:

1.	Compacted Clay Subgrade:	plus 0.2 foot, minus 0.0 foot.
2.	Liner Subgrade:	plus 0.2 foot, minus 0.0 foot.
3	All Other Surfaces:	plus 0.1 foot, minus 0.0 foot.

D. Grade Tolerances: All grades/slopes shall be completed within

1.	Compacted Clay Surface:	plus or minus 0.1 percent of design slope.
2.	Liner Subgrade Surface:	plus or minus 0.1 percent of design slope.
3.	Gravel and Drainage Features:	plus or minus 0.1 percent of design slope.
4.	All Other Surfaces:	plus or minus 0.2 percent of design slope.

E. Horizontal Coordinates and/or Earthwork Dimensions: plus or minus 0.5 feet

1.8 UTILITIES

A. COMPANY will attempt to deactivate electrical and other utilities in areas to be excavated; however, CONTRACTOR shall be ultimately responsible for ensuring that no energized equipment or utilities are present prior to initiating excavation activities. If CONTRACTOR identifies energized or active equipment or utilities, CONTRACTOR shall cease work and notify COMPANY so that the equipment/utilities may be deactivated. CONTRACTOR shall again check the equipment and utilities to ensure they are deactivated prior to proceeding with excavation activities.

B. CONTRACTOR shall note that underground and aboveground utilities may be located in the area of the Work. CONTRACTOR shall be ultimately responsible for protecting the utilities during earthwork and related activities.

1.9 EARTHWORK SAFETY

A. As discussed in other areas of these specifications, CONTRACTOR shall be fully responsible for the health and safety of all personnel in the work area, at all times, and shall take all necessary precautions to protect personnel.

B. In addition to general health and safety responsibilities, CONTRACTOR shall be fully responsible for complying with all applicable OSHA and related regulations regarding earthwork, including, but not limited to, the requirements of 40 CFR Part 126.

PART 2 - PRODUCTS

2.1 SELECT FILL

A. Select fill shall consist of soil excavated during foundation soil grading. CONTRACTOR shall be responsible for loading, transporting, placement and compaction of select fill.

B. Select fill shall classify as CH, CL or SC using ASTM D2487, shall have a plasticity index between 15 and 40, and shall be free of roots, brush, sod, or other perishable materials and debris.

2.2 GENERAL FILL

A. General fill shall be any non-classified soil deemed suitable by the COMPANY. General fill shall be free of trash, rubbish or other deleterious substances. The maximum particle size of general fill shall be 6 inches.

2.3 LINER SUBGRADE

A. Liner Subgrade shall consist of soil excavated from the site during foundation grading. CONTRACTOR shall be responsible for loading, transporting, placement and compaction of Liner Subgrade.

B. Liner Subgrade shall classify as CH or CL using ASTM D2487 and shall contain no organic material, sticks, or other deleterious material.

C. The maximum particle size of liner subgrade shall be 3 inches. Particles larger than 1 inch shall be subrounded to rounded.

2.4 COMPACTED CLAY

A. Compacted Clay shall consist of soil excavated from the COMPANY-designated Borrow Area or other COMPANY-approved off-site source. CONTRACTOR shall be responsible for loading, transporting, placement and compaction of Compacted Clay.

B. Compacted Clay shall classify as CH or CL using ASTM D2487 and shall contain no organic material, sticks, or other deleterious material.

C. Compacted Clay shall conform to the following:

Parameter	Specification
Plasticity Index	15 Minimum
Liquid Limit	30 Minimum
Percent Passing No. 200 Sieve	30% Minimum
Percent Passing 1.5-inch Sieve	100%
Hydraulic Conductivity	1 x 10^{-7} cm/s Maximum
In-Place Density	95% Standard Proctor Minimum
In-Place Moisture Content	-1% to +3% Optimum Moisture Content

2.5 VEGETATIVE SOIL

A. Vegetative soil shall consist of soil stripped from the work area and stockpiled by the CONTRACTOR. Vegetative soil shall be free of deleterious material, materials toxic to plant growth, noxious weed seeds, rhizomes, roots, subsoil, rocks, or other debris.

2.6 GRAVEL

A. Gravel shall be washed, angular crushed gravel or crushed limestone, free of mud, clay, vegetation or other debris, conforming to ASTM C33 for stone quality.

B. Gravel shall have the following size gradation:

U.S. Sieve Size	Percent Passing
1.5 Inch	100
1 Inch	90 to 100
0.5 Inch	15 to 60
No. 4	0 to 10
No. 8	0 to 5

C. Gravel shall conform to the following:

1. Liquid Limit (LL) less than or equal to 35.

2. Plasticity Index (PI) less than or equal to 10.

2.7 ROAD BASE

A. Road base shall consist of crushed stone, free of mud, clay, vegetation or other debris, conforming to the requirements of TXDOT Item 248, Type A (Grade I). Size Gradation shall comply with the following:

U.S. Sieve Size	Percent Passing
2.5 inch	100
1.75 inch	100
0.875 inch	65 to 90
0.375 inch	50 to 70
No. 4	35 to 55
No. 40	15 to 30
No. 200	0

B. Road Base shall conform to the following:

1. Liquid Limit (LL) less than or equal to 35.

2. Plasticity Index (PI) less than or equal to 10.

2.8 RIPRAP

A. Riprap shall be clean, well-graded durable natural stone with a minimum specific gravity of 2.4.

Unless other wise approved by the COMPANY, riprap shall comply with the following:

1. No deleterious material, noxious weed seeds, roots, subsoil, or other debris shall be present.

2. Riprap shall consist of stone conforming to the following gradation:

Stone Weight (pounds)	Percent Lighter Than
700	100
300	50 to 100
150	15 to 50
45	0 to 15

3. Stones shall be at least 3 inches in their least dimension. The breadth or thickness of each stone shall not be less than one-third the length of the stone.

PART 3 - EXECUTION

3.1 GENERAL

A. All earthwork shall be completed to the lines and grades shown on the Drawings and as required by the COMPANY.

B. CONTRACTOR shall not place material in the presence of water unless approved by the COMPANY. Saturated areas shall be dewatered by CONTRACTOR as specified herein prior to initiating earthwork activities. CONTRACTOR shall remove all saturated soils, muck, organic matter and other materials not suitable for compaction or proof-rolling from dewatered areas prior to placing fill materials.

C. All proof rolling shall be performed as follows unless another method is approved by the COMPANY:

1. Proof rolling equipment shall be approved by the COMPANY. Proof rolling equipment may be self-propelled or towed by a suitable tractor.

2. Proof rolling equipment shall have a rolling width of 8 to 10 feet and shall be capable of operating under various contact pressures.

3. Contact pressure of proof rolling equipment shall be a minimum of 2000 pounds per square foot.

4. A minimum of two passes with the proof rolling equipment shall be completed across the entire native soil surface prior to placement of any material.

5. Any area shown to be unstable or non-uniform after proof rolling shall be recompacted and/or reworked until proof rolled to the satisfaction of the COMPANY.

D. Compaction of all materials shall be performed with an appropriately heavy, properly ballasted penetrating-foot compactor. A minimum of four passes of the compactor shall be performed on each material lift regardless of whether the lift complies with specified density requirements within less than four passes.

E. When target compaction/density is specified using ASTM D698 (Standard Proctor), the minimum weight of the compacting equipment shall be 1500 pounds per linear foot of drum length.

F. The daily work area shall extend a distance no greater than necessary to maintain moist conditions and continuous operations. Desiccation and crusting of the lift surface shall be avoided as much as possible.

G. Water added to soils shall be clean and shall not have come into contact with waste or any objectionable material. Source of water shall be approved by COMPANY prior to application.

H. Unless otherwise specified or approved by the COMPANY, the maximum clod size in each lift prior to compaction shall be 2 inches in diameter. Clod size shall be reduced through discing, pulverizing or similar methods. Unless otherwise approved by the COMPANY, a minimum of 4 passes with discing or pulverizing equipment shall be made across each lift prior to beginning compaction. A pass is defined as one trip across the lift surface. Passes shall be made at alternating right angles across the lift surface.

I. Finished, compacted lifts of all material shall be sprayed with clean water as necessary to prevent drying and desiccation.

J. At the end of each construction day's activities, completed lifts shall be sealed by rolling with a rubber-tired or smooth drum roller. Prior to resuming placement of overlying material, the surface of the previous lift shall be scarified to a minimum depth of 2 inches.

3.2 DEWATERING

A. CONTRACTOR shall note that some of the work may be performed in areas exhibiting saturated conditions at and below the groundwater table. CONTRACTOR shall not place material in the presence of water unless approved by the COMPANY.

B. CONTRACTOR shall dewater the work area using pumps or other method approved by the COMPANY. Dewatering measures shall be implemented by the time the excavation reaches the water level in order to maintain the integrity of the in-situ material. Dewatering water shall be discharged in accordance with COMPANY requirements in a manner that minimizes erosion and other disturbances to existing drainage features and adjacent areas.

C. All dewatering system components, including cofferdams, pumps, piping and related equipment shall be removed by the CONTRACTOR at the completion of the work.

3.3 COMPACTED CLAY

A. Construction of the Compacted Clay layer will begin after the underlying native soil has been finished to the proper lines and grade. The depth of the top of the underlying native soil prior to compacted clay construction shall coincide with the bottom of the Compacted Clay layer. The Compacted Clay layer shall be keyed into the underlying native soil or otherwise constructed to ensure stability.

B. Compacted Clay shall be placed and compacted in lifts. Maximum loose lift thickness shall be 8 inches. Maximum compacted lift thickness shall be 6 inches.

C. New Compacted Clay lifts shall be properly tied back into previous clay sections to ensure continuous clay layer coverage. Compacted Clay layers shall be tied into previously placed Compacted Clay layers using a stair-step construction method with benches, no steeper than a five horizontal to one vertical face.

D. For excavation surfaces with a slope of 3(H):1(V) or flatter, Compacted Clay layer construction may utilize lifts parallel to the finished surface. For excavation surfaces that have steeper than 3(H):1(V) slopes, Compacted Clay lifts shall be placed in successive horizontal lifts. All horizontal lifts shall be sufficiently wide to safely accommodate construction equipment.

E. Testing requirements for lifts placed on all sloped surfaces shall be the same as specified for non-sloped surfaces. Lift areas on sloped surfaces shall be measured parallel to the surface of the excavation.

F. Prior to compaction of each lift, the moisture content of the Compacted Clay shall comply with the requirements of these specifications. If the moisture content is above the specified maximum, the Compacted Clay shall be pulverized, disced or similarly reworked to air dry the material and decrease the moisture content.

G. Each lift shall be compacted to a minimum of 95 percent maximum dry density as determined by ASTM D698 (Standard Proctor). Material with densities less than the specified density shall be recompacted and/or reworked as necessary to achieve the specified density.

H. Each lift shall be thoroughly compacted and shall satisfy all specified requirements before a subsequent lift is placed.

I. After the final lift has been compacted and tested, the surface of the Compacted Clay shall be rolled and sealed with a smooth drum roller. A minimum of four passes of the roller shall be performed on the Compacted Clay. A pass is defined as one trip across the entire Compacted Clay surface.

J. COMPANY will test Compacted Clay per the following guidelines:

1. Pre-Construction Testing. Prior to beginning placement of the Compacted Clay, CONTRACTOR shall collect composite samples from the prospective clay source(s) and test the samples as described below. All composite samples shall consist of equal volumes of soil collected from a minimum of four locations within the prospective clay source.

    a. Two soil classifications in accordance with ASTM D2487 shall be performed from each clay source. Plasticity Index (PI) shall be included in the soil classification.

    b. Two moisture-density relationship tests in accordance with ASTM D698 (Standard Proctor) shall be performed from each clay source.

    c. Two hydraulic conductivity tests by ASTM D5084 shall be performed from each clay source. Each sample shall be compacted to 95 percent maximum dry density as determined by ASTM D698 (Standard Proctor) prior to performing the hydraulic conductivity test.

2. In-Place Testing. After each Compacted Clay lift has been placed, COMPANY will perform the following in-place tests:

    a. One in-place density test in accordance with ASTM D6938 shall be performed per each 4,000 square feet for each lift.

    b. One in-place moisture density relationship shall be reported for every in-place density test performed.

K. After completion of the Compacted Clay layer, but before beginning installation of the overlying materials, CONTRACTOR shall survey the finished elevations of the Compacted Clay to ensure that the top of the Compacted Clay is at the grades and elevations specified on the Drawings. There shall be a minimum of one survey point for every 5,000 square feet of Compacted Clay surface area.

3.4 SELECT FILL

A. Select fill shall be placed and compacted in lifts. Maximum loose lift thickness shall be 8 inches. Maximum compacted lift thickness shall be 6 inches.

B. Prior to compaction, the moisture content of the select fill shall be no greater than plus 3 percent of the optimum moisture content as determined by ASTM D698 (Standard Proctor). If the moisture content is above the specified maximum, select fill shall be pulverized, disced or similarly reworked to air dry the material and decrease the moisture content.

C. Each select fill lift shall be compacted to a minimum of 90 percent maximum dry density as determined by ASTM D698 (Standard Proctor). Material with densities less than the specified density shall be recompacted and/or reworked as necessary to achieve the specified density.

D. Each lift shall be thoroughly compacted and shall satisfy all moisture and density requirements before a subsequent lift is placed.

E. COMPANY will test select fill per the following guidelines:

1. One moisture density relationship test in accordance with ASTM D698 (Standard Proctor) shall be performed for every 50,000 cubic yards placed.

2. One in-place density test in accordance with ASTM D6938 shall be performed for every 20,000 square feet of surface area for each lift. Surface area shall be measured in the horizontal plane.

3. One soil classification in accordance with ASTM D2487 shall be performed for every 50,000 cubic yards placed.

4. Plasticity Index (PI) shall be included in the soil classification. One moisture-density relationship test in accordance with ASTM D698 (Standard Proctor) shall be performed any time a PI change greater than 10 is observed in the soil classification tests.

F. After completion of the select fill, but before beginning installation of the overlying materials, CONTRACTOR shall survey the finished elevations of the select fill to ensure that the top of the select fill is at the grades and elevations specified on the Drawings. There shall be a minimum of one survey point for every 5,000 square feet of select fill surface area.

3.5 SELECT FILL ON STEEP SLOPES

A. Steep slopes are defined as surfaces with slopes steeper than 5 horizontal to 1 vertical.

B. Construction of select fill on steep slopes shall comply with all other requirements for select fill, in addition to those specified herein.

C. Select fill shall be placed and compacted in benched, horizontal lifts. Maximum loose lift thickness shall be 8 inches. Maximum compacted lift thickness shall be 6 inches.

D. Lifts shall be placed and compacted horizontally (benched parallel to the toe of the slope) rather than vertically (up and down the slope). Each lift shall be wide enough to permit passage of compacting equipment.

E. Lifts shall extend horizontally beyond the required final elevations of select fill to permit grading back to the required slopes after compaction and testing.

F. After each lift has been compacted, tested and accepted by the COMPANY, Contractor shall grade the slope to the required elevations

3.6 LINER SUBGRADE

K. Liner Subgrade shall be placed and compacted in lifts. Maximum loose lift thickness shall be 8 inches. Maximum compacted lift thickness shall be 6 inches. A total of 2 lifts will be placed to construct the 12 inch Liner Subgrade thickness.

L. Prior to compaction of each of the lifts, CONTRACTOR shall manually remove all visible rock 3 inches or greater in size from the lift. After the visible rocks have been removed, CONTRACTOR shall compact each lift as discussed below.

C. Prior to compaction of each lift, the moisture content of the Liner Subgrade shall be no greater than plus 4 percent of the optimum moisture content as determined by ASTM D698 (Standard Proctor). If the moisture content is above the specified maximum, Liner Subgrade shall be pulverized, disced or similarly reworked to air dry the material and decrease the moisture content.

D. Each lift shall be compacted to a minimum of 90 percent maximum dry density as determined by ASTM D698 (Standard Proctor). Material with densities less than the specified density shall be recompacted and/or reworked as necessary to achieve the specified density.

E. Each lift shall be thoroughly compacted and shall satisfy all specified requirements before a subsequent lift is placed.

F. After the second lift has been compacted and tested, the surface of the Liner Subgrade shall be rolled and sealed with a smooth drum roller. A minimum of four passes of the roller shall be performed on the Liner Subgrade. A pass is defined as one trip across the entire Liner Subgrade surface.

H. CONTRACTOR shall test Liner Subgrade as specified herein:

1. One moisture density relationship test in accordance with ASTM D698 (Standard Proctor) shall be performed for every 10,000 cubic yards placed.

2. One in-place density test in accordance with ASTM D6938 shall be performed for every 20,000 square feet of surface area for each lift. Surface area shall be measured in the horizontal plane.

3. One soil classification in accordance with ASTM D2487 shall be performed for every 10,000 cubic yards placed.

4. Plasticity Index (PI) shall be included in the soil classification. One moisture-density relationship test in accordance with ASTM D698 (Standard Proctor) shall be performed any time a PI change greater than 10 is observed in the soil classification tests.

5. One hydraulic conductivity test by ASTM D5084 for every 10,000 cubic yards of Liner Subgrade. Each test shall be performed on a composite Liner Subgrade sample collected from the Liner Subgrade stockpile as approved by COMPANY. The composite sample shall be compacted to 90 percent maximum dry density as determined by ASTM D698 (Standard Proctor) prior to performing the hydraulic conductivity test.

I. After completion of the Liner Subgrade, but before beginning installation of the overlying materials, CONTRACTOR shall survey the finished elevations of the Liner Subgrade to ensure that the top of the Liner Subgrade is at the grades and elevations specified on the Drawings. There shall be a minimum of one survey point for every 10,000 square feet of Liner Subgrade surface area.

3.7 VEGETATIVE SOIL

A. Vegetative Soil shall not be placed until the underlying soil has been approved by the COMPANY.

B. Vegetative Soil shall be placed in one 12 inch lift without damaging the underlying soil. Vegetative Soil shall be tracked in and smoothed out using tracked equipment. No direct compactive effort shall be used on vegetative soil.

C. After completion of the Vegetative Soil layer, CONTRACTOR shall survey the finished elevations of the Vegetative Soil to ensure that the top of the vegetative soil is at the grades and elevations specified on the Drawings. There shall be a minimum of one survey point for every 5,000 square feet of Vegetative Soil surface area.

3.8 ROAD BASE

A. Road Base shall be placed on access ramps, on the top of the dike and as required by the COMPANY.

B. Geotextile shall be placed beneath all Road Base in accordance with Section 2430 of these specifications.

C. Road Base shall be placed and compacted in lifts, with a maximum loose lift thickness of 8 inches. Each fill lift shall be compacted using a minimum of four passes of the compactor. A pass is defined as one trip across the lift surface. There is no target maximum density requirement for road base.

D. After completion of the road base, but before beginning installation of the overlying materials, CONTRACTOR shall survey the finished elevations of the road base to ensure that the top of the road base is at the grades and elevations specified on the Drawings. There shall be a minimum of one survey point for every 5,000 square feet of road base surface area.

3.9 RIPRAP

A. Riprap shall be placed on geotextile conforming to the requirements of Section 02300 of these specifications. Place geotextile with the length running up and down the slope. Ensure geotextile has a minimum overlap of 2 feet at all seams.

B. Riprap shall be placed in such manner as to produce a well graded mass of rock with the minimum practicable percentage of voids, and shall be constructed within a tolerance of plus 4 inches or minus 2 inches from the lines and grades shown on the Drawings. Placement shall begin at the bottom of the area to be covered and continue up slope. Subsequent loads of material shall be placed against previously placed material in such a manner as to ensure a relatively homogenous mass. Open joints shall be filled with spalls or small rocks. Rocks shall be arranged to present a uniform finished top surface such that the variation between tops of adjacent rocks shall not exceed 3 inches.

C. No stone shall be dropped through air from a height greater than 3 feet on top of the geotextile. The larger stones shall be well distributed and the entire mass of stones in their final position shall be roughly graded to conform to the gradation specified in this specification. The finished riprap shall be free from objectionable pockets of small stones and clusters of larger stones. Placing riprap by dumping into chutes or by similar methods likely to cause segregation of the various sizes will not be permitted. Placing riprap by dumping it at the top of the slope and pushing it down the slope will not be permitted. Rearranging of individual stones will be required to the extent necessary to obtain a well-graded distribution of stone sizes as specified above.

++END OF SECTION++

SECTION 02310

CCR STABILIZATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section shall govern work associated with grading, excavation, supply, hauling, placement and compaction of bridging lift.

B. Work associated with the CCR stabilization shall also conform to Section 02300 – Earthwork of the Specifications.

1.2 MATERIALS INCLUDED IN THIS SECTION

A. Bottom ash used for bridging lift

B. Contractor-supplied material used for bridging lift

1.3 RELATED SECTIONS

A. Section 02300 Earthwork

B. Section 02320 Cap Subgrade

1.4 REFERENCES

A. Reference Standards for bridging lift shall be as referenced in Section 02300 – Earthwork

1.5 SUBMITTALS

A. Submittals for bridging lift shall be as specified in Section 02300 – Earthwork

PART 2 - PRODUCTS

2.1 COAL COMBUSTION RESIDUALS AS BRIDGING LIFT

A. OWNER will supply CCR or existing CCR suitable for beneficial re-use within the surface impoundment for general site grading and use as bridging lift.

B. OWNER will identify the location of CCR outside of the surface impoundment that may be used to supplement existing impounded materials. Contractor shall be responsible for loading, transporting, placement, and compaction of CCR used as bridging lift.

C. Bridging lift shall be free of roots, brush, sod, or other perishable materials and debris.

2.2 CONTRACTOR-SUPPLIED MATERIAL AS BRIDGING LIFT

A. Contractor-supplied bridging lift material shall be as specified herein.

B. CCR suitable for re-use of contractor-supplied bridging lift material shall be approved by the Engineer prior to delivery to the Site.

C. Contractor shall provide written Certification to Engineer that material to be supplied conforms to the requirements of this specification.

D. Bridging lift shall be clean fill material free of waste material (other than CCR approved for beneficial re-use), organic material, sticks, or other deleterious material.

E. Bridging lift may include crushed rock, broken rock, broken concrete and similar materials provided these materials do not exceed 30 percent (by weight) of the total material in the lift of which they are part.

F. Contractor-supplied material shall be soil class “SC”, “CL” or “CH” according to ASTM D2487 and shall conform to the following:

1. No material larger than 3-inch diameter.
2. Plasticity Index (PI) greater than or equal to 7.
3. Particle size distribution shall conform to the following:

U.S. Sieve Size	Percent Passing
No. 4	80-95
No. 40	55-75
No. 200	Greater than 50

PART 3 – EXECUTION

3.1 GENERAL

A. Compaction of all materials shall be performed with an appropriately heavy, properly ballasted penetrating foot compactor. A minimum of four passes of the compactor shall be performed on each material lift. A pass is defined as one trip of the compactor over the lift and back to the starting point by a single drum roller or one trip across the lift surface from one side to the other if the compacting equipment has front and back compacting rollers.

B. The minimum weight of the compacting equipment shall be 1,500 pounds per linear foot of drum length.

C. The daily work area shall extend a distance no greater than necessary to maintain moist conditions and continuous operations. Desiccation and crusting of the lift surface shall be avoided as much as possible.

D. Water added to soils shall be clean and shall not have come into contact with waste or any objectionable material.

3.2 CONSTRUCTION OF BRIDGING LIFT

A. All existing vegetation on areas to be capped or regraded shall be stripped or otherwise removed prior to placing bridging lift or regrading. Contractor shall be responsible for disposal of all debris resulting from vegetation removal in accordance with applicable laws and regulations.

B. After existing vegetation has been removed, material underlying the bridging lift shall be graded to ± 1% slope prior to placement of bridging lift. Areas that only require regrading may not require compaction provided that such areas meet the requirements of Subsection 3.2.C of this Specification.

C. Bridging lift underlying the cap subgrade shall conform to the following:

1. Bridging lift shall be placed in three compacted lifts. The first lift shall be 12” and consist of bottom ash and/or select fill. The remaining two lifts shall each be 6” each and consist of select fill material. A minimum of four passes of the compacting equipment shall be required for each lift.

2. After the final lift has been placed and compacted to the required elevations, the bridging lift shall be proof rolled using the methods specified herein or other method approved by the Engineer:

   a. Proof rolling equipment shall consist of not less than four pneumatic tired wheels, arranged so that the wheels carry approximately equal loads when operating on uneven surfaces. Proof rolling equipment may be self-propelled or towed by a suitable tractor.

   b. Proof rolling equipment shall have a rolling width of 8 to 10 feet and shall be capable of operating under various contact pressures.

   c. Contact pressure of proof rolling equipment shall be a minimum of 2,000 pounds per square foot.

   d. A minimum of two passes with proof rolling equipment shall be completed across the entire prepared bridging lift surface.

3. Any area of the bridging lift shown to be unstable or non-uniform after proof rolling shall be recompacted and/or reworked until proof rolled to the satisfaction of the ENGINEER.

D. Finished lifts of bridging lift shall be sprayed with clean water as necessary to prevent drying and desiccation.

E. At the end of each construction day's activities, completed lifts shall be sealed by rolling with a rubber-tired or smooth drum roller. Prior to resuming placement of material the surface of the bridging lift shall be scarified to a minimum depth of 2 inches.

F. After completion of the bridging lift, but before beginning installation of the overlying cap subgrade, Contractor shall survey the finished elevations of the bridging lift to ensure that the top of the bridging lift is at the specified grades and elevations presented in the Conceptual Closure Plan. There shall be a minimum of one survey point for every 10,000 square feet of cap surface area.

++END OF SECTION++

SECTION 02320

CAP SUBGRADE

PART 1 - GENERAL

1.1 DESCRIPTION

C. This section shall govern work associated with grading, excavation, supply, hauling, placement and compaction of cap subgrade material.

D. Work associated with the cap subgrade shall also conform to Section 02300 – Earthwork of the Specifications.

1.2 MATERIALS INCLUDED IN THIS SECTION

C. Existing Coal Combustion By-Products used as cap subgrade

D. Contractor-supplied material used as cap subgrade

1.3 RELATED SECTIONS

C. Section 02300 Earthwork

D. Section 02330 Clay Cap

1.4 REFERENCES

G. Reference Standards for cap subgrade shall be as referenced in Section 02300 – Earthwork

1.5 SUBMITTALS

A. Submittals for cap subgrade shall be as specified in Section 02300 – Earthwork

PART 2 - PRODUCTS

2.1 COAL COMBUSTION BY-PRODUCTS AS CAP SUBGRADE

A. OWNER will supply CCBs or existing CCBs within the landfill may be re-graded for use as cap subgrade.

B. OWNER will identify the location of CCBs outside of the landfill that may be used to supplement existing landfilled materials. Contractor shall be responsible for loading, transporting, placement, and compaction of CCBs used as cap subgrade.

C. Cap subgrade shall be free of roots, brush, sod, or other perishable materials and debris.

2.2 CONTRACTOR-SUPPLIED MATERIAL AS CAP SUBGRADE

A. Contractor-supplied cap subgrade material shall be as specified herein.

B. Cap subgrade material shall be approved by the Engineer prior to delivery to the Site.

C. Contractor shall provide written Certification to Engineer that material to be supplied conforms to the requirements of this specification.

D. Cap subgrade shall be clean fill material free of waste material, organic material, sticks, or other deleterious material.

E. Cap subgrade may include crushed rock, broken rock, broken concrete and similar materials provided these materials do not exceed 30 percent (by weight) of the total material in the cap subgrade lift of which they are part.

F. Contractor-supplied cap subgrade shall be soil class “CL” or “CH” according to ASTM D2487 and shall conform to the following:

1. No material larger than 3-inch diameter.
2. Plasticity Index (PI) greater than or equal to 7.
3. Particle size distribution shall conform to the following:

U.S. Sieve Size	Percent Passing
No. 4	80-95
No. 40	55-75
No. 200	Greater than 50

PART 3 – EXECUTION

3.1 GENERAL

A. Compaction of all materials shall be performed with an appropriately heavy, properly ballasted penetrating foot compactor. A minimum of four passes of the compactor shall be performed on each material lift. A pass is defined as one trip of the compactor over the lift and back to the starting point by a single drum roller or one trip across the lift surface from one side to the other if the compacting equipment has front and back compacting rollers.

B. The minimum weight of the compacting equipment shall be 1,500 pounds per linear foot of drum length.

C. The daily work area shall extend a distance no greater than necessary to maintain moist conditions and continuous operations. Desiccation and crusting of the lift surface shall be avoided as much as possible.

D. Water added to soils shall be clean and shall not have come into contact with waste or any objectionable material.

3.2 CONSTRUCTION OF CAP SUBGRADE

A. All existing vegetation on areas to be capped or regraded shall be stripped or otherwise removed prior to placing cap subgrade or regarding. Contractor shall be responsible for disposal of all debris resulting from vegetation removal in accordance with applicable laws and regulations.

H. After existing vegetation has been removed, material underlying the cap subgrade shall be scarified to a minimum depth of 2-inches prior to placement of cap subgrade. Areas that only require regarding may not require scarifiying and compaction provided that such areas meet that are regarded to meet the requirements of Subsection 3.2.C of this Specification.

I. Cap subgrade underlying the clay cap shall conform to the following:

4. Cap subgrade shall be placed in compacted lifts. Maximum loose lift thickness shall be 12 inches and a minimum of four passes of the compacting equipment shall be required for each lift.

5. After the final lift has been placed and compacted to the required elevations, the cap subgrade shall be proof rolled using the methods specified herein or other method approved by the Engineer:

   a. Proof rolling equipment shall consist of not less than four pneumatic tired wheels, arranged so that the wheels carry approximately equal loads when operating on uneven surfaces. Proof rolling equipment may be self-propelled or towed by a suitable tractor.

   b. Proof rolling equipment shall have a rolling width of 8 to 10 feet and shall be capable of operating under various contact pressures.

   c. Contact pressure of proof rolling equipment shall be a minimum of 2,000 pounds per square foot.

   d. A minimum of two passes with proof rolling equipment shall be completed across the entire prepared cap subgrade surface.

6. Any area of the cap subgrade shown to be unstable or non-uniform after proof rolling shall be recompacted and/or reworked until proof rolled to the satisfaction of the ENGINEER.

J. Finished lifts of cap subgrade shall be sprayed with clean water as necessary to prevent drying and desiccation.

K. At the end of each construction day's activities, completed lifts shall be sealed by rolling with a rubber-tired or smooth drum roller. Prior to resuming placement of material the surface of the cap subgrade shall be scarified to a minimum depth of 2 inches.

L. After completion of the cap subgrade, but before beginning installation of the overlying clay cap, Contractor shall survey the finished elevations of the cap subgrade to ensure that the top of the cap subgrade is at the specified grades and elevations presented in the Conceptual Closure Plan. There shall be a minimum of one survey point for every 10,000 square feet of cap surface area.

++END OF SECTION++

SECTION 02330

CLAY CAP

PART 1 - GENERAL

3.3 DESCRIPTION

A. This section shall govern work associated with grading, excavation, supply, hauling, placement and compaction of the clay cap material.

B. Work associated with the cap subgrade shall also conform to Section 02300 – Earthwork of the Specifications.

3.4 MATERIALS INCLUDED IN THIS SECTION

A. OWNER-supplied material used as clay cap

B. Contractor-supplied material used as cap subgrade

3.5 RELATED SECTIONS

A. Section 02300 Earthwork

B. Section 02330 Clay Cap

3.6 REFERENCES

A. Reference Standards for cap subgrade shall be as referenced in Section 02300 – Earthwork

1.5 SUBMITTALS

A. Submittals for cap subgrade shall be as specified in Section 02300 – Earthwork

PART 2 - PRODUCTS

2.1 COAL COMBUSTION BY-PRODUCTS AS CAP SUBGRADE

A. OWNER may identify a suitable on-site borrow area for supplying clay cap material.

B. OWNER will identify the location of suitable material that may be used as clay cap. Contractor shall be responsible for loading, transporting, placement, and compaction of material used as the clay cap.

C. Clay cap material shall be free of roots, brush, sod, or other perishable materials and debris.

2.2 CONTRACTOR-SUPPLIED MATERIAL AS CLAY CAP

A. Contractor-supplied clay cap material shall be as specified herein.

B. Cap material shall be approved by the Engineer prior to delivery to the Site.

C. Contractor shall provide written Certification to Engineer that material to be supplied conforms to the requirements of this specification.

D. Clay cap shall be clean fill material free of waste material, organic material, sticks, or other

deleterious material.

E. Contractor-supplied clay cap shall be soil class “CL” or “CH” according to ASTM D2487 and shall conform to the following:

1. No material larger than 3-inch diameter.

2. Plasticity Index (PI) greater than or equal to 15.

3. In-place permeability by ASTM D5084 no greater than $1x10^{-7}$ cm/sec

4. All material retained on the No. 4 Sieve shall be subrounded to rounded.

5. Particle size distribution shall conform to the following:

U.S. Sieve Size	Percent Passing
No. 4	80-95
No. 40	55-75
No. 200	Greater than 50

PART 3 – EXECUTION

3.1 GENERAL

A. Compaction of all materials shall be performed with an appropriately heavy, properly ballasted penetrating foot compactor. A minimum of four passes of the compactor shall be performed on each material lift. A pass is defined as one trip of the compactor over the lift and back to the starting point by a single drum roller or one trip across the lift surface from one side to the other if the compacting equipment has front and back compacting rollers.

B. The minimum weight of the compacting equipment shall be 1,500 pounds per linear foot of drum length.

C. The daily work area shall extend a distance no greater than necessary to maintain moist conditions and continuous operations. Desiccation and crusting of the lift surface shall be avoided as much as possible.

D. Water added to soils shall be clean and shall not have come into contact with waste or any objectionable material.

3.2 CONSTRUCTION OF CAP SUBGRADE

A. Clay cap shall be placed and compacted with a maximum loose lift thickness of 8 inches and a maximum compacted lift thickness of 6 inches.

B. The clay cap shall be compacted as necessary to achieve an in-place permeability of no greater than $1x10^{-7}$ cm/second. At a minimum, four passes of the compacting equipment shall be required for each lift.

G. Contractor shall test the clay cap as specified herein:

1. Two soil classifications in accordance with ASTM D2487 shall be performed for each lift.

2. One in-place density test in accordance with ASTM D2922 shall be performed for every 20,000 square feet of cap subgrade placed for each 12 inches of compacted thickness.

3. One permeability test in accordance with ASTM D5084 shall be performed for every 4 acres of cap subgrade placed for each 12 inches of compacted thickness.

H. Finished lifts of cap subgrade shall be sprayed with clean water as necessary to prevent drying and desiccation.

I. At the end of each construction day's activities, completed lifts shall be sealed by rolling with a rubber-tired or smooth drum roller. Prior to resuming placement of material the surface of the cap subgrade shall be scarified to a minimum depth of 2 inches.

J. After completion of the cap subgrade, but before beginning installation of the overlying clay cap, Contractor shall survey the finished elevations of the cap subgrade to ensure that the top of the cap subgrade is at the specified grades and elevations presented in the Conceptual Closure Plan. There shall be a minimum of one survey point for every 10,000 square feet of cap surface area.

++END OF SECTION++

SECTION 02340

VEGETATIVE SOIL LAYER

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section shall govern work associated with grading, excavation, supply, hauling, placement and compaction of the vegetative soil material.

B. Work associated with the vegetative soil layer shall also conform to Section 02300 – Earthwork of the Specifications.

1.2 MATERIALS INCLUDED IN THIS SECTION

A. OWNER-supplied material used as vegetative soil

B. Contractor-supplied material used as vegetative soil

1.3 RELATED SECTIONS

A. Section 02300 Earthwork

B. Section 02330 Clay Cap

C. Vegetation

1.4 REFERENCES

A. Reference Standards for vegetative soil layer shall be as referenced in Section 02300 – Earthwork

1.5 SUBMITTALS

A. Submittals for cap subgrade shall be as specified in Section 02300 – Earthwork

PART 2 - PRODUCTS

2.1 OWNER-SUPPLIED MATERIAL AS VEGETATIVE SOIL LAYER

A. OWNER will supply Contractor with material for use as vegetative soil layer.

B. OWNER will identify the location of material for Contractor. Contractor shall be responsible for loading, transporting, placement, and compaction of material used as the vegetative soil layer.

2.2 CONTRACTOR-SUPPLIED MATERIAL AS VEGETATIVE SOIL LAYER

A. Vegetative soil layer shall be a clay loam or silty clay loam as classified by the United States Department of Agriculture and shall comply with all of the following:

1. Free of deleterious material, materials toxic to plant growth, noxious weed seeds, rhizomes, roots, subsoil, rocks, or other debris.
2. Maximum sodium adsorption ration (SAR): 8
3. Maximum electrical conductivity (EC): 2 mmhos/cm

4. Maximum particle dimension: 2 inches.
5. The pH shall be between 6.0 and 8.5 standard units. If approved by the Engineer, Contractor may amend soil as necessary to achieve the specified pH.

PART 3 - EXECUTION

3.1 VEGETATIVE SOIL LAYER PLACEMENT

A. Vegetative Soil shall not be placed until the underlying soil has been approved by the ENGINEER.

B. Vegetative Soil shall be placed in one 18 inch lift without damaging the underlying soil. Vegetative Soil shall be tracked in and smoothed out using tracked equipment. No direct compactive effort shall be used on vegetative soil.

C. After completion of the Vegetative Soil layer, CONTRACTOR shall survey the finished elevations of the Vegetative Soil to ensure that the top of the protective soil is at the grades and elevations specified on the Drawings. There shall be a minimum of one survey point for every 10,000 square feet of Vegetative Soil surface area.

++END OF SECTION++

SECTION 02350

VEGETATION

PART 1 – GENERAL

1.1 SUMMARY

A. This Section describes the requirements for vegetation establishment in areas disturbed during construction activities.

1.2 SUBMITTALS

A. CONTRACTOR shall submit information regarding proposed seed, fertilizer, mulch, tackifier and any other materials to be used to establish vegetation at least 10 days prior to delivery.

PART 2 – PRODUCTS

2.1 SEED SUPPLIERS

A. Seed suppliers must provide labeling of variety, purity, and germination. The supplier must satisfy State of Texas seed quality laws. The COMPANY must approve seed supplier.

2.2 SEED DELIVERY, STORAGE, AND HANDLING

A. Grass seed mixture shall be delivered in sealed containers. Seed in damaged packaging will not be accepted. CONTRACTOR shall provide seed mixture in containers showing the percentage of each species in the seed mix, year of production, net weight, date of packaging, name and address of supplier, percent of weed seed content, and guaranteed percentage of purity and germination.

B. Fertilizer shall be delivered in appropriate waterproof containers showing weight, chemical analysis, and name of manufacturer.

2.3 SEED MIXTURE

A. Seed mixture shall be appropriate for the season in which it is planted and shall be approved by the COMPANY prior to placement.

B. Seed shall be hulled, extra-fine grade, treated with fungicide, and shall have a germination and purity that will produce, after allowance for Federal Seed Act tolerances, a pure live seed (PLS) content of not less than 85 percent. Seed shall be labeled in accordance with U.S. Department of Agriculture rules and regulations.

C. Unless otherwise approved by the COMPANY, vegetation seed mixture shall consist of the following grasses at the application rates specified:

Grass Species	Application Rate (pounds PLS per acre)
Gulf Rye	30
Common Bermudagrass	20
Total:	50

D. Alternative seed mixtures may be submitted in writing to the COMPANY and must be approved by the COMPANY prior to seed application.

2.4 ACCESSORIES

A. Mulching materials shall consist of dry oat, wheat, or Bermuda straw, free from weeds and foreign matter detrimental to plant life. Native hay or chopped cornstalks are acceptable. Also acceptable is approved chip-form wood cellulose fiber that is free of ingredients that could inhibit growth or germination.

B. Compost, if used as an organic admixture, shall be applied per TXDOT Special Specification; Item 1027 "Furnishing and Placing Compost." Compost application is optional and subject to the approval of the COMPANY, which must be obtained at least 10 days prior to use.

C. Fertilizer shall be applied to vegetative soil layer material and shall be inorganic chemical fertilizer consisting of 20-5-5 fertilizer applied at 200 pounds per acre.

D. Stakes shall be softwood lumber, chisel pointed.

E. Water shall be from fresh water sources and shall be free from soil, acids, alkalis, salt, or any other substance injurious to growth of grass.

PART 3 – EXECUTION

3.1 INSPECTION OF VEGETATIVE SOIL

A. CONTRACTOR shall verify that vegetative soil and areas disturbed during construction activities are ready to receive the work covered by this section.

3.2 FERTILIZER

A. All fertilizer shall be applied in accordance with manufacturer's instructions.

B. Manure, if used, may be applied at a rate of up to 10 tons/acre. Manure application is optional subject to the approval of the COMPANY, which must be obtained at least 10 days prior to use.

C. Pre-planting fertilizer shall be mixed thoroughly into the upper 3 in. of vegetative-soil layer prior to applying seed.

3.3 SEEDING

A. Drill seed application is acceptable for slopes equal to or flatter than 4(H):1(V).

B. Seed shall be applied evenly by broadcast or hydroseed application at the rate specified in this Section. Adjustment to rate shall be made for variations in seed purity and germination to achieve the PLS equivalent rate. Hydroseeding is acceptable as a broadcast method of seeding and fertilizing. If dry broadcasting is done, seeds must be raked into the upper soil surface and seed must be applied at half of the specified broadcast rate. Designated areas for erosion control may not be seeded in excess of that which can be covered with erosion control material on the same day.

C. CONTRACTOR shall not sow immediately following rain, when ground is too dry, or during windy periods.

3.4 SEED PROTECTION/EROSION CONTROL

A. Straw/hay mulch shall be applied to all seeded areas, with slopes less than 4(H) to 1(V), within 24 hours after seeding operations. Straw or hay mulch shall be applied at a rate of approximately 150 pounds per 1000 square feet (6,500 pounds per acre) and crimped in place. Cellulose fiber

mulch shall be applied at a rate of approximately 75 pounds per 1,000 square feet (3,200 pounds per acre).

B. Seeded sloped areas shall be covered with erosion control fabric on all exterior slopes of 4(H) to I(V) and steeper; and in all drainage channels and swales in accordance with Section 1100, "Erosion and Sedimentation Control."

3.5 IRRIGATION

A. CONTRACTOR shall irrigate seeded areas if and as necessary to comply with the Uniform Grass Coverage (UGC) requirements of this Section.

B. Irrigation may be performed by water truck or by temporary irrigation system. If a temporary irrigation system is used, CONTRACTOR shall remove temporary irrigation system once COMPANY has accepted vegetated areas.

C. Irrigation shall be performed for a minimum of thirty days after initial planting and for as long as necessary to establish UGC across the entire seeded area.

3.6 ESTABLISHMENT AND ACCEPTANCE OF PERMANENT VEGETATION

A. It shall be solely the CONTRACTOR’s responsibility to establish UGC across all application areas, regardless of unseasonable climatic conditions or other adverse conditions affecting planting operations and growth of vegetation.

B. Uniform Grass Coverage (UGC) shall be defined as a uniform stand of the specified grass with not less than 12 growing plants per square foot of seeded areas.

C. COMPANY will consider application areas acceptable only when:

1. A statistically significant number of randomly sampled plots have an average of 12 growing plants per square foot.
2. A minimum of one mowing has been performed in the seeded areas.
3. UGC has been deemed to have been achieved by the COMPANY.

D. Any application areas, which are not determined to be acceptable by the COMPANY, shall be replanted, refertilized, and reirrigated at no additional cost to the COMPANY.

E. The life and satisfactory condition of all plants (including grass) shall be guaranteed by CONTRACTOR for a period of up to one calendar year after written notice of first acceptance of vegetation by COMPANY. The guarantee period shall include one complete growing season and dormant period.

++END OF SECTION++

SECTION 02420

FLEXIBLE MEMBRANE LINER

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section shall govern work associated with furnishing and installing Flexible Membrane Liner, including, but not limited to, layout, placement, seaming, patching and testing.

1.2 REFERENCES

A. American Society of Testing Materials (ASTM) Standards/Publications (Latest version):

D 638	Standard Test Method for Tensile Properties of Plastics
D 1004	Test Method for Initial Tear Resistance of Plastic or Film Sheeting
D 1238	Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
D 1505	Test Method for Density of Plastics by the Density-Gradient Technique
D 1603	Test Method for Carbon Black in Olefin Plastics
D 2216	Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-aggregate Mixtures
D 3895	Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
D 4354	Standard Practice for Sampling of Geosynthetics for Testing
D 4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
D 4643	Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method
D 4759	Standard of Practice for Determining the Specification Conformance of Geosynthetics
D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Other Related Products.
D 5084	Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
D 5199	Measuring Nominal Thickness of Geotextiles and Geomembranes
D 5261	Standard Test Method for Measuring Mass Per Unit Area of Geotextiles
D 5321	Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
D 5397	Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test

D 5596	Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
D 5641	Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
D 5820	Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
D 5887	Test Method for Measurement of Index Flux through Saturated Geosynthetic Clay Liner Using Flexible Wall Permeameter
D 5888	Identification, Storage, and Handling of Geosynthetic Clay Liners
D 5889	Standard Practice for Quality Control of Geosynthetic Clay Liners
D 5890	Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
D 5891	Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners
D 5993	Standard Test Method for Measuring Mass Per Unit Area of Geosynthetic Clay Liners
D 5994	Standard Test Method for Measuring Core Thickness of Textured Geomembranes
D 6102	Standard Guide for Installation of Geosynthetic Clay Liners
D 6243	Standard Test Method for Determining the Coefficient of Soil and GCL or Geosynthetic and GCL Friction by the Direct Shear Method
D 6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
D 6496	Standard Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners
D 6693	Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
D 6768	Standard Test Method for Tensile Strength of Geosynthetic Clay Liners
E 96	Standard Test Methods for Water Vapor Transmission of Materials

B. Geosynthetic Research Institute (GRI)

GM 17	Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes

1.3 DEFINITIONS

A. Flexible Membrane Liner (FML) - An essentially impermeable flexible geomembrane liner of linear low density polyethylene (LLDPE).

B. INSTALLER -Party responsible for liner installation, including handling, transporting, storing, deploying, protecting, sampling, patching damaged liner and temporary restraining against wind and thermal/solar expansion.

C. Lot - Group of consecutively numbered rolls from the same manufacturing line.

D. MANUFACTURER - Party responsible for the production and quality of the liner.

E. Overlap - The width of material of a liner panel in contact with an adjacent liner panel. The overlap distance is measured perpendicular from the overlying edge of one panel to the underlying edge of the other.

1.4 SUBMITTALS

A. CONTRACTOR shall submit the following product information at least 10 days prior to delivery:

1. FML: Certification stating that the FML meets the product requirements of this specification and copies of quality control tests performed by MANUFACTURER.

B. CONTRACTOR shall submit the name of the INSTALLER at least 3 weeks prior to installation, including resume of installation supervisor to be assigned to the project and a list of FML projects completed by INSTALLER.

C. CONTRACTOR shall submit a Quality Control Plan and Installation Procedures at least 3 weeks prior to installation. The information shall include a list of quality control tests performed and typical testing frequencies, recommended installation procedures, and panel layout drawing identifying panels and overlaps.

D. CONTRACTOR shall submit the following upon completion of the FML installation:

1. Certification from the INSTALLER stating that the FML has been installed in accordance with the Drawings and Specifications.

2. As-built record drawings showing instrument surveyed locations of all panels, seams, repairs, patches and test samples.

3. Test reports verifying that the FML has been installed in accordance with the specified requirements.

4. Test reports verifying completion of all field seams and repairs are in accord with specified requirements.

1.5 QUALIFICATIONS

A. INSTALLER must have experience installing FML liners on at least 5 projects of each liner type and have installed a minimum of 2,000,000 square feet of each liner type.

B. INSTALLER shall provide a minimum of one Master Seamer (minimum 1,000,000 square feet using the type of seaming apparatus proposed for this project) for work on the project.

C. MANUFACTURER may serve as the INSTALLER or may use an outside INSTALLER that has been approved and certified by MANUFACTURER.

1.6 QUALITY CONTROL

A. CONTRACTOR is responsible for the overall quality of the installed FML. CONTRACTOR shall maintain quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

B. CONTRACTOR shall perform construction surveys, as needed, to ensure that the location and grades of all liner installations are in accordance with the design requirements.

C. ENGINEER may perform periodic quality assurance monitoring above and beyond that specified herein. CONTRACTOR shall cooperate, as required, in quality assurance monitoring.

1.8 WARRANTY

A. FML material shall be warranted by the MANUFACTURER on a pro-rata basis against defects for a period of 5 years from the date of acceptance by the COMPANY.

B. FML installation shall be warranted by the INSTALLER against defects in workmanship for a period of 1 year from the date of acceptance by the COMPANY.

PART 2 - PRODUCTS

2.1 FML PRODUCT STANDARD

A. FML shall be Type “UltraFlex” as manufactured by GSE Environmental, Inc. (GSE) of Houston, Texas; or ENGINEER-approved equivalent. The FML shall be a black, coextruded geomembrane.

B. Smooth FML shall be installed on flat surfaces and slopes less than 4(H) to I(V). Textured FML shall be installed on slopes 4(H) to I(V) and steeper.

C. <u>FML Material Properties</u>

1. FML shall be 40 mil thick linear low density polyethylene (LLDPE) and shall comply with the following:

Property	ASTM Method	Frequency	Unit	Minimum Average Values
Thickness	D5994	Every Roll	mil	40
Density	D1505	200,000 lbs	g/cm^3	0.94
Tensile Break Strength (smooth/textured)	D6693	20,000 lbs	lb/in	152/60
Elongation at Break (smooth/textured)	D6693	20,000 lbs	%	800/250
Tear Resistance	D1004	45,000 lbs	lb	22
Puncture Resistance (smooth/textured)	D4833	45,000 lbs	lb	56/44
Carbon Black Content	D1603	20,000 lbs	%	2.0 – 3.0
Notch Constant Tensile Load	D5397	200,000 lbs	hr	300
Oxidative Induction Time	D3895	200,000 lbs	min	>100

D. FML Extrudate Rod or Bead shall conform to the following:

1. Extrudate material shall be made from same type resin as the FML.
2. Additives shall be thoroughly dispersed.

3. Materials shall be free of contamination by moisture or foreign matter.

E. FML Welding/Seaming Equipment shall meet the following requirements:

1. Gauges showing temperatures in apparatus (extrusion welder) or wedge (wedge welder) shall be present.
2. An adequate number of welding apparati shall be available to avoid delaying work.
3. Power source must be capable of providing constant voltage under combined line load.

2.2 FML PACKING AND LABELING

A. FML shall be wrapped around a structurally sound core than can support the weight of the liner. Liners shall be supplied in rolls wrapped in relatively impermeable and opaque protective covers and marked or tagged with the following information:

1. MANUFACTURER's name
2. product identification
3. lot or batch number
4. roll number
5. roll dimensions

2.3 FML MANUFACTURING QUALITY CONTROL

A. FML shall be subjected to quality control and conformance testing to assure that the materials provided meet the specified requirements. Where possible, sampling shall be performed on sacrificial portions of the material to minimize repair of sampled locations.

B. All materials shall be tested in accordance with MANUFACTURER's quality control program and as specified herein. The MANUFACTURER shall perform the testing. Samples not satisfying the requirements of these specifications shall result in the rejection of the applicable rolls. At CONTRACTOR's expense, additional testing of individual rolls may be performed to more closely identify the non-complying rolls and/or to qualify individual rolls.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE and HANDLING

A. Deliver material to the job site only after ENGINEER/COMPANY accepts required submittals.

B. Comply with MANUFACTURER'S recommendations regarding product protection. Maintain product clean and free of damage.

C. Liner shall be covered with a waterproof, tight-fitting plastic protective covering resistant to ultraviolet degradation. Damage to protective covering shall be repaired immediately. Repairs shall be such that the liner is protected from moisture or other deleterious conditions.

D. Deliver product to the job site in MANUFACTURER's original packaging, with labels intact and legible. Maintain packaged materials with seals unbroken and labels intact until time of use. Promptly remove damaged or unsuitable products from the job site and promptly replace with products meeting the required specifications.

E. Comply with MANUFACTURER's recommendations when hauling, unloading, deploying, and installing liner. Do not fold liner. Inspect for defects before installing.

3.2 FML DEPLOYMENT

A. MANUFACTURER shall verify to the ENGINEER that the materials upon which the FML will be installed are acceptable prior to initiating FML deployment.

B. Assign each panel a simple and logical identifying code. The coding system shall be subject to approval by the ENGINEER and shall be determined at the job site.

C. Visually inspect the FML during deployment for imperfections and mark faulty or suspect areas.

D. Deployment of FML panels shall be performed in a manner that will comply with the following guidelines:

   1. Unroll FML using methods that will not damage FML and will protect underlying surface from damage (spreader bar, protected equipment bucket).

   2. Place ballast (commonly sandbags) on FML which will not damage FML to prevent wind uplift.

   3. Personnel walking on FML shall not engage in activities or wear shoes that could damage it. Smoking will not be permitted on the FML.

   4. Do not allow heavy vehicular traffic directly on FML. Rubber-tired ATV's and trucks are acceptable if wheel contact is less than 6 psi.

   5. Protect FML in areas of heavy traffic by placing protective cover over the FML.

E. Sufficient material (slack) shall be provided to allow for thermal expansion and contraction of the material.

F. During installation avoid bridging, stresses in the FML, wrinkles and folds.

G. Schedule FML deployment so deployment, welding and covering occur within as narrow a temperature range as possible. Do not deploy in the presence of excessive moisture, precipitation, ponded water or high winds.

H. Deploy panels to minimize field seams in corners, odd-shaped geometric locations and outside corners.

I. Shingle panels on slopes and grades so upgradient panel is on top.

J. Unroll only those factory-packaged sections which are to be anchored or seamed together in one day.

K. After panels are initially in place, remove as many wrinkles as possible. Unroll several panels and allow the liner to "relax" before beginning field seaming. The purpose of this is to make the edges which are to be bonded as smooth and free of wrinkles as possible.

L. Once panels are in-place and smooth, commence field seaming operations.

M. Personnel working on the FML shall not smoke, wear damaging shoes or engage in any activity which damages the FML.

N. Anchor trenches shall be constructed as shown on the Drawings. Round edges of anchor trenches or cushion with geotextile. The anchor trench shall be excavated, backfilled and compacted in accordance with MANUFACTURER's recommendations. Care should be taken when backfilling the trench to prevent any damage to the FML.

O. Damaged and sample coupon areas of FML shall be repaired by the CONTRACTOR before leaving the site at the end of each day. Any damage to subgrade while coupons are open is the responsibility of the CONTRACTOR. Repaired areas will be tested for seam integrity by the CONTRACTOR. Damaged materials are the property of the CONTRACTOR and will be removed from the site at the CONTRACTOR's expense. The CONTRACTOR will retain all ownership and responsibility for the FML until acceptance by the COMPANY.

3.3 FML SEAMING

A. Provide at least one Master Seamer who shall provide direct supervision over other welders as necessary.

B. Use a sequential seam numbering system compatible with panel numbering system that is acceptable to the ENGINEER and INSTALLER.

C. Seaming may be extrusion or wedge welding or a combination of these methods. Solvent welding is not acceptable. ENGINEER reserves the right to reject any proposed seaming method.

1. Extrusion Welding. Extrusion welding applies a molten bead of material to preheated sheets of FML which are then joined by pressure. Prior to extrusion welding:

   a. Hot-air tack adjacent pieces together using procedures that do not damage the FML.
   b. Clean FML surfaces by disc grinder or equivalent.
   c. Purge welding apparatus of heat-degraded extrudate before welding.

2. Wedge Welding. The wedge welding process heats the FML area to be joined to the melting point and then applies pressure to join the melted surfaces. Wedge welding apparatus shall be a self-propelled device equipped with an electronic controller which displays applicable temperatures.

D. Seaming shall be performed in accordance with the following:

1. All foreign matter (dirt, water, oil, etc) shall be removed from the area to be bonded. No solvents shall be used to clean the FML.

2. It is imperative to keep surface water runoff from beneath the FML at all times during installation. The CONTRACTOR's panel placement, seam welding technique and welding schedule shall minimize or eliminate the accumulation of water beneath the FML. Any water found ponded beneath the FML after the FML has been installed shall be removed by the CONTRACTOR at no cost to the COMPANY. Subgrade beneath FML that has become excessively moist, soft or unsuitable to perform its intended function shall be replaced at no cost to the COMPANY.

3. As much as practical, field seaming shall start in the middle and work toward an open end in order to minimize cutting and patching of large wrinkles that become trapped. When seaming the side slopes, seaming should start at the toe of the slope and work up the slope. Tack welds, if used, shall use heat only; no double-sided tape, glue or other method will be permitted. The FML should be seamed completely to the ends of all panels to minimize the potential of tear propagation along the seam. Seaming of the bottom membrane to the sidewall membrane shall be conducted when conditions minimize thermal expansion effects. The completed liner shall not exhibit "trampolining" and shall be in full contact with the underlying materials.

4. FML sheets to be joined shall be overlapped at least 6-inches after the necessary aligning and cutting, unless otherwise shown on the Contract Drawings.

5. In corners and odd shaped geometric locations, the number of field seams should be minimized.

6. No seaming should be attempted above 40 degrees C (104 degrees F) ambient air temperature. Below 5 degrees C (41 degrees F) ambient air temperature, preheating of

the FML may be required. It shall be the responsibility of the CONTRACTOR to demonstrate that conditions are favorable for seaming by acceptable test (start-up) seams which duplicate, as closely as possible, actual field conditions. Preheating may be achieved by natural and/or artificial means (shelters and heating devices).

7. A moveable protective layer of plastic may be required, as recommended by the ENGINEER, to be placed directly below each overlap of FML that is to be seamed. This is to prevent any moisture build-up between the sheets to be welded.

8. Seaming will extend to the outside edge of panels to be placed in anchor trenches.

9. If required, a firm substratum should be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support.

10. No folds, wrinkles or "fish-mouths" shall be allowed within the seam area. Where wrinkles or folds occur, the material shall be cut, overlapped and an extrusion-weld shall be applied. All welds on completion of the work shall be tightly bonded and sealed. Do not cover FML at locations that have been repaired until test results with passing values are available.

11. After seaming is complete in a given area, FML edges in the anchor trench should be buried. Do not bury the FML edge in the anchor trench within 30 feet of an incomplete or unbounded field seam.

12. At the end of each day or installation segment, all unseamed edges shall be anchored by sand bags or other approved device. Sand bags shall weigh approximately 20 pounds and shall be placed no further apart than 20 foot spacing along the open end of the FML. Sand bags securing the FML on the side slopes should be connected by a rope fastened at the top of the slope by a temporary anchor. If high winds are expected, boards along the edge of unseamed panels, with weighted sand bags on top, should be used to anchor the FML on the bottom of the cell. Sand bags fastened by rope should be used to secure unseamed edges on the side slopes. Staples, U-shaped rods or other penetrating anchors shall not be used to secure the FML. The temporary anchoring of the FML is the responsibility of the CONTRACTOR. Any material damaged as the result of weather effects, shall be repaired or replaced at no cost to the COMPANY.

3.4 FML TESTING

A. General

1. CONTRACTOR shall employ a Geosynthetic Quality Assurance Laboratory to conduct all laboratory testing required by these Specifications.

2. Samples of the field seams shall be taken and tested in accordance with ASTM D638 to ensure that tensile strength at yield and break, elongation at yield and break meet the minimum specifications. A quality control certificate shall be issued with the material.

3. The CONTRACTOR shall employ on-site physical non-destructive testing on all welds.

4. A quality control technician shall inspect each sheet and seam. Any area showing a defect shall be marked and repaired in accordance with the FML repair procedures presented in these Specifications.

B. Trial Weld Testing. Trial weld testing shall be performed to verify welding equipment is operating properly. Trial weld testing shall be made each day prior to commencing field seaming and no welding equipment or welder shall be allowed to perform production welds until equipment and welders have successfully completed a trial weld test. Trial weld testing shall be completed in accordance with the following:

1. Make trial welds under the same surface and environmental conditions as the production welds, i.e., in contact with subgrade and similar ambient temperature.

2. Minimum of two trial weld tests per day, per welding apparatus, one made prior to the start of work and one completed at mid shift. Each seamer will make at least one trial weld test each day.

3. Cut four, one-inch wide by six-inch long test specimens from the trial weld and quantitatively test the specimens for peel adhesion and shear strength. Trial weld test specimens shall pass when the results are in compliance with the following minimum seam values:

Property	ASTM Procedure	Unit	Minimum Values
Peel Strength (fusion)	D6392	lb/in	75
Peel Strength (extrusion)	D6392	lb/in	72
Shear Strength	D6392	lb/in	90

4. The criteria for passing a peel test shall be conformance with all of the following:

   a. Failure shall be by Film Tear Bond (FTB);

   b. No greater than 10 percent of the seam width peels (separates) at any point;

   c. Compliance with the specified minimum seam values for peel; and

   d. The break shall be ductile and shall occur in the FML material itself, not through peel separation.

5. The criteria for passing a shear test shall be conformance with all of the following:

   a. Failure shall be by FTB; and

   b. Compliance with the specified minimum seam values for shear.

6. If a trial weld fails, the entire operation will be repeated. If the additional trial weld fails, the seaming apparatus or seamer will not be accepted and will not be used for seaming until the deficiencies are corrected and two consecutive successful full test seams are achieved. Trial weld failure is defined as failure of any one of the specimens tested in shear or peel.

7. Successful trial weld samples shall be assigned a number and marked accordingly by the CONTRACTOR, who will also log the date, hour, ambient temperature, number of seaming unit, name of seamer and pass or fail description. The CONTRACTOR shall submit this data to the COMPANY following acceptance of the FML.

C. Non-Destructive Testing. All field seams shall be tested by the CONTRACTOR continuously using non-destructive techniques. Requirements for non-destructive testing are as follows:

1. Single Weld Seams: CONTRACTOR shall maintain and use equipment and personnel at the site to perform continuous vacuum box testing on all single weld production seams or when the geometry of the weld makes pressure testing impractical. Vacuum testing shall be performed in accordance with ASTM D 5641.

2. Double Weld Seams: CONTRACTOR shall maintain and use equipment and personnel to perform air pressure testing of all double weld seams. Air pressure testing shall be performed in accordance with ASTM D 5820.

D. Destructive Testing. Field seams shall be tested by the CONTRACTOR at specified intervals using destructive tests. Requirements for destructive testing are as follows:

1. Destructive testing will be performed on an average of every 1,500 linear feet of field seam. Test locations shall be approved by the ENGINEER.

2. Destructive test samples shall be 12 inches wide and of sufficient length to provide one sample to archive, one sample to the ENGINEER, and two samples to the CONTRACTOR for both field and laboratory testing.

3. Destructive testing shall be performed in accordance with ASTM D 6392, Standard Test Method for Determining the Integrity of Non-Reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods. Testing requirements are as follows:

   a. Each sample shall be large enough to test five specimens in peel and five specimens in shear.

   b. The average values of each set of five specimens must comply with the material and seam requirements of this Specification and four of the five specimen tests must meet the material and seam requirements of this Specification for the seam to be considered a passing seam. If the average of the five specimens is adequate, but one of the specimens is failing, values for the failing specimen must be at least 80 percent of the specified values for the seam sample to pass.

   c. A maximum of one non-FTB failure out of five tests is acceptable provided the non-FTB specimen meets strength requirements.

   d. If unresolved discrepancies exist between Engineer's and CONTRACTOR's test results, the archived sample may be tested by the Engineer.

4. Test specimens shall pass when the results are in compliance with the following minimum seam values:

Property	ASTM Procedure	Unit	Minimum Values
Peel Strength (fusion)	D6392	lb/in	75
Peel Strength (extrusion)	D6392	lb/in	72
Shear Strength	D6392	lb/in	90

5. Failed Seam Procedures:

   a. If the seam fails, INSTALLER shall follow one of two options:

      i. Reconstruct the seam between any two passed test locations.

      ii. Trace the weld to intermediate location at least 10 feet minimum or where the seam ends in both directions from the location of the failed test.

   b. The next seam welded using the same welding device is required to obtain an additional sample, i.e., if one side of the seam is less than 10 feet long.

   c. If sample passes, then the seam shall be reconstructed or capped between the test sample locations.

6. CONTRACTOR shall repair all holes in the FML resulting from destructive sampling and shall test the continuity of the repair in accordance with these Specifications.

3.5 FML REPAIR

A. Remove damaged FML and replace with acceptable FML materials if damage cannot be satisfactorily repaired.

B. Repair any portion of unsatisfactory FML or seam area failing a destructive or non-destructive test.

C. INSTALLER shall be responsible for repair of defective areas.

D. Agreement upon the appropriate repair method shall be decided between ENGINEER and CONTRACTOR by using one of the following repair methods:

1. Patching- Used to repair large holes, tears, undispersed raw materials and contamination by foreign matter.

2. Abrading and Re-welding- Used to repair short section of a seam.

3. Spot Welding- Used to repair pinholes or other minor, localized flaws or where FML thickness has been reduced.

4. Capping- Used to repair long lengths of failed seams.

5. Flap Welding- Used to extrusion weld the flap (excess outer portion) of a fusion weld in lieu of a full cap.

6. Remove the unacceptable seam and replace with new material.

E. The following procedures shall be followed when a repair method is used:

1. All FML surfaces shall be clean and dry at the time of repair.

2. Surfaces of the FML which are to be repaired by extrusion welds shall be lightly abraded to assure cleanliness.

3. Extend patches or caps at least 6 inches for extrusion welds and 4 inches for wedge welds beyond the edge of the defect, and around all corners of patch material.

F. Repair Verification. CONTRACTOR shall number and log each patch repair and shall non-destructively test each repair using methods specified in this Specification

3.6 PROTECTIVE SOIL PLACEMENT

A. Protective Soil shall be placed over the FML as specified in Section 02300 of these Specifications and as specified herein.

B. When an FML is installed over a GCL, Protective Soil placement shall also comply with the requirements of Section 02410 of these specifications.

3.7 FML ACCEPTANCE

A. COMPANY will accept the FML installation when:

1. The installation is complete as determined by the ENGINEER.

2. All required submittals and documentation have been received and approved by ENGINEER.

3. Test reports verifying completion of all field seams and repairs are in accord with specified requirements.

4. CONTRACTOR provides ENGINEER with as-built record drawings of the instrument surveyed panel layout and seam locations with reference numbers for test locations.

5. Written certification documents have been received and approved by ENGINEER.

++END OF SECTION++

SECTION 02430

GEOTEXTILE

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section shall govern work associated with furnishing and installing geotextile including, but not limited to, layout, installation, and testing.

1.2 REFERENCES

A. American Society of Testing Materials (ASTM) Standards/Publications (Latest version):

D3776	Test Method for Mass per Unit Area (weight) of Woven Fabric
D3786	Test Method for Hydraulic Bursting Strength of Knitted Goods and Non-woven Fabrics
D3787	Test Method for Hydraulic Bursting Strength of Knitted Goods and Non-woven Fabrics, Diaphragm Bursting Strength Test
D4354	Standard Practice for Sampling Geosynthetics for Testing
D4355	Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
D4491	Test Method for Water Permeability of Geotextiles by Permittivity
D4533	Test Method for Trapezoid Tearing Strength of Geotextiles
D4595	Test Method for Tensile Properties by the Wide-width Strip Method
D4632	Test Method for Breaking Load and Elongation of Geotextiles (Grab Method)
D4751	Test Method for Determining Apparent Opening Size of Geotextile
D4833	Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
D5199	Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes

1.3 SUBMITTALS

A. At least 14 days prior to installation of the geotextile, CONTRACTOR shall submit for approval the following information:

1. Manufacturer's Literature. Submit manufacturer's literature for proposed geotextile, including catalog cut sheets, material samples and, written instructions for delivery, storage, handling, installation, seaming, and repair.

2. Manufacturer Certification. Written certification from the manufacturer that the geotextile complies with the requirements of these specifications and is appropriate for the intended application.

PART 2 - PRODUCTS

2.1 GEOTEXTILE

A. Geotextile shall be non-woven, continuous or staple filament, needle-punched polypropylene or polyester suitable for AASHTO M-288 Class 2 applications. Yarn shall be oriented into a stable network that maintains its structure during handling, installation, and long-term service.

B. Geotextile shall be uniform in color, density, and other physical properties and free of foreign inclusions or other defects.

C. Geotextile shall be nominal 8 oz per square yard and shall conform to the following minimum average roll values for the properties listed:

Property	ASTM	Unit	Minimum Values
Mass per Unit Area	D5261	oz/yd2	8
Grab Tensile Strength	D4632	lb	220
Grab Elongation	D4632	%	50
CBR Puncture Strength	D6241	lb	575
Trapezoid Tear Strength	D4533	lb	90
Apparent Opening Size	D4751	US Sieve	80
Permittivity	D4491	sec^{-1}	1.3
Water Flow Rate	D4491	gpm/ft2	95
UV Resistance	D4355	% Retained	70

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE and HANDLING

A. Comply with the manufacturer's recommendations regarding product handling and protection.

B. Deliver products to the job site in their manufacturer's original packaging, with labels intact and legible.

C. Maintain packaged materials with seals unbroken and labels intact until time of use. Maintain in a manner that keeps product clean, dry and free of damage. Promptly remove damaged or unsuitable products from the job site and promptly replace with products meeting the required specifications.

D. Comply with manufacturer's recommendations when hauling, unloading, deploying, and installing geotextile. Inspect for defects before installing.

3.2 GEOTEXTILE INSTALLATION

A. Extend geotextile into anchor trenches as shown in the Drawings. Roll geotextile down the slope in such a manner as to maintain tension to preclude folds and wrinkles. Remove any folds or wrinkles by hand.

B. Ballast geotextile during deployment. Remove ballast immediately prior to covering geotextile with succeeding construction layer.

C. During installation, do no entrap rocks, dust, or moisture that could damage geotextile or cause clogging.

D. Schedule deployment activities so geotextile is exposed to direct sunlight for no more than 5 days, unless geotextile is ultraviolet-light stabilized.

E. Overlap geotextile 2 feet minimum at all seams.

F. Inspect geotextile and repair holes or tears. Patch using the same geotextile, with minimum overlap of 2 feet in all directions.

++END OF SECTION++

SECTION 02440

GEOCOMPOSITE DRAINAGE LAYER

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section shall govern work associated with furnishing and installing geocompsite drainage layer including, but not limited to, layout, installation, and testing.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM)

D1238	Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
D4218	Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle Furnace Technique D 1603-94 Standard Test Method for Carbon Black in Olefin Plastics
D4355	Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
D4491	Standard Test Method for Water Permeability of Geotextiles by Permittivity
D4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
D4716	Standard Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
D4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
D6241	Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile- Related Products Using a 50-mm Probe D 4833-88 (1996) Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
D5261	Standard Test Method for Measuring the Mass Per Unit Area of Geotextiles
D7005	Determining the Bond Strength (Ply-Adhesion) of Geocomposites
D7179	Standard Test Method for Determining Geonet Breaking Force

B. Environmental Protection Agency (EPA)

Daniel, D.E. and R.M. Koerner, (1993), Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities, EPA/600/R-93/182.

1.3 DEFINITIONS

A. COMPANY - The individual or firm responsible for the design and preparation of the project’s Contract Drawings and Specifications.

B. Geocomposite Manufacturer (MANUFACTURER) - The party responsible for manufacturing the geocomposite rolls.

C. Geosynthetic Quality Assurance Laboratory (TESTING LABORATORY) – Provided by CONTRACTOR, party that's independent from the MANUFACTURER and INSTALLER, responsible for conducting laboratory tests on samples of geosynthetics obtained at the site or during manufacturing.

D. INSTALLER- Party responsible for field handling, transporting, storing and deploying the geocomposite.

E. Lot- A quantity of resin (usually the capacity of one rail car) used to manufacture polyethylene geocomposite rolls. The finished rolls will be identified by a roll number traceable to the resin lot.

1.4 QUALIFICATIONS

A. MANUFACTURER

1. MANUFACTURER shall have manufactured a minimum of 10,000,000 square feet of polyethylene geocomposite material.

B. INSTALLER

1. INSTALLER shall have installed a minimum of 1 million square feet of geocomposite in the last year.

2. INSTALLER shall have worked in a similar capacity on at least 5 projects similar in complexity to the project described in the contract documents.

3. The Installation Supervisor shall have worked in a similar capacity on projects similar in size and complexity to the project described in the Contract Documents.

1.5 SUBMITTALS

A. At least 14 days prior to installation of the geocomposite, CONTRACTOR shall submit for approval the following information:

1. Manufacturer's Literature. Submit manufacturer's literature for proposed geocomposite, including catalog cut sheets, material samples and, written instructions for delivery, storage, handling, installation, seaming, and repair.

2. Manufacturer Certification. Written certification from the manufacturer that the geocomposite complies with the requirements of these specifications and is appropriate for the intended application.

1.6 MATERIAL LABELING, DELIVERY, STORAGE AND HANDLING

A. Labeling - Each roll delivered to the site shall be wrapped and labeled by the MANUFACTURER. The label will identify:

1. manufacturer's name
2. product identification
3. length
4. width
5. roll number

B. Delivery - Rolls will be prepared to ship by appropriate means to prevent damage to the material and to facilitate off-loading.

C. Storage - The on-site storage location provided by the CONTRACTOR to protect the geonet from abrasions, excessive dirt and moisture shall have the following characteristics:

1. level (no wooden pallets)
2. smooth
3. dry
4. protected from theft and vandalism
5. adjacent to the area being lined

D. Handling

1. The CONTRACTOR and INSTALLER shall handle all rolls in such a manner to ensure they are not damaged in any way.

2. The INSTALLER shall take any necessary precautions to prevent damage to underlying layers during placement of the drainage material.

1. 7 WARRANTY

A. Material shall include one-year warranty against defects.

B. Installation shall be warranted against defects in workmanship for a period of 1-year from the date of geocomposite completion.

PART 2 - PRODUCTS

2.1 GEOCOMPOSITE PRODUCT STANDARD

A. Geocomposite shall be 275-mil FabriNet Geocomposite Double-sided with 8 oz geotextile as manufactured by GSE, or approved equal.

B. Geocomposite shall be manufactured by extruding two crossing strands to form a bi-planar drainage net structure with a non-woven geotextile bonded to one or both sides.

C. Geocomposite shall have properties that meet or exceed the values listed as follows:

1. Geocomposite

Property	ASTM	Frequency	Unit	Minimum Values
Transmissivity	D4716	1/540,000 ft2	gal/min/ft	3.4
Ply Adhesion	D7005	1/50,000 ft2	lb/in	1.0

2. Geonet

Property	ASTM	Frequency	Unit	Minimum Values
Core Thickness	D5199	1/50,000 ft2	mil	275
Transmissivity	D4716	1/50,000 ft2	gal/min/ft	29
Density	D1505	1/50,000 ft2	g/cm3	0.94
Tensile Strength	D7179	1/50,000 ft2	lb/in	65
Carbon Black Content	D4218	1/50,000 ft2	%	2.0

3. Geotextile

Property	ASTM	Frequency	Unit	Minimum Values
Mass per Unit Area	D5261	1/90,000 ft2	oz/yd2	8
Grab Tensile Strength	D4632	1/90,000 ft2	lb	220

Grab Elongation	D4632	1/90,000 ft2	%	50
CBR Puncture Strength	D6241	1/90,000 ft2	lb	575
Trapezoid Tear Strength	D4533	1/90,000 ft2	lb	90
Apparent Opening Size	D4751	1/540,000 ft2	US Sieve	80
Permittivity	D4491	1/540,000 ft2	sec^{-1}	1.3
Water Flow Rate	D4491	1/540,000 ft2	gpm/ft2	95
UV Resistance	D4355	Per Formulation	% Retained	70

D. Resin

1. Resin shall be new first quality, compounded polyethylene resin.

2. Natural resin (without carbon black) shall meet the following additional minimum requirements:

Property	ASTM Test Method	Value
Density (g/cm3)	D1505	>0.932
Melt Flow Index (g/10 min)	D1238	< 1.0

2.2 MANUFACTURING QUALITY CONTROL

1. Geocomposite shall be manufactured in accordance with the Manufacturer's Quality Control Plan.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE and HANDLING

A. Comply with the manufacturer's recommendations regarding product handling and protection.

B. Deliver products to the job site in their manufacturer's original packaging, with labels intact and legible.

C. Maintain packaged materials with seals unbroken and labels intact until time of use. Maintain in a manner that keeps product clean, dry and free of damage. Promptly remove damaged or unsuitable products from the job site and promptly replace with products meeting the required specifications.

D. Comply with manufacturer's recommendations when hauling, unloading, deploying, and installing geotextile. Inspect for defects before installing.

3.2 FAMILIARIZATION

A. Inspection

1. Prior to implementing any of the work in the Section to be lined, the INSTALLER shall carefully inspect and approve the areas to receive the geocomposite.

2. If INSTALLER has any concerns regarding the areas to receive geocomposite, he shall immediately notify COMPANY.

3.3 INSTALLATION

A. The geocomposite roll should be installed in the direction of the slope and in the intended direction of flow unless otherwise specified by the COMPANY.

B. If the project contains long, steep slopes, special care should be taken so that only full length rolls are used at the top of the slope.

C. In the presence of wind, all geocomposites shall be weighted down with sandbags or the equivalent. Such sandbags shall be used during placement and remain until replaced with cover material.

D. The geocomposite shall be properly anchored to resist sliding. Anchor trench compacting equipment shall not come into direct contact with the geocomposite.

E. In applying fill material, no equipment can drive directly across the geocomposite. The specified fill material shall be placed and spread utilizing vehicles with a low ground pressure.

F. The cover soil shall be placed in the geocomposite in a manner that prevents damage to the geocomposite. Placement of the cover soil shall proceed immediately following the placement and inspection of the geocomposite.

3.4 SEAMS AND OVERLAPS

A. Each component of the geocomposite will be secured or seamed to the like component at overlaps.

B. Geonet Components

1. Adjacent edges of the geonet along the length of the geocomposite roll shall be placed with the edges of each geonet butted against each other.

2. The overlaps shall be joined by tying the geonet structure with cable ties. These ties shall be spaced every 5 feet along the roll length.

3. Adjoining geocomposite rolls (end to end) across the roll width should be shingled down in the direction of the slope, with the geonet portion of the top overlapping the geonet portion of the bottom geocomposite a minimum of 12 inches across the roll width.

4. The geonet portion should be tied every 6 inches in the anchor trench or as specified by the COMPANY.

3.5 REPAIR

A. Prior to covering the deployed geocomposite, each roll shall be inspected for damage resulting from construction.

B. Any rips, tears or damaged areas on the deployed geocomposite shall be removed and patched. The patch shall be secured to the original geonet by tying every 6 inches with the approved tying devices. If the area to be repaired is more than 50 percent of the width of the panel, the damaged area shall be cut out and the two portions of the geonet shall be cut out and the two portions of the geonet shall be joined in accordance with 3.4 above.

++END OF SECTION++

SECTION 02450

GEOCELLS

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section shall govern work associated with furnishing and installing geocells (cellular confinement system) including, but not limited to, layout, installation, and testing.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM)

D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
D1603	Standard Test Method for Carbon Black In Olefin Plastics
D1693	Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
D5199	Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
D5397	Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test

B. US Army Corps of COMPANYs (USACE)

Technical Report GL-86-19, Appendix A.

1.4 QUALIFICATIONS

A. Geocell Manufacturer's Field Representative shall have worked in a similar capacity on at least 5 geocell projects similar in complexity to the project described in the contract documents.

B. Geocell Installer shall have worked in a similar capacity on at least 5 geocell projects similar in complexity to the project described in the contract documents.

1.5 SUBMITTALS

A. At least 14 days prior to installation of the geocells, CONTRACTOR shall submit for approval the following information:

1. Manufacturer‘s Literature. Submit manufacturer’s literature for proposed geocells, including catalog cut sheets, material samples and, written instructions for delivery, storage, handling, installation, seaming, and repair.

2. Manufacturer Certification. Written certification from the manufacturer that the geocells comply with the requirements of these specifications and is appropriate for the intended application.

1. 6 WARRANTY

A. Material shall include one-year warranty against defects.

B. Installation shall be warranted against defects in workmanship for a period of 1-year from the date of geocell completion.

PART 2 - PRODUCTS

2.1 GEOCELL PRODUCT STANDARD

A. Geocells shall be black Terracell 140 perforated, textured high-density polyethylene (HDPE) geocell as manufactured by Hanes Geo Components, or approved equal.

B. Geocells shall be manufactured to meet the values listed as follows:

Property	Values
Cell Depth	4 in
Nominal Expanded Cell Size	10.2 in X 8.8 in
Nominal Expanded Cell Area	44.8 in
Nominal Expanded Section (L X W)	21.4 ft X 8.4 ft
Cells per Section (L X W)	29 cells X 10 cells
Nominal Expanded Section Area	180 sf
Weld Spacing	14 in

C. Geocells shall be constructed using virgin, non-thermally degraded HDPE with material properties that meet or exceed the following values:

Property	ASTM	Unit	Minimum Values
Polymer Density	D1505	g/cm3	0.935-0.965
Environmental Stress Crack Resistance	D5397	hours	>400
Environmental Stress Crack Resistance	D1693	hours	>6000
Minimum Carbon Black Content	D1603	%	1.5
Nominal Sheet Thickness	D5199	mil	60 (+10%, -5%)
Seam Peel Strength	USACE	lb	320

D. Geocell weld joints shall have a Seam Hang Strength able to support a load of 160 pounds for 30 days minimum or for 7 days minimum while undergoing temperature change from 74 degrees F to 130 degrees F on 1-hour cycle.

E. The HDPE strips used to construct the Geocell shall be textured with diamond shaped indentations. The rhomboidal indentations shall have a surface density of 140 to 200 per in^2.

F. Geocells shall be perforated with10 mm diameter holes spaced at 16.6 mm on center. The holes shall be placed in horizontal rows staggered 8.3 mm on relative to hole centers.

G. Geocell section length shall be in accordance with manufacturer recommendations for intended application.

2.2 ACCESSORIES

A. J-Hooks:

1. J-Hooks shall be uncoated steel reinforcing bars as follows:

   a. Diameter: 0.5 inch
   b. Length: 12 inches minimum.
   c. Hook: 180-degree bend

2.3 INFILL MATERIAL

A. Infill Material shall be concrete. Concrete shall at a minimum be Class A, 3,000-psi concrete with three-quarter inch diameter aggregate.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE and HANDLING

A. Comply with the Manufacturer's recommendations regarding product handling and protection.

B. Deliver products to the job site in their manufacturer's original packaging, with labels intact and legible.

C. Maintain packaged materials with seals unbroken and labels intact until time of use. Maintain in a manner that keeps product clean, dry and free of damage. Promptly remove damaged or unsuitable products from the job site and promptly replace with products meeting the required specifications.

D. Comply with Manufacturer's recommendations when hauling, unloading, deploying, and installing geotextile. Inspect for defects before installing.

3.2 FAMILIARIZATION

A. Inspection

3. Prior to beginning geocell installation, Geocell Installer and Geocell Manufacturer's Field Representative shall carefully inspect and approve the area to receive geocells.

4. If Geocell Installer or Geocell Manufacturer's Field Representative have any concerns regarding the proposed geocell area, they shall immediately notify COMPANY.

3.3 PREPARATION

A. Prepare site by removing vegetative cover, debris, and unacceptable soils from area where geocells will be installed.

B. Replace removed soils with acceptable materials.

3.4 INSTALLATION

A. Install geocells in accordance with manufacturer's instructions at locations indicated on the drawings.

B. Anchor geocell sections as necessary to resist sliding due to gravitational forces and sheet flow. The upper edge of the geocell shall be buried in an anchor trench as recommended by the Manufacturer and shown on the Drawings. Geocells shall also be anchored using J-Hooks in

accordance with manufacturer recommendations.

C. Ensure top edges of adjoining cell walls are flush with each other and in proper alignment.

D. Geocells shall be infilled with concrete. Deliver infill material to geocells from top of slope or channel to bottom in accordance with manufacturer's instructions.

E. Limit drop height of infill material to a maximum of 3 feet to prevent damage to geocells.

F. Manually rake and machine finish concrete infill material.

++END OF SECTION++

APPENDIX B
HELP MODEL OUTPUT

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**                                                                          **
**                                                                          **
**  HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                           **
**       HELP MODEL VERSION 3.07 (1 November 1997)                          **
**       DEVELOPED BY ENVIRONMENTAL LABORATORY                              **
**          USAE WATERWAYS EXPERIMENT STATION                               **
**FOR USEPA RISK REDUCTION ENGINEERING LABORATORY**
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PRECIPITATION DATA FILE:      C:\WHI\VHELP22\data\P8054.VHP\_weather1.dat
TEMPERATURE DATA FILE:        C:\WHI\VHELP22\data\P8054.VHP\_weather2.dat
SOLAR RADIATION DATA FILE:    C:\WHI\VHELP22\data\P8054.VHP\_weather3.dat
EVAPOTRANSPIRATION DATA:      C:\WHI\VHELP22\data\P8054.VHP\_weather4.dat
SOIL AND DESIGN DATA FILE:    C:\WHI\VHELP22\data\P8054.VHP\I_394172.inp
OUTPUT DATA FILE:             C:\WHI\VHELP22\data\P8054.VHP\O_394172.prt


TIME:   11:21       DATE:    9/ 7/2016


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      TITLE:   BAP Option 1 Compacted Clay

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      NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
             COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                              LAYER  1
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                     TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER   6
          THICKNESS                   =     45.72    CM
          POROSITY                    =      0.4530 VOL/VOL
          FIELD CAPACITY              =      0.1900 VOL/VOL
          WILTING POINT               =      0.0850 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.4399 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.720001612800E-03 CM/SEC
       NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY   5.00
              FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                              LAYER  2
                              --------

                        TYPE 3 - BARRIER SOIL LINER
                        MATERIAL TEXTURE NUMBER  29
          THICKNESS                   =     91.44    CM
          POROSITY                    =      0.4510 VOL/VOL
          FIELD CAPACITY              =      0.4190 VOL/VOL
          WILTING POINT               =      0.3320 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.4510 VOL/VOL
          EFFECTIVE SAT. HYD. COND.   =  0.100000000000E-06 CM/SEC
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GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 6 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 3.% AND A SLOPE LENGTH OF 133. METERS.

SCS RUNOFF CURVE NUMBER = 68.71
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 16.9563 HECTARES
EVAPORATIVE ZONE DEPTH = 25.4 CM
INITIAL WATER IN EVAPORATIVE ZONE = 10.908 CM
UPPER LIMIT OF EVAPORATIVE STORAGE = 11.506 CM
LOWER LIMIT OF EVAPORATIVE STORAGE = 2.159 CM
INITIAL SNOW WATER = 0.000 CM
INITIAL WATER IN LAYER MATERIALS = 61.352 CM
TOTAL INITIAL WATER = 61.352 CM
TOTAL SUBSURFACE INFLOW = 0.00 MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM Martin Lake (Shreveport)LA

STATION LATITUDE = 32.47 DEGREES
MAXIMUM LEAF AREA INDEX = 4.50
START OF GROWING SEASON (JULIAN DATE) = 58
END OF GROWING SEASON (JULIAN DATE) = 331
EVAPORATIVE ZONE DEPTH = 10.0 INCHES
AVERAGE ANNUAL WIND SPEED = 8.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 70.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 72.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 72.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR Martin Lake (Shreveport)LA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.02	3.46	3.77	4.71	4.70	3.54
3.56	2.52	3.29	2.63	3.77	3.87

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR Martin Lake (Shreveport)LA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
46.00	49.80	57.00	65.70	73.00	79.80
82.90	82.40	77.10	66.70	55.70	48.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR Martin Lake (Shreveport)LA AND STATION LATITUDE = 30.56 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 2
DRAIN #1: LATERAL DRAINAGE FROM LAYER 1 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 2

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.60	2.99	3.85	4.96	4.51	3.71
	3.53	2.17	3.08	2.64	3.69	3.58
STD. DEVIATIONS	2.46	1.49	1.64	2.11	2.06	2.37
	1.79	1.84	1.72	1.45	1.20	2.26
RUNOFF						
TOTALS	1.975	1.050	0.835	0.826	0.353	0.209
	0.084	0.000	0.094	0.122	0.699	1.894
STD. DEVIATIONS	2.253	1.145	1.157	1.020	0.853	0.792
	0.413	0.001	0.306	0.452	1.042	2.058
EVAPOTRANSPIRATION						
TOTALS	1.676	2.116	3.147	4.858	4.895	3.799
	3.460	2.101	2.482	1.665	1.067	1.258
STD. DEVIATIONS	0.173	0.297	0.585	0.653	1.407	2.182
	1.626	1.550	1.242	0.832	0.204	0.203
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.1535	0.1379	0.1490	0.1403	0.1351	0.1275
	0.1299	0.1285	0.1247	0.1323	0.1390	0.1534
STD. DEVIATIONS	0.0033	0.0043	0.0036	0.0049	0.0056	0.0043
	0.0038	0.0027	0.0045	0.0069	0.0110	0.0057

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 2						
AVERAGES	16.4152	15.7057	14.8556	13.5131	10.1369	8.9804
	8.3509	7.8723	7.9925	9.1751	13.0502	16.3664
STD. DEVIATIONS	1.1326	1.3339	1.2299	1.7131	1.9056	1.5045
	1.2876	0.9221	1.5915	2.3676	3.8956	1.9529

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	42.31 (7.468)	6435590.8	100.00
RUNOFF	8.142 (4.7829)	1238398.78	19.243
EVAPOTRANSPIRATION	32.524 (4.3641)	4946752.80	76.866
PERCOLATION/LEAKAGE THROUGH LAYER 2	1.65128 (0.02656)	251148.752	3.90250
AVERAGE HEAD ON TOP OF LAYER 2	11.868 (0.765)		
CHANGE IN WATER STORAGE	-0.005 (0.5515)	-709.45	-0.011

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30 and their dates (DDDYYYY)

	(INCHES)	(CU. FT.)	
PRECIPITATION	4.10	623584.10814	1980021
RUNOFF	3.751	570506.18552	130016
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.005102	776.02172	110002
AVERAGE HEAD ON TOP OF LAYER 2	18.000		
SNOW WATER	2.84	432025.9329	130002
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4530		
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0850		

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	7.7784	0.4321
2	16.2360	0.4510
SNOW WATER	0.000	

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**      HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                       **
**            HELP MODEL VERSION 3.07  (1 November 1997)                    **
**            DEVELOPED BY ENVIRONMENTAL LABORATORY                         **
**              USAE WATERWAYS EXPERIMENT STATION                           **
**FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                           **
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PRECIPITATION DATA FILE:      C:\WHI\VHELP22\data\P8054.VHP\_weather1.dat
TEMPERATURE DATA FILE:        C:\WHI\VHELP22\data\P8054.VHP\_weather2.dat
SOLAR RADIATION DATA FILE:    C:\WHI\VHELP22\data\P8054.VHP\_weather3.dat
EVAPOTRANSPIRATION DATA:      C:\WHI\VHELP22\data\P8054.VHP\_weather4.dat
SOIL AND DESIGN DATA FILE:    C:\WHI\VHELP22\data\P8054.VHP\I_394191.inp
OUTPUT DATA FILE:             C:\WHI\VHELP22\data\P8054.VHP\O_394191.prt


TIME:  15:51       DATE:   9/ 8/2016


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   TITLE:  BAP Option 2 LLDPE Cap

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   NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
          COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                              LAYER  1
                              --------

                     TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER   6
          THICKNESS                  =     45.23    CM
          POROSITY                   =     0.4530 VOL/VOL
          FIELD CAPACITY             =     0.1900 VOL/VOL
          WILTING POINT              =     0.0850 VOL/VOL
          INITIAL SOIL WATER CONTENT =     0.2269 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =  0.720001612800E-03 CM/SEC
        NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  5.00
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                              LAYER  2
                              --------

                      TYPE 2 - LATERAL DRAINAGE LAYER
                        MATERIAL TEXTURE NUMBER  20
          THICKNESS                  =      0.50    CM
          POROSITY                   =     0.8500 VOL/VOL
          FIELD CAPACITY             =     0.0100 VOL/VOL
          WILTING POINT              =     0.0050 VOL/VOL
          INITIAL SOIL WATER CONTENT =     0.1071 VOL/VOL
          EFFECTIVE SAT. HYD. COND.  =   10.0000000000       CM/SEC
          SLOPE                      =      3.00    PERCENT
          DRAINAGE LENGTH            =     132.6     METERS
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LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 36

THICKNESS = 0.10 CM
POROSITY = 0.0000 VOL/VOL
FIELD CAPACITY = 0.0000 VOL/VOL
WILTING POINT = 0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.400000000000E-12 CM/SEC
FML PINHOLE DENSITY = 9.88 HOLES/HECTARE
FML INSTALLATION DEFECTS = 9.88 HOLES/HECTARE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 30

THICKNESS = 609.60 CM
POROSITY = 0.5410 VOL/VOL
FIELD CAPACITY = 0.1870 VOL/VOL
WILTING POINT = 0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.1870 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.500000000000E-04 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 6 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 3.% AND A SLOPE LENGTH OF 133. METERS.

SCS RUNOFF CURVE NUMBER = 68.71
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 16.9563 HECTARES
EVAPORATIVE ZONE DEPTH = 25.4 CM
INITIAL WATER IN EVAPORATIVE ZONE = 5.100 CM
UPPER LIMIT OF EVAPORATIVE STORAGE = 11.506 CM
LOWER LIMIT OF EVAPORATIVE STORAGE = 2.159 CM
INITIAL SNOW WATER = 0.000 CM
INITIAL WATER IN LAYER MATERIALS = 124.311 CM
TOTAL INITIAL WATER = 124.311 CM
TOTAL SUBSURFACE INFLOW = 0.00 MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM Martin Lake (Shreveport)LA

STATION LATITUDE = 32.47 DEGREES
MAXIMUM LEAF AREA INDEX = 4.50
START OF GROWING SEASON (JULIAN DATE) = 58
END OF GROWING SEASON (JULIAN DATE) = 331
EVAPORATIVE ZONE DEPTH = 10.0 INCHES
AVERAGE ANNUAL WIND SPEED = 8.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 70.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 72.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 72.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR Martin Lake (Shreveport)LA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.02	3.46	3.77	4.71	4.70	3.54
3.56	2.52	3.29	2.63	3.77	3.87

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR Martin Lake (Shreveport)LA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
46.00	49.80	57.00	65.70	73.00	79.80
82.90	82.40	77.10	66.70	55.70	48.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR Martin Lake (Shreveport)LA AND STATION LATITUDE = 30.56 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 3
DRAIN #1: LATERAL DRAINAGE FROM LAYER 2 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 3
LEAK #2: PERCOLATION OR LEAKAGE THROUGH LAYER 4

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.60	2.99	3.85	4.96	4.51	3.71
	3.53	2.17	3.08	2.64	3.69	3.58
STD. DEVIATIONS	2.46	1.49	1.64	2.11	2.06	2.37
	1.79	1.84	1.72	1.45	1.20	2.26
RUNOFF						
TOTALS	0.014	0.005	0.001	0.003	0.018	0.015
	0.016	0.000	0.007	0.010	0.000	0.023
STD. DEVIATIONS	0.075	0.018	0.004	0.007	0.061	0.031
	0.063	0.001	0.024	0.053	0.000	0.068
EVAPOTRANSPIRATION						
TOTALS	1.664	1.975	2.773	3.513	3.469	2.797
	2.867	1.919	2.269	1.594	1.173	1.396
STD. DEVIATIONS	0.215	0.435	0.710	0.886	1.096	1.440
	1.221	1.309	1.054	0.869	0.274	0.187
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	2.2725	1.3084	1.1701	1.4245	1.2842	1.0571
	0.6942	0.3687	0.5116	0.7686	1.7627	2.1822
STD. DEVIATIONS	2.1005	1.0801	1.1888	1.0712	1.3010	1.2471
	0.8857	0.5702	0.8153	0.8450	1.0683	2.0368
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0020	0.0007	0.0006	0.0007	0.0014	0.0011
	0.0004	0.0001	0.0004	0.0005	0.0007	0.0022
STD. DEVIATIONS	0.0037	0.0012	0.0010	0.0009	0.0037	0.0024
	0.0013	0.0003	0.0011	0.0017	0.0008	0.0038

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0023	0.0008	0.0008	0.0007	0.0007	0.0016
	0.0006	0.0001	0.0004	0.0002	0.0010	0.0016
STD. DEVIATIONS	0.0032	0.0021	0.0016	0.0009	0.0015	0.0036
	0.0016	0.0004	0.0011	0.0005	0.0019	0.0028

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	0.1951	0.0699	0.0495	0.0683	0.1335	0.1096
	0.0393	0.0092	0.0402	0.0470	0.0599	0.2128
STD. DEVIATIONS	0.3743	0.1357	0.0943	0.0926	0.3752	0.2501
	0.1262	0.0304	0.1139	0.1766	0.0793	0.3852

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	42.31 (7.468)	6435590.8	100.00
RUNOFF	0.114 (0.1604)	17269.01	0.268
EVAPOTRANSPIRATION	27.409 (3.3915)	4168783.89	64.777
LATERAL DRAINAGE COLLECTED FROM LAYER 2	14.80479 (5.16879)	2251715.423	34.98848
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.01081 (0.00836)	1644.551	0.02555
AVERAGE HEAD ON TOP OF LAYER 3	0.086 (0.070)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.01082 (0.00778)	1645.189	0.02556
CHANGE IN WATER STORAGE	-0.025 (1.0370)	-3822.63	-0.059

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30 and their dates (DDDYYYY)

	(INCHES)	(CU. FT.)	
PRECIPITATION	4.10	623584.10814	1980021
RUNOFF	0.407	61892.85900	130016
DRAINAGE COLLECTED FROM LAYER 2	0.77630	118069.67852	1390030
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.004928	749.50458	1390030
AVERAGE HEAD ON TOP OF LAYER 3	15.800		
MAXIMUM HEAD ON TOP OF LAYER 3	24.062		
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	103.5 FEET		
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.001406	213.89658	1710030
SNOW WATER	2.84	432025.9329	130002
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4360		
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0850		

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	3.3025	0.1855
2	0.0050	0.0255
3	0.0000	0.0000
4	44.8797	0.1870
SNOW WATER	0.000	

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APPENDIX C

SLIDE 7.0 – CAP/COVER SYSTEM SLOPE STABILITY MODEL OUTPUT

Bullock, Bennett & Associates, LLC ∗ 165 N. Lampasas Street ∗ Bertram, Texas 78605
Telephone: 512.355.9198 ∗ Fax: 512.355.9197

September 30, 2016

Mr. Pat Behling
Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664

Re: Evaluation of Landfill Cap Slope Stability, Bottom Ash Ponds – Martin Lake Steam Electric Station, near Beckville, Texas

Dear Mr. Behling:

As requested by Pastor, Behling & Wheeler, LLC (PBW), Bullock, Bennett & Associates, LLC (BBA) has completed evaluation of slope-stability of the proposed cap for the Bottom Ash Ponds ash disposal facility at the Martin Lake Steam Electric Station (MLSES) located near Beckville, Texas. This analysis is based on the most recent preliminary design drawings dated August 2016, provided to BBA by PBW. No site specific geotechnical data was provided to BBA for this analysis, therefore, assumptions regarding typical soil properties and interface friction angles are made in this evaluation. It is recommended that site-specific soils and proposed synthetic materials be tested for engineering strength properties, and slope stability analysis using the on-site data and final design criteria be completed prior to construction activities.

The PBW design includes options for two different cap configurations, one including synthetic components and the other including use of a compacted clay liner system. Each system has been evaluated, as further discussed below.

Stability Analysis of Synthetic Cap Components

This stability analysis includes evaluation of veneer cover soils and synthetics on 10(H):1(V) slopes, assuming the following cap configuration (from bottom to top):

- Compacted clay subgrade;
- Textured (both sides) flexible membrane liner (FML);
- Double-sided (geotextile on both sides) geonet drainage layer; and,
- 1.5 foot-thick cover soils.

Soil slopes of 10(H):1(V) typically are stable and do not require slope stability analysis; however, when placed as a thin veneer over a barrier such as a synthetic liner/lateral drainage layer, stability can be compromised if resisting forces along the material interfaces are not sufficient to prevent sliding. To evaluate these conditions for the proposed cap system described above, slope stability analysis was completed using limit equilibrium and a finite slope model. As discussed in the attached analysis, veneer cover soil slope stability is very sensitive to the interface friction angle of materials, while typical variance of soil properties such as unit weight and internal friction angle have considerably less effect on the analysis. Given the sensitivity to interface friction angle, this parameter was varied for analysis, while a generally representative soil unit weight and internal friction angle were used.

A range of interface friction angles from 19 to 27 were used to capture the range associated with proposed cap components, as shown in the attached Appendix Table 1 of the *Geosynthetics Research Institute, Direct Shear Database of Geosynthetic-to Geosynthetic and Geosynthetic-to-Soil Interfaces (Koerner, Narejo, June 14, 2005)*. For conservative analysis, cohesion and adhesion values were assumed to be zero. A unit weight and internal friction angle of 115 pounds per cubic foot (pcf) and 15 degrees, respectively, were used for the soil and are generally representative of commonly available soils in Texas, including a wide range of silty, sandy, and lean to fat clays commonly used as cover soil.

Estimated factors of safety for this analysis range from approximately 3.5 to 5.2 for interface friction angles ranging from 19 to 27, respectively, with assumed cohesion and adhesion values of zero. See *Veneer Cover Soil Analysis of Synthetic Cap System* in Attachment 1 for calculations and further stated assumptions.

Slope Stability Analysis of Alternate Clay Cap

The alternate clay cap system consists of the following, bottom to top:

- 1.0 foot-thick subgrade soil;
- 3.0 foot-thick compacted clay liner; and,
- 1.5 foot-thick protective cover/vegetative soil.

This slope stability analysis includes evaluation of the clay cap system using Rocscience Slide 7.0 software. The Simplified Bishop and Morgenstern-Price methods of analysis were conducted on over 400 potential failure surfaces, with the lowest calculated safety factor reported. Slope stability evaluation of the cap was performed for assumed short- and long-term conditions. Site specific geotechnical test data is not available; therefore assumptions regarding soil strength properties (for each soil layer) were made as follows:

Short-Term Conditions:

Cohesion, C:	500 pcf
Friction Angle:	0

Long-Term Conditions:

Cohesion, C:	250 pcf
Friction Angle:	15

The unit weight of soil was assumed to be 115 pcf for each soil layer. Coal combustion residual (ash) material underlies the cap. It is assumed the ash is non-cohesive, well drained and has been in place for a long time prior to capping. For ash the following properties were assumed for both short and long-term cap analysis:

Dry Unit Weight of Ash:	90 pcf
Saturated Unit Weight of Ash:	95 pcf
Cohesion, C:	0 pcf
Friction Angle:	20 deg

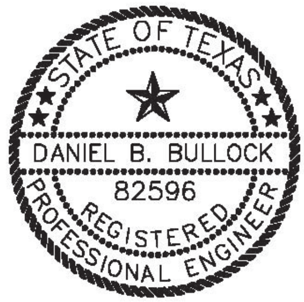
The calculated factor of safety for the short- and long-term conditions were both determined to be approximately 3.9.

Please find attached the landfill cap slope stability analysis and supporting notes, assumptions, and documentation, and please feel free to contact me at (512) 355-9198 if you have any questions about this submittal, or if I can be of any further assistance.

Sincerely,

BBA, LLC

Dan Bullock, P.E.
Principal Engineer



9/30/2016

Attachments

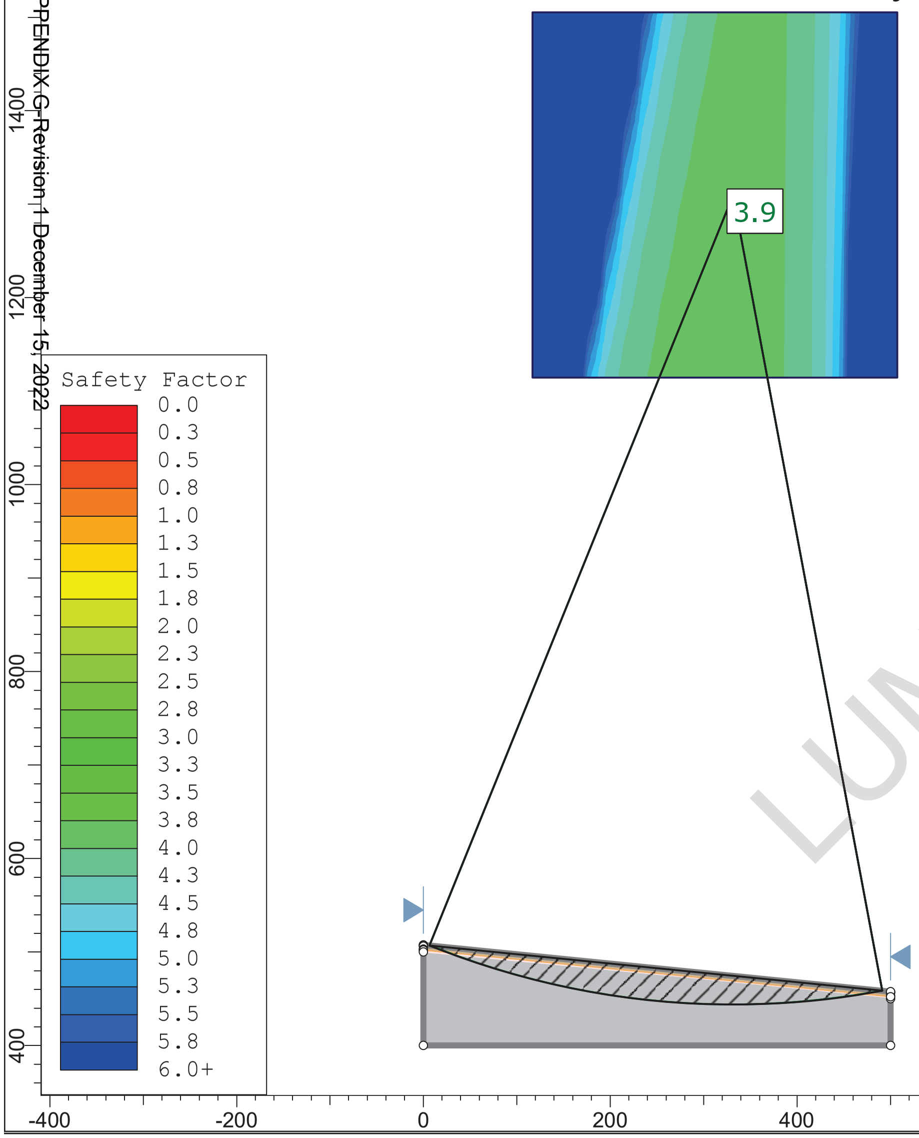
S:\management\Jobs\PBW Slope Stability\Deliverables_9_30_16\MLSES\MLSES Bott Ash Ponds\Synthetic Cap Report\MLSES BAPs Cap Stability_RPT_09302016.doc

ATTACHMENT 1

Landfill Cover Slope Stability Analysis

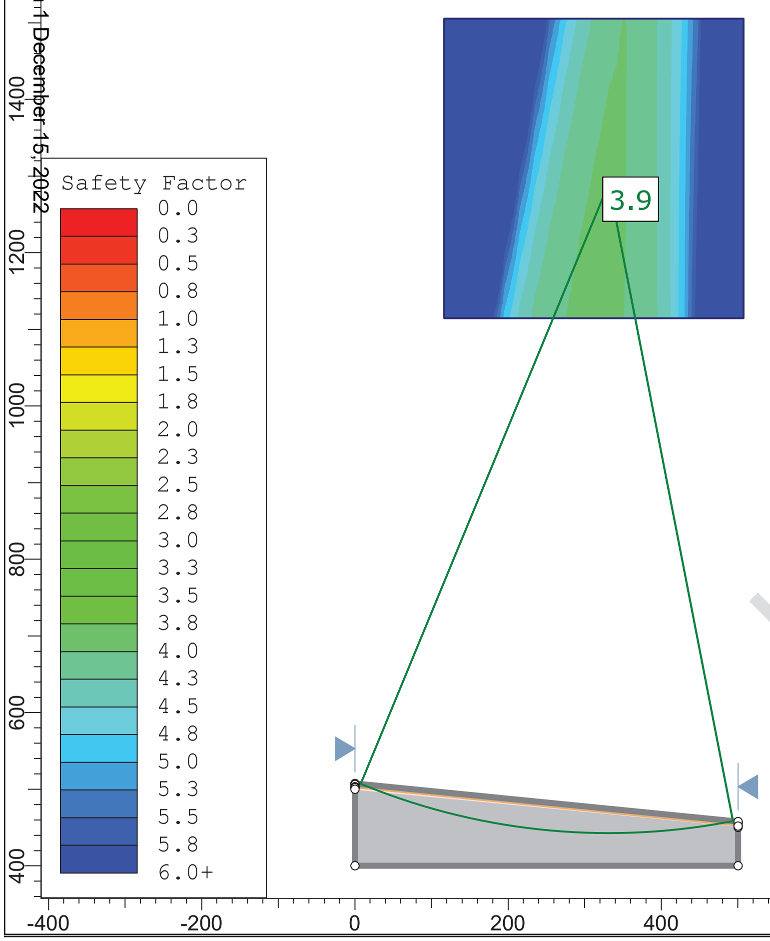
Slide 7.0 Analysis of Clay Cap

Martin Lake Bottom Ash Ponds - Effective Stress Analysis



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Vegetative Soil		115	Mohr-Coulomb	250	15
Fill		115	Mohr-Coulomb	250	15
Compacted Clay Liner		115	Mohr-Coulomb	250	15
Cap Subgrade		115	Mohr-Coulomb	250	15
Bridging Layer		115	Mohr-Coulomb	250	15
Ash		90	Mohr-Coulomb	0	20

Martin Lake Bottom Ash Ponds Cap - Total Stress Analysis



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
'Vegetative Soil		115	Mohr-Coulomb	500	0
'Fill		115	Mohr-Coulomb	500	0
'Compacted Clay Liner		115	Mohr-Coulomb	500	0
'Cap Subgrade		115	Mohr-Coulomb	500	0
'Bridging Layer		115	Mohr-Coulomb	500	0
'Ash		90	Mohr-Coulomb	0	20

MLSES PDP-5_Cap_total.slmd

Bullock, Bennett & Associates, LLC

Veneer Cover Soil Analysis of Synthetic Cap System

LANDFILL COVER SLOPE STABILITY ANALYSIS - BOTTOM ASH PONDS
Martin Lake Steam Electric Station, near Beckville, Texas

<u>DEFINITION OF TERMS</u>

Wa	Total weight of active wedge
Wp	Total weight of passive wedge
Na	Effective force normal to the failure plane of the active wedge
Np	Effective force normal to the failure plane of the passive wedge
Y	Unit weight of the cover soil
h	Thickness of the cover soil
L	Length of slope measured along the geomembrane
B	Soil slope angle beneath the geomembrane
Phi	Friction angle of the cover soil
Delta	Interface friction angle between cover soil and geomembrane
Ca	Adhesive force between cover soil of the active wedge and the geomembrane
ca	Adhesion between cover soil of the active wedge and the geomembrane
C	Cohesive force along the failure plane of the passive wedge
c	Cohesion of the cover soil
Ea	Interwedge force acting on the active wedge from the passive wedge
Ep	Interwedge force acting on the passive wedge from the active wedge, and
FS	Factor of safety against cover soil sliding on the geocomposite

<u>EQUATIONS:</u> (Designing with Geosynthetics (4th Edition), Robert M. Koerner)

Wa = Yh^2(L/h - 1/sinB - tanB/2) (3.14)

Na= WaCosB (3.15)

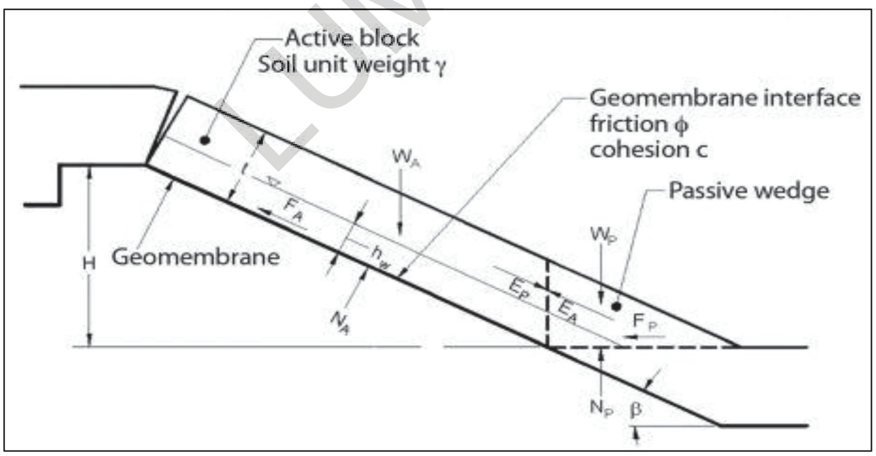
Wp= Yh^2/Sin2B (3.17)

a=(Wa-NaCosB)CosB

b=-[(Wa-NaCosB)sinB*tanPhi+(NaTanDelta+Ca)SinBCosB+sinB(C+WpTanPhi)]

c=(NaTanDelta+Ca)Sin^2BTanPhi

$$FS = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad (3.22)$$



FREE BODY DIAGRAM

LANDFILL COVER SLOPE STABILITY ANALYSIS - BOTTOM ASH PONDS
Martin Lake Steam Electric Station, near Beckville, Texas

INPUT PARAMETERS:

Delta	19	21	23	25	27	degrees
Y	115	115	115	115	115	pcf
Phi	15	15	15	15	15	degrees
h	1.5	1.5	1.5	1.5	1.5	feet
L	500	500	500	500	500	feet
B	5.7	5.7	5.7	5.7	5.7	degrees
Ca	0	0	0	0	0	
ca	0	0	0	0	0	
C	0	0	0	0	0	
c	0	0	0	0	0	

CALCULATIONS:

Wa	83,631.86	83,631.86	83,631.86	83,631.86	83,631.86	lb/ft
Wp	1,309.08	1,309.08	1,309.08	1,309.08	1,309.08	lb/ft
Na	83,218.35	83,218.35	83,218.35	83,218.35	83,218.35	lb/ft
a	820.92	820.92	820.92	820.92	820.92	
b	-2,888.67	-3,213.83	-3,547.83	-3,891.87	-4,247.31	
c	75.99	84.71	93.67	102.91	112.44	
FS	**3.49**	**3.89**	**4.30**	**4.71**	**5.15**	

NOTES/ASSUMPTIONS:

- Assumes cap system includes, from bottom to top: 1 foot compacted clay subgrade, 40 mil textured FML, double-sided geocomposite drainage layer (geotextile on both sides), and 1.5 feet of vegetative cover soil.
- Assumes slopes of 10(h):1(v) (5.7deg).
- Assumes solid waste is stable (stability of waste not evaluated).
- Dynamic loading associated with construction or operations equipment were not evaluated. Use of construction methods protective of the liner system are assumed.
- Assumes effective lateral drainage layer and drained cover soil conditions prevents excess pore water pressure.
- Assumes no landfill gas migration into cap components.
- Interface friction angles between geotextile and soil, and between FML and geotextile are considered. For conservative evaluation purposes, no contribution of material tensile strengths, adhesion, or cohesion are considered for increased stability.
- Sensitivity analysis indicates very little effect on FS with moderate (plus or minus 10 pcf) change in soil unit weight and soil friction angle (plus or minus 10 degrees) parameters, but is very sensitive to variation in interface friction angles therefore, 5 different interface friction angles (19, 21, 23, 25, and 27) were evaluated. Typical values for interface friction angle are provided in attachments. GRI30 - Appendix Table 1 (Geosynthetics Research Institute, Direct Shear Database of Geosynthetic-to-Geosynthetic and Geosynthetic-to-Soil Interfaces - Koerner, Narejo, June 14, 2005) is attached.
- Assumes cover soil of uniform thickness and constant unit weight. Unit weight of 115 pcf, and friction angle of 15 degrees assumed.
- Due to lack of available on-site soil data, generalized soil engineering properties were assumed. A general range of synthetic material interface friction angles (with soil and other synthetic materials) were also assumed. Use of actual on-site soil materials and proposed synthetic materials for follow up laboratory testing and slope stability analysis is recommended prior to construction. Testing should include interface friction angle (and internal friction angle, as appropriate) measurements for all materials.
- Maximum slope length of less than 500 feet measured from preliminary design drawings, 500 feet was conservatively used in calculations.

ATTACHMENT 2

GRI30 – Appendix Table 1

Geosynthetic Research Institute
475 Kedron Avenue
Folsom, PA 19033-1208 USA
TEL (610) 522-8440
FAX (610) 522-8441

Direct Shear Database of Geosynthetic-to-Geosynthetic and Geosynthetic-to-Soil Interfaces

by

George R. Koerner, Ph.D., P.E.
Geosynthetic Research Institute
Folsom, PA 19033-1208
gkoerner@dca.net

and

Dhani Narejo, Ph.D.
GSE Lining Technology, Inc.
Houston, TX 77073
dnarejo@gseworld.com

GRI Report #30

June 14, 2005

Appendix Table 1. Summary of interface shear strengths.

Interface 1*	Interface 2*	Peak Strength					Residual Strength				
		Fig. No.	δ (deg)	Ca (kPa)	Points	R^2	Fig. No.	δ (deg)	Ca (kPa)	Points	R^2
HDPE-S	Granular Soil	1a	21	0	162	0.93	1b	17	0	128	0.92
HDPE-S	Cohesive Soil										
	Saturated	1c	11	7	79	0.94	1d	11	0	59	0.95
	Unsaturated	1c	22	0	44	0.93	1d	18	0	32	0.93
HDPE-S	NW-NP GT	1e	11	0	149	0.93	1f	9	0	82	0.96
HDPE-S	Geonet	1g	11	0	196	0.90	1h	9	0	118	0.93
HDPE-S	Geocomposite	1i	15	0	36	0.97	1j	12	0	30	0.93
HDPE-T	Granular Soil	2a	34	0	251	0.98	2b	31	0	239	0.96
HDPE-T	Cohesive Soil										
	~~Saturated~~	~~2c~~	~~18~~	~~10~~	~~167~~	~~0.93~~	~~2d~~	~~16~~	~~0~~	~~150~~	~~0.90~~
	Unsaturated	2c	19	23	62	0.91	2d	22	0	35	0.93
HDPE-T	NW-NP GT	2e	25	8	254	0.96	2f	17	0	217	0.95
HDPE-T	Geonet	2g	13	0	31	0.99	2h	10	0	27	0.99
HDPE-T	Geocomposite	2i	26	0	168	0.95	2j	15	0	164	0.94
LLDPE-S	Granular Soil	3a	27	0	6	1.00	3b	24	0	9	1.00
LLDPE-S	Cohesive Soil	3c	11	12.4	12	0.94	3d	12	3.7	9	0.93
LLDPE-S	NW-NP GT	3e	10	0	23	0.63	3f	9	0	23	0.49
LLDPE-S	Geonet	3g	11	0	9	0.99	3h	10	0	9	1.00
LLDPE-T	Granular Soil	4a	26	7.7	12	0.95	4b	25	5.2	12	0.95
LLDPE-T	Cohesive Soil	4c	21	5.8	12	1.00	4d	13	7.0	9	0.98
LLDPE-T	NW-NP GT	4e	26	8.1	9	1.00	4f	17	9.5	9	0.96
LLDPE-T	Geonet	4g	15	3.6	6	0.97	4h	11	0	6	0.98
PVC-S	Granular Soil	5a	26	0.4	6	0.99	5b	19	0	6	0.99
PVC-S	Cohesive Soil	5c	22	0.9	11	0.88	5d	15	0	9	0.95
PVC-S	NW-NP GT	5e	20	0	89	0.91	5f	16	0	83	0.74
PVC-S	NW-HB GT	5g	18	0	3	1.00	5h	12	0.1	3	1.00
PVC-S	Woven GT	5i	17	0	6	0.54	5j	7	0	6	0.93
PVC-S	Geonet	5k	18	0.1	3	1.00	5l	16	0.6	3	1.00

Appendix Table 1. (continued)

Interface 1*	Interface 2*	Peak Strength					Residual Strength				
		Fig. No.	δ (deg)	Ca (kPa)	Points	R^2	Fig. No.	δ (deg)	Ca (kPa)	Points	R^2
PVC-F	NW-NP GT	6a	27	0.2	26	0.95	6b	23	0	26	0.95
PVC-F	NW-HB GT	6c	30	0	8	0.97	6d	27	0	8	0.90
PVC-F	Woven GT	6e	15	0	6	0.78	6f	10	0	6	0.76
PVC-F	Geonet	6g	25	0	11	1.00	6h	19	0	11	0.99
PVC-F	Geocomposite	6i	27	1.1	5	1.00	6j	22	4.7	6	1.00
CSPE-R	Granular Soil	7a	36	0	3	1.00	7b	16	0	3	1.00
CSPE-R	Cohesive Soil	7c	31	5.7	6	0.71	7d	18	0	6	0.99
CSPE-R	NW-NP GT	7e	14	0	6	0.97	7f	10	0	6	0.98
CSPE-R	NW-HB GT	7g	21	0	3	1.00	7h	10	0	3	1.00
CSPE-R	Woven GT	7i	11	0	6	0.92	7j	11	0	3	1.00
CSPE-R	Geonet	7k	28	0	9	0.87	7l	16	0	9	0.80
NW-NP GT	Granular Soil	8a	33	0	290	0.97	8b	33	0	117	0.96
NW-HB GT	Granular Soil	8c	28	0	6	0.99	8d	16	0	6	0.91
Woven GT	Granular Soil	8e	32	0	81	0.99	8f	29	0	28	0.98
NW-NP GT	Cohesive Soil	9a	30	5	79	0.96	9b	21	0	28	0.79
NW-HB GT	Cohesive Soil	9c	29	0.9	15	0.71	9d	10	0	15	0.83
Woven GT	Cohesive Soil	9e	29	0	34	0.94	9f	19	0	16	0.86
GCL Reinforced (internal)	N/A	10a	16	38	406	0.85	10b	6	12	182	0.91
GCL (NW-NP GT)	HDPE-T	11a	23	8	180	0.95	11b	13	0	157	0.90
GCL (W-SF GT)	HDPE-T	11c	18	11	196	0.96	11d	12	0	153	0.92
Geonet	NW-NP GT	12a	23	0	52	0.97	12b	16	0	32	0.97
Geocomposite (NW-NP GT)	Granular Soil	13a	27	14	14	0.86	13b	21	8	10	0.92

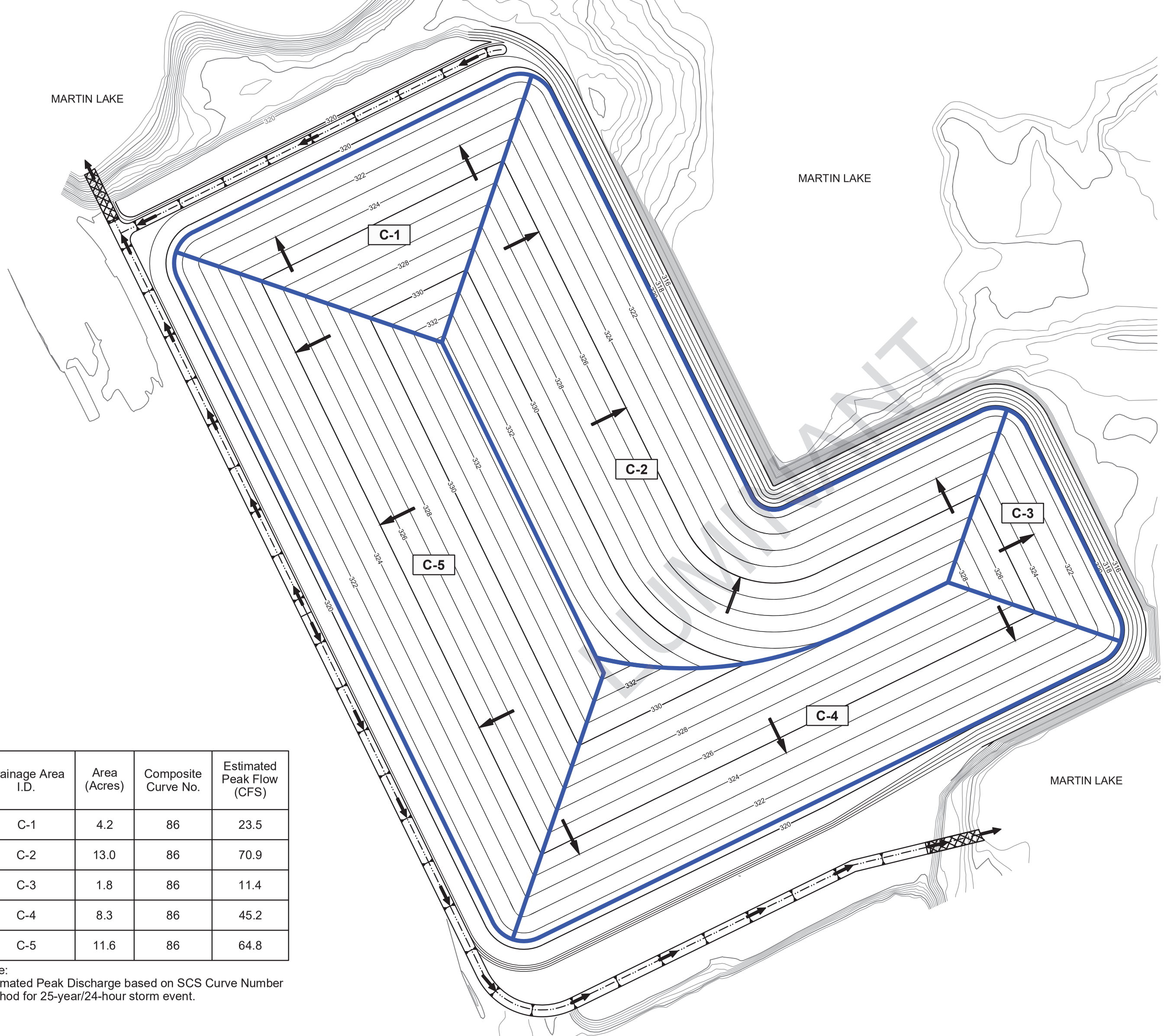
APPENDIX D
STORMWATER HYDROLOGY CALCULATIONS

Summary of Peak Flow Estimate - SCC TR-55 Method
Luminant - ASH POND AREA (BAPs & SP) CCR Unit Closure Area - MLSES

SCS TR-55 Equation & Variables	
Q_p= Qu*Area (miles2)* Q*Fp	
Q_p= Estimated Peak Discharge (cfs)	Q= $(P-I_a)^2/(P-I_a) + S)$
Q_u=Unit Peak Discharge (cfs/mile2-inch)	P= Design Storm Rainfall (inches)
A= Area (square miles)	Ia=0.2S (Initial abstractions; inches)
Q= Rainfall Excess (Depth of Runoff Over Watershed)	S= 1000/CN-10
F_p= Ponding Factor (% of ponds/swamps)	CN= SCS Curve Number

-0.56864

Drainage Area I.D.	Area (acres)	Area (mi^2)	Composite Curve Number	Estimated Peak Flow (CFS) Q_p	P (25yr,24hr)	S	I_a	Q	I_a/P	TIME OF CONCENTRATION ESTIMATE						Q_u	F_p
										v1=aS^.5 fps	v2	Cap/Overland Flow T_t (Min.)	Estimated Time of Concen. (Min.)	CAP Roughness Coeff (Table 3.20)	Cap Slope (ft/ft)		
C-1	4.2	0.0066	86	23.5	8.6	1.63	0.33	6.91	0.04	0.43	-	16	16	2.5	0.03	517.3	1
C-2	13	0.0203	86	70.9	8.6	1.63	0.33	6.91	0.04	0.43	-	17	17	2.5	0.03	504.5	1
C-3	1.8	0.00	86	11.4	8.6	1.63	0.33	6.91	0.04	0.43	-	11	11	2.5	0.03	584.6	1
C-4	8.3	0.013	86	45.2	8.6	1.63	0.33	6.91	0.04	0.43	-	17	17	2.5	0.03	504.5	1
C-5	11.6	0.0181	86	64.8	8.6	1.63	0.33	6.91	0.04	0.43	-	16	16	2.5	0.03	517.3	1



Drainage Area I.D.	Area (Acres)	Composite Curve No.	Estimated Peak Flow (CFS)
C-1	4.2	86	23.5
C-2	13.0	86	70.9
C-3	1.8	86	11.4
C-4	8.3	86	45.2
C-5	11.6	86	64.8

Note:
Estimated Peak Discharge based on SCS Curve Number Method for 25-year/24-hour storm event.

EXPLANATION

- Proposed Finished Grade Contour 1 ft Interval
- Proposed Finished Grade Contour 5 ft Interval
- Limits of CAP
- Sheet Flow
- Concentration Flow Path
- Storm Water Drainage Divide

N

Scale in Feet
0 110 220

LUMINANT GENERATION COMPANY, LLC
MARTIN LAKE STEAM ELECTRIC STATION

Appendix D

CCR COVER SYSTEM DRAINAGE AREAS AND ESTIMATED PEAK DISCHARGE

PROJECT: 5196B	BY: AJD	REVISIONS
DATE: SEPT., 2016	CHECKED: BDT	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS

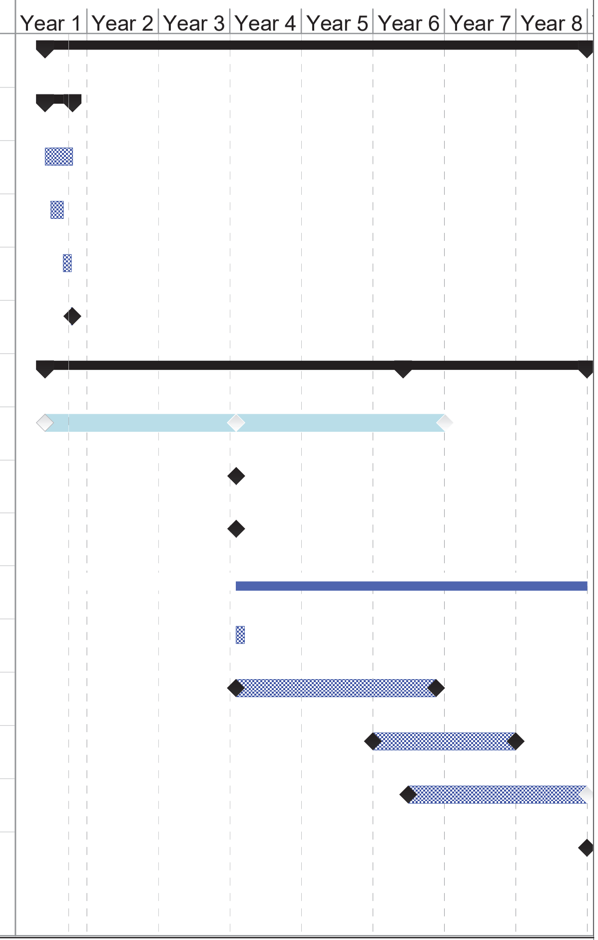
APPENDIX E

PROJECT SCHEDULE – CCR CLOSURE PROCESS

Thu 9/29/16

APPENDIX E
PROJECT SCHEDULE - CCR UNIT CLOSURE PROCESS

ID	Task Name
1	**MLSES BOTTOM ASH PONDS & NEW SCRUBBER POND - CLOSURE PLAN**
2	**TASK-1 257.102 Closure Planning for CCR Units**
3	**Preparation of Closure Plan**
4	Review Draft Closure Plan
5	Revise Draft Closure Plan
6	Finalize Closure Plan
7	**Task 2 - 257.102 (d) Closure In-Place of CCR Unit (BAPs & SP)**
8	**Closure Triggers**
9	Closure Initiated within 2-years of Last Receipt of Waste
10	Closure Initiated within 2-years of Last Beneficial Use of CCR
11	**Closure Sequence**
12	TPDES Storm Water Construction General Permit NOI
13	CCR Dewatering
14	CCR Grading/Bridging Lift Placement
15	Construct Final Cover System
16	Closure Completion Deadline or 2-year Extension Note - Extension requires demonstration of infeasibility 257.102(f)(2))



Task | Split | Milestone | Summary | Project Summary | External Tasks | External Milestone | Inactive Task | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | Progress | Deadline

Notes: Schedule does not include administrative/legal/receiver activities. Closure initiation will be determined in accordance with the CCR Rule and this timeline only illustrates the anticipated construction sequencing following closure initiation.

REPORT

CLOSURE PLAN ADDENDUM NO. 1

Martin Lake Steam Electric Station - Ash Ponds
Rusk County, Texas

Submitted to:

Luminant Generation Company LLC

Submitted by:

WSP GOLDER

1601 S MoPac Expressway

Suite 325D

Austin, Texas, USA 78746

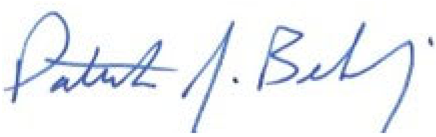
+1 737 703 3900

31404097.007

December 2022

PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by WSP Golder under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I hereby certify that Addendum No.1 to the Closure Plan for the Ash Ponds at the Martin Lake Steam Electric Station has been prepared in accordance with the requirements of 40 C.F.R. §257.102(b).



Patrick J. Behling, P.E.
Principal Engineer
WSP Golder
Texas Firm Registration No. 22771

Table of Contents

DOCUMENT REVISION RECORD

Issue No.	Date	Details of Revisions
Revision 0	October 2016	Original Document
Addendum 1	December 2022	Revised configuration of final cap/cover system for Ash Ponds, added equivalency determination for proposed alternative final cover systems, added cap settlement evaluation, added confirmation that cap slope stability will be modeled using site-specific geotechnical data during final closure design, removal of HELP Modeling from Closure Plan, revised closure schedule to state closure will be completed within five years and add estimated completion year, added section addressing the initiation of closure, and added section to address notification citations.

1.0 INTRODUCTION

On behalf of Luminant Generation Company LLC (Luminant), WSP Golder (Golder) has prepared this Addendum No. 1 to the Closure Plan for the East Ash Pond (EAP), West Ash Pond (WAP), and New Scrubber Pond (NSP) (collectively referred to as the "Ash Ponds") located at the Martin Lake Steam Electric Station (MLSES) in Rusk County, Texas (hereafter, the "Site"). Coal Combustion Residuals (CCR) including flue gas desulfurization (FGD) wastewater and bottom ash generated as part of MLSES operation are managed in the Ash Ponds. The Ash Ponds are regulated as Existing CCR Impoundments under 40 C.F.R. § 257, Subpart D (the "CCR Rule").

The original Closure Plan for the Ash Ponds was prepared in October 2016 in accordance with 40 C.F.R. §257.102(b) and placed in the MLSES operating record in accordance with 40 C.F.R. §257.105(h)(10) (PBW, 2016). This Addendum No. 1 updates the Closure Plan to reflect the following:

- Revisions to the configuration of the Ash Pond final cap/cover systems due to retrofits of the Ash Pond liner systems;
- Addition of equivalency determination for proposed alternative final cover systems for Ash Ponds;
- Addition of cap settlement evaluation;
- Confirmation that the slope stability of Ash Pond cap/cover systems will be modeled using site-specific geotechnical data during design of the final closure of the impoundments;
- Removal of HELP Modeling from Closure Plan;
- Revisions to the Ash Pond closure schedule to state closure will be completed within five years and add estimated completion year;
- Addition of section addressing the initiation of Ash Pond closure; and
- Addition of section to address notification citations.

2.0 ASH POND FINAL CAP/COVER SYSTEMS

The EAP, WAP and NSP are constructed partially above and partially below grade and are surrounded by engineered earthen dikes that extend above surrounding ground level. The EAP and WAP share an interior embankment and cover areas of approximately 10 acres and 15 acres, respectively. The NSP is an approximately 13 acre surface impoundment.

At the time the 2016 Closure Plan was prepared, the configuration of the liner systems in the EAP, WAP and NSP consisted of the following (from bottom to top):

- 18-inch thick compacted clay layer with a hydraulic conductivity of $1x10^{-7}$ cm/sec;
- a 60-mil HDPE geomembrane;
- a geosynthetic drainage layer;
- a second 60-mil HDPE geomembrane; and
- a 4-inch thick concrete revetment mat.

From 2020 through 2022, the EAP and WAP were each retrofitted with a new composite liner system meeting the alternative composite liner requirements of 40 CFR § 257.70(c) (HDR, 2021; HDR, 2022). The retrofitted liner system was installed on top of the existing liner system in each pond and consisted of the following (from bottom to top):

- a 6-inch thick layer of general soil fill material placed over the existing liner system;
- a polymer-enhanced geosynthetic clay liner (GCL) with a maximum hydraulic conductivity of $1x10^{-9}$ cm/sec and a minimum thickness of 6 mm; and
- a 60-mil HDPE geomembrane.

A similar composite liner system is currently being installed in the NSP.

The 2016 Closure Plan for the Ash Ponds included two options for final cap/cover systems: a compacted clay cap system and a geosynthetic cap system (PBW, 2016). Due to the retrofits of the Ash Pond liner systems described above, the final cap/cover systems for the EAP, WAP and NSP have been revised to consist of the following (from bottom to top):

- a geosynthetic clay liner (GCL) with a maximum hydraulic conductivity of $1x10^{-9}$ cm/sec and a minimum thickness of 6 mm;
- a 40-mil linear low-density polyethylene (LLDPE) textured geomembrane;
- a geosynthetic drainage layer; and
- a 18-inch erosion layer consisting of 12 inches of general fill overlain with 6 inches of soil capable of supporting native vegetation.

The proposed final cap/cover systems for the Ash Ponds are alternative final cover systems that must comply with the requirements of 40 C.F.R. §257.102(d)(3)(ii)(A) through (C):

(A) The design of the final cover system must include an infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified in paragraphs 40 C.F.R. §257.102(d)(3)(i)(A) and (B).

(B) The design of the final cover system must include an erosion layer that provides equivalent protection from wind or water erosion as the erosion layer specified in paragraph 40 C.F.R. §257.102(d)(3)(i)(C).

(C) The disruption of the integrity of the final cover system must be minimized through a design that accommodates settling and subsidence.

2.1 Equivalent Infiltration Reduction - Ash Pond Cap/Cover Systems

The final cap/cover systems for the Ash Ponds must include an infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified in paragraphs 40 C.F.R. §257.102(d)(3)(i)(A) and (B):

(A) The permeability of the final cover system must be less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1×10^{-5} cm/sec, whichever is less.

(B) The infiltration of liquids through the closed CCR unit must be minimized by the use of an infiltration layer that contains a minimum of 18 inches of earthen material.

2.1.1 Permeability Comparison Between Ash Pond Cap Systems and Liner Systems

The final cap/cover systems for the Ash Ponds comply with the requirements of 40 C.F.R. §257.102(d)(3)(i)(A) based on the following:

- The retrofitted bottom liner system for each of the Ash Ponds includes an infiltration layer consisting of a GCL with a maximum hydraulic conductivity of $1x10^{-9}$ cm/sec and a geomembrane and the final cap/cover system for each of the Ash Ponds includes an infiltration layer consisting of a GCL with a maximum hydraulic conductivity of $1x10^{-9}$ cm/sec and a geomembrane. Since the infiltration layers in the bottom liner and final cap both consist of a GCL and a geomembrane, the permeability of the final cap/cover system is equivalent to the permeability of the bottom liner system.
- The GCL in the final cap/cover system has a maximum hydraulic conductivity of $1x10^{-9}$ cm/sec which is significantly lower permeability than the specified minimum of 1×10^{-5} cm/sec.

2.2.2 Infiltration Comparison of Ash Pond Cap Systems to 18-Inch Earth Infiltration Layer

Compliance of the final cap/cover systems to the requirements of 40 C.F.R. §257.102(d)(3)(i)(B) was determined by comparing the estimated liquid flow rate through the low permeability components of the Ash Pond final cap/cover systems to the estimated liquid flow rate through the specified minimum of 18 inches of earthen material. The results of the comparison are presented below.

- Estimated Liquid Flow Through Ash Pond Final Cap/Cover System

  The low permeability components of the Ash Pond cap/cover system are a GCL with a maximum hydraulic conductivity of $1x10^{-9}$ cm/sec and a minimum thickness of 6 mm and a 40-mil LLDPE geomembrane. The liquid flow rate through the cap (per acre of cap area) was estimated using the Giroud Equation as follows (Giroud, 1997):

  - Giroud Equation: $Q = N \text{ X } C \, [1 + 0.1(h/t)^{0.95}] \text{ X } a^{0.1} \text{ X } h^{0.9} \text{ X } k^{0.74}$

    where: Q = flow rate through the liner (m^3/s)

    N = number of geomembrane defects per acre of cap area

    C = contact coefficient (0.05 for excellent, 0.21 for good, and 1.25 for poor)

h = head above liner (m)

t = thickness of soil portion of the liner (m)

a = assumed area of defect in geomembrane through which leak occurs (m^2)

k = hydraulic conductivity of the GCL portion of the liner (m/s)

- Assumptions:

1) The GCL is assumed to have a maximum hydraulic conductivity of $1x10^{-9}$ cm/sec and a minimum thickness of 6 mm.
2) The hydraulic head above the cap geomembrane and GCL is assumed to be 12 inches (30.48 cm). This is a conservative assumption for the cap, since the final cap/cover system will be sloped and includes a geosynthetic drainage layer to divert water that infiltrates through the overlying erosion soil layer away from the cap.
3) Geomembranes are nearly impermeable to liquids; however, liquids typically pass through holes/defects in the geomembrane. The area of a hole (defect) in the geomembrane was estimated to be 1 cm^2. For a typical geomembrane installed using good installation techniques, it is estimated that 4 defects (holes) occur per acre of geomembrane.

- Liquid Flow Rate Through Cap Geomembrane and GCL

N = 4 per acre (assume good geomembrane installation)

C = 0.21 (assume good contact between geomembrane and GCL)

h = 1 foot x 30.48cm/ft = 30.48 cm (0.3048 m)

t = 6 mm x 0.001 m/mm = 0.006 m for GCL

a = 1 cm^2 (0.0001 m^2) for the area of the hole (defect) in the geomembrane

k = $1x10^{-9}$ cm/sec ($1 X 10^{-11}$ m/sec) for GCL

Q = 4 X 0.21 $[1 + 0.1(0.3048/0.006)^{0.95}]$ X $0.0001^{0.1}$ X $0.3048^{0.9}$ X $(1EE-11)^{0.74}$

= 0.84 [1 + 4.1742] X 0.3981 X 0.3433 X 7.24EE-9

= $4.3 X 10^{-9}$ m^3/s per acre of cap or 0.10 gallons per day per acre of cap

- Estimated Liquid Flow Through 18-inch Earthen Infiltration Layer

The 18-inch earthen infiltration layer is assumed to consist of compacted clay with a maximum hydraulic conductivity of $1x10^{-7}$ cm/sec. Flow rate through the infiltration layer was calculated using Darcy's Law for gravity flow through porous media as follows:

- Darcy Equation: Q=A X k X (h/t+1)

Where:

Q = flow rate through the Infiltration Layer (m^3/s)

A = Cap area perpendicular to the flow (m^2)

h = head above Infiltration Layer (m)

t = thickness of Infiltration Layer (m)

k = hydraulic conductivity of Infiltration Layer (m/s)

- Assumptions:

1) The 18-inch infiltration layer is assumed to have a maximum hydraulic conductivity of $1x10^{-7}$ cm/sec.

2) The hydraulic head above the infiltration layer was assumed to be 12 inches (30.48 cm). This is a conservative assumption for the infiltration layer, since the final cap/cover system will be sloped to divert water that infiltrates through the overlying erosion soil layer away from the infiltration layer.

3) Cap area for evaluation is assumed to be 1 acre to match area used for the above Ash Pond geomembrane/GCL cap evaluation.

- Flow Rate Through 18-inch Infiltration Layer

A = 1 acre (4046.86 m^2)

k = $1x10^{-7}$ cm/sec (1 X 10^{-9} m/sec)

h = 1 foot x 30.48 cm/ft = 30.48 cm (0.3048 m)

t = 18 inches X 2.54 cm/in = 45.72 cm (0.4572 m)

Q = (4046.86 m^2) x ($1x10^{-9}$ m/sec) x ((0.3048 m / 0.4572 m) + 1)

= $6.75x10^{-6}$ m^3/s per acre of cap or 154 gallons per day per acre of cap

The final cap/cover systems for the Ash Ponds comply with the requirements of 40 C.F.R. §257.102(d)(3)(i)(B), since the estimated liquid flow rate through the final cap/cover system (0.10 gallons per acre per day) is significantly less than the estimated liquid flow rate through an 18-inch thick infiltration layer (154 gallons per acre per day).

2.2 Equivalent Erosion Protection - Ash Pond Cap/Cover Systems

The final cap/cover systems for the Ash Ponds include an 18-inch erosion layer consisting of 12 inches of general fill overlain with 6 inches of soil capable of supporting native vegetation. This complies with the requirements of 40 C.F.R. §257.102(d)(3)(ii)(B), which states that the final cover system must use of an erosion layer that contains a minimum of six inches of earthen material that is capable of sustaining native plant growth.

2.3 Settling and Subsidence - Ash Pond Cap/Cover Systems

40 C.F.R. §257.102(d)(3)(i)(D) states that the disruption of the integrity of the final cover system must be minimized through a design that accommodates settling and subsidence. An evaluation of potential settlement for the final cap/cover systems for the Ash Ponds is attached as Appendix A to this Addendum. The Ash Pond Closure Plan will be updated to include a cap/cover system settlement evaluation using site-specific data during design of the final cap/closure systems for the Ash Ponds.

2.4 Slope Stability - Ash Pond Cap/Cover Systems

The Ash Pond Closure Plan will be updated to include cap/cover system slope stability modeling using site-specific geotechnical data during design of the final cap/closure systems for the Ash Ponds.

2.5 HELP Modeling in 2016 Closure Plan

The 2016 Closure Plan for the Ash Ponds included Hydrologic Evaluation of Landfill Performance (HELP) model evaluations to compare the permeability of the then-proposed cap options against each other and to the pond bottom liner systems in place at the time (PBW, 2016). The HELP model evaluations in the 2016 Closure Plan have been replaced by the infiltration evaluations presented above for the new cap/cover systems and have been deleted from this amended Closure Plan.

2.6 Conclusions

The final cap/cover systems for the Ash Ponds described above are alternative final cover systems that comply with the requirements of 40 C.F.R. §257.102(d)(3)(ii)(A) through (C).

3.0 ASH POND CLOSURE SCHEDULE AND NOTIFICATION UPDATES

The closure schedule for the Ash Ponds is described in Section 2.7 and Appendix E of the 2016 Closure Plan (PBW, 2016). The 2016 Ash Pond Closure Schedule is updated as follows:

- Initiation of Ash Pond Closure. For the purposes of the Ash Pond Closure Schedule, Luminant estimates that the MLSES will cease operations in approximately 2045. However, CCR and related waste will continue to be generated after plant operation has terminated as part of facility decommissioning and demolition and the CCR and related waste may be managed in the Ash Ponds. In accordance with 40 C.F.R. §257.102(e)(2)(i), the Ash Ponds will commence closure within two years of the date of final receipt of either CCR or non-CCR waste; however, in accordance with 40 C.F.R. §257.102(e)(2)(ii) an additional two years may be required to initiate closure provided Luminant provides written documentation that the Ash Ponds will continue to accept wastes beyond the original two-year period. For the purposes of the Ash Pond Closure Schedule, Luminant estimates that Ash Pond Closure will be initiated in approximately 2047.
- Completion of Ash Pond Closure. In accordance with 40 C.F.R. §257.102(f)(1)(ii), Luminant estimates that final closure of the Ash Ponds will be completed within 5 years of start of closure or in approximately 2052. It should be noted; however, that 40 CFR §257.102(f)(2) of the CCR Rule allow for extension of the closure schedule in the event that it is not feasible to complete closure of the Ash Ponds within the required timeframes due to factors beyond the facility's control.

Luminant will provide the following notifications related to closure of the Ash Ponds:

- In accordance with 40 C.F.R. §257.102(g), Luminant will prepare a notification of intent to close the Ash Ponds. The notice will be prepared no later than the date of closure initiation, will be sealed by a qualified professional engineer, and will be placed in the MLSES operating record as required by 40 C.F.R. §257.105(i)(7).
- In accordance with 40 C.F.R. §257.102(h), Luminant will prepare a notification of closure of the Ash Ponds within 30 days of completion of closure. The notice will be sealed by a qualified professional engineer and will be placed in the MLSES operating record as required by 40 C.F.R. §257.105(i)(8).
- In accordance with 40 C.F.R. §257.102(h) Luminant will provide deed notification for the Ash Pond Closure.

4.0 REFERENCES

Giroud, J.P., “Equations for Calculating the Rate of Liquid Migration Through Composite Liners Due to Geomembrane Defects”, Geosynthetics International, Vol. 4, Nos. 3-4, pp. 335-348, 1997.

HDR (2021). Construction Completion and Construction Quality Assurance Report, CCR Impoundment Reline East Ash Pond, Martin Lake Steam Electric Station, May.

HDR (2022). Construction Completion and Construction Quality Assurance Report, CCR Impoundment Reline West Ash Pond, Martin Lake Steam Electric Station, June.

Pastor, Behling & Wheeler, LLC (PBW), 2016. CCR Closure Plan – Bottom Ash Ponds and New Scrubber Pond, Martin Lake Steam Electric Station. October.

APPENDIX A

Evaluation of Potential Cap/Cover System Settlement

December 6, 2022

Mr. Pat Behling
WSP Golder
1601 S MoPac Expressway
Suite 325D
Austin, Texas, USA 78746

Re: Evaluation of Potential for Impoundment Cap Settlement, Bottom Ash Ponds and New Scrubber Pond – Martin Lake Steam Electric Station, Rusk County, Texas

Dear Mr. Behling:

As requested by WSP Golder, Bullock, Bennett & Associates, LLC (BBA) has evaluated the proposed cap system at the East Ash Pond and West Ash Pond surface impoundments (collectively hereafter referred to as the Bottom Ash Ponds, or BAPs) and New Scrubber Pond (NP) surface impoundment at the Martin Lake Steam Electric Station (MLSES) located in Rusk County, Texas – specifically in regard to the suitability of the proposed cap system to accommodate anticipated settlement. The BAPs and the NP are located adjacent to one another and will be capped as one unit. This evaluation is based on the most recent design drawings dated September 2016, provided to BBA by WSP Golder. No site-specific geotechnical data for the coal combustion residuals (CCR) fill material was provided to BBA for this analysis, and no site-specific consolidation or settlement data for on-site soils were provided; therefore, general assumptions regarding typical soil and CCR properties are made in this evaluation. It is BBA's understanding that site-specific soils and CCRs will be tested for engineering properties and that a detailed engineering settlement analysis using the on-site data and final design criteria will be completed prior to final cap construction activities.

The original Closure Plan for the BAPs and NP was prepared in October 2016 (PBW, 2016). The 2016 Closure Plan included options for two different cap configurations, one including synthetic components and the other including use of a compacted clay liner system. On December 6, 2022, WSP Golder prepared Addendum No.1 to the BAPs and NP Closure Plan and revised the final cap/cover system to be as follows, from bottom to top (WSP Golder, 2022):

- a geosynthetic clay liner (GCL) with a maximum hydraulic conductivity of 1×10^{-9} cm/sec and a minimum thickness of 6 mm;
- a 40-mil linear low-density polyethylene (LLDPE) textured geomembrane;
- a geosynthetic drainage layer; and
- an 18-inch-thick erosion layer consisting of 12 inches of general fill overlain with 6 inches of soil capable of supporting native vegetation.

The grades, slopes, etc. for the revised BAPs and NP final cap/cover system will remain as presented in the 2016 BAPs and NP Closure Plan.

The cap system will tie into the perimeter earth embankment system, which ranges between approximately 10- to 20- feet above the surrounding natural grades. The perimeter earth embankment was constructed in thin lifts of compacted embankment fill meeting engineering specifications.

Engineering Properties of CCR Fill Material Underlying the Proposed Cap System:

CCR fill material in the BAPs consist of bottom ash, and in the NP consists of flue gas desulfurization material (FGD, or gypsum). These CCRs are non-plastic and moderately to highly permeable (typically drain better than clays and silts) and are well suited as fill materials(1,2,3). The coefficient of consolidation of bottom ash when compared to typical soils is typically low and decreases with incremental loading and time. This indicates the bottom ash possesses load taking ability and that structures, or in this case a cap system, lying above the ash will undergo gradual settling and not suffer large deformation - making ash well suited as a fill material.(1) According to the American Coal Ash Association approximately 3.63. million metric tons (4.0 million tons) of bottom ash were used in structural fill applications in 2006 (ACAA 2007). Structural fill and embankment material is the largest use of bottom ash in the US.(2) FGD material has engineering properties that also make it suitable for use as embankment fill.(3) BBA has experience in capping multiple impoundments and landfills in Texas containing bottom ash and gypsum and has performed annual engineering inspections for years following final capping activities at these facilities and has observed very little cap settlement.

Based upon review of the BAPs and NP bottom and proposed cap elevations, it appears there will be a layer of CCRs approximately 15- to 20-feet thick under the proposed cap system. These CCR materials will be dewatered prior to initiating cap construction activities.

Subsurface Conditions:

Based on results of subsurface investigations summarized in the Safety Factor Assessment 5-Year Update (WSP Golder, 2021) performed by East Texas Testing Laboratories (ETTL), and Golder in 2008 and 2012, respectively, the subsurface stratigraphy is described as consisting of interchanging layers of clays, sandy clays, clayey sands and non-plastic sands. The sandy clay and clay layers are described as firm to hard, low to high plasticity clays that vary in thickness from 2 to 38 feet. Loose to very dense, silty or poorly graded sand was encountered beneath or interlayered with sandy clay/clayey sand strata. A 100-foot-deep boring completed by ETTL showed deeper layers of very dense silty sand with intermittent layers of hard low plasticity clay.

Based on the description of subsurface conditions, large settlement of subsurface soils is not expected.

Based on review of the proposed cap system and technical specifications for materials and placement, evaluation of typical CCR engineering properties, the perimeter embankment system, and the site underlying subsurface conditions, it appears the cap design for the BAPs and NP is designed appropriately to accommodate settling and subsidence and will minimize the disruption of the integrity of the final capping system. Final cap grade designs include a 3% slope that will promote storm water drainage off the cap system, and these slopes appear sufficient to accommodate anticipated settlement while continuing to maintain positive surface water drainage. In addition, MLSES will conduct regularly scheduled cap inspections during post-closure care, and any settlement identified will be addressed to maintain cap design functions.

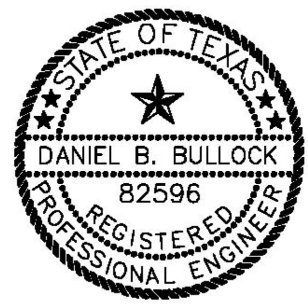
Please feel free to contact me at (512) 355-9198 if you have any questions about this submittal, or if I can be of any further assistance.

Sincerely,

Bullock, Bennett & Associates, LLC

Daniel B. Bullock

Dan Bullock, PE (TX 82596)
Principal Engineer
Texas Professional Engineering Firm No. F-8542



12/06/2022

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(1) One-Dimensional Consolidation of Sedimented Stowed Pond Ash, Devi Presad Mishra and Samir Kumar Das Document: Geotech Geol Eng (2012) 30:685-695 DOI 10.1007/s10706-011-9486-x
(2) User Guideline for Coal Bottom Ash and Boiler Slag in Green Infrastructure construction, Craig H. Benson and Sabrina Bradshaw. December 2011. Recycled Materials Resource Center, University of Wisconsin-Madison.
(3) User Guideline for Flue Gas Desulfurization Material in Green Infrastructure construction, Craig H. Benson and Sabrina Bradshaw. December 2011. Recycled Materials Resource Center, University of Wisconsin-Madison

CCR CLOSURE PLAN
MARTIN LAKE STEAM ELECTRIC STATION
PERMANENT DISPOSAL POND - 5
RUSK COUNTY, TEXAS

OCTOBER 2016

PREPARED FOR:

LUMINANT GENERATION COMPANY, LLC
1601 Bryan Street (EP-27)
Dallas, Texas 75201

PREPARED BY:

PASTOR, BEHLING & WHEELER, LLC
5416 Plaza Drive
Texarkana, Texas 75503
Texas Engineering Firm No. 4760

PBW Project No. 5196B

PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by Pastor, Behling & Wheeler, LLC under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I hereby certify that the conceptual closure plan was developed in accordance with the requirements of 40 CFR 257.102(b) of the CCR Rule.

STATE OF TEXAS
10/5/16
BRIAN D. THOMAS
91192
LICENSED
PROFESSIONAL ENGINEER

10/5/16
Brian Thomas, P.E.
Principal Engineer
PASTOR, BEHLING & WHEELER, LLC

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1.0 INTRODUCTION

Luminant Generation Company, LLC (Luminant) owns and operates the Martin Lake Steam Electric Station (MLSES) located approximately five miles southwest of Tatum in Rusk County, Texas. The power plant and related support areas occupy approximately 700 acres on a peninsula on the southwest side of Martin Lake (Figure 1) The MLSES consists of three coal/lignite-fired units with a combined operating capacity of approximately 2,250 megawatts. Coal Combustion Residuals (CCR) including fly ash, bottom ash, gypsum are generated as part of MLSES unit operation. The CCRs are transported off-site for beneficial use by third-parties, are managed by Luminant on-site at Permanent Disposal Pond No. 5 (PDP-5) or are disposed at Luminant's A-1 Area Landfill.

The CCR Rule (40 CFR 257 Subpart D - *Standards for the Receipt of Coal Combustion Residuals in Landfills and Surface Impoundments*) has been promulgated by EPA to regulate the management and disposal of CCRs as solid waste under Resource Conservation and Recovery Act (RCRA) Subtitle D. The final CCR Rule was published in the Federal Register on April 17, 2015. The effective date of the CCR Rule was October 19, 2015.

The CCR Rule establishes national operating criteria for existing CCR surface impoundments and landfills, including development of closure plans for all CCR impoundments and landfills. Pastor, Behling & Wheeler, LLC (PBW) was retained by Luminant to develop this closure plan for the CCR impoundments at the MLSES.

1.1 CCR Surface Impoundment Closure Plan Requirements

40 CFR 257.102(b) of the CCR Rule specifies that a written closure plan must be prepared for each existing CCR surface impoundment that describes the steps necessary to close the impoundment at any point during the active life of the unit consistent with recognized and generally accepted good engineering practices. The closure plan must include, at a minimum, the following information:

- A narrative description of how the CCR impoundment will be closed in accordance with 40 CFR 257.102;
- If closure of the impoundment will be accomplished through removal of CCR from the unit, a description of the procedures to remove the CCR and decontaminate the impoundment in accordance with 40 CFR 257.102(c) of the CCR Rule. CCR removal and decontamination of the impoundment are considered complete when constituent concentrations throughout the impoundment and any areas affected by releases from the unit have been removed and groundwater monitoring concentrations do not exceed applicable groundwater protection

standards.

- If closure of the impoundment will be accomplished by leaving CCR in place, the closure plan will provide a description of the final cover system designed in accordance with 40 CFR 257.102(d) of the CCR Rule, including details concerning the methods and procedures used to install the final cover. The closure plan must also discuss how the final cover system will achieve the following performance standards specified in 40 CFR 257.102(d):

  - Control, minimize or eliminate, to the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere;

  - Preclude the probability of future impoundment of water, sediment, or slurry;

  - Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during the closure and post-closure care period;

  - Minimize the need for further maintenance of the unit; and

  - Be completed in the shortest amount of time consistent with recognized and generally accepted good engineering practices.

  Prior to installing the final cover system on the closed impoundment, free liquids must be eliminated by removing liquid wastes or solidifying the remaining wastes and waste residues and the remaining wastes must be stabilized sufficiently to support the final cover system.

  The final cover system must be designed and constructed to meet the following criteria:

  - The permeability of the final cover system must be less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1 X 10^{-5} cm/sec, whichever is less.

  - The infiltration of liquids through the closed CCR unit must be minimized by the use of an infiltration layer that contains a minimum of 18 inches of earthen material.

  - The erosion of the final cover system must be minimized by the use of an erosion layer that contains a minimum of six inches of earthen material that is capable of sustaining native plant growth.

  - The disruption of the integrity of the final cover system must be minimized through a design that accommodates settling and subsidence.

  An alternative final cover system design may also be used, provided the alternative final cover system is designed and constructed to meet the following criteria:

  - The alternative final cover system must include an infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified above.

  - The alternative final cover system must include an erosion layer that provides equivalent protection from wind or water erosion as the erosion layer specified above

  - The disruption of the integrity of the alternative final cover system must be minimized through a design that accommodates settling and subsidence.

- An estimate of the maximum inventory of CCR ever on-site over the active life of the impoundment and an estimate of the largest area of the impoundment ever requiring a final cover at any time during the active life of the unit.

- A schedule for completing all activities necessary to satisfy the closure criteria, including an estimate of the year in which all closure activities for the impoundment will be completed. The schedule should provide sufficient information to describe the sequential steps that will be taken to close the unit, including identification of major milestones such as coordinating with and obtaining necessary approvals and permits from other agencies, the dewatering and stabilization phases of impoundment closure, or installation of the final cover system, and the estimated timeframes to complete each step or phase of unit closure.

- In accordance with 40 CFR 257.102(e)(1) of the CCR Rule, closure of a surface impoundment must be initiated no later than 30 days after the date on which the impoundment either receives the known final receipt of CCR or non-CCR waste or the known final volume of CCR is removed from the impoundment for the purpose of beneficial use. Alternatively, under 40 CFR 257.1032(e)(2), closure of the impoundment must be initiated if the impoundment has been idle and has not received CCR or non-CCR waste for two years. Additional two year extensions to initiate closure may be obtained with appropriate documentation.

- In accordance with 40 CFR 257.102(f) of the CCR Rule, closure of a surface impoundment must be completed within five years of commencing closure activities. Additional extensions to complete closure may be obtained with appropriate documentation.

The impoundment closure plan must be certified by a qualified professional engineer and must document how the closure plan has been designed and constructed to comply with the requirements of 40 CFR 257.102(b)(4) of the CCR Rule.

In accordance with 40 CFR 257.102(b)(2) of the CCR Rule, the initial written closure plan for an existing CCR surface impoundment must be completed and placed in the facility operating record no later than October 17, 2016.

1.2 MLSES Impoundments Subject to CCR Closure Plan Requirements

The CCR Rule defines coal combustion residuals such as fly ash, bottom ash, boiler slag, flue gas desulfurization (FGD) materials (gypsum), and related solids generated from burning coal for the purpose of generating electricity by electric utilities and independent power producers. The closure plan requirements of the CCR Rule apply to surface impoundments that dispose or otherwise engage in solid waste management of CCRs. The surface impoundments at the MLSES that meet the definition of an Existing CCR Unit are the West Ash Pond (WAP), East Ash Pond (EAP), New Scrubber Pond (SP), and Permanent Disposal Pond – 5 (PDP-5).

Although other CCR surface impoundments are present at MLSES, this closure plan only addresses PDP-5.

1.3 Description of PDP-5

PDP-5 is located is located approximately 3,000 feet west-northwest of the MLSES power plant (Figure 2). A site plan for PDP-5 is shown on Figure 3. PDP-5 is an approximately 40-acre surface impoundment that was constructed in 2010 over three impoundments previously closed as landfills. PDP-5 is primarily used to manage excess liquids, including storm water from large precipitation events and excess process wastewater from both the FGD and bottom ash loops. Recovered CCR wastewaters are received in PDP-5 during cleaning cycles for the BAPs and SP. Process wastewater can be transferred between the BAPs, SP, or used as makeup water for specific CCR related systems. Process wastewater can be transferred from PDP-5 to the BAPs and the SP.

PDP-5 is constructed above grade and is surrounded by engineered earthen embankments. The crest elevation of the PDP-5 embankments is 405.5 feet MSL, and the embankments are approximately 10 to 15 feet above surrounding grade (Figure 3). The liner system for the PDP-5 consists of the following (from bottom to top):

- a six-inch thick soil layer over the closed PDPs (in-place permeability of $1x10^{-5}$ cm/sec);
- two-foot thick compacted clay liner (in-place permeability of $1x10^{-7}$ cm/sec); and
- three-foot thick compacted clay interior/exterior embankment liner (minimum in-place permeability of $1x10^{-7}$ cm/sec).

Based on available construction data PDP-5 was constructed to provide an estimated 190.3 acre-feet (62,000,000 gallons) storage capacity.

PDP-5 is classified as a low hazard potential impoundment in accordance with the requirements of 40 CFR 257.73(a)(2) of the CCR Rule (PBW, 2016).

2.0 CLOSURE PLAN FOR CCR IMPOUNDMENTS

Although the closure plan presented herein for PDP-5 was developed in accordance with the requirements of 40 CFR 257.102 of the CCR Rule, this plan should be considered conceptual in nature given the fundamental assumptions used as the basis of the closure plan. As part of the initiation of final CCR unit closure activities, the conceptual closure plan should be reviewed and revised to ensure appropriate modifications are incorporated into the final design plans and specifications prior to release for bidding and construction.

2.1 Description of CCR Impoundment Closure

Luminant plans to close PDP-5 in accordance with 40 CFR 257.102(d) of the CCR Rule by leaving CCR in-place and constructing a final cover system over CCR located within the footprint of the existing surface impoundment.

2.2 Removal of Free Liquids and CCR Stabilization – PDP-5

Free liquids present within PDP-5 will be removed by constructing dewatering sumps within accessible areas of the CCR prior to placement of cap subgrade and the final cover system. Free liquids removed from the impoundment will be managed in accordance with applicable state regulations. Following removal of liquids from the impoundment, the stability of the CCR material should be evaluated to ensure adequate bearing capacity for equipment used to construct the cap. For the purposes of this conceptual closure plan, PBW has assumed that the dewatered CCR will accommodate construction equipment necessary to place a minimum two-foot thick bridging lift of approved fill. To the extent practicable prior to and during placement of the bridging lift, CCR within the impoundments will be progressively graded to achieve a uniform slope (+/- 1%) across the impoundment. The bridging lift will be placed to establish a suitable base for placement of the cap subgrade, and will consist of an initial one-foot thick compacted lift followed by two six-inch compacted lifts. Approved materials for use in the bridging lift and placement methods will conform to the Technical Specifications for general earthwork and CCR stabilization provided in Sections 02300 and 02310, respectively (Appendix A).

2.3 Final Cover System – PDP-5

For the purposes of this conceptual closure plan, two final cover system options for PDP-5 are presented in this section. In accordance with 40 CFR 257.102(d) of the CCR Rule, the permeability of each final cover system option will be less than or equal to the permeability of the existing bottom liner in PDP-5 (i.e. 3 foot clay liner with a permeability of <1 X 10^{-7} cm/sec). The proposed final grading plan for the final cover system is illustrated in Figure 4, and typical construction details and surface water drainage controls for each the final cover systems are provided in Figures 5-7.

Technical Specifications for material selection and placement of the proposed final cover system alternatives and the associated cap subgrade have been developed to minimize potential for differential settlement and subsidence. Post-closure monitoring activities will be performed to ensure the cover system complies with the requirements of the CCR Rule. Furthermore, an evaluation of infiltration through the proposed cover systems was developed using the U.S. Army Corps of Engineers – Hydrologic Evaluation of Landfill Performance (HELP) model (Appendix B). As demonstrated by the HELP model results, the permeability of the clay cap (infiltration layer) final cover system option will be less than or equal to the permeability of the bottom liner system and the permeability of the linear low density polyethylene cap option will achieve an improved reduction in infiltration compared to the clay cap (infiltration layer) option. Both final cover options will be designed to minimize impounding of water on the cap and associated long-term care activities.

2.3.1 Compacted Clay Cap

Select fill and/or CCR deemed suitable for beneficial re-use will be placed within the proposed limits of the impoundment cover system for PDP-5 to the lines and grades specified for the cap subgrade (Figures 4 and 6). Upon placement of cap subgrade to within approximately five feet of proposed finished grade, only approved select fill material (i.e. embankment spoil material or contactor-supplied select fill) will be placed in accordance with the specifications for cap subgrade. A three foot thick compacted clay liner with permeability of no greater than $1x10^{-7}$ cm/sec will be placed on the prepared cap subgrade material. Cap subgrade and clay cap material selection, placement, compaction and testing will conform to the Technical Specifications in Section 02320 and 02330, respectively (Appendix A). An 18-inch minimum thickness vegetative soil layer will be placed in a single loose lift over the prepared clay cap and permanent vegetative cover will be established in accordance with Sections 02340 and 02350 of the Technical Specification (Appendix A).

2.3.2 Geosynthetic Cap

Select fill and/or CCR deemed suitable for beneficial re-use will be placed within the proposed limits of the impoundment cover system for PDP-5 to the lines and grades specified for the cap subgrade (Figures 4 and 6). Upon placement of cap subgrade to within approximately 2.5 feet of proposed finished grade, only approved select fill material (i.e. embankment spoil material or contactor-supplied select fill) will be placed in accordance with the specifications for cap subgrade. A 40-mil linear low-density polyethylene (LLDPE) liner will be installed over the prepared cap subgrade. LLDPE liner deployment, field seaming, and field quality assurance testing will conform to Section 02420 of the Technical Specifications (Appendix A). A geonet drainage layer will be installed above the LLDPE liner to provide lateral drainage relief of infiltration from the overlying vegetative soil layer. An 18-inch (minimum thickness) vegetative soil layer will be placed in a single loose lift over the prepared geosynthetic cap system and permanent vegetative cover will be established in accordance with Sections 02340 and 02350 of the Technical Specification (Appendix A).

2.4 Final Cover System Slope Stability

Selection of suitable construction materials, proper material placement, and quality assurance testing of both the subgrade preparation and cover system installation in accordance with the Technical Specifications (Appendix A) will ensure stability of the final cover system. The SLIDE 7.0 equilibrium slope stability model was used to demonstrate that the proposed cover system is stable at the slopes specified in the conceptual closure plan (see Appendix C). Previous slope stability modeling performed prior to construction of PDP-5 in 2009 conducted by ETTL concluded that the existing embankments are stable under both short-term and long-term modeling conditions. Updated slope stability modeling of the existing PDP-5 embankments is currently being prepared by others to comply with initial and periodic stability evaluations required by 40 CFR 257.73(f) of the CCR Rule.

2.5 Stormwater Run-off Control

The final grading of PDP-5 cover system will establish uniform slopes of approximately 3 to 5 percent on the portion of the cap overlying CCR, and slope lengths will generally not exceed 500 feet. Surface drainage of the portion of the cap covering CCR will generally consist of sheet flow or shallow concentrated flow along diversion berms and/or within perimeter grass-lined channels (located outside the capped area) that will convey run-off to reinforced stormwater let-down structures. Both cover system alternatives will allow for lateral drainage of infiltration off the capped area to prevent saturation of the vegetative layer and/or ponding on the cover system. The geosynthetic cover system includes a drainage layer above the impermeable capping system that is designed to collect infiltration from the vegetative layer and control discharge to the limits of the cover system, which also prevents saturation of the vegetative layer and/or ponding on the cover system. A conceptual run-off control plan that includes estimated peak discharges based on the 25-year/24-hour storm event (8.6 inches) for capped area is presented in Appendix D. Typical construction details for the geocomposite drainage layer, surface water conveyance structures are provided on Figure 6, and Technical Specifications for the geocomposite drainage layer and EnviroGrid™ slope erosion control are provided in Appendix A.

2.6 CCR Inventory and Area to Be Capped

For the purposes of this conceptual closure plan, in-place closure of CCR within PDP-5 is based on the assumed volume of CCR (solids) contained in the pond being limited to 50 percent of the capacity of the pond. Based on this assumption, PDP-5 will be closed containing approximately 360,000 cubic yards of CCR. This estimated volume of CCR does not include decontamination spoil material generated from the decontamination of the interior embankments of PDP-5 above the elevation of the aforementioned 50 percent solids capacity. The proposed limit of the cover system extends beyond the centerline of the existing PDP-5 perimeter embankment, and the final surface area of the cover system will slightly exceed 40-acres.

2.7 Closure Schedule

The final closure of PDP-5 will be completed within 5 years of start of closure; however, 40 CFR 257.102(f)(2) and 257.103 of the CCR Rule allow for extension of the closure schedule or demonstration that alternative closure requirements should apply to the CCR unit. A Gantt chart illustrating the sequential steps of the CCR closure process, including pre-construction activities (i.e. necessary notifications and permitting) as well as closure milestones, is included as Appendix E.

3.0 REFERENCES

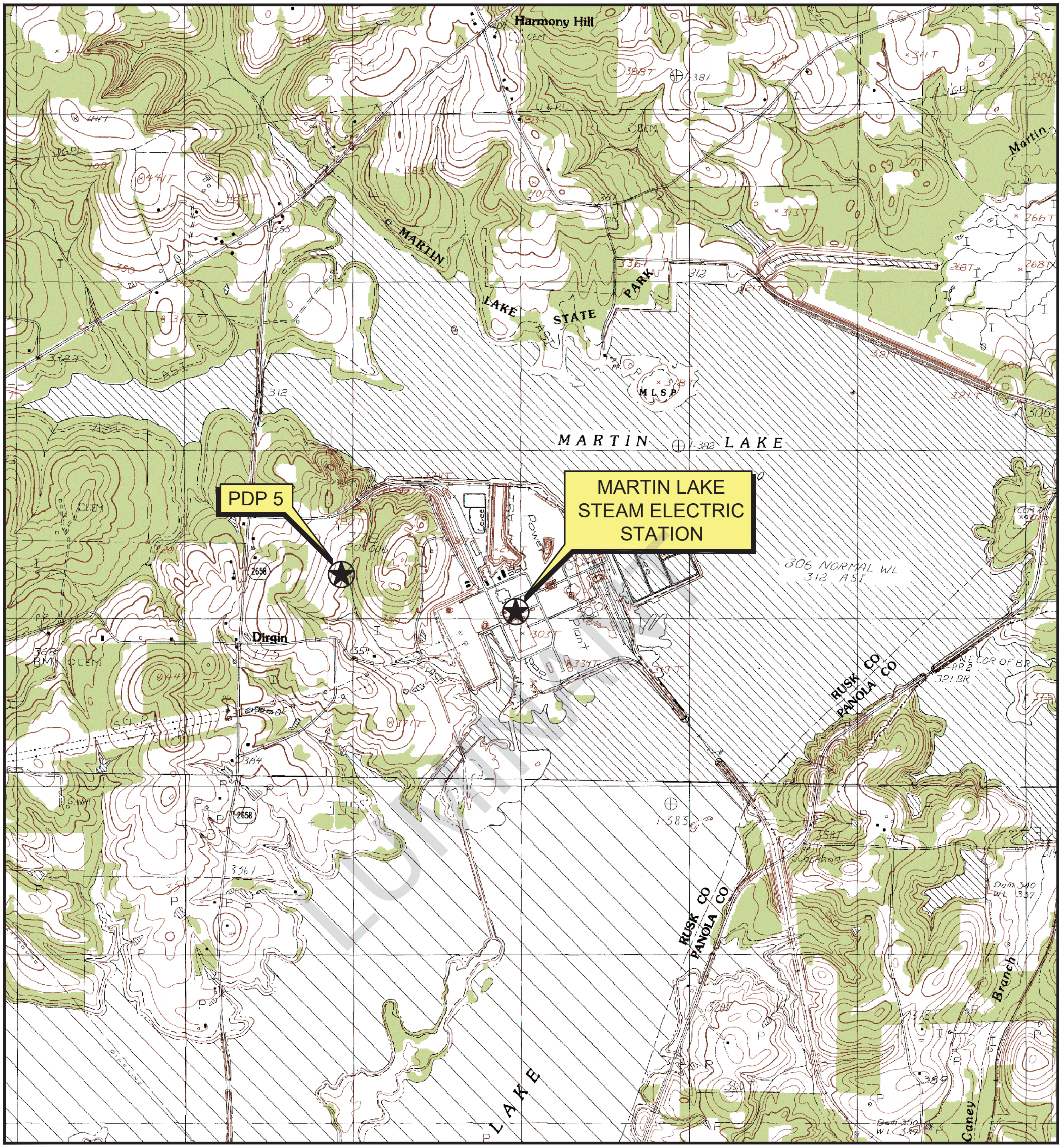
Hershfield, OM. 1961. Rainfall Frequency Atlas of the United States for Durations from 30 minutes to 24 hours and Return Periods from 1 to 100 Years, U.S. Dept. Commerce, Weather Bureau. Technical Paper No. 40. Washington, DC.

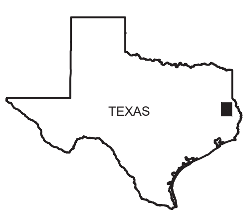
U.S. Army Corps of Engineer, 1997, Hydrologic Evaluation of Landfill Performance (Version 3.07), November 1.

Dewberry Consultants, LLC (Dewberrry), 2014. *Coal Combustion Residue Impoundment Round 12 - Dam Assessment Report, Martin Lake Steam Electric Plant Coal Combustion Residuals Impoundments, Tatum, Texas*, EP-09W001727, March.

Pastor, Behling & Wheeler, LLC (PBW), 2016. Hazard Classification Assessment – Martin Lake Steam Electric Station Ash Pond Area and Permanent Disposal Pond No. 5, Rusk County, Texas. October.

FIGURES





QUADRANGLE LOCATION

N

Scale in Feet

0 1500 3000

SOURCE:
Base map from www.tnris.gov, Tatum, TX 7.5 min. USGS Quadrangle dated 1983.

LUMINANT GENERATION COMPANY, LLC
MARTIN LAKE STEAM ELECTRIC STATION

Figure 1

SITE LOCATION MAP

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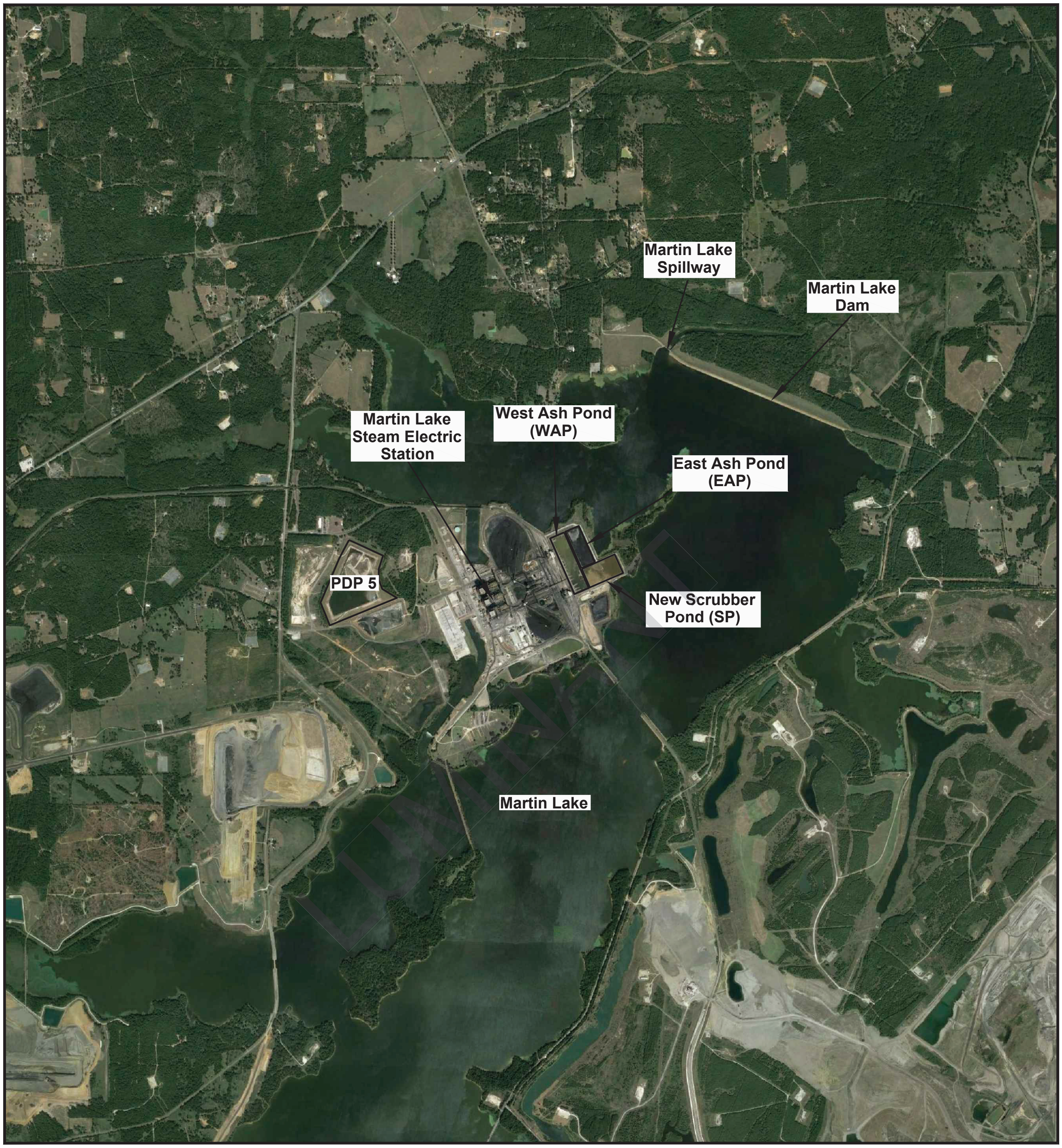

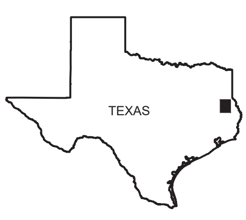

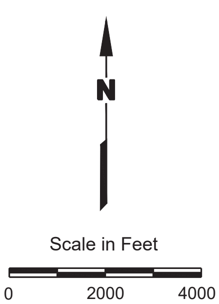

SOURCE:
Imagery from Google Earth, photography dated October 1, 2015.

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MARTIN LAKE STEAM ELECTRIC STATION

Figure 2

SITE VICINITY MAP

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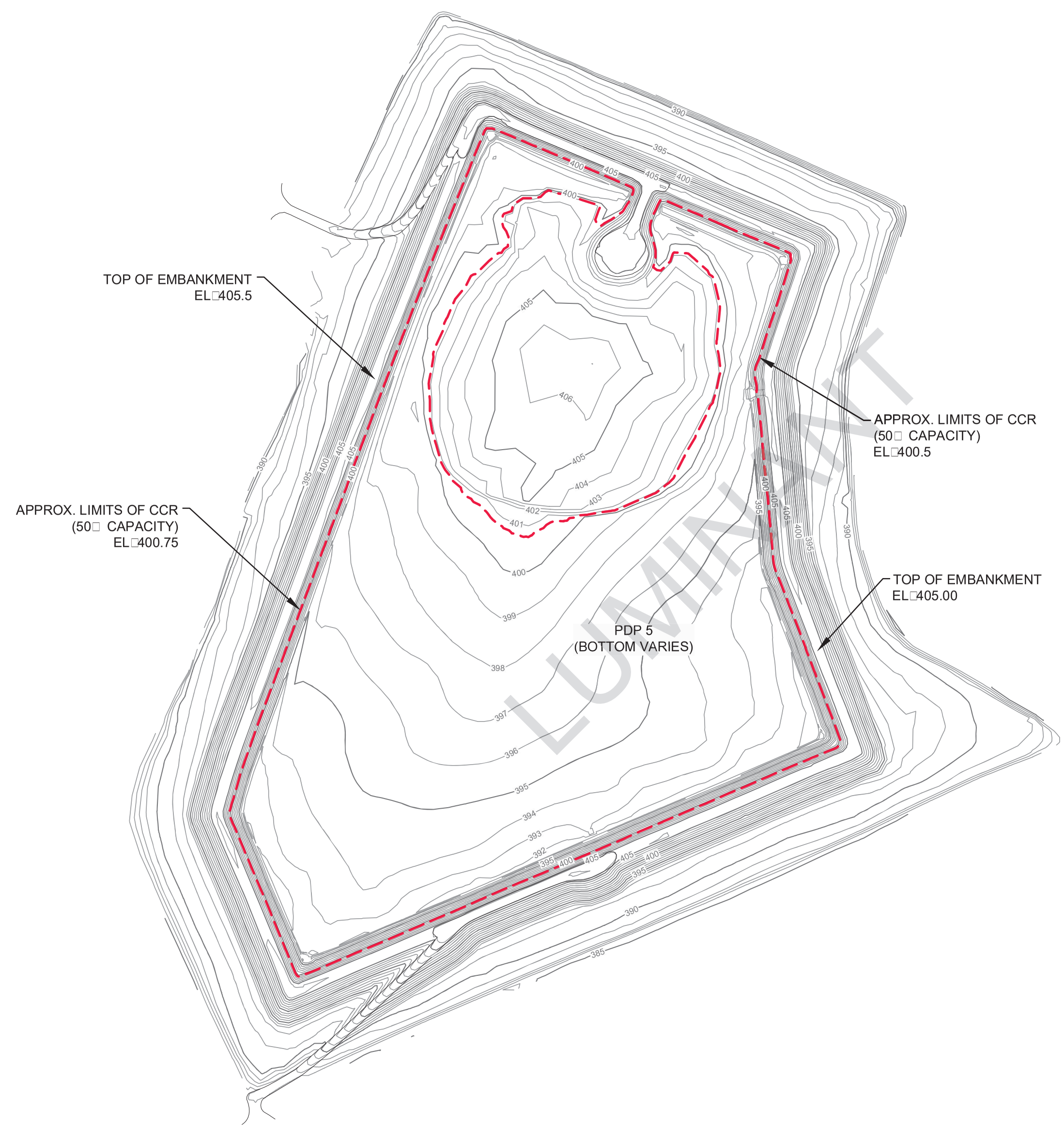

EXPLANATION

- Existing Grade Contour 1 ft Interval
- Existing Grade Contour 5 ft Interval
- Estimated 50 Percent Solids Fill Limit

N

Scale in Feet
0 125 250

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Figure 3

EXISTING SITE PLAN

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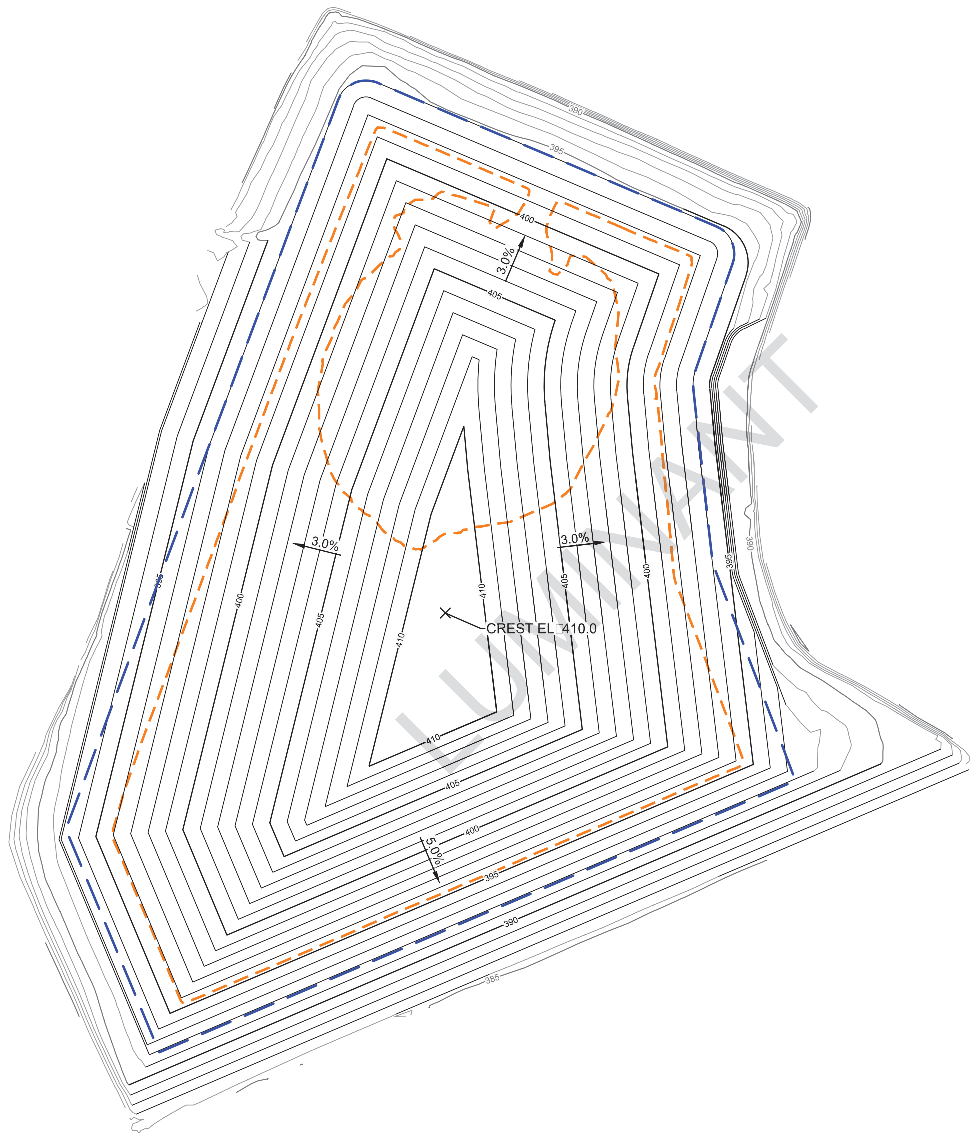

EXPLANATION

- Proposed Finished Grade Contour 1 ft Interval
- Proposed Finished Grade Contour 5 ft Interval
- Proposed Limits of CAP
- Estimated Limits of CCR (Elev. 400.5)

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Figure 4

PROPOSED GRADING PLAN

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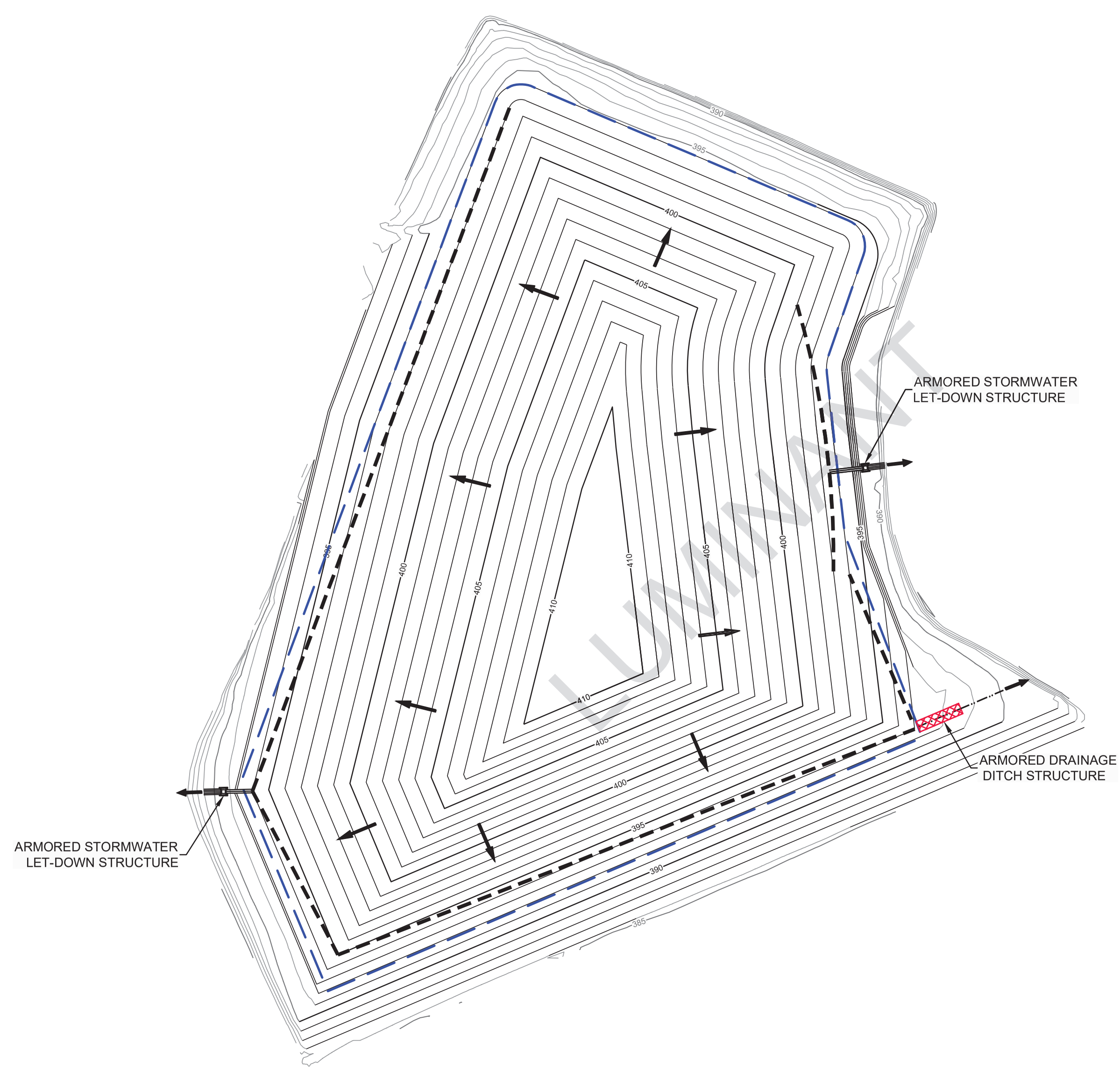

EXPLANATION

- Proposed Finished Grade Contour 1 ft Interval
- Proposed Finished Grade Contour 5 ft Interval
- Limits of CAP
- Sheet Flow
- Concentration Flow Path
- Approximate Alignment Stormwater Diversion Berm

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Figure 5

SURFACE WATER CONTROL PLAN

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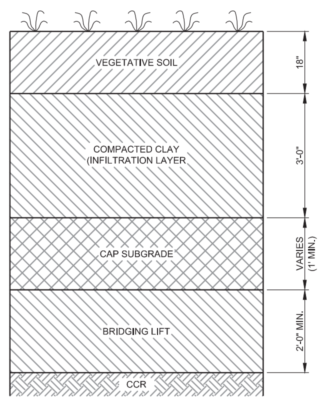

1/6 CLAY CAP DETAIL
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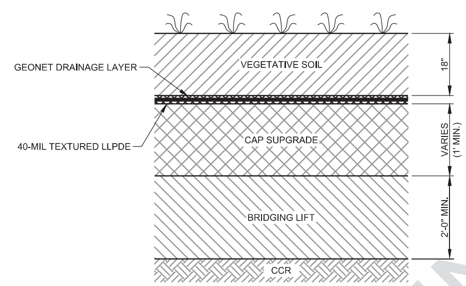

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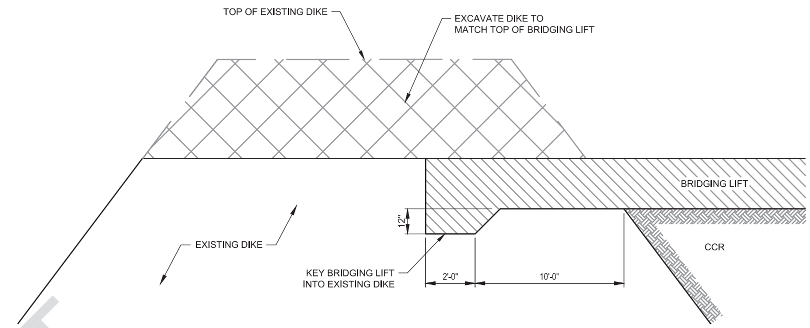
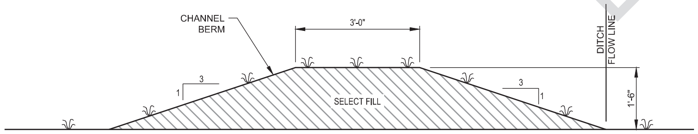
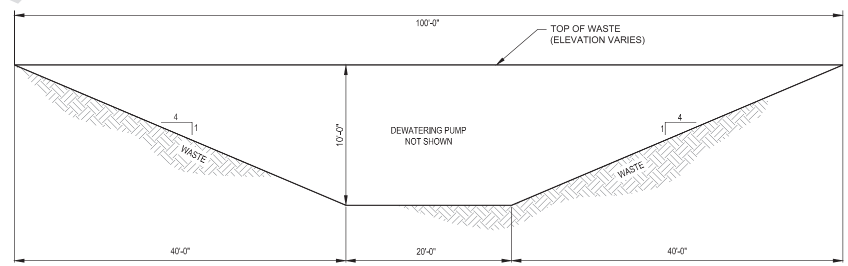


3/6 DIKE CONNECTION DETAIL
NOT TO SCALE



4/6 CHANNEL BERM
NOT TO SCALE



5/6 DEWATERING SUMP DETAIL
NOT TO SCALE

LUMINANT GENERATION COMPANY, LLC MARTIN LAKE STEAM ELECTRIC STATION		
Figure 6 **TYPICAL CONSTRUCTION DETAILS - CCR COVER SYSTEM**		
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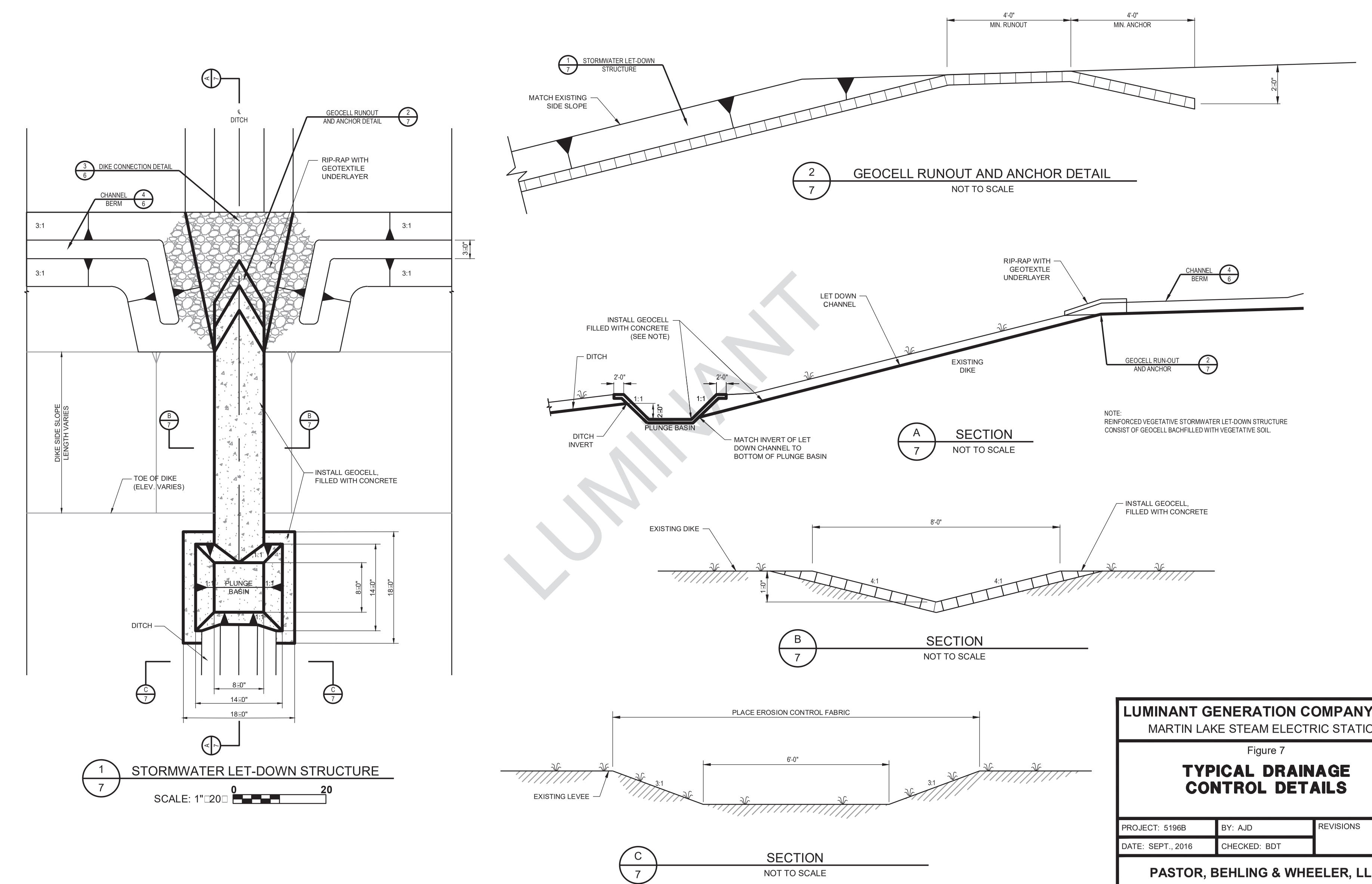

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Figure 7

TYPICAL DRAINAGE CONTROL DETAILS

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APPENDIX A

TECHNICAL SPECIFICATIONS

PERMANENT DISPOSAL POND - 5
TECHNICAL SPECIFICATIONS

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SECTION 01100

EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section consists of furnishing, placing, and maintaining erosion and sedimentation control measures as shown on the Drawings, as directed by the COMPANY, and where necessary to reduce sediment content of runoff prior to establishment of permanent vegetation.

1.2 PERFORMANCE REQUIREMENTS

A. CONTRACTOR shall provide erosion and sedimentation control measures to control erosion and sediment runoff in any location where erosion and sediment runoff is likely to occur and as required by the COMPANY. Erosion and sedimentation control measures shall remain in place until removal is approved by the COMPANY.

B. Clearing and stripping of vegetation, regrading and other construction activities shall be conducted in a manner to minimize erosion. Existing drainage patterns and vegetation shall be protected and retained to the greatest extent practicable.

C. The size and duration of exposure of disturbed areas shall be kept to a minimum and all disturbed soil shall be stabilized as quickly as practicable. Diversion channels/berms shall be located upstream from disturbed areas to minimize the amount of run-on to the disturbed areas.

D. In the event that erosion and sedimentation control measures used by CONTRACTOR prove to be inadequate as determined by COMPANY, CONTRACTOR shall be required to adjust his operations to the extent necessary to control sedimentation and shall repair areas impacted by sedimentation as directed by COMPANY at no additional cost to COMPANY.

1.3 SUBMITTALS

A. CONTRACTOR shall submit the following to COMPANY a minimum of 14 days prior to initiating field activities:

1. A copy of the construction Storm Water Pollution Prevention Plan (SWPPP) developed for the Work.
2. An installation schedule for erosion and sedimentation control measures. This schedule shall cover all ground disturbance activities including material staging areas and planned excavation and grading areas.
3. Certification that all proposed erosion and sedimentation control products comply with the requirements of these specifications.

PART 2 - PRODUCTS

2.1 SILT FENCE

A. Silt fence fabric material shall be a woven geotextile conforming to the following requirements:

Physical Property	Test Method	Requirement
Tensile Strength, lb.	ASTM D4632	100 Minimum
Elongation @ Yield, %	ASTM D4632	10-40
Trapezoidal Tear, N (lb.)	ASTM D4533	50 Minimum
Apparent Opening Size	ASTM D4751	20-50
Permittivity, 1/sec	ASTM D4491	0.1 Minimum
UV Stability, 500 hr.	ASTM D4355	80 Minimum

B. Posts shall be essentially straight wood or steel posts with a minimum length of 48 inches. Soft wood posts must be at least 3 in. in diameter or nominal 2 x 4 in. Hardwood posts must have a minimum cross-section of 1-1/2 x 1-1/2 inches. T- or L-shaped steel posts must have a minimum weight of 1.3 pounds per foot.

2.2 EROSION CONTROL FABRIC

A. Erosion Control Fabric shall be North American Green S150 or COMPANY-approved equal.

B. Erosion control fabric blanket shall have a minimum width of 6 feet. The fabric mat shall be machine-produced of 100 percent coconut fiber with colored line or thread along outer edges to indicate material overlap limits and shall have a minimum weight of 0.50lb./sq.yd.

C. The top and bottom cover of the fabric shall be heavy-weight polypropylene netting with ultraviolet additives to delay breakdown. The mesh size shall be a minimum of 0.5 inch by 0.5 inch.

D. The blanket and top/bottom covers shall be sown together on 1.5 inch center at 50 stitches per roll width with UV stable polypropylene thread.

E. Erosion Control Fabric shall be installed using 6-in. wooden stakes or metal staples of sufficient material quality, cross-section, and strength to anchor the erosion control blanket against loads imposed by surface runoff and sediment.

2.3 HAY BALES

A. Hay bales may be obtained from local sources and shall weigh 40 to 120 pounds per bale. Only grain hay bales, free of noxious weeds, shall be used. Bales shall be tightly and securely bound with wire to provide a stable bale and to extend the functional life of the bale to the extent practicable. Bales shall be free from rot and mold.

B. Stakes for hay bales shall be wooden stakes or metal rebar of sufficient material quality, cross-section, and strength to secure the hay bales.

2.4 TEMPORARY VEGETATION

A. Temporary Vegetation shall be applied on areas left exposed for greater than 30 days. CONTRACTOR shall use temporary vegetation seed mixture and application rate as specified in Section 02350, "Vegetation," or CONTRACTOR may alternatively submit proposed temporary vegetation seed mix and application rate to COMPANY for approval no later than 7 days prior to use.

B. Mulch shall be applied after temporary vegetation seeding at a rate of 1.5 tons/acre for straw mulch, or at the rate recommended by the manufacturer if wood fiber mulch is used.

CONTRACTOR shall ensure that mulch does not redistribute after application. CONTRACTOR shall reapply mulch as necessary to maintain uniform coverage. Straw mulch shall include dry oat or wheat straw, native hay, or chopped corn stalks. The mulch shall be free from weeds and foreign matter detrimental to plant life. Wood fiber mulch shall include approved wood cellulose fiber in chip form and be free of ingredients that could inhibit germination and growth.

PART 3 - EXECUTION

3.1 GENERAL

A. Delivery, Storage, and Handling. Product delivery, storage and handling shall comply with manufacturer's recommendations. All erosion and sedimentation control products shall be delivered in manufacturer's wrapping and shall be stored in a manner to prevent damage. Damaged or unsuitable products shall be promptly removed from the job site and replaced with products meeting these specifications.

B. All erosion and sedimentation control measures shall be installed in accordance with manufacturer's recommendations and approved by the COMPANY prior to initiating any clearing, demolition or construction activities.

C. Cut Areas. Establish an erosion control line (hay bales or filter fabric) at toe of slope in all cut areas prior to beginning cut operations.

D. Fill Areas. Establish an erosion control line (hay bales or filter fabric) approximately 10 feet from toe of slope of proposed fill areas prior to beginning fill operations.

E. Stockpiles. Sides of soil stockpiles shall have a maximum slope of 2:1. All stockpiles shall be surrounded by a sediment barrier (hay bales or filter fabric) unless other wise approved by the COMPANY. All stockpiles left bare for more than 30 days shall be stabilized with temporary vegetation and/or mulch.

3.2 SILT FENCE

A. Silt fence shall be installed along the downstream perimeter of all disturbed areas to intercept sediment from sheet flow.

B. Posts shall be embedded into the ground at least 18 inches deep and shall be spaced a maximum of 8 feet apart.

C. Filter fabric shall be installed by digging a 6 inch wide by 6 inch deep trench along the upstream side of the fence. Place approximately 6 to 8 inches of the fabric in the trench and backfill the trench.

D. Unless otherwise shown on the Drawings, attach the wire mesh to wooden posts with staples, or to steel posts with T-clips, in at least 4 places equally spaced. Sewn vertical pockets may be used to attach wire mesh or fabric to end posts.

E. Fasten the fabric to the top strand of the reinforcement by rings or cord every 15 inches or less. Locate fabric splices at a fence post with a minimum overlap of 6 inches attached in at least 4 places equally spaced. Do not locate fabric splices in concentrated flow areas.

3.3 EROSION CONTROL FABRIC

A. Erosion control fabric shall be installed following completion of final grading activities in the following disturbed earth areas unless otherwise approved by the COMPANY:

1. All exterior slopes 4(H) to I(V) and steeper; and
2. All drainage ditches, channels and swales.

B. Erosion control fabric shall be anchored at the top of the slope using an anchor trench and shall be rolled down the slope so as to maintain tension to preclude folds and wrinkles. Any folds or wrinkles shall be removed by hand.

C. The erosion control fabric anchor trench shall be 6 inches wide by 6 inches deep. The trench fabric shall be connected to the vertical face of the trench using stakes or staples spaced at 12 inches on center. The trench shall be backfilled and compacted upon completion of stapling.

D. Successive erosion control fabric panels shall be overlapped in such a manner that the upstream and upslope panel is placed over the downstream and downslope panel. Panels shall overlap a minimum of 6 inches at end joints and on sideslopes.

E. Stake or staple through both panels with stakes/staples driven flush with the soil surface. Stake/staple spacing shall be in accordance with manufacturer's recommendations.

3.4 HAY BALES

A. Hay bales shall be installed to form water stops, filtration dams, diversions, etc. as required for erosion and sedimentation control. On sloping terrain, hay bales may be used to trap sediment until vegetation has become established.

B. Place bales lengthwise with ends tight, abutting one another. Install bales with bindings located on the sides.

C. Entrench hay bales a minimum of 4 inches and backfill. Place backfill on the upstream side of the bales.

D. Secure the bale in place with two stakes per bale and insert straw in voids between bales.

3.5 MAINTENANCE

A. All erosion and sedimentation controls shall be maintained in a structurally sound and functional manner. All erosion and sedimentation controls shall be inspected at least on a weekly basis, immediately after each rainfall and daily during prolonged rainfall.

B. Any damaged or deteriorating systems shall be replaced immediately upon discovery or as directed by COMPANY.

C. Sediment deposits shall be removed when the deposit reaches 1/3 the height of the fence or sooner to provide a functional and stable system. Sediment retained by sedimentation and erosion control systems shall be removed by CONTRACTOR and may be used on the project as fill as approved by COMPANY.

D. Areas where temporary vegetation or mulch has been applied shall be inspected to ensure proper growth and coverage. Temporary vegetation or mulch shall be reapplied as necessary to minimize erosion.

3.6 REMOVAL

A. Erosion and sedimentation controls shall remain in-place until the COMPANY directs their removal. Upon removal CONTRACTOR shall dispose of any sediment accumulations, dress the area to the satisfaction of COMPANY, and shall vegetate all bare areas in accordance with the Contract Documents. Temporary erosion control blanket materials specified are biodegradable and will remain in place after establishment of permanent vegetation.

++END OF SECTION++

SECTION 01200

DUST CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section consists of performance of dust control measures as necessary to prevent fugitive dust during construction activities or as directed by the ENGINEER.

1.2 PERFORMANCE REQUIREMENTS

A. CONTRACTOR shall implement all necessary dust control measures to prevent fugitive dust during all construction activities.

B. The need for dust control measures will be based on visual observation of airborne dust. CONTRACTOR shall implement dust control measures on a regular basis throughout the duration of the work unless other wise authorized by the ENGINEER. CONTRACTOR shall adjust operations and/or dust controls as necessary, at no additional cost to OWNER, if directed by ENGINEER to mitigate dust.

1.3 SUBMITTALS

A. CONTRACTOR shall submit the following to ENGINEER a minimum of 5 days prior to initiating dust control measures:

1. Source of dust control water;
2. List of dust control equipment; and
3. Manufacturer specification sheets and material safety data sheets (MSDS) for chemical additives used for dust control.

PART 2 - PRODUCTS

2.1 WATER

A. Water used for dust control need not be potable, but must not be contaminated. Proposed source of dust control water must be approved by ENGINEER prior to initiating dust control measures.

2.2 CHEMICAL ADDITIVES

A. Chemical additives shall be incorporated into dust control measures only if approved by the ENGINEER.

B. Calcium Chloride for dust control shall conform to the requirements of ASTM D98, Type 1 or Type 2.

C. Alternative chemical additives for dust control may be used if approved by the ENGINEER.

2.3 EQUIPMENT

A. Dust control water shall be applied using tank trucks equipped with water cannon capable of delivering water through either front- or rear-mounted nozzles. Tank trucks shall be of sufficient size and mobility and carry a sufficient quantity of water to control dust generated by CONTRACTOR's activities.

B. More than one water tank truck may be required during construction activities to sufficiently suppress dust.

PART 3 - EXECUTION

3.1 IMPLEMENTATION OF DUST CONTROL MEASURES

A. Vehicular traffic in disturbed areas shall be limited to the extent practicable. Construction vehicles shall maintain low speeds to minimize the amount of dust created. Adequate freeboard in loaded trucks shall be maintained to prevent spillage during operations. Roadway surfaces shall be kept free of spilled/tracked soil.

B. Soil stockpiles shall be graded and shaped to minimize surface area. Water or covers shall be applied to stockpiles as needed to control dust.

C. Apply dust control water uniformly over roads and disturbed areas from trucks capable of uniform distribution. Provide suitable devices for positive shut-off and for regulating flow of water.

D. Apply calcium chloride or other chemical additives at locations only when directed by ENGINEER. Spread calcium chloride or other chemical additives by approved devices and methods for uniform distribution.

E. Dust control water and/or chemical additives shall be applied so as to limit and/or prevent formation of standing water and mud; over spray of chemical dust suppressants in areas adjacent to surface water bodies or sensitive habitats; and/or flushing of materials off of the work area.

++END OF SECTION++

SECTION 02200

SITE PREPARATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section consists of all work associated with clearing and preparing the work area, borrow areas, and other work areas for earthwork and other construction activities, including removal of existing vegetation and verification of existing site conditions.

1.2 EXISTING SITE CONDITIONS

A. CONTRACTOR shall verify that existing topographic conditions in the Work Area as shown on the Drawings are an accurate representation of existing site conditions prior to initiating construction activities.

B. If CONTRACTOR contends that existing topographic conditions are different from that shown on the Drawings, Contractor shall submit survey data from a Texas-registered land surveyor to document actual topographic conditions, and shall identify with such submission additional work required which was not accounted for in CONTRACTOR's bid. There shall be no opportunity for a Claim for extra work due to differing topographic conditions once stripping or excavation work has started.

C. Existing site improvements (utilities, monitoring wells, and similar items) shall be located and protected by CONTRACTOR before CONTRACTOR begins clearing operations.

1.3 SUBMITTALS

A. Clearing and grubbing and solid waste generated during cap subgrade preparation shall be placed within the active portion of the landfill unless otherwise approved by the ENGINEER. CONTRACTOR shall submit name and address of the alternate disposal facility proposed for management of trash and rubbish generated in connection with site preparation at least 5 days prior to beginning clearing operations.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 CLEARING

A. Clearing shall consist of the cutting, shredding, and stockpiling of all trees and shrubs and the stripping of all grass and similar surface vegetation within the limits of the landfill and borrow areas. Clearing shall be limited to the areas required to perform the work.

B. CONTRACTOR shall segregate material removed as part of clearing from soils to be incorporated into subsequent earthwork activities.

3.2 VEGETATIVE SOIL STRIPPING AND STOCKPILING

A. After completion of clearing activities, CONTRACTOR shall strip the uppermost approximately 12 inches of existing vegetative soil from the cleared areas. Material identified as vegetative soil shall be subject to ENGINEER’s approval.

B. CONTRACTOR shall stockpile stripped vegetative soil in the work area in a location acceptable to the ENGINEER.

3.3 DISPOSAL OF BRUSH AND OTHER VEGETATIVE MATERIAL

A. CONTRACTOR shall dispose of all brush and other vegetative materials generated during site clearing in accordance with all applicable regulations and as approved by the ENGINEER.

B. If approved by the ENGINEER, CONTRACTOR may burn brush and other vegetative material in accordance with the requirements of TCEQ Publication RG-049 “Outdoor Burning in Texas”, as modified to comply with OWNER requirements. Specific requirements for burning of brush and other vegetative material include, but are not limited to, the following:

1. Commence or continue burning only when the wind direction and other weather conditions are such that the smoke and other pollutants will not present a hazard to any public road, landing strip, or water body or have an adverse effect on any off-site structure.

2. Don’t start burning unless weather conditions are such that the smoke will dissipate (winds of at least 6 miles per hour; no temperature inversions) while still allowing the fire to be contained and controlled (winds no faster than 23 miles per hour).

3. Post someone to flag traffic if at any time the burning causes or may tend to cause smoke to blow onto or across a road or highway.

4. Begin burning no earlier than one hour after sunrise, end it the same day and no later than one hour before sunset, and make sure that a responsible party is present while the burn is active and the fire is progressing.

5. At the end of the burn, extinguish isolated residual fires or smoldering objects if the smoke they produce can be a nuisance or a traffic hazard.

C. CONTRACTOR will be responsible for controlling fires in compliance with all Federal, State, and Local laws and regulations. The securing of necessary burning permits shall be the responsibility of the CONTRACTOR. All burning shall be under the constant care of competent watchmen. All materials resulting from clearing and grubbing operations and disposed of by burning on the site shall be thoroughly and completely reduced to ashes.

D. CONTRACTOR shall be responsible for providing a suitable location (subject to ENGINEER and OWNER approval) for off-site disposal of cleared material not burned on-site. Once ENGINEER and OWNER have approved the disposal location, CONTRACTOR shall transport and dispose the material in accordance with all applicable regulations.

++END OF SECTION++

SECTION 02300

EARTHWORK

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section consists of all activities associated with earthwork construction, including, but not necessarily limited to:

1. Excavation, loading, transportation, unloading and stockpiling of soil from COMPANY-designated locations;
2. Placement, compaction, and grading of various earthen materials;
3. Ditch grading; and
4. All other activities required to complete earthwork construction as shown on the Drawings, specified herein and or required by the COMPANY.

1.2 REFERENCES

A. American Society of Testing Materials (ASTM) Standards/Publications (Latest version):

C33	Standard Specification for Concrete Aggregates
D422	Method of Particle Size Analysis of Soils
D698	Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3)
D1557	Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3)
D1587	Standard Practice for Thin-walled Tube Sampling of Soils
D2487	Classification of Soils for Engineering Purposes
D2922	Density of Soil In Place by Nuclear Density Gage
D3080	Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions
D4318	Liquid Limit, Plastic Limit and Plasticity Index of Soils
D5084	Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.3 DEFINITIONS

A. Select Fill: Soil material suitable for use as cap fill, for dike construction or other areas identified by the COMPANY.

B. General Fill: Any non-classified soil deemed suitable by the COMPANY.

C. Liner Subgrade: Soil complying with the specified requirements located immediately beneath the geosynthetic clay liner (GCL).

D. Compacted Clay: Low-permeability soil layer of liner system.

E. Vegetative Soil: Growth medium used along with any necessary admixtures to support vegetation.

F. Gravel: Granular crushed stone material used as erosion protection in ditches.

G. Road Base: Granular material placed on the surface of haul roads, access roads and other areas designated on the Drawings, identified in the Specifications or required by the COMPANY.

H. Rip Rap: Stone armor material used in drainage features for erosion control and energy dissipation.

1.4 SUBMITTALS

A. CONTRACTOR shall identify all earthwork material suppliers and shall submit written verification from his material suppliers that all earthwork materials to be used for the work comply with the requirements of this Section.

B. CONTRACTOR shall submit copies of all geotechnical laboratory reports within 10 working days after sample collection.

1.5 QUALITY CONTROL

A. CONTRACTOR shall perform construction surveys, as needed, to ensure that the lines and grades of all excavations, embankments, ditches, pipe trenches, pipe inverts, and graded surfaces are in accordance with the drawings and specifications.

B. COMPANY may perform pre-construction and post-construction topographic surveys of the work area and related areas and may perform additional quality assurance surveys. CONTRACTOR shall coordinate his activities with COMPANY's surveyor and provide safe access to all excavation areas for survey and/or verification sampling activities.

1.6 TESTING

A. The number and type of testing required for each type of earthwork shall be as specified in the specific section related to the type of earthwork.

B. COMPANY will select the locations for all tests. Tests performed at locations not approved by the COMPANY will not be accepted.

C. All undisturbed earthwork samples shall be collected using a thin-walled sampler complying with ASTM D1587. The length of the sampler shall be suitable for collection of an undisturbed sample over the specified sampling interval.

D. Unless otherwise specified, testing shall be performed in accordance with the following methods:

1. Soil classification shall be performed using ASTM D2487. Liquid Limits, Plastic Limits and Plasticity Indices shall be determined using ASTM D4318.

2. Moisture-Density Relationships shall be determined using ASTM D698. Unless otherwise directed by COMPANY. ASTM D1557 may be used only where specified.

3. In-place density and moisture content shall be determined using ASTM D6938 (Nuclear Density Gage). Other methods for determining in-place density and moisture may not be used unless approved by the COMPANY.

4. Hydraulic conductivity shall be determined using ASTM D5084.

5. Direct shear testing shall be performed in accordance with ASTM D3040.

1.7 TOLERANCES

A. Grades and slopes of all earthwork shall be straight and true. Unless otherwise specified, CONTRACTOR shall complete all earthwork within the dimensional tolerances presented below.

B. Elevation Tolerances:

1.	Compacted Clay Surface:	plus 0.1 foot, minus 0.0 foot.
2.	Liner Subgrade Surface:	plus 0.1 foot, minus 0.0 foot.
3.	Gravel Surface:	plus 0.1 foot, minus 0.0 foot.
4.	All Other Surfaces:	plus 0.2 foot, minus 0.0 foot.

C. Thickness Tolerances:

1.	Compacted Clay Subgrade:	plus 0.2 foot, minus 0.0 foot.
2.	Liner Subgrade:	plus 0.2 foot, minus 0.0 foot.
3	All Other Surfaces:	plus 0.1 foot, minus 0.0 foot.

D. Grade Tolerances: All grades/slopes shall be completed within

1.	Compacted Clay Surface:	plus or minus 0.1 percent of design slope.
2.	Liner Subgrade Surface:	plus or minus 0.1 percent of design slope.
3.	Gravel and Drainage Features:	plus or minus 0.1 percent of design slope.
4.	All Other Surfaces:	plus or minus 0.2 percent of design slope.

E. Horizontal Coordinates and/or Earthwork Dimensions: plus or minus 0.5 feet

1.8 UTILITIES

A. COMPANY will attempt to deactivate electrical and other utilities in areas to be excavated; however, CONTRACTOR shall be ultimately responsible for ensuring that no energized equipment or utilities are present prior to initiating excavation activities. If CONTRACTOR identifies energized or active equipment or utilities, CONTRACTOR shall cease work and notify COMPANY so that the equipment/utilities may be deactivated. CONTRACTOR shall again check the equipment and utilities to ensure they are deactivated prior to proceeding with excavation activities.

B. CONTRACTOR shall note that underground and aboveground utilities may be located in the area of the Work. CONTRACTOR shall be ultimately responsible for protecting the utilities during earthwork and related activities.

1.9 EARTHWORK SAFETY

A. As discussed in other areas of these specifications, CONTRACTOR shall be fully responsible for the health and safety of all personnel in the work area, at all times, and shall take all necessary precautions to protect personnel.

B. In addition to general health and safety responsibilities, CONTRACTOR shall be fully responsible for complying with all applicable OSHA and related regulations regarding earthwork, including, but not limited to, the requirements of 40 CFR Part 126.

PART 2 - PRODUCTS

2.1 SELECT FILL

A. Select fill shall consist of soil excavated during foundation soil grading. CONTRACTOR shall be responsible for loading, transporting, placement and compaction of select fill.

B. Select fill shall classify as CH, CL or SC using ASTM D2487, shall have a plasticity index between 15 and 40, and shall be free of roots, brush, sod, or other perishable materials and debris.

2.2 GENERAL FILL

A. General fill shall be any non-classified soil deemed suitable by the COMPANY. General fill shall be free of trash, rubbish or other deleterious substances. The maximum particle size of general fill shall be 6 inches.

2.3 LINER SUBGRADE

A. Liner Subgrade shall consist of soil excavated from the site during foundation grading. CONTRACTOR shall be responsible for loading, transporting, placement and compaction of Liner Subgrade.

B. Liner Subgrade shall classify as CH or CL using ASTM D2487 and shall contain no organic material, sticks, or other deleterious material.

C. The maximum particle size of liner subgrade shall be 3 inches. Particles larger than 1 inch shall be subrounded to rounded.

2.4 COMPACTED CLAY

A. Compacted Clay shall consist of soil excavated from the COMPANY-designated Borrow Area or other COMPANY-approved off-site source. CONTRACTOR shall be responsible for loading, transporting, placement and compaction of Compacted Clay.

B. Compacted Clay shall classify as CH or CL using ASTM D2487 and shall contain no organic material, sticks, or other deleterious material.

C. Compacted Clay shall conform to the following:

Parameter	Specification
Plasticity Index	15 Minimum
Liquid Limit	30 Minimum
Percent Passing No. 200 Sieve	30% Minimum
Percent Passing 1.5-inch Sieve	100%
Hydraulic Conductivity	1×10^{-7} cm/s Maximum
In-Place Density	95% Standard Proctor Minimum
In-Place Moisture Content	-1% to +3% Optimum Moisture Content

2.5 VEGETATIVE SOIL

A. Vegetative soil shall consist of soil stripped from the work area and stockpiled by the CONTRACTOR. Vegetative soil shall be free of deleterious material, materials toxic to plant growth, noxious weed seeds, rhizomes, roots, subsoil, rocks, or other debris.

2.6 GRAVEL

A. Gravel shall be washed, angular crushed gravel or crushed limestone, free of mud, clay, vegetation or other debris, conforming to ASTM C33 for stone quality.

B. Gravel shall have the following size gradation:

U.S. Sieve Size	Percent Passing
1.5 Inch	100
1 Inch	90 to 100
0.5 Inch	15 to 60
No. 4	0 to 10
No. 8	0 to 5

C. Gravel shall conform to the following:

1. Liquid Limit (LL) less than or equal to 35.

2. Plasticity Index (PI) less than or equal to 10.

2.7 ROAD BASE

A. Road base shall consist of crushed stone, free of mud, clay, vegetation or other debris, conforming to the requirements of TXDOT Item 248, Type A (Grade I). Size Gradation shall comply with the following:

U.S. Sieve Size	Percent Passing
2.5 inch	100
1.75 inch	100
0.875 inch	65 to 90
0.375 inch	50 to 70
No. 4	35 to 55
No. 40	15 to 30
No. 200	0

B. Road Base shall conform to the following:

1. Liquid Limit (LL) less than or equal to 35.

2. Plasticity Index (PI) less than or equal to 10.

2.8 RIPRAP

A. Riprap shall be clean, well-graded durable natural stone with a minimum specific gravity of 2.4.

Unless other wise approved by the COMPANY, riprap shall comply with the following:

1. No deleterious material, noxious weed seeds, roots, subsoil, or other debris shall be present.

2. Riprap shall consist of stone conforming to the following gradation:

Stone Weight (pounds)	Percent Lighter Than
700	100
300	50 to 100
150	15 to 50
45	0 to 15

3. Stones shall be at least 3 inches in their least dimension. The breadth or thickness of each stone shall not be less than one-third the length of the stone.

PART 3 - EXECUTION

3.1 GENERAL

A. All earthwork shall be completed to the lines and grades shown on the Drawings and as required by the COMPANY.

B. CONTRACTOR shall not place material in the presence of water unless approved by the COMPANY. Saturated areas shall be dewatered by CONTRACTOR as specified herein prior to initiating earthwork activities. CONTRACTOR shall remove all saturated soils, muck, organic matter and other materials not suitable for compaction or proof-rolling from dewatered areas prior to placing fill materials.

C. All proof rolling shall be performed as follows unless another method is approved by the COMPANY:

1. Proof rolling equipment shall be approved by the COMPANY. Proof rolling equipment may be self-propelled or towed by a suitable tractor.

2. Proof rolling equipment shall have a rolling width of 8 to 10 feet and shall be capable of operating under various contact pressures.

3. Contact pressure of proof rolling equipment shall be a minimum of 2000 pounds per square foot.

4. A minimum of two passes with the proof rolling equipment shall be completed across the entire native soil surface prior to placement of any material.

5. Any area shown to be unstable or non-uniform after proof rolling shall be recompacted and/or reworked until proof rolled to the satisfaction of the COMPANY.

D. Compaction of all materials shall be performed with an appropriately heavy, properly ballasted penetrating-foot compactor. A minimum of four passes of the compactor shall be performed on each material lift regardless of whether the lift complies with specified density requirements within less than four passes.

E. When target compaction/density is specified using ASTM D698 (Standard Proctor), the minimum weight of the compacting equipment shall be 1500 pounds per linear foot of drum length.

F. The daily work area shall extend a distance no greater than necessary to maintain moist conditions and continuous operations. Desiccation and crusting of the lift surface shall be avoided as much as possible.

G. Water added to soils shall be clean and shall not have come into contact with waste or any objectionable material. Source of water shall be approved by COMPANY prior to application.

H. Unless otherwise specified or approved by the COMPANY, the maximum clod size in each lift prior to compaction shall be 2 inches in diameter. Clod size shall be reduced through discing, pulverizing or similar methods. Unless otherwise approved by the COMPANY, a minimum of 4 passes with discing or pulverizing equipment shall be made across each lift prior to beginning compaction. A pass is defined as one trip across the lift surface. Passes shall be made at alternating right angles across the lift surface.

I. Finished, compacted lifts of all material shall be sprayed with clean water as necessary to prevent drying and desiccation.

J. At the end of each construction day's activities, completed lifts shall be sealed by rolling with a rubber-tired or smooth drum roller. Prior to resuming placement of overlying material, the surface of the previous lift shall be scarified to a minimum depth of 2 inches.

3.2 DEWATERING

A. CONTRACTOR shall note that some of the work may be performed in areas exhibiting saturated conditions at and below the groundwater table. CONTRACTOR shall not place material in the presence of water unless approved by the COMPANY.

B. CONTRACTOR shall dewater the work area using pumps or other method approved by the COMPANY. Dewatering measures shall be implemented by the time the excavation reaches the water level in order to maintain the integrity of the in-situ material. Dewatering water shall be discharged in accordance with COMPANY requirements in a manner that minimizes erosion and other disturbances to existing drainage features and adjacent areas.

C. All dewatering system components, including cofferdams, pumps, piping and related equipment shall be removed by the CONTRACTOR at the completion of the work.

3.3 COMPACTED CLAY

A. Construction of the Compacted Clay layer will begin after the underlying native soil has been finished to the proper lines and grade. The depth of the top of the underlying native soil prior to compacted clay construction shall coincide with the bottom of the Compacted Clay layer. The Compacted Clay layer shall be keyed into the underlying native soil or otherwise constructed to ensure stability.

B. Compacted Clay shall be placed and compacted in lifts. Maximum loose lift thickness shall be 8 inches. Maximum compacted lift thickness shall be 6 inches.

C. New Compacted Clay lifts shall be properly tied back into previous clay sections to ensure continuous clay layer coverage. Compacted Clay layers shall be tied into previously placed Compacted Clay layers using a stair-step construction method with benches, no steeper than a five horizontal to one vertical face.

D. For excavation surfaces with a slope of 3(H):1(V) or flatter, Compacted Clay layer construction may utilize lifts parallel to the finished surface. For excavation surfaces that have steeper than 3(H):1(V) slopes, Compacted Clay lifts shall be placed in successive horizontal lifts. All horizontal lifts shall be sufficiently wide to safely accommodate construction equipment.

E. Testing requirements for lifts placed on all sloped surfaces shall be the same as specified for non-sloped surfaces. Lift areas on sloped surfaces shall be measured parallel to the surface of the excavation.

F. Prior to compaction of each lift, the moisture content of the Compacted Clay shall comply with the requirements of these specifications. If the moisture content is above the specified maximum, the Compacted Clay shall be pulverized, disced or similarly reworked to air dry the material and decrease the moisture content.

G. Each lift shall be compacted to a minimum of 95 percent maximum dry density as determined by ASTM D698 (Standard Proctor). Material with densities less than the specified density shall be recompacted and/or reworked as necessary to achieve the specified density.

H. Each lift shall be thoroughly compacted and shall satisfy all specified requirements before a subsequent lift is placed.

I. After the final lift has been compacted and tested, the surface of the Compacted Clay shall be rolled and sealed with a smooth drum roller. A minimum of four passes of the roller shall be performed on the Compacted Clay. A pass is defined as one trip across the entire Compacted Clay surface.

J. COMPANY will test Compacted Clay per the following guidelines:

1. Pre-Construction Testing. Prior to beginning placement of the Compacted Clay, CONTRACTOR shall collect composite samples from the prospective clay source(s) and test the samples as described below. All composite samples shall consist of equal volumes of soil collected from a minimum of four locations within the prospective clay source.

   a. Two soil classifications in accordance with ASTM D2487 shall be performed from each clay source. Plasticity Index (PI) shall be included in the soil classification.

   b. Two moisture-density relationship tests in accordance with ASTM D698 (Standard Proctor) shall be performed from each clay source.

   c. Two hydraulic conductivity tests by ASTM D5084 shall be performed from each clay source. Each sample shall be compacted to 95 percent maximum dry density as determined by ASTM D698 (Standard Proctor) prior to performing the hydraulic conductivity test.

2. In-Place Testing. After each Compacted Clay lift has been placed, COMPANY will perform the following in-place tests:

   a. One in-place density test in accordance with ASTM D6938 shall be performed per each 4,000 square feet for each lift.

   b. One in-place moisture density relationship shall be reported for every in-place density test performed.

K. After completion of the Compacted Clay layer, but before beginning installation of the overlying materials, CONTRACTOR shall survey the finished elevations of the Compacted Clay to ensure that the top of the Compacted Clay is at the grades and elevations specified on the Drawings. There shall be a minimum of one survey point for every 5,000 square feet of Compacted Clay surface area.

3.4 SELECT FILL

A. Select fill shall be placed and compacted in lifts. Maximum loose lift thickness shall be 8 inches. Maximum compacted lift thickness shall be 6 inches.

B. Prior to compaction, the moisture content of the select fill shall be no greater than plus 3 percent of the optimum moisture content as determined by ASTM D698 (Standard Proctor). If the moisture content is above the specified maximum, select fill shall be pulverized, disced or similarly reworked to air dry the material and decrease the moisture content.

C. Each select fill lift shall be compacted to a minimum of 90 percent maximum dry density as determined by ASTM D698 (Standard Proctor). Material with densities less than the specified density shall be recompacted and/or reworked as necessary to achieve the specified density.

D. Each lift shall be thoroughly compacted and shall satisfy all moisture and density requirements before a subsequent lift is placed.

E. COMPANY will test select fill per the following guidelines:

1. One moisture density relationship test in accordance with ASTM D698 (Standard Proctor) shall be performed for every 50,000 cubic yards placed.

2. One in-place density test in accordance with ASTM D6938 shall be performed for every 20,000 square feet of surface area for each lift. Surface area shall be measured in the horizontal plane.

3. One soil classification in accordance with ASTM D2487 shall be performed for every 50,000 cubic yards placed.

4. Plasticity Index (PI) shall be included in the soil classification. One moisture-density relationship test in accordance with ASTM D698 (Standard Proctor) shall be performed any time a PI change greater than 10 is observed in the soil classification tests.

F. After completion of the select fill, but before beginning installation of the overlying materials, CONTRACTOR shall survey the finished elevations of the select fill to ensure that the top of the select fill is at the grades and elevations specified on the Drawings. There shall be a minimum of one survey point for every 5,000 square feet of select fill surface area.

3.5 SELECT FILL ON STEEP SLOPES

A. Steep slopes are defined as surfaces with slopes steeper than 5 horizontal to 1 vertical.

B. Construction of select fill on steep slopes shall comply with all other requirements for select fill, in addition to those specified herein.

C. Select fill shall be placed and compacted in benched, horizontal lifts. Maximum loose lift thickness shall be 8 inches. Maximum compacted lift thickness shall be 6 inches.

D. Lifts shall be placed and compacted horizontally (benched parallel to the toe of the slope) rather than vertically (up and down the slope). Each lift shall be wide enough to permit passage of compacting equipment.

E. Lifts shall extend horizontally beyond the required final elevations of select fill to permit grading back to the required slopes after compaction and testing.

F. After each lift has been compacted, tested and accepted by the COMPANY, Contractor shall grade the slope to the required elevations

3.6 LINER SUBGRADE

K. Liner Subgrade shall be placed and compacted in lifts. Maximum loose lift thickness shall be 8 inches. Maximum compacted lift thickness shall be 6 inches. A total of 2 lifts will be placed to construct the 12 inch Liner Subgrade thickness.

L. Prior to compaction of each of the lifts, CONTRACTOR shall manually remove all visible rock 3 inches or greater in size from the lift. After the visible rocks have been removed, CONTRACTOR shall compact each lift as discussed below.

C. Prior to compaction of each lift, the moisture content of the Liner Subgrade shall be no greater than plus 4 percent of the optimum moisture content as determined by ASTM D698 (Standard Proctor). If the moisture content is above the specified maximum, Liner Subgrade shall be pulverized, disced or similarly reworked to air dry the material and decrease the moisture content.

D. Each lift shall be compacted to a minimum of 90 percent maximum dry density as determined by ASTM D698 (Standard Proctor). Material with densities less than the specified density shall be recompacted and/or reworked as necessary to achieve the specified density.

E. Each lift shall be thoroughly compacted and shall satisfy all specified requirements before a subsequent lift is placed.

F. After the second lift has been compacted and tested, the surface of the Liner Subgrade shall be rolled and sealed with a smooth drum roller. A minimum of four passes of the roller shall be performed on the Liner Subgrade. A pass is defined as one trip across the entire Liner Subgrade surface.

H. CONTRACTOR shall test Liner Subgrade as specified herein:

1. One moisture density relationship test in accordance with ASTM D698 (Standard Proctor) shall be performed for every 10,000 cubic yards placed.

2. One in-place density test in accordance with ASTM D6938 shall be performed for every 20,000 square feet of surface area for each lift. Surface area shall be measured in the horizontal plane.

3. One soil classification in accordance with ASTM D2487 shall be performed for every 10,000 cubic yards placed.

4. Plasticity Index (PI) shall be included in the soil classification. One moisture-density relationship test in accordance with ASTM D698 (Standard Proctor) shall be performed any time a PI change greater than 10 is observed in the soil classification tests.

5. One hydraulic conductivity test by ASTM D5084 for every 10,000 cubic yards of Liner Subgrade. Each test shall be performed on a composite Liner Subgrade sample collected from the Liner Subgrade stockpile as approved by COMPANY. The composite sample shall be compacted to 90 percent maximum dry density as determined by ASTM D698 (Standard Proctor) prior to performing the hydraulic conductivity test.

I. After completion of the Liner Subgrade, but before beginning installation of the overlying materials, CONTRACTOR shall survey the finished elevations of the Liner Subgrade to ensure that the top of the Liner Subgrade is at the grades and elevations specified on the Drawings. There shall be a minimum of one survey point for every 10,000 square feet of Liner Subgrade surface area.

3.7 VEGETATIVE SOIL

A. Vegetative Soil shall not be placed until the underlying soil has been approved by the COMPANY.

B. Vegetative Soil shall be placed in one 12 inch lift without damaging the underlying soil. Vegetative Soil shall be tracked in and smoothed out using tracked equipment. No direct compactive effort shall be used on vegetative soil.

C. After completion of the Vegetative Soil layer, CONTRACTOR shall survey the finished elevations of the Vegetative Soil to ensure that the top of the vegetative soil is at the grades and elevations specified on the Drawings. There shall be a minimum of one survey point for every 5,000 square feet of Vegetative Soil surface area.

3.8 ROAD BASE

A. Road Base shall be placed on access ramps, on the top of the dike and as required by the COMPANY.

B. Geotextile shall be placed beneath all Road Base in accordance with Section 2430 of these specifications.

C. Road Base shall be placed and compacted in lifts, with a maximum loose lift thickness of 8 inches. Each fill lift shall be compacted using a minimum of four passes of the compactor. A pass is defined as one trip across the lift surface. There is no target maximum density requirement for road base.

D. After completion of the road base, but before beginning installation of the overlying materials, CONTRACTOR shall survey the finished elevations of the road base to ensure that the top of the road base is at the grades and elevations specified on the Drawings. There shall be a minimum of one survey point for every 5,000 square feet of road base surface area.

3.9 RIPRAP

A. Riprap shall be placed on geotextile conforming to the requirements of Section 02300 of these specifications. Place geotextile with the length running up and down the slope. Ensure geotextile has a minimum overlap of 2 feet at all seams.

B. Riprap shall be placed in such manner as to produce a well graded mass of rock with the minimum practicable percentage of voids, and shall be constructed within a tolerance of plus 4 inches or minus 2 inches from the lines and grades shown on the Drawings. Placement shall begin at the bottom of the area to be covered and continue up slope. Subsequent loads of material shall be placed against previously placed material in such a manner as to ensure a relatively homogenous mass. Open joints shall be filled with spalls or small rocks. Rocks shall be arranged to present a uniform finished top surface such that the variation between tops of adjacent rocks shall not exceed 3 inches.

C. No stone shall be dropped through air from a height greater than 3 feet on top of the geotextile. The larger stones shall be well distributed and the entire mass of stones in their final position shall be roughly graded to conform to the gradation specified in this specification. The finished riprap shall be free from objectionable pockets of small stones and clusters of larger stones. Placing riprap by dumping into chutes or by similar methods likely to cause segregation of the various sizes will not be permitted. Placing riprap by dumping it at the top of the slope and pushing it down the slope will not be permitted. Rearranging of individual stones will be required to the extent necessary to obtain a well-graded distribution of stone sizes as specified above.

++END OF SECTION++

SECTION 02310

CCR STABILIZATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section shall govern work associated with grading, excavation, supply, hauling, placement and compaction of bridging lift.

B. Work associated with the CCR stabilization shall also conform to Section 02300 – Earthwork of the Specifications.

1.2 MATERIALS INCLUDED IN THIS SECTION

A. Bottom ash used for bridging lift

B. Contractor-supplied material used for bridging lift

1.3 RELATED SECTIONS

A. Section 02300 Earthwork

B. Section 02320 Cap Subgrade

1.4 REFERENCES

A. Reference Standards for bridging lift shall be as referenced in Section 02300 – Earthwork

1.5 SUBMITTALS

A. Submittals for bridging lift shall be as specified in Section 02300 – Earthwork

PART 2 - PRODUCTS

2.1 COAL COMBUSTION RESIDUALS AS BRIDGING LIFT

A. OWNER will supply CCR or existing CCR suitable for beneficial re-use within the surface impoundment for general site grading and use as bridging lift.

B. OWNER will identify the location of CCR outside of the surface impoundment that may be used to supplement existing impounded materials. Contractor shall be responsible for loading, transporting, placement, and compaction of CCR used as bridging lift.

C. Bridging lift shall be free of roots, brush, sod, or other perishable materials and debris.

2.2 CONTRACTOR-SUPPLIED MATERIAL AS BRIDGING LIFT

A. Contractor-supplied bridging lift material shall be as specified herein.

B. CCR suitable for re-use of contractor-supplied bridging lift material shall be approved by the Engineer prior to delivery to the Site.

C. Contractor shall provide written Certification to Engineer that material to be supplied conforms to the requirements of this specification.

D. Bridging lift shall be clean fill material free of waste material (other than CCR approved for beneficial re-use), organic material, sticks, or other deleterious material.

E. Bridging lift may include crushed rock, broken rock, broken concrete and similar materials provided these materials do not exceed 30 percent (by weight) of the total material in the lift of which they are part.

F. Contractor-supplied material shall be soil class “SC”, “CL” or “CH” according to ASTM D2487 and shall conform to the following:

1. No material larger than 3-inch diameter.
2. Plasticity Index (PI) greater than or equal to 7.
3. Particle size distribution shall conform to the following:

U.S. Sieve Size	Percent Passing
No. 4	80-95
No. 40	55-75
No. 200	Greater than 50

PART 3 – EXECUTION

3.1 GENERAL

A. Compaction of all materials shall be performed with an appropriately heavy, properly ballasted penetrating foot compactor. A minimum of four passes of the compactor shall be performed on each material lift. A pass is defined as one trip of the compactor over the lift and back to the starting point by a single drum roller or one trip across the lift surface from one side to the other if the compacting equipment has front and back compacting rollers.

B. The minimum weight of the compacting equipment shall be 1,500 pounds per linear foot of drum length.

C. The daily work area shall extend a distance no greater than necessary to maintain moist conditions and continuous operations. Desiccation and crusting of the lift surface shall be avoided as much as possible.

D. Water added to soils shall be clean and shall not have come into contact with waste or any objectionable material.

3.2 CONSTRUCTION OF BRIDGING LIFT

A. All existing vegetation on areas to be capped or regraded shall be stripped or otherwise removed prior to placing bridging lift or regrading. Contractor shall be responsible for disposal of all debris resulting from vegetation removal in accordance with applicable laws and regulations.

B. After existing vegetation has been removed, material underlying the bridging lift shall be graded to ± 1% slope prior to placement of bridging lift. Areas that only require regrading may not require compaction provided that such areas meet the requirements of Subsection 3.2.C of this Specification.

C. Bridging lift underlying the cap subgrade shall conform to the following:

1. Bridging lift shall be placed in three compacted lifts. The first lift shall be 12” and consist of bottom ash and/or select fill. The remaining two lifts shall each be 6” each and consist of select fill material. A minimum of four passes of the compacting equipment shall be required for each lift.

2. After the final lift has been placed and compacted to the required elevations, the bridging lift shall be proof rolled using the methods specified herein or other method approved by the Engineer:

   a. Proof rolling equipment shall consist of not less than four pneumatic tired wheels, arranged so that the wheels carry approximately equal loads when operating on uneven surfaces. Proof rolling equipment may be self-propelled or towed by a suitable tractor.

   b. Proof rolling equipment shall have a rolling width of 8 to 10 feet and shall be capable of operating under various contact pressures.

   c. Contact pressure of proof rolling equipment shall be a minimum of 2,000 pounds per square foot.

   d. A minimum of two passes with proof rolling equipment shall be completed across the entire prepared bridging lift surface.

3. Any area of the bridging lift shown to be unstable or non-uniform after proof rolling shall be recompacted and/or reworked until proof rolled to the satisfaction of the ENGINEER.

D. Finished lifts of bridging lift shall be sprayed with clean water as necessary to prevent drying and desiccation.

E. At the end of each construction day's activities, completed lifts shall be sealed by rolling with a rubber-tired or smooth drum roller. Prior to resuming placement of material the surface of the bridging lift shall be scarified to a minimum depth of 2 inches.

F. After completion of the bridging lift, but before beginning installation of the overlying cap subgrade, Contractor shall survey the finished elevations of the bridging lift to ensure that the top of the bridging lift is at the specified grades and elevations presented in the Conceptual Closure Plan. There shall be a minimum of one survey point for every 10,000 square feet of cap surface area.

++END OF SECTION++

SECTION 02320

CAP SUBGRADE

PART 1 - GENERAL

1.1 DESCRIPTION

C. This section shall govern work associated with grading, excavation, supply, hauling, placement and compaction of cap subgrade material.

D. Work associated with the cap subgrade shall also conform to Section 02300 – Earthwork of the Specifications.

1.2 MATERIALS INCLUDED IN THIS SECTION

C. Existing Coal Combustion By-Products used as cap subgrade

D. Contractor-supplied material used as cap subgrade

1.3 RELATED SECTIONS

C. Section 02300 Earthwork

D. Section 02330 Clay Cap

1.4 REFERENCES

G. Reference Standards for cap subgrade shall be as referenced in Section 02300 – Earthwork

1.5 SUBMITTALS

A. Submittals for cap subgrade shall be as specified in Section 02300 – Earthwork

PART 2 - PRODUCTS

2.1 COAL COMBUSTION BY-PRODUCTS AS CAP SUBGRADE

A. OWNER will supply CCBs or existing CCBs within the landfill may be re-graded for use as cap subgrade.

B. OWNER will identify the location of CCBs outside of the landfill that may be used to supplement existing landfilled materials. Contractor shall be responsible for loading, transporting, placement, and compaction of CCBs used as cap subgrade.

C. Cap subgrade shall be free of roots, brush, sod, or other perishable materials and debris.

2.2 CONTRACTOR-SUPPLIED MATERIAL AS CAP SUBGRADE

A. Contractor-supplied cap subgrade material shall be as specified herein.

B. Cap subgrade material shall be approved by the Engineer prior to delivery to the Site.

C. Contractor shall provide written Certification to Engineer that material to be supplied conforms to the requirements of this specification.

D. Cap subgrade shall be clean fill material free of waste material, organic material, sticks, or other deleterious material.

E. Cap subgrade may include crushed rock, broken rock, broken concrete and similar materials provided these materials do not exceed 30 percent (by weight) of the total material in the cap subgrade lift of which they are part.

F. Contractor-supplied cap subgrade shall be soil class “CL” or “CH” according to ASTM D2487 and shall conform to the following:

1. No material larger than 3-inch diameter.
2. Plasticity Index (PI) greater than or equal to 7.
3. Particle size distribution shall conform to the following:

U.S. Sieve Size	Percent Passing
No. 4	80-95
No. 40	55-75
No. 200	Greater than 50

PART 3 – EXECUTION

3.1 GENERAL

A. Compaction of all materials shall be performed with an appropriately heavy, properly ballasted penetrating foot compactor. A minimum of four passes of the compactor shall be performed on each material lift. A pass is defined as one trip of the compactor over the lift and back to the starting point by a single drum roller or one trip across the lift surface from one side to the other if the compacting equipment has front and back compacting rollers.

B. The minimum weight of the compacting equipment shall be 1,500 pounds per linear foot of drum length.

C. The daily work area shall extend a distance no greater than necessary to maintain moist conditions and continuous operations. Desiccation and crusting of the lift surface shall be avoided as much as possible.

D. Water added to soils shall be clean and shall not have come into contact with waste or any objectionable material.

3.2 CONSTRUCTION OF CAP SUBGRADE

A. All existing vegetation on areas to be capped or regraded shall be stripped or otherwise removed prior to placing cap subgrade or regarding. Contractor shall be responsible for disposal of all debris resulting from vegetation removal in accordance with applicable laws and regulations.

H. After existing vegetation has been removed, material underlying the cap subgrade shall be scarified to a minimum depth of 2-inches prior to placement of cap subgrade. Areas that only require regarding may not require scarifiying and compaction provided that such areas meet that are regarded to meet the requirements of Subsection 3.2.C of this Specification.

I. Cap subgrade underlying the clay cap shall conform to the following:

4. Cap subgrade shall be placed in compacted lifts. Maximum loose lift thickness shall be 12 inches and a minimum of four passes of the compacting equipment shall be required for each lift.

5. After the final lift has been placed and compacted to the required elevations, the cap subgrade shall be proof rolled using the methods specified herein or other method approved by the Engineer:

    a. Proof rolling equipment shall consist of not less than four pneumatic tired wheels, arranged so that the wheels carry approximately equal loads when operating on uneven surfaces. Proof rolling equipment may be self-propelled or towed by a suitable tractor.

    b. Proof rolling equipment shall have a rolling width of 8 to 10 feet and shall be capable of operating under various contact pressures.

    c. Contact pressure of proof rolling equipment shall be a minimum of 2,000 pounds per square foot.

    d. A minimum of two passes with proof rolling equipment shall be completed across the entire prepared cap subgrade surface.

6. Any area of the cap subgrade shown to be unstable or non-uniform after proof rolling shall be recompacted and/or reworked until proof rolled to the satisfaction of the ENGINEER.

J. Finished lifts of cap subgrade shall be sprayed with clean water as necessary to prevent drying and desiccation.

K. At the end of each construction day's activities, completed lifts shall be sealed by rolling with a rubber-tired or smooth drum roller. Prior to resuming placement of material the surface of the cap subgrade shall be scarified to a minimum depth of 2 inches.

L. After completion of the cap subgrade, but before beginning installation of the overlying clay cap, Contractor shall survey the finished elevations of the cap subgrade to ensure that the top of the cap subgrade is at the specified grades and elevations presented in the Conceptual Closure Plan. There shall be a minimum of one survey point for every 10,000 square feet of cap surface area.

++END OF SECTION++

SECTION 02330

CLAY CAP

PART 1 - GENERAL

3.3 DESCRIPTION

A. This section shall govern work associated with grading, excavation, supply, hauling, placement and compaction of the clay cap material.

B. Work associated with the cap subgrade shall also conform to Section 02300 – Earthwork of the Specifications.

3.4 MATERIALS INCLUDED IN THIS SECTION

A. OWNER-supplied material used as clay cap

B. Contractor-supplied material used as cap subgrade

3.5 RELATED SECTIONS

A. Section 02300 Earthwork

B. Section 02330 Clay Cap

3.6 REFERENCES

A. Reference Standards for cap subgrade shall be as referenced in Section 02300 – Earthwork

1.5 SUBMITTALS

A. Submittals for cap subgrade shall be as specified in Section 02300 – Earthwork

PART 2 - PRODUCTS

2.1 COAL COMBUSTION BY-PRODUCTS AS CAP SUBGRADE

A. OWNER may identify a suitable on-site borrow area for supplying clay cap material.

B. OWNER will identify the location of suitable material that may be used as clay cap. Contractor shall be responsible for loading, transporting, placement, and compaction of material used as the clay cap.

C. Clay cap material shall be free of roots, brush, sod, or other perishable materials and debris.

2.2 CONTRACTOR-SUPPLIED MATERIAL AS CLAY CAP

A. Contractor-supplied clay cap material shall be as specified herein.

B. Cap material shall be approved by the Engineer prior to delivery to the Site.

C. Contractor shall provide written Certification to Engineer that material to be supplied conforms to the requirements of this specification.

D. Clay cap shall be clean fill material free of waste material, organic material, sticks, or other

deleterious material.

E. Contractor-supplied clay cap shall be soil class “CL” or “CH” according to ASTM D2487 and shall conform to the following:

1. No material larger than 3-inch diameter.

2. Plasticity Index (PI) greater than or equal to 15.

3. In-place permeability by ASTM D5084 no greater than $1x10^{-7}$ cm/sec

4. All material retained on the No. 4 Sieve shall be subrounded to rounded.

5. Particle size distribution shall conform to the following:

U.S. Sieve Size	Percent Passing
No. 4	80-95
No. 40	55-75
No. 200	Greater than 50

PART 3 – EXECUTION

3.1 GENERAL

A. Compaction of all materials shall be performed with an appropriately heavy, properly ballasted penetrating foot compactor. A minimum of four passes of the compactor shall be performed on each material lift. A pass is defined as one trip of the compactor over the lift and back to the starting point by a single drum roller or one trip across the lift surface from one side to the other if the compacting equipment has front and back compacting rollers.

B. The minimum weight of the compacting equipment shall be 1,500 pounds per linear foot of drum length.

C. The daily work area shall extend a distance no greater than necessary to maintain moist conditions and continuous operations. Desiccation and crusting of the lift surface shall be avoided as much as possible.

D. Water added to soils shall be clean and shall not have come into contact with waste or any objectionable material.

3.2 CONSTRUCTION OF CAP SUBGRADE

A. Clay cap shall be placed and compacted with a maximum loose lift thickness of 8 inches and a maximum compacted lift thickness of 6 inches.

B. The clay cap shall be compacted as necessary to achieve an in-place permeability of no greater than $1x10^{-7}$ cm/second. At a minimum, four passes of the compacting equipment shall be required for each lift.

G. Contractor shall test the clay cap as specified herein:

1. Two soil classifications in accordance with ASTM D2487 shall be performed for each lift.

2. One in-place density test in accordance with ASTM D2922 shall be performed for every 20,000 square feet of cap subgrade placed for each 12 inches of compacted thickness.

3. One permeability test in accordance with ASTM D5084 shall be performed for every 4 acres of cap subgrade placed for each 12 inches of compacted thickness.

H. Finished lifts of cap subgrade shall be sprayed with clean water as necessary to prevent drying and desiccation.

I. At the end of each construction day's activities, completed lifts shall be sealed by rolling with a rubber-tired or smooth drum roller. Prior to resuming placement of material the surface of the cap subgrade shall be scarified to a minimum depth of 2 inches.

J. After completion of the cap subgrade, but before beginning installation of the overlying clay cap, Contractor shall survey the finished elevations of the cap subgrade to ensure that the top of the cap subgrade is at the specified grades and elevations presented in the Conceptual Closure Plan. There shall be a minimum of one survey point for every 10,000 square feet of cap surface area.

++END OF SECTION++

SECTION 02340

VEGETATIVE SOIL LAYER

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section shall govern work associated with grading, excavation, supply, hauling, placement and compaction of the vegetative soil material.

B. Work associated with the vegetative soil layer shall also conform to Section 02300 – Earthwork of the Specifications.

1.2 MATERIALS INCLUDED IN THIS SECTION

A. OWNER-supplied material used as vegetative soil

B. Contractor-supplied material used as vegetative soil

1.3 RELATED SECTIONS

A. Section 02300 Earthwork

B. Section 02330 Clay Cap

C. Vegetation

1.4 REFERENCES

A. Reference Standards for vegetative soil layer shall be as referenced in Section 02300 – Earthwork

1.5 SUBMITTALS

A. Submittals for cap subgrade shall be as specified in Section 02300 – Earthwork

PART 2 - PRODUCTS

2.1 OWNER-SUPPLIED MATERIAL AS VEGETATIVE SOIL LAYER

A. OWNER will supply Contractor with material for use as vegetative soil layer.

B. OWNER will identify the location of material for Contractor. Contractor shall be responsible for loading, transporting, placement, and compaction of material used as the vegetative soil layer.

2.2 CONTRACTOR-SUPPLIED MATERIAL AS VEGETATIVE SOIL LAYER

A. Vegetative soil layer shall be a clay loam or silty clay loam as classified by the United States Department of Agriculture and shall comply with all of the following:

1. Free of deleterious material, materials toxic to plant growth, noxious weed seeds, rhizomes, roots, subsoil, rocks, or other debris.
2. Maximum sodium adsorption ration (SAR): 8
3. Maximum electrical conductivity (EC): 2 mmhos/cm

4. Maximum particle dimension: 2 inches.
5. The pH shall be between 6.0 and 8.5 standard units. If approved by the Engineer, Contractor may amend soil as necessary to achieve the specified pH.

PART 3 - EXECUTION

3.1 VEGETATIVE SOIL LAYER PLACEMENT

A. Vegetative Soil shall not be placed until the underlying soil has been approved by the ENGINEER.

B. Vegetative Soil shall be placed in one 18 inch lift without damaging the underlying soil. Vegetative Soil shall be tracked in and smoothed out using tracked equipment. No direct compactive effort shall be used on vegetative soil.

C. After completion of the Vegetative Soil layer, CONTRACTOR shall survey the finished elevations of the Vegetative Soil to ensure that the top of the protective soil is at the grades and elevations specified on the Drawings. There shall be a minimum of one survey point for every 10,000 square feet of Vegetative Soil surface area.

++END OF SECTION++

SECTION 02350

VEGETATION

PART 1 – GENERAL

1.1 SUMMARY

A. This Section describes the requirements for vegetation establishment in areas disturbed during construction activities.

1.2 SUBMITTALS

A. CONTRACTOR shall submit information regarding proposed seed, fertilizer, mulch, tackifier and any other materials to be used to establish vegetation at least 10 days prior to delivery.

PART 2 – PRODUCTS

2.1 SEED SUPPLIERS

A. Seed suppliers must provide labeling of variety, purity, and germination. The supplier must satisfy State of Texas seed quality laws. The COMPANY must approve seed supplier.

2.2 SEED DELIVERY, STORAGE, AND HANDLING

A. Grass seed mixture shall be delivered in sealed containers. Seed in damaged packaging will not be accepted. CONTRACTOR shall provide seed mixture in containers showing the percentage of each species in the seed mix, year of production, net weight, date of packaging, name and address of supplier, percent of weed seed content, and guaranteed percentage of purity and germination.

B. Fertilizer shall be delivered in appropriate waterproof containers showing weight, chemical analysis, and name of manufacturer.

2.3 SEED MIXTURE

A. Seed mixture shall be appropriate for the season in which it is planted and shall be approved by the COMPANY prior to placement.

B. Seed shall be hulled, extra-fine grade, treated with fungicide, and shall have a germination and purity that will produce, after allowance for Federal Seed Act tolerances, a pure live seed (PLS) content of not less than 85 percent. Seed shall be labeled in accordance with U.S. Department of Agriculture rules and regulations.

C. Unless otherwise approved by the COMPANY, vegetation seed mixture shall consist of the following grasses at the application rates specified:

Grass Species	Application Rate (pounds PLS per acre)
Gulf Rye	30
Common Bermudagrass	20
Total:	50

D. Alternative seed mixtures may be submitted in writing to the COMPANY and must be approved by the COMPANY prior to seed application.

2.4 ACCESSORIES

A. Mulching materials shall consist of dry oat, wheat, or Bermuda straw, free from weeds and foreign matter detrimental to plant life. Native hay or chopped cornstalks are acceptable. Also acceptable is approved chip-form wood cellulose fiber that is free of ingredients that could inhibit growth or germination.

B. Compost, if used as an organic admixture, shall be applied per TXDOT Special Specification; Item 1027 "Furnishing and Placing Compost." Compost application is optional and subject to the approval of the COMPANY, which must be obtained at least 10 days prior to use.

C. Fertilizer shall be applied to vegetative soil layer material and shall be inorganic chemical fertilizer consisting of 20-5-5 fertilizer applied at 200 pounds per acre.

D. Stakes shall be softwood lumber, chisel pointed.

E. Water shall be from fresh water sources and shall be free from soil, acids, alkalis, salt, or any other substance injurious to growth of grass.

PART 3 – EXECUTION

3.1 INSPECTION OF VEGETATIVE SOIL

A. CONTRACTOR shall verify that vegetative soil and areas disturbed during construction activities are ready to receive the work covered by this section.

3.2 FERTILIZER

A. All fertilizer shall be applied in accordance with manufacturer's instructions.

B. Manure, if used, may be applied at a rate of up to 10 tons/acre. Manure application is optional subject to the approval of the COMPANY, which must be obtained at least 10 days prior to use.

C. Pre-planting fertilizer shall be mixed thoroughly into the upper 3 in. of vegetative-soil layer prior to applying seed.

3.3 SEEDING

A. Drill seed application is acceptable for slopes equal to or flatter than 4(H):1(V).

B. Seed shall be applied evenly by broadcast or hydroseed application at the rate specified in this Section. Adjustment to rate shall be made for variations in seed purity and germination to achieve the PLS equivalent rate. Hydroseeding is acceptable as a broadcast method of seeding and fertilizing. If dry broadcasting is done, seeds must be raked into the upper soil surface and seed must be applied at half of the specified broadcast rate. Designated areas for erosion control may not be seeded in excess of that which can be covered with erosion control material on the same day.

C. CONTRACTOR shall not sow immediately following rain, when ground is too dry, or during windy periods.

3.4 SEED PROTECTION/EROSION CONTROL

A. Straw/hay mulch shall be applied to all seeded areas, with slopes less than 4(H) to 1(V), within 24 hours after seeding operations. Straw or hay mulch shall be applied at a rate of approximately 150 pounds per 1000 square feet (6,500 pounds per acre) and crimped in place. Cellulose fiber

mulch shall be applied at a rate of approximately 75 pounds per 1,000 square feet (3,200 pounds per acre).

B. Seeded sloped areas shall be covered with erosion control fabric on all exterior slopes of 4(H) to I(V) and steeper; and in all drainage channels and swales in accordance with Section 1100, "Erosion and Sedimentation Control."

3.5 IRRIGATION

A. CONTRACTOR shall irrigate seeded areas if and as necessary to comply with the Uniform Grass Coverage (UGC) requirements of this Section.

B. Irrigation may be performed by water truck or by temporary irrigation system. If a temporary irrigation system is used, CONTRACTOR shall remove temporary irrigation system once COMPANY has accepted vegetated areas.

C. Irrigation shall be performed for a minimum of thirty days after initial planting and for as long as necessary to establish UGC across the entire seeded area.

3.6 ESTABLISHMENT AND ACCEPTANCE OF PERMANENT VEGETATION

A. It shall be solely the CONTRACTOR's responsibility to establish UGC across all application areas, regardless of unseasonable climatic conditions or other adverse conditions affecting planting operations and growth of vegetation.

B. Uniform Grass Coverage (UGC) shall be defined as a uniform stand of the specified grass with not less than 12 growing plants per square foot of seeded areas.

C. COMPANY will consider application areas acceptable only when:

1. A statistically significant number of randomly sampled plots have an average of 12 growing plants per square foot.
2. A minimum of one mowing has been performed in the seeded areas.
3. UGC has been deemed to have been achieved by the COMPANY.

D. Any application areas, which are not determined to be acceptable by the COMPANY, shall be replanted, refertilized, and reirrigated at no additional cost to the COMPANY.

E. The life and satisfactory condition of all plants (including grass) shall be guaranteed by CONTRACTOR for a period of up to one calendar year after written notice of first acceptance of vegetation by COMPANY. The guarantee period shall include one complete growing season and dormant period.

++END OF SECTION++

SECTION 02420

FLEXIBLE MEMBRANE LINER

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section shall govern work associated with furnishing and installing Flexible Membrane Liner, including, but not limited to, layout, placement, seaming, patching and testing.

1.2 REFERENCES

A. American Society of Testing Materials (ASTM) Standards/Publications (Latest version):

D 638	Standard Test Method for Tensile Properties of Plastics
D 1004	Test Method for Initial Tear Resistance of Plastic or Film Sheeting
D 1238	Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
D 1505	Test Method for Density of Plastics by the Density-Gradient Technique
D 1603	Test Method for Carbon Black in Olefin Plastics
D 2216	Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-aggregate Mixtures
D 3895	Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
D 4354	Standard Practice for Sampling of Geosynthetics for Testing
D 4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
D 4643	Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method
D 4759	Standard of Practice for Determining the Specification Conformance of Geosynthetics
D 4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Other Related Products.
D 5084	Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
D 5199	Measuring Nominal Thickness of Geotextiles and Geomembranes
D 5261	Standard Test Method for Measuring Mass Per Unit Area of Geotextiles
D 5321	Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
D 5397	Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test

D 5596	Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
D 5641	Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
D 5820	Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
D 5887	Test Method for Measurement of Index Flux through Saturated Geosynthetic Clay Liner Using Flexible Wall Permeameter
D 5888	Identification, Storage, and Handling of Geosynthetic Clay Liners
D 5889	Standard Practice for Quality Control of Geosynthetic Clay Liners
D 5890	Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
D 5891	Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners
D 5993	Standard Test Method for Measuring Mass Per Unit Area of Geosynthetic Clay Liners
D 5994	Standard Test Method for Measuring Core Thickness of Textured Geomembranes
D 6102	Standard Guide for Installation of Geosynthetic Clay Liners
D 6243	Standard Test Method for Determining the Coefficient of Soil and GCL or Geosynthetic and GCL Friction by the Direct Shear Method
D 6392	Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
D 6496	Standard Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners
D 6693	Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
D 6768	Standard Test Method for Tensile Strength of Geosynthetic Clay Liners
E 96	Standard Test Methods for Water Vapor Transmission of Materials

B. Geosynthetic Research Institute (GRI)

GM 17	Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes

1.3 DEFINITIONS

A. Flexible Membrane Liner (FML) - An essentially impermeable flexible geomembrane liner of linear low density polyethylene (LLDPE).

B. INSTALLER -Party responsible for liner installation, including handling, transporting, storing, deploying, protecting, sampling, patching damaged liner and temporary restraining against wind and thermal/solar expansion.

C. Lot - Group of consecutively numbered rolls from the same manufacturing line.

D. MANUFACTURER - Party responsible for the production and quality of the liner.

E. Overlap - The width of material of a liner panel in contact with an adjacent liner panel. The overlap distance is measured perpendicular from the overlying edge of one panel to the underlying edge of the other.

1.4 SUBMITTALS

A. CONTRACTOR shall submit the following product information at least 10 days prior to delivery:

1. FML: Certification stating that the FML meets the product requirements of this specification and copies of quality control tests performed by MANUFACTURER.

B. CONTRACTOR shall submit the name of the INSTALLER at least 3 weeks prior to installation, including resume of installation supervisor to be assigned to the project and a list of FML projects completed by INSTALLER.

C. CONTRACTOR shall submit a Quality Control Plan and Installation Procedures at least 3 weeks prior to installation. The information shall include a list of quality control tests performed and typical testing frequencies, recommended installation procedures, and panel layout drawing identifying panels and overlaps.

D. CONTRACTOR shall submit the following upon completion of the FML installation:

1. Certification from the INSTALLER stating that the FML has been installed in accordance with the Drawings and Specifications.

2. As-built record drawings showing instrument surveyed locations of all panels, seams, repairs, patches and test samples.

3. Test reports verifying that the FML has been installed in accordance with the specified requirements.

4. Test reports verifying completion of all field seams and repairs are in accord with specified requirements.

1.5 QUALIFICATIONS

A. INSTALLER must have experience installing FML liners on at least 5 projects of each liner type and have installed a minimum of 2,000,000 square feet of each liner type.

B. INSTALLER shall provide a minimum of one Master Seamer (minimum 1,000,000 square feet using the type of seaming apparatus proposed for this project) for work on the project.

C. MANUFACTURER may serve as the INSTALLER or may use an outside INSTALLER that has been approved and certified by MANUFACTURER.

1.6 QUALITY CONTROL

A. CONTRACTOR is responsible for the overall quality of the installed FML. CONTRACTOR shall maintain quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

B. CONTRACTOR shall perform construction surveys, as needed, to ensure that the location and grades of all liner installations are in accordance with the design requirements.

C. ENGINEER may perform periodic quality assurance monitoring above and beyond that specified herein. CONTRACTOR shall cooperate, as required, in quality assurance monitoring.

1.8 WARRANTY

A. FML material shall be warranted by the MANUFACTURER on a pro-rata basis against defects for a period of 5 years from the date of acceptance by the COMPANY.

B. FML installation shall be warranted by the INSTALLER against defects in workmanship for a period of 1 year from the date of acceptance by the COMPANY.

PART 2 - PRODUCTS

2.1 FML PRODUCT STANDARD

A. FML shall be Type “UltraFlex” as manufactured by GSE Environmental, Inc. (GSE) of Houston, Texas; or ENGINEER-approved equivalent. The FML shall be a black, coextruded geomembrane.

B. Smooth FML shall be installed on flat surfaces and slopes less than 4(H) to I(V). Textured FML shall be installed on slopes 4(H) to I(V) and steeper.

C. FML Material Properties

1. FML shall be 40 mil thick linear low density polyethylene (LLDPE) and shall comply with the following:

Property	ASTM Method	Frequency	Unit	Minimum Average Values
Thickness	D5994	Every Roll	mil	40
Density	D1505	200,000 lbs	g/cm^3	0.94
Tensile Break Strength (smooth/textured)	D6693	20,000 lbs	lb/in	152/60
Elongation at Break (smooth/textured)	D6693	20,000 lbs	%	800/250
Tear Resistance	D1004	45,000 lbs	lb	22
Puncture Resistance (smooth/textured)	D4833	45,000 lbs	lb	56/44
Carbon Black Content	D1603	20,000 lbs	%	2.0 – 3.0
Notch Constant Tensile Load	D5397	200,000 lbs	hr	300
Oxidative Induction Time	D3895	200,000 lbs	min	>100

D. FML Extrudate Rod or Bead shall conform to the following:

1. Extrudate material shall be made from same type resin as the FML.
2. Additives shall be thoroughly dispersed.
3. Materials shall be free of contamination by moisture or foreign matter.

E. FML Welding/Seaming Equipment shall meet the following requirements:

1. Gauges showing temperatures in apparatus (extrusion welder) or wedge (wedge welder) shall be present.
2. An adequate number of welding apparati shall be available to avoid delaying work.
3. Power source must be capable of providing constant voltage under combined line load.

2.2 FML PACKING AND LABELING

A. FML shall be wrapped around a structurally sound core than can support the weight of the liner. Liners shall be supplied in rolls wrapped in relatively impermeable and opaque protective covers and marked or tagged with the following information:

1. MANUFACTURER's name
2. product identification
3. lot or batch number
4. roll number
5. roll dimensions

2.3 FML MANUFACTURING QUALITY CONTROL

A. FML shall be subjected to quality control and conformance testing to assure that the materials provided meet the specified requirements. Where possible, sampling shall be performed on sacrificial portions of the material to minimize repair of sampled locations.

B. All materials shall be tested in accordance with MANUFACTURER's quality control program and as specified herein. The MANUFACTURER shall perform the testing. Samples not satisfying the requirements of these specifications shall result in the rejection of the applicable rolls. At CONTRACTOR's expense, additional testing of individual rolls may be performed to more closely identify the non-complying rolls and/or to qualify individual rolls.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE and HANDLING

A. Deliver material to the job site only after ENGINEER/COMPANY accepts required submittals.

B. Comply with MANUFACTURER'S recommendations regarding product protection. Maintain product clean and free of damage.

C. Liner shall be covered with a waterproof, tight-fitting plastic protective covering resistant to ultraviolet degradation. Damage to protective covering shall be repaired immediately. Repairs shall be such that the liner is protected from moisture or other deleterious conditions.

D. Deliver product to the job site in MANUFACTURER's original packaging, with labels intact and legible. Maintain packaged materials with seals unbroken and labels intact until time of use. Promptly remove damaged or unsuitable products from the job site and promptly replace with products meeting the required specifications.

E. Comply with MANUFACTURER's recommendations when hauling, unloading, deploying, and installing liner. Do not fold liner. Inspect for defects before installing.

3.2 FML DEPLOYMENT

A. MANUFACTURER shall verify to the ENGINEER that the materials upon which the FML will be installed are acceptable prior to initiating FML deployment.

B. Assign each panel a simple and logical identifying code. The coding system shall be subject to approval by the ENGINEER and shall be determined at the job site.

C. Visually inspect the FML during deployment for imperfections and mark faulty or suspect areas.

D. Deployment of FML panels shall be performed in a manner that will comply with the following guidelines:

1. Unroll FML using methods that will not damage FML and will protect underlying surface from damage (spreader bar, protected equipment bucket).

2. Place ballast (commonly sandbags) on FML which will not damage FML to prevent wind uplift.

3. Personnel walking on FML shall not engage in activities or wear shoes that could damage it. Smoking will not be permitted on the FML.

4. Do not allow heavy vehicular traffic directly on FML. Rubber-tired ATV's and trucks are acceptable if wheel contact is less than 6 psi.

5. Protect FML in areas of heavy traffic by placing protective cover over the FML.

E. Sufficient material (slack) shall be provided to allow for thermal expansion and contraction of the material.

F. During installation avoid bridging, stresses in the FML, wrinkles and folds.

G. Schedule FML deployment so deployment, welding and covering occur within as narrow a temperature range as possible. Do not deploy in the presence of excessive moisture, precipitation, ponded water or high winds.

H. Deploy panels to minimize field seams in corners, odd-shaped geometric locations and outside corners.

I. Shingle panels on slopes and grades so upgradient panel is on top.

J. Unroll only those factory-packaged sections which are to be anchored or seamed together in one day.

K. After panels are initially in place, remove as many wrinkles as possible. Unroll several panels and allow the liner to "relax" before beginning field seaming. The purpose of this is to make the edges which are to be bonded as smooth and free of wrinkles as possible.

L. Once panels are in-place and smooth, commence field seaming operations.

M. Personnel working on the FML shall not smoke, wear damaging shoes or engage in any activity which damages the FML.

N. Anchor trenches shall be constructed as shown on the Drawings. Round edges of anchor trenches or cushion with geotextile. The anchor trench shall be excavated, backfilled and compacted in accordance with MANUFACTURER's recommendations. Care should be taken when backfilling the trench to prevent any damage to the FML.

O. Damaged and sample coupon areas of FML shall be repaired by the CONTRACTOR before leaving the site at the end of each day. Any damage to subgrade while coupons are open is the responsibility of the CONTRACTOR. Repaired areas will be tested for seam integrity by the CONTRACTOR. Damaged materials are the property of the CONTRACTOR and will be removed from the site at the CONTRACTOR's expense. The CONTRACTOR will retain all ownership and responsibility for the FML until acceptance by the COMPANY.

3.3 FML SEAMING

A. Provide at least one Master Seamer who shall provide direct supervision over other welders as necessary.

B. Use a sequential seam numbering system compatible with panel numbering system that is acceptable to the ENGINEER and INSTALLER.

C. Seaming may be extrusion or wedge welding or a combination of these methods. Solvent welding is not acceptable. ENGINEER reserves the right to reject any proposed seaming method.

   1. Extrusion Welding. Extrusion welding applies a molten bead of material to preheated sheets of FML which are then joined by pressure. Prior to extrusion welding:

      a. Hot-air tack adjacent pieces together using procedures that do not damage the FML.
      b. Clean FML surfaces by disc grinder or equivalent.
      c. Purge welding apparatus of heat-degraded extrudate before welding.

   2. Wedge Welding. The wedge welding process heats the FML area to be joined to the melting point and then applies pressure to join the melted surfaces. Wedge welding apparatus shall be a self-propelled device equipped with an electronic controller which displays applicable temperatures.

D. Seaming shall be performed in accordance with the following:

   1. All foreign matter (dirt, water, oil, etc) shall be removed from the area to be bonded. No solvents shall be used to clean the FML.

   2. It is imperative to keep surface water runoff from beneath the FML at all times during installation. The CONTRACTOR's panel placement, seam welding technique and welding schedule shall minimize or eliminate the accumulation of water beneath the FML. Any water found ponded beneath the FML after the FML has been installed shall be removed by the CONTRACTOR at no cost to the COMPANY. Subgrade beneath FML that has become excessively moist, soft or unsuitable to perform its intended function shall be replaced at no cost to the COMPANY.

   3. As much as practical, field seaming shall start in the middle and work toward an open end in order to minimize cutting and patching of large wrinkles that become trapped. When seaming the side slopes, seaming should start at the toe of the slope and work up the slope. Tack welds, if used, shall use heat only; no double-sided tape, glue or other method will be permitted. The FML should be seamed completely to the ends of all panels to minimize the potential of tear propagation along the seam. Seaming of the bottom membrane to the sidewall membrane shall be conducted when conditions minimize thermal expansion effects. The completed liner shall not exhibit "trampolining" and shall be in full contact with the underlying materials.

   4. FML sheets to be joined shall be overlapped at least 6-inches after the necessary aligning and cutting, unless otherwise shown on the Contract Drawings.

   5. In corners and odd shaped geometric locations, the number of field seams should be minimized.

   6. No seaming should be attempted above 40 degrees C (104 degrees F) ambient air temperature. Below 5 degrees C (41 degrees F) ambient air temperature, preheating of the FML may be required. It shall be the responsibility of the CONTRACTOR to demonstrate that conditions are favorable for seaming by acceptable test (start-up) seams which duplicate, as closely as possible, actual field conditions. Preheating may be achieved by natural and/or artificial means (shelters and heating devices).

7. A moveable protective layer of plastic may be required, as recommended by the ENGINEER, to be placed directly below each overlap of FML that is to be seamed. This is to prevent any moisture build-up between the sheets to be welded.

8. Seaming will extend to the outside edge of panels to be placed in anchor trenches.

9. If required, a firm substratum should be provided by using a flat board, a conveyor belt, or similar hard surface directly under the seam overlap to achieve proper support.

10. No folds, wrinkles or "fish-mouths" shall be allowed within the seam area. Where wrinkles or folds occur, the material shall be cut, overlapped and an extrusion-weld shall be applied. All welds on completion of the work shall be tightly bonded and sealed. Do not cover FML at locations that have been repaired until test results with passing values are available.

11. After seaming is complete in a given area, FML edges in the anchor trench should be buried. Do not bury the FML edge in the anchor trench within 30 feet of an incomplete or unbounded field seam.

12. At the end of each day or installation segment, all unseamed edges shall be anchored by sand bags or other approved device. Sand bags shall weigh approximately 20 pounds and shall be placed no further apart than 20 foot spacing along the open end of the FML. Sand bags securing the FML on the side slopes should be connected by a rope fastened at the top of the slope by a temporary anchor. If high winds are expected, boards along the edge of unseamed panels, with weighted sand bags on top, should be used to anchor the FML on the bottom of the cell. Sand bags fastened by rope should be used to secure unseamed edges on the side slopes. Staples, U-shaped rods or other penetrating anchors shall not be used to secure the FML. The temporary anchoring of the FML is the responsibility of the CONTRACTOR. Any material damaged as the result of weather effects, shall be repaired or replaced at no cost to the COMPANY.

3.4 FML TESTING

A. General

1. CONTRACTOR shall employ a Geosynthetic Quality Assurance Laboratory to conduct all laboratory testing required by these Specifications.

2. Samples of the field seams shall be taken and tested in accordance with ASTM D638 to ensure that tensile strength at yield and break, elongation at yield and break meet the minimum specifications. A quality control certificate shall be issued with the material.

3. The CONTRACTOR shall employ on-site physical non-destructive testing on all welds.

4. A quality control technician shall inspect each sheet and seam. Any area showing a defect shall be marked and repaired in accordance with the FML repair procedures presented in these Specifications.

B. Trial Weld Testing. Trial weld testing shall be performed to verify welding equipment is operating properly. Trial weld testing shall be made each day prior to commencing field seaming and no welding equipment or welder shall be allowed to perform production welds until equipment and welders have successfully completed a trial weld test. Trial weld testing shall be completed in accordance with the following:

1. Make trial welds under the same surface and environmental conditions as the production welds, i.e., in contact with subgrade and similar ambient temperature.

2. Minimum of two trial weld tests per day, per welding apparatus, one made prior to the start of work and one completed at mid shift. Each seamer will make at least one trial weld test each day.

3. Cut four, one-inch wide by six-inch long test specimens from the trial weld and quantitatively test the specimens for peel adhesion and shear strength. Trial weld test specimens shall pass when the results are in compliance with the following minimum seam values:

Property	ASTM Procedure	Unit	Minimum Values
Peel Strength (fusion)	D6392	lb/in	75
Peel Strength (extrusion)	D6392	lb/in	72
Shear Strength	D6392	lb/in	90

4. The criteria for passing a peel test shall be conformance with all of the following:

   a. Failure shall be by Film Tear Bond (FTB);

   b. No greater than 10 percent of the seam width peels (separates) at any point;

   c. Compliance with the specified minimum seam values for peel; and

   d. The break shall be ductile and shall occur in the FML material itself, not through peel separation.

5. The criteria for passing a shear test shall be conformance with all of the following:

   a. Failure shall be by FTB; and

   b. Compliance with the specified minimum seam values for shear.

6. If a trial weld fails, the entire operation will be repeated. If the additional trial weld fails, the seaming apparatus or seamer will not be accepted and will not be used for seaming until the deficiencies are corrected and two consecutive successful full test seams are achieved. Trial weld failure is defined as failure of any one of the specimens tested in shear or peel.

7. Successful trial weld samples shall be assigned a number and marked accordingly by the CONTRACTOR, who will also log the date, hour, ambient temperature, number of seaming unit, name of seamer and pass or fail description. The CONTRACTOR shall submit this data to the COMPANY following acceptance of the FML.

C. Non-Destructive Testing. All field seams shall be tested by the CONTRACTOR continuously using non-destructive techniques. Requirements for non-destructive testing are as follows:

1. Single Weld Seams: CONTRACTOR shall maintain and use equipment and personnel at the site to perform continuous vacuum box testing on all single weld production seams or when the geometry of the weld makes pressure testing impractical. Vacuum testing shall be performed in accordance with ASTM D 5641.

2. Double Weld Seams: CONTRACTOR shall maintain and use equipment and personnel to perform air pressure testing of all double weld seams. Air pressure testing shall be performed in accordance with ASTM D 5820.

D. Destructive Testing. Field seams shall be tested by the CONTRACTOR at specified intervals using destructive tests. Requirements for destructive testing are as follows:

1. Destructive testing will be performed on an average of every 1,500 linear feet of field seam. Test locations shall be approved by the ENGINEER.

2. Destructive test samples shall be 12 inches wide and of sufficient length to provide one sample to archive, one sample to the ENGINEER, and two samples to the CONTRACTOR for both field and laboratory testing.

3. Destructive testing shall be performed in accordance with ASTM D 6392, Standard Test Method for Determining the Integrity of Non-Reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods. Testing requirements are as follows:

   a. Each sample shall be large enough to test five specimens in peel and five specimens in shear.

   b. The average values of each set of five specimens must comply with the material and seam requirements of this Specification and four of the five specimen tests must meet the material and seam requirements of this Specification for the seam to be considered a passing seam. If the average of the five specimens is adequate, but one of the specimens is failing, values for the failing specimen must be at least 80 percent of the specified values for the seam sample to pass.

   c. A maximum of one non-FTB failure out of five tests is acceptable provided the non-FTB specimen meets strength requirements.

   d. If unresolved discrepancies exist between Engineer's and CONTRACTOR's test results, the archived sample may be tested by the Engineer.

4. Test specimens shall pass when the results are in compliance with the following minimum seam values:

Property	ASTM Procedure	Unit	Minimum Values
Peel Strength (fusion)	D6392	lb/in	75
Peel Strength (extrusion)	D6392	lb/in	72
Shear Strength	D6392	lb/in	90

5. Failed Seam Procedures:

   a. If the seam fails, INSTALLER shall follow one of two options:

      i. Reconstruct the seam between any two passed test locations.

      ii. Trace the weld to intermediate location at least 10 feet minimum or where the seam ends in both directions from the location of the failed test.

   b. The next seam welded using the same welding device is required to obtain an additional sample, i.e., if one side of the seam is less than 10 feet long.

   c. If sample passes, then the seam shall be reconstructed or capped between the test sample locations.

6. CONTRACTOR shall repair all holes in the FML resulting from destructive sampling and shall test the continuity of the repair in accordance with these Specifications.

3.5 FML REPAIR

A. Remove damaged FML and replace with acceptable FML materials if damage cannot be satisfactorily repaired.

B. Repair any portion of unsatisfactory FML or seam area failing a destructive or non-destructive test.

C. INSTALLER shall be responsible for repair of defective areas.

D. Agreement upon the appropriate repair method shall be decided between ENGINEER and CONTRACTOR by using one of the following repair methods:

1. Patching- Used to repair large holes, tears, undispersed raw materials and contamination by foreign matter.

2. Abrading and Re-welding- Used to repair short section of a seam.

3. Spot Welding- Used to repair pinholes or other minor, localized flaws or where FML thickness has been reduced.

4. Capping- Used to repair long lengths of failed seams.

5. Flap Welding- Used to extrusion weld the flap (excess outer portion) of a fusion weld in lieu of a full cap.

6. Remove the unacceptable seam and replace with new material.

E. The following procedures shall be followed when a repair method is used:

1. All FML surfaces shall be clean and dry at the time of repair.

2. Surfaces of the FML which are to be repaired by extrusion welds shall be lightly abraded to assure cleanliness.

3. Extend patches or caps at least 6 inches for extrusion welds and 4 inches for wedge welds beyond the edge of the defect, and around all corners of patch material.

F. Repair Verification. CONTRACTOR shall number and log each patch repair and shall non-destructively test each repair using methods specified in this Specification

3.6 PROTECTIVE SOIL PLACEMENT

A. Protective Soil shall be placed over the FML as specified in Section 02300 of these Specifications and as specified herein.

B. When an FML is installed over a GCL, Protective Soil placement shall also comply with the requirements of Section 02410 of these specifications.

3.7 FML ACCEPTANCE

A. COMPANY will accept the FML installation when:

1. The installation is complete as determined by the ENGINEER.

2. All required submittals and documentation have been received and approved by ENGINEER.

3. Test reports verifying completion of all field seams and repairs are in accord with specified requirements.

4. CONTRACTOR provides ENGINEER with as-built record drawings of the instrument surveyed panel layout and seam locations with reference numbers for test locations.

5. Written certification documents have been received and approved by ENGINEER.

++END OF SECTION++

SECTION 02430

GEOTEXTILE

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section shall govern work associated with furnishing and installing geotextile including, but not limited to, layout, installation, and testing.

1.2 REFERENCES

A. American Society of Testing Materials (ASTM) Standards/Publications (Latest version):

D3776	Test Method for Mass per Unit Area (weight) of Woven Fabric
D3786	Test Method for Hydraulic Bursting Strength of Knitted Goods and Non-woven Fabrics
D3787	Test Method for Hydraulic Bursting Strength of Knitted Goods and Non-woven Fabrics, Diaphragm Bursting Strength Test
D4354	Standard Practice for Sampling Geosynthetics for Testing
D4355	Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
D4491	Test Method for Water Permeability of Geotextiles by Permittivity
D4533	Test Method for Trapezoid Tearing Strength of Geotextiles
D4595	Test Method for Tensile Properties by the Wide-width Strip Method
D4632	Test Method for Breaking Load and Elongation of Geotextiles (Grab Method)
D4751	Test Method for Determining Apparent Opening Size of Geotextile
D4833	Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
D5199	Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes

1.3 SUBMITTALS

A. At least 14 days prior to installation of the geotextile, CONTRACTOR shall submit for approval the following information:

1. Manufacturer's Literature. Submit manufacturer's literature for proposed geotextile, including catalog cut sheets, material samples and, written instructions for delivery, storage, handling, installation, seaming, and repair.

2. Manufacturer Certification. Written certification from the manufacturer that the geotextile complies with the requirements of these specifications and is appropriate for the intended application.

PART 2 - PRODUCTS

2.1 GEOTEXTILE

A. Geotextile shall be non-woven, continuous or staple filament, needle-punched polypropylene or polyester suitable for AASHTO M-288 Class 2 applications. Yarn shall be oriented into a stable network that maintains its structure during handling, installation, and long-term service.

B. Geotextile shall be uniform in color, density, and other physical properties and free of foreign inclusions or other defects.

C. Geotextile shall be nominal 8 oz per square yard and shall conform to the following minimum average roll values for the properties listed:

Property	ASTM	Unit	Minimum Values
Mass per Unit Area	D5261	oz/yd2	8
Grab Tensile Strength	D4632	lb	220
Grab Elongation	D4632	%	50
CBR Puncture Strength	D6241	lb	575
Trapezoid Tear Strength	D4533	lb	90
Apparent Opening Size	D4751	US Sieve	80
Permittivity	D4491	sec^{-1}	1.3
Water Flow Rate	D4491	gpm/ft2	95
UV Resistance	D4355	% Retained	70

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE and HANDLING

A. Comply with the manufacturer's recommendations regarding product handling and protection.

B. Deliver products to the job site in their manufacturer's original packaging, with labels intact and legible.

C. Maintain packaged materials with seals unbroken and labels intact until time of use. Maintain in a manner that keeps product clean, dry and free of damage. Promptly remove damaged or unsuitable products from the job site and promptly replace with products meeting the required specifications.

D. Comply with manufacturer's recommendations when hauling, unloading, deploying, and installing geotextile. Inspect for defects before installing.

3.2 GEOTEXTILE INSTALLATION

A. Extend geotextile into anchor trenches as shown in the Drawings. Roll geotextile down the slope in such a manner as to maintain tension to preclude folds and wrinkles. Remove any folds or wrinkles by hand.

B. Ballast geotextile during deployment. Remove ballast immediately prior to covering geotextile with succeeding construction layer.

C. During installation, do no entrap rocks, dust, or moisture that could damage geotextile or cause clogging.

D. Schedule deployment activities so geotextile is exposed to direct sunlight for no more than 5 days, unless geotextile is ultraviolet-light stabilized.

E. Overlap geotextile 2 feet minimum at all seams.

F. Inspect geotextile and repair holes or tears. Patch using the same geotextile, with minimum overlap of 2 feet in all directions.

++END OF SECTION++

SECTION 02440

GEOCOMPOSITE DRAINAGE LAYER

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section shall govern work associated with furnishing and installing geocompsite drainage layer including, but not limited to, layout, installation, and testing.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM)

D1238	Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
D4218	Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle Furnace Technique D 1603-94 Standard Test Method for Carbon Black in Olefin Plastics
D4355	Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
D4491	Standard Test Method for Water Permeability of Geotextiles by Permittivity
D4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
D4716	Standard Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
D4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
D6241	Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile- Related Products Using a 50-mm Probe D 4833-88 (1996) Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
D5261	Standard Test Method for Measuring the Mass Per Unit Area of Geotextiles
D7005	Determining the Bond Strength (Ply-Adhesion) of Geocomposites
D7179	Standard Test Method for Determining Geonet Breaking Force

B. Environmental Protection Agency (EPA)

Daniel, D.E. and R.M. Koerner, (1993), Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities, EPA/600/R-93/182.

1.3 DEFINITIONS

A. COMPANY - The individual or firm responsible for the design and preparation of the project's Contract Drawings and Specifications.

B. Geocomposite Manufacturer (MANUFACTURER) - The party responsible for manufacturing the geocomposite rolls.

C. Geosynthetic Quality Assurance Laboratory (TESTING LABORATORY) – Provided by CONTRACTOR, party that's independent from the MANUFACTURER and INSTALLER, responsible for conducting laboratory tests on samples of geosynthetics obtained at the site or during manufacturing.

D. INSTALLER- Party responsible for field handling, transporting, storing and deploying the geocomposite.

E. Lot- A quantity of resin (usually the capacity of one rail car) used to manufacture polyethylene geocomposite rolls. The finished rolls will be identified by a roll number traceable to the resin lot.

1.4 QUALIFICATIONS

A. MANUFACTURER

1. MANUFACTURER shall have manufactured a minimum of 10,000,000 square feet of polyethylene geocomposite material.

B. INSTALLER

1. INSTALLER shall have installed a minimum of 1 million square feet of geocomposite in the last year.

2. INSTALLER shall have worked in a similar capacity on at least 5 projects similar in complexity to the project described in the contract documents.

3. The Installation Supervisor shall have worked in a similar capacity on projects similar in size and complexity to the project described in the Contract Documents.

1.5 SUBMITTALS

A. At least 14 days prior to installation of the geocomposite, CONTRACTOR shall submit for approval the following information:

1. Manufacturer's Literature. Submit manufacturer's literature for proposed geocomposite, including catalog cut sheets, material samples and, written instructions for delivery, storage, handling, installation, seaming, and repair.

2. Manufacturer Certification. Written certification from the manufacturer that the geocomposite complies with the requirements of these specifications and is appropriate for the intended application.

1.6 MATERIAL LABELING, DELIVERY, STORAGE AND HANDLING

A. Labeling - Each roll delivered to the site shall be wrapped and labeled by the MANUFACTURER. The label will identify:

1. manufacturer's name
2. product identification
3. length
4. width
5. roll number

B. Delivery - Rolls will be prepared to ship by appropriate means to prevent damage to the material and to facilitate off-loading.

C. Storage - The on-site storage location provided by the CONTRACTOR to protect the geonet from abrasions, excessive dirt and moisture shall have the following characteristics:

1. level (no wooden pallets)
2. smooth
3. dry
4. protected from theft and vandalism
5. adjacent to the area being lined

D. Handling

1. The CONTRACTOR and INSTALLER shall handle all rolls in such a manner to ensure they are not damaged in any way.

2. The INSTALLER shall take any necessary precautions to prevent damage to underlying layers during placement of the drainage material.

1. 7 WARRANTY

A. Material shall include one-year warranty against defects.

B. Installation shall be warranted against defects in workmanship for a period of 1-year from the date of geocomposite completion.

PART 2 - PRODUCTS

2.1 GEOCOMPOSITE PRODUCT STANDARD

A. Geocomposite shall be 275-mil FabriNet Geocomposite Double-sided with 8 oz geotextile as manufactured by GSE, or approved equal.

B. Geocomposite shall be manufactured by extruding two crossing strands to form a bi-planar drainage net structure with a non-woven geotextile bonded to one or both sides.

C. Geocomposite shall have properties that meet or exceed the values listed as follows:

1. Geocomposite

Property	ASTM	Frequency	Unit	Minimum Values
Transmissivity	D4716	1/540,000 ft2	gal/min/ft	3.4
Ply Adhesion	D7005	1/50,000 ft2	lb/in	1.0

2. Geonet

Property	ASTM	Frequency	Unit	Minimum Values
Core Thickness	D5199	1/50,000 ft2	mil	275
Transmissivity	D4716	1/50,000 ft2	gal/min/ft	29
Density	D1505	1/50,000 ft2	g/cm3	0.94
Tensile Strength	D7179	1/50,000 ft2	lb/in	65
Carbon Black Content	D4218	1/50,000 ft2	%	2.0

3. Geotextile

Property	ASTM	Frequency	Unit	Minimum Values
Mass per Unit Area	D5261	1/90,000 ft2	oz/yd2	8
Grab Tensile Strength	D4632	1/90,000 ft2	lb	220

Grab Elongation	D4632	1/90,000 ft2	%	50
CBR Puncture Strength	D6241	1/90,000 ft2	lb	575
Trapezoid Tear Strength	D4533	1/90,000 ft2	lb	90
Apparent Opening Size	D4751	1/540,000 ft2	US Sieve	80
Permittivity	D4491	1/540,000 ft2	sec^{-1}	1.3
Water Flow Rate	D4491	1/540,000 ft2	gpm/ft2	95
UV Resistance	D4355	Per Formulation	% Retained	70

D. Resin

1. Resin shall be new first quality, compounded polyethylene resin.

2. Natural resin (without carbon black) shall meet the following additional minimum requirements:

Property	ASTM Test Method	Value
Density (g/cm3)	D1505	>0.932
Melt Flow Index (g/10 min)	D1238	< 1.0

2.2 MANUFACTURING QUALITY CONTROL

1. Geocomposite shall be manufactured in accordance with the Manufacturer's Quality Control Plan.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE and HANDLING

A. Comply with the manufacturer's recommendations regarding product handling and protection.

B. Deliver products to the job site in their manufacturer's original packaging, with labels intact and legible.

C. Maintain packaged materials with seals unbroken and labels intact until time of use. Maintain in a manner that keeps product clean, dry and free of damage. Promptly remove damaged or unsuitable products from the job site and promptly replace with products meeting the required specifications.

D. Comply with manufacturer's recommendations when hauling, unloading, deploying, and installing geotextile. Inspect for defects before installing.

3.2 FAMILIARIZATION

A. Inspection

1. Prior to implementing any of the work in the Section to be lined, the INSTALLER shall carefully inspect and approve the areas to receive the geocomposite.

2. If INSTALLER has any concerns regarding the areas to receive geocomposite, he shall immediately notify COMPANY.

3.3 INSTALLATION

A. The geocomposite roll should be installed in the direction of the slope and in the intended direction of flow unless otherwise specified by the COMPANY.

B. If the project contains long, steep slopes, special care should be taken so that only full length rolls are used at the top of the slope.

C. In the presence of wind, all geocomposites shall be weighted down with sandbags or the equivalent. Such sandbags shall be used during placement and remain until replaced with cover material.

D. The geocomposite shall be properly anchored to resist sliding. Anchor trench compacting equipment shall not come into direct contact with the geocomposite.

E. In applying fill material, no equipment can drive directly across the geocomposite. The specified fill material shall be placed and spread utilizing vehicles with a low ground pressure.

F. The cover soil shall be placed in the geocomposite in a manner that prevents damage to the geocomposite. Placement of the cover soil shall proceed immediately following the placement and inspection of the geocomposite.

3.4 SEAMS AND OVERLAPS

A. Each component of the geocomposite will be secured or seamed to the like component at overlaps.

B. Geonet Components

1. Adjacent edges of the geonet along the length of the geocomposite roll shall be placed with the edges of each geonet butted against each other.

2. The overlaps shall be joined by tying the geonet structure with cable ties. These ties shall be spaced every 5 feet along the roll length.

3. Adjoining geocomposite rolls (end to end) across the roll width should be shingled down in the direction of the slope, with the geonet portion of the top overlapping the geonet portion of the bottom geocomposite a minimum of 12 inches across the roll width.

4. The geonet portion should be tied every 6 inches in the anchor trench or as specified by the COMPANY.

3.5 REPAIR

A. Prior to covering the deployed geocomposite, each roll shall be inspected for damage resulting from construction.

B. Any rips, tears or damaged areas on the deployed geocomposite shall be removed and patched. The patch shall be secured to the original geonet by tying every 6 inches with the approved tying devices. If the area to be repaired is more than 50 percent of the width of the panel, the damaged area shall be cut out and the two portions of the geonet shall be cut out and the two portions of the geonet shall be joined in accordance with 3.4 above.

++END OF SECTION++

SECTION 02450

GEOCELLS

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section shall govern work associated with furnishing and installing geocells (cellular confinement system) including, but not limited to, layout, installation, and testing.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM)

D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
D1603	Standard Test Method for Carbon Black In Olefin Plastics
D1693	Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
D5199	Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
D5397	Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test

B. US Army Corps of COMPANYs (USACE)

Technical Report GL-86-19, Appendix A.

1.4 QUALIFICATIONS

A. Geocell Manufacturer's Field Representative shall have worked in a similar capacity on at least 5 geocell projects similar in complexity to the project described in the contract documents.

B. Geocell Installer shall have worked in a similar capacity on at least 5 geocell projects similar in complexity to the project described in the contract documents.

1.5 SUBMITTALS

A. At least 14 days prior to installation of the geocells, CONTRACTOR shall submit for approval the following information:

1. Manufacturer's Literature. Submit manufacturer's literature for proposed geocells, including catalog cut sheets, material samples and, written instructions for delivery, storage, handling, installation, seaming, and repair.

2. Manufacturer Certification. Written certification from the manufacturer that the geocells comply with the requirements of these specifications and is appropriate for the intended application.

1. 6 WARRANTY

A. Material shall include one-year warranty against defects.

B. Installation shall be warranted against defects in workmanship for a period of 1-year from the date of geocell completion.

PART 2 - PRODUCTS

2.1 GEOCELL PRODUCT STANDARD

A. Geocells shall be black Terracell 140 perforated, textured high-density polyethylene (HDPE) geocell as manufactured by Hanes Geo Components, or approved equal.

B. Geocells shall be manufactured to meet the values listed as follows:

Property	Values
Cell Depth	4 in
Nominal Expanded Cell Size	10.2 in X 8.8 in
Nominal Expanded Cell Area	44.8 in
Nominal Expanded Section (L X W)	21.4 ft X 8.4 ft
Cells per Section (L X W)	29 cells X 10 cells
Nominal Expanded Section Area	180 sf
Weld Spacing	14 in

C. Geocells shall be constructed using virgin, non-thermally degraded HDPE with material properties that meet or exceed the following values:

Property	ASTM	Unit	Minimum Values
Polymer Density	D1505	g/cm3	0.935-0.965
Environmental Stress Crack Resistance	D5397	hours	>400
Environmental Stress Crack Resistance	D1693	hours	>6000
Minimum Carbon Black Content	D1603	%	1.5
Nominal Sheet Thickness	D5199	mil	60 (+10%, -5%)
Seam Peel Strength	USACE	lb	320

D. Geocell weld joints shall have a Seam Hang Strength able to support a load of 160 pounds for 30 days minimum or for 7 days minimum while undergoing temperature change from 74 degrees F to 130 degrees F on 1-hour cycle.

E. The HDPE strips used to construct the Geocell shall be textured with diamond shaped indentations. The rhomboidal indentations shall have a surface density of 140 to 200 per in^2.

F. Geocells shall be perforated with10 mm diameter holes spaced at 16.6 mm on center. The holes shall be placed in horizontal rows staggered 8.3 mm on relative to hole centers.

G. Geocell section length shall be in accordance with manufacturer recommendations for intended application.

2.2 ACCESSORIES

A. J-Hooks:

1. J-Hooks shall be uncoated steel reinforcing bars as follows:

   a. Diameter: 0.5 inch
   b. Length: 12 inches minimum.
   c. Hook: 180-degree bend

2.3 INFILL MATERIAL

A. Infill Material shall be concrete. Concrete shall at a minimum be Class A, 3,000-psi concrete with three-quarter inch diameter aggregate.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE and HANDLING

A. Comply with the Manufacturer's recommendations regarding product handling and protection.

B. Deliver products to the job site in their manufacturer's original packaging, with labels intact and legible.

C. Maintain packaged materials with seals unbroken and labels intact until time of use. Maintain in a manner that keeps product clean, dry and free of damage. Promptly remove damaged or unsuitable products from the job site and promptly replace with products meeting the required specifications.

D. Comply with Manufacturer's recommendations when hauling, unloading, deploying, and installing geotextile. Inspect for defects before installing.

3.2 FAMILIARIZATION

A. Inspection

3. Prior to beginning geocell installation, Geocell Installer and Geocell Manufacturer's Field Representative shall carefully inspect and approve the area to receive geocells.

4. If Geocell Installer or Geocell Manufacturer's Field Representative have any concerns regarding the proposed geocell area, they shall immediately notify COMPANY.

3.3 PREPARATION

A. Prepare site by removing vegetative cover, debris, and unacceptable soils from area where geocells will be installed.

B. Replace removed soils with acceptable materials.

3.4 INSTALLATION

A. Install geocells in accordance with manufacturer's instructions at locations indicated on the drawings.

B. Anchor geocell sections as necessary to resist sliding due to gravitational forces and sheet flow. The upper edge of the geocell shall be buried in an anchor trench as recommended by the Manufacturer and shown on the Drawings. Geocells shall also be anchored using J-Hooks in

accordance with manufacturer recommendations.

C. Ensure top edges of adjoining cell walls are flush with each other and in proper alignment.

D. Geocells shall be infilled with concrete. Deliver infill material to geocells from top of slope or channel to bottom in accordance with manufacturer's instructions.

E. Limit drop height of infill material to a maximum of 3 feet to prevent damage to geocells.

F. Manually rake and machine finish concrete infill material.

++END OF SECTION++

APPENDIX B
HELP MODEL OUTPUT

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**                                                                          **
**                                                                          **
**    HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                         **
**           HELP MODEL VERSION 3.07 (1 November 1997)                      **
**           DEVELOPED BY ENVIRONMENTAL LABORATORY                          **
**               USAE WATERWAYS EXPERIMENT STATION                          **
**   FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                        **
**                                                                          **
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PRECIPITATION DATA FILE: C:\WHI\VHELP22\data\P8054.VHP_weather1.dat
TEMPERATURE DATA FILE: C:\WHI\VHELP22\data\P8054.VHP_weather2.dat
SOLAR RADIATION DATA FILE: C:\WHI\VHELP22\data\P8054.VHP_weather3.dat
EVAPOTRANSPIRATION DATA: C:\WHI\VHELP22\data\P8054.VHP_weather4.dat
SOIL AND DESIGN DATA FILE: C:\WHI\VHELP22\data\P8054.VHP\I_394318.inp
OUTPUT DATA FILE: C:\WHI\VHELP22\data\P8054.VHP\O_394318.prt

TIME: 12:37 DATE: 9/ 7/2016

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TITLE: PDP-5 Option 1 Compacted Clay

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NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 6
THICKNESS = 45.72 CM
POROSITY = 0.4530 VOL/VOL
FIELD CAPACITY = 0.1900 VOL/VOL
WILTING POINT = 0.0850 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.4399 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.720001612800E-03 CM/SEC
NOTE: SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY 5.00
FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.

LAYER 2

TYPE 3 - BARRIER SOIL LINER
MATERIAL TEXTURE NUMBER 29
THICKNESS = 91.44 CM
POROSITY = 0.4510 VOL/VOL
FIELD CAPACITY = 0.4190 VOL/VOL
WILTING POINT = 0.3320 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.4510 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.100000000000E-06 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 6 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 3.% AND A SLOPE LENGTH OF 152. METERS.

SCS RUNOFF CURVE NUMBER	=	68.42	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	16.1874	HECTARES
EVAPORATIVE ZONE DEPTH	=	25.4	CM
INITIAL WATER IN EVAPORATIVE ZONE	=	10.908	CM
UPPER LIMIT OF EVAPORATIVE STORAGE	=	11.506	CM
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.159	CM
INITIAL SNOW WATER	=	0.000	CM
INITIAL WATER IN LAYER MATERIALS	=	61.352	CM
TOTAL INITIAL WATER	=	61.352	CM
TOTAL SUBSURFACE INFLOW	=	0.00	MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM Martin Lake (Shreveport)LA

STATION LATITUDE	=	32.47 DEGREES
MAXIMUM LEAF AREA INDEX	=	4.50
START OF GROWING SEASON (JULIAN DATE)	=	58
END OF GROWING SEASON (JULIAN DATE)	=	331
EVAPORATIVE ZONE DEPTH	=	10.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	8.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	70.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	72.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	72.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR Martin Lake (Shreveport)LA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.02	3.46	3.77	4.71	4.70	3.54
3.56	2.52	3.29	2.63	3.77	3.87

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR Martin Lake (Shreveport)LA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
46.00	49.80	57.00	65.70	73.00	79.80
82.90	82.40	77.10	66.70	55.70	48.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR Martin Lake (Shreveport)LA AND STATION LATITUDE = 30.56 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 2
DRAIN #1: LATERAL DRAINAGE FROM LAYER 1 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 2

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.60	2.99	3.85	4.96	4.51	3.71
	3.53	2.17	3.08	2.64	3.69	3.58
STD. DEVIATIONS	2.46	1.49	1.64	2.11	2.06	2.37
	1.79	1.84	1.72	1.45	1.20	2.26
RUNOFF						
TOTALS	1.976	1.050	0.835	0.827	0.356	0.208
	0.084	0.000	0.094	0.122	0.698	1.893
STD. DEVIATIONS	2.253	1.145	1.157	1.020	0.852	0.793
	0.413	0.001	0.306	0.452	1.043	2.059
EVAPOTRANSPIRATION						
TOTALS	1.676	2.116	3.147	4.859	4.894	3.799
	3.459	2.101	2.481	1.666	1.067	1.258
STD. DEVIATIONS	0.173	0.297	0.585	0.654	1.406	2.183
	1.625	1.548	1.242	0.832	0.204	0.203
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.1535	0.1379	0.1490	0.1403	0.1351	0.1275
	0.1299	0.1285	0.1247	0.1323	0.1390	0.1534
STD. DEVIATIONS	0.0033	0.0043	0.0036	0.0049	0.0056	0.0043
	0.0038	0.0027	0.0045	0.0069	0.0110	0.0057

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 2						
AVERAGES	16.4167	15.7057	14.8558	13.5123	10.1302	8.9743
	8.3456	7.8667	7.9907	9.1722	13.0495	16.3676
STD. DEVIATIONS	1.1294	1.3341	1.2296	1.7130	1.9045	1.5004
	1.2858	0.9183	1.5924	2.3698	3.8958	1.9481

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	42.31 (7.468)	6143762.1	100.00
RUNOFF	8.144 (4.7832)	1182463.56	19.247
EVAPOTRANSPIRATION	32.523 (4.3635)	4722220.53	76.862
PERCOLATION/LEAKAGE THROUGH LAYER 2	1.65120 (0.02652)	239748.749	3.90231
AVERAGE HEAD ON TOP OF LAYER 2	11.866 (0.764)		
CHANGE IN WATER STORAGE	-0.005 (0.5494)	-670.66	-0.011

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 30 and their dates (DDDYYYY)

	(INCHES)	(CU. FT.)	
PRECIPITATION	4.10	595307.02448	1980021
RUNOFF	3.751	544632.06410	130016
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.005102	740.83219	110002
AVERAGE HEAD ON TOP OF LAYER 2	18.000		
SNOW WATER	2.84	412435.2581	130002
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4530		
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0850		

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	7.7797	0.4322
2	16.2360	0.4510
SNOW WATER	0.000	

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**                                                                        **
**                                                                        **
**       HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                    **
**       HELP MODEL VERSION 3.07  (1 November 1997)                       **
**       DEVELOPED BY ENVIRONMENTAL LABORATORY                            **
**       USAE WATERWAYS EXPERIMENT STATION                                **
**       FOR USEPA RISK REDUCTION ENGINEERING LABORATORY                  **
**                                                                        **
**                                                                        **
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PRECIPITATION DATA FILE:     C:\WHI\VHELP22\data\P8054.VHP\_weather1.dat
TEMPERATURE DATA FILE:       C:\WHI\VHELP22\data\P8054.VHP\_weather2.dat
SOLAR RADIATION DATA FILE:   C:\WHI\VHELP22\data\P8054.VHP\_weather3.dat
EVAPOTRANSPIRATION DATA:     C:\WHI\VHELP22\data\P8054.VHP\_weather4.dat
SOIL AND DESIGN DATA FILE:   C:\WHI\VHELP22\data\P8054.VHP\I_394337.inp
OUTPUT DATA FILE:            C:\WHI\VHELP22\data\P8054.VHP\O_394337.prt


TIME:  15:53     DATE:   9/ 8/2016


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    TITLE:  PDP-5 Option 2 LLDPE Cap

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    NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
           COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                             LAYER  1
                             --------

                   TYPE 1 - VERTICAL PERCOLATION LAYER
                     MATERIAL TEXTURE NUMBER   6
         THICKNESS                    =    45.72    CM
         POROSITY                     =     0.4530 VOL/VOL
         FIELD CAPACITY               =     0.1900 VOL/VOL
         WILTING POINT                =     0.0850 VOL/VOL
         INITIAL SOIL WATER CONTENT   =     0.2274 VOL/VOL
         EFFECTIVE SAT. HYD. COND.    =  0.720001612800E-03 CM/SEC
      NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  5.00
             FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                             LAYER  2
                             --------

                   TYPE 2 - LATERAL DRAINAGE LAYER
                     MATERIAL TEXTURE NUMBER  20
         THICKNESS                    =     0.50    CM
         POROSITY                     =     0.8500 VOL/VOL
         FIELD CAPACITY               =     0.0100 VOL/VOL
         WILTING POINT                =     0.0050 VOL/VOL
         INITIAL SOIL WATER CONTENT   =     0.1235 VOL/VOL
         EFFECTIVE SAT. HYD. COND.    =   10.0000000000      CM/SEC
         SLOPE                        =     3.00    PERCENT
         DRAINAGE LENGTH              =    152.4     METERS
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LAYER 3

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 36
THICKNESS = 0.10 CM
POROSITY = 0.0000 VOL/VOL
FIELD CAPACITY = 0.0000 VOL/VOL
WILTING POINT = 0.0000 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.0000 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.400000000000E-12 CM/SEC
FML PINHOLE DENSITY = 9.88 HOLES/HECTARE
FML INSTALLATION DEFECTS = 9.88 HOLES/HECTARE
FML PLACEMENT QUALITY = 3 - GOOD

LAYER 4

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 30
THICKNESS = 609.60 CM
POROSITY = 0.5410 VOL/VOL
FIELD CAPACITY = 0.1870 VOL/VOL
WILTING POINT = 0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT = 0.1870 VOL/VOL
EFFECTIVE SAT. HYD. COND. = 0.500000000000E-04 CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
SOIL DATA BASE USING SOIL TEXTURE # 6 WITH A
FAIR STAND OF GRASS, A SURFACE SLOPE OF 3.%
AND A SLOPE LENGTH OF 152. METERS.

SCS RUNOFF CURVE NUMBER = 68.42
FRACTION OF AREA ALLOWING RUNOFF = 100.0 PERCENT
AREA PROJECTED ON HORIZONTAL PLANE = 16.1874 HECTARES
EVAPORATIVE ZONE DEPTH = 25.4 CM
INITIAL WATER IN EVAPORATIVE ZONE = 5.100 CM
UPPER LIMIT OF EVAPORATIVE STORAGE = 11.506 CM
LOWER LIMIT OF EVAPORATIVE STORAGE = 2.159 CM
INITIAL SNOW WATER = 0.000 CM
INITIAL WATER IN LAYER MATERIALS = 124.451 CM
TOTAL INITIAL WATER = 124.451 CM
TOTAL SUBSURFACE INFLOW = 0.00 MM/YR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Martin Lake (Shreveport)LA

STATION LATITUDE = 32.47 DEGREES
MAXIMUM LEAF AREA INDEX = 4.50
START OF GROWING SEASON (JULIAN DATE) = 58
END OF GROWING SEASON (JULIAN DATE) = 331
EVAPORATIVE ZONE DEPTH = 10.0 INCHES
AVERAGE ANNUAL WIND SPEED = 8.60 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY = 70.00 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY = 72.00 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY = 72.00 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY = 72.00 %

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Martin Lake (Shreveport)LA

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
4.02	3.46	3.77	4.71	4.70	3.54
3.56	2.52	3.29	2.63	3.77	3.87

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Martin Lake (Shreveport)LA

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
46.00	49.80	57.00	65.70	73.00	79.80
82.90	82.40	77.10	66.70	55.70	48.70

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR Martin Lake (Shreveport)LA
AND STATION LATITUDE = 30.56 DEGREES

HEAD #1: AVERAGE HEAD ON TOP OF LAYER 3
DRAIN #1: LATERAL DRAINAGE FROM LAYER 2 (RECIRCULATION AND COLLECTION)
LEAK #1: PERCOLATION OR LEAKAGE THROUGH LAYER 3
LEAK #2: PERCOLATION OR LEAKAGE THROUGH LAYER 4

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 30

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.60	2.99	3.85	4.96	4.51	3.71
	3.53	2.17	3.08	2.64	3.69	3.58
STD. DEVIATIONS	2.46	1.49	1.64	2.11	2.06	2.37
	1.79	1.84	1.72	1.45	1.20	2.26
RUNOFF						
TOTALS	0.013	0.005	0.001	0.002	0.017	0.014
	0.016	0.000	0.006	0.010	0.000	0.022
STD. DEVIATIONS	0.072	0.016	0.004	0.006	0.058	0.029
	0.060	0.001	0.023	0.051	0.000	0.065
EVAPOTRANSPIRATION						
TOTALS	1.664	1.976	2.769	3.521	3.468	2.799
	2.864	1.920	2.270	1.598	1.173	1.397
STD. DEVIATIONS	0.217	0.438	0.710	0.888	1.096	1.444
	1.221	1.309	1.054	0.873	0.275	0.187
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	2.2791	1.3035	1.1785	1.4159	1.2848	1.0623
	0.6974	0.3709	0.5095	0.7648	1.7555	2.1781
STD. DEVIATIONS	2.0984	1.0738	1.2049	1.0624	1.2998	1.2547
	0.8978	0.5685	0.8095	0.8386	1.0713	2.0313
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0025	0.0008	0.0007	0.0008	0.0016	0.0014
	0.0005	0.0001	0.0005	0.0006	0.0008	0.0027
STD. DEVIATIONS	0.0046	0.0015	0.0013	0.0011	0.0043	0.0030

	0.0015	0.0004	0.0013	0.0020	0.0010	0.0047

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0025	0.0014	0.0009	0.0008	0.0009	0.0013
	0.0012	0.0001	0.0005	0.0003	0.0011	0.0019
STD. DEVIATIONS	0.0033	0.0031	0.0020	0.0011	0.0017	0.0025
	0.0033	0.0004	0.0013	0.0005	0.0023	0.0032

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	0.2439	0.0841	0.0625	0.0795	0.1574	0.1357
	0.0447	0.0112	0.0469	0.0543	0.0707	0.2586
STD. DEVIATIONS	0.4586	0.1611	0.1222	0.1080	0.4378	0.3129
	0.1478	0.0336	0.1304	0.2067	0.0991	0.4675

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 30

	INCHES	CU. FEET	PERCENT
PRECIPITATION	42.31 (7.468)	6143762.1	100.00
RUNOFF	0.107 (0.1537)	15495.66	0.252
EVAPOTRANSPIRATION	27.419 (3.3954)	3981128.04	64.800
LATERAL DRAINAGE COLLECTED FROM LAYER 2	14.80026 (5.17558)	2148950.731	34.97777
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.01299 (0.01009)	1885.933	0.03070
AVERAGE HEAD ON TOP OF LAYER 3	0.104 (0.085)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.01298 (0.00915)	1884.337	0.03067
CHANGE IN WATER STORAGE	-0.025 (1.0670)	-3696.59	-0.060

PEAK DAILY VALUES FOR YEARS 1 THROUGH 30 and their dates (DDDYYYY)

	(INCHES)	(CU. FT.)	
PRECIPITATION	4.10	595307.02448	1980021
RUNOFF	0.394	57233.52829	130016
DRAINAGE COLLECTED FROM LAYER 2	0.67614	98173.64850	1390030
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.005171	750.84398	1390030
AVERAGE HEAD ON TOP OF LAYER 3	16.581		
MAXIMUM HEAD ON TOP OF LAYER 3	25.597		
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	113.7 FEET		
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.001417	205.74779	1770030
SNOW WATER	2.84	412435.2581	130002
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4469		
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0850		

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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FINAL WATER STORAGE AT END OF YEAR 30

LAYER	(INCHES)	(VOL/VOL)
1	3.3473	0.1860
2	0.0056	0.0283
3	0.0000	0.0000
4	44.8800	0.1870
SNOW WATER	0.000	

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APPENDIX C

SLIDE 7.0 – CAP/COVER SYSTEM SLOPE STABILITY MODEL OUTPUT

September 30, 2016

Mr. Pat Behling
Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664

Re: Evaluation of Landfill Cap Slope Stability, PDP-5 – Martin Lake Steam Electric Station, near Beckville, Texas

Dear Mr. Behling:

As requested by Pastor, Behling & Wheeler, LLC (PBW), Bullock, Bennett & Associates, LLC (BBA) has completed evaluation of slope-stability of the proposed cap for the PDP-5 ash disposal facility at the Martin Lake Steam Electric Station (MLSES) located near Beckville, Texas. This analysis is based on the most recent preliminary design drawings dated August 2016, provided to BBA by PBW. No site specific geotechnical data was provided to BBA for this analysis, therefore, assumptions regarding typical soil properties and interface friction angles are made in this evaluation. It is recommended that site-specific soils and proposed synthetic materials be tested for engineering strength properties, and slope stability analysis using the on-site data and final design criteria be completed prior to construction activities.

The PBW design includes options for two different cap configurations, one including synthetic components and the other including use of a compacted clay liner system. Each system has been evaluated, as further discussed below.

Stability Analysis of Synthetic Cap Components

This stability analysis includes evaluation of veneer cover soils and synthetics on 10(H):1(V) slopes, assuming the following cap configuration (from bottom to top):

- Compacted clay subgrade;
- Textured (both sides) flexible membrane liner (FML);
- Double-sided (geotextile on both sides) geonet drainage layer; and,
- 1.5 foot-thick cover soils.

Soil slopes of 10(H):1(V) typically are stable and do not require slope stability analysis; however, when placed as a thin veneer over a barrier such as a synthetic liner/lateral drainage layer, stability can be compromised if resisting forces along the material interfaces are not sufficient to prevent sliding. To evaluate these conditions for the proposed cap system described above, slope stability analysis was completed using limit equilibrium and a finite slope model. As discussed in the attached analysis, veneer cover soil slope stability is very sensitive to the interface friction angle of materials, while typical variance of soil properties such as unit weight and internal friction angle have considerably less effect on the analysis. Given the sensitivity to interface friction angle, this parameter was varied for analysis, while a generally representative soil unit weight and internal friction angle were used.

A range of interface friction angles from 19 to 27 were used to capture the range associated with proposed cap components, as shown in the attached Appendix Table 1 of the *Geosynthetics Research Institute, Direct Shear Database of Geosynthetic-to Geosynthetic and Geosynthetic-to-Soil Interfaces (Koerner, Narejo, June 14, 2005)*. For conservative analysis, cohesion and adhesion values were assumed to be zero. A unit weight and internal friction angle of 115 pounds per cubic foot (pcf) and 15 degrees, respectively, were used for the soil and are generally representative of commonly available soils in Texas, including a wide range of silty, sandy, and lean to fat clays commonly used as cover soil.

Estimated factors of safety for this analysis range from approximately 3.5 to 5.2 for interface friction angles ranging from 19 to 27, respectively, with assumed cohesion and adhesion values of zero. See *Veneer Cover Soil Analysis of Synthetic Cap System* in Attachment 1 for calculations and further stated assumptions.

Slope Stability Analysis of Alternate Clay Cap

The alternate clay cap system consists of the following, bottom to top:

- 1.0 foot-thick subgrade soil;
- 3.0 foot-thick compacted clay liner; and,
- 1.5 foot-thick protective cover/vegetative soil.

This slope stability analysis includes evaluation of the clay cap system using Rocscience Slide 7.0 software. The Simplified Bishop and Morgenstern-Price methods of analysis were conducted on over 400 potential failure surfaces, with the lowest calculated safety factor reported. Slope stability evaluation of the cap was performed for assumed short- and long-term conditions. Site specific geotechnical test data is not available; therefore assumptions regarding soil strength properties (for each soil layer) were made as follows:

Short-Term Conditions:

Cohesion, C:	500 pcf
Friction Angle:	0

Long-Term Conditions:

Cohesion, C:	250 pcf
Friction Angle:	15

The unit weight of soil was assumed to be 115 pcf for each soil layer. Coal combustion residual (ash) material underlies the cap. It is assumed the ash is non-cohesive, well drained and has been in place for a long time prior to capping. For ash the following properties were assumed for both short and long-term cap analysis:

Dry Unit Weight of Ash:	90 pcf
Saturated Unit Weight of Ash:	95 pcf
Cohesion, C:	0 pcf
Friction Angle:	20 deg

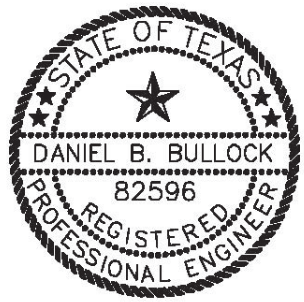
The calculated factor of safety for the short- and long-term conditions were both determined to be approximately 3.9.

Please find attached the landfill cap slope stability analysis and supporting notes, assumptions, and documentation, and please feel free to contact me at (512) 355-9198 if you have any questions about this submittal, or if I can be of any further assistance.

Sincerely,

BBA, LLC

Dan Bullock, P.E.
Principal Engineer



9/30/2016

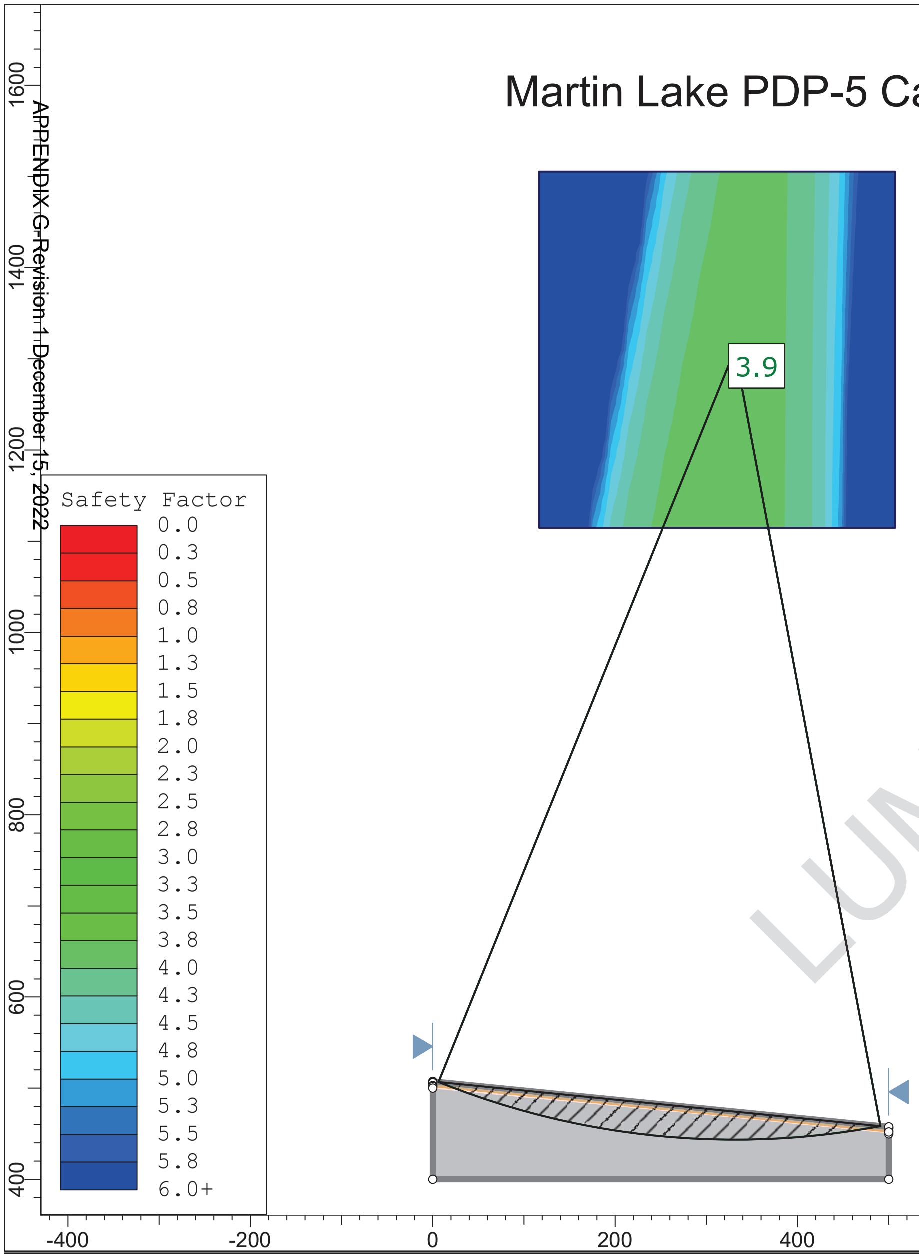
Attachments

ATTACHMENT 1

Landfill Cover Slope Stability Analysis

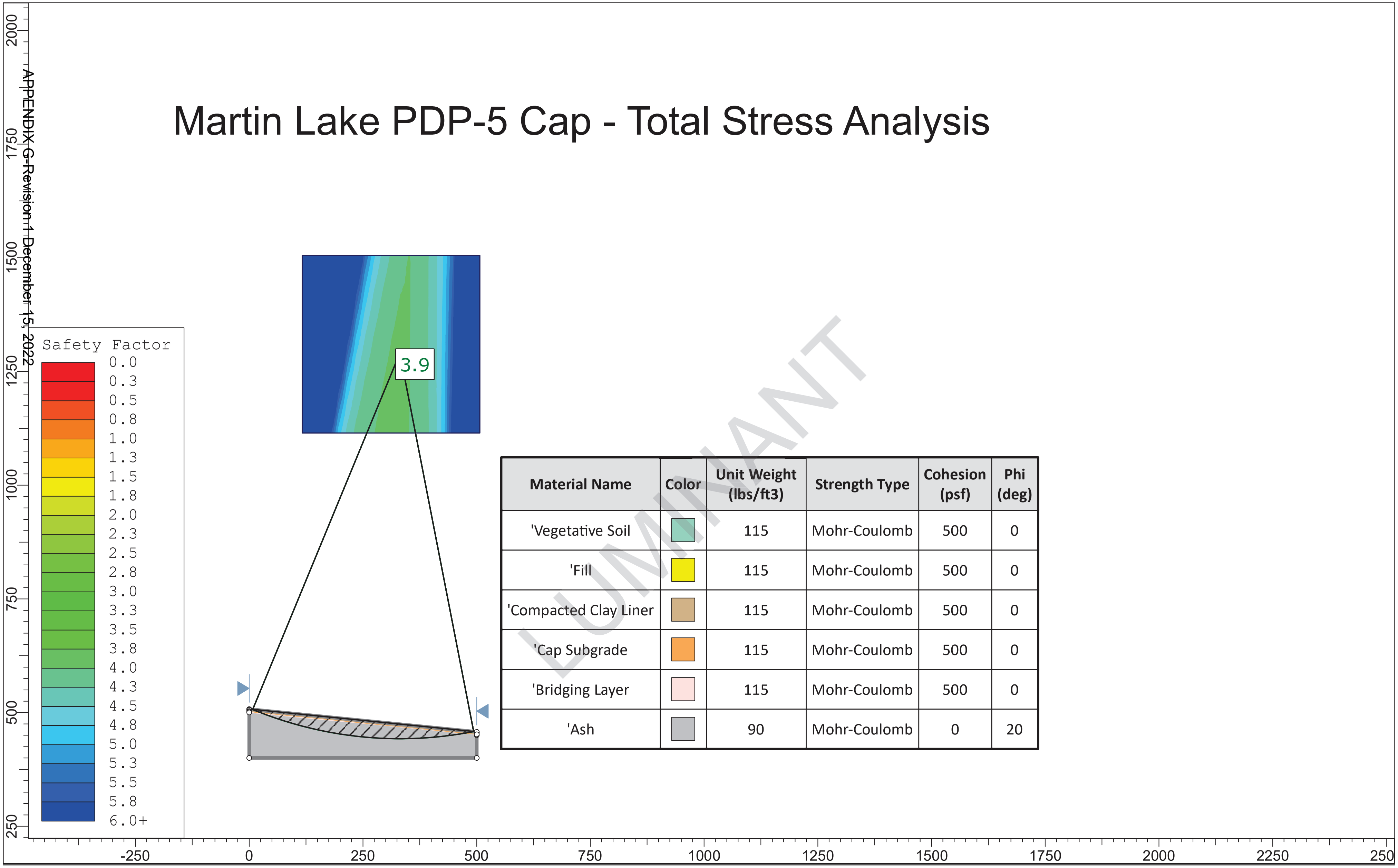
Slide 7.0 Analysis of Clay Cap

Martin Lake PDP-5 Cap - Effective Stress Analysis



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Vegetative Soil		115	Mohr-Coulomb	250	15
Fill		115	Mohr-Coulomb	250	15
Compacted Clay Liner		115	Mohr-Coulomb	250	15
Cap Subgrade		115	Mohr-Coulomb	250	15
Bridging Layer		115	Mohr-Coulomb	250	15
Ash		90	Mohr-Coulomb	0	20

Martin Lake PDP-5 Cap - Total Stress Analysis



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
'Vegetative Soil		115	Mohr-Coulomb	500	0
'Fill		115	Mohr-Coulomb	500	0
'Compacted Clay Liner		115	Mohr-Coulomb	500	0
'Cap Subgrade		115	Mohr-Coulomb	500	0
'Bridging Layer		115	Mohr-Coulomb	500	0
'Ash		90	Mohr-Coulomb	0	20

Veneer Cover Soil Analysis of Synthetic Cap System

LANDFILL COVER SLOPE STABILITY ANALYSIS - PDP-5
Martin Lake Steam Electric Station, near Beckville, Texas

	DEFINITION OF TERMS
Wa	Total weight of active wedge
Wp	Total weight of passive wedge
Na	Effective force normal to the failure plane of the active wedge
Np	Effective force normal to the failure plane of the passive wedge
Y	Unit weight of the cover soil
h	Thickness of the cover soil
L	Length of slope measured along the geomembrane
B	Soil slope angle beneath the geomembrane
Phi	Friction angle of the cover soil
Delta	Interface friction angle between cover soil and geomembrane
Ca	Adhesive force between cover soil of the active wedge and the geomembrane
ca	Adhesion between cover soil of the active wedge and the geomembrane
C	Cohesive force along the failure plane of the passive wedge
c	Cohesion of the cover soil
Ea	Interwedge force acting on the active wedge from the passive wedge
Ep	Interwedge force acting on the passive wedge from the active wedge, and
FS	Factor of safety against cover soil sliding on the geocomposite

EQUATIONS: (Designing with Geosynthetics (4th Edition), Robert M. Koerner)

Wa = Yh^2(L/h - 1/sinB - tanB/2) (3.14)

Na= WaCosB (3.15)

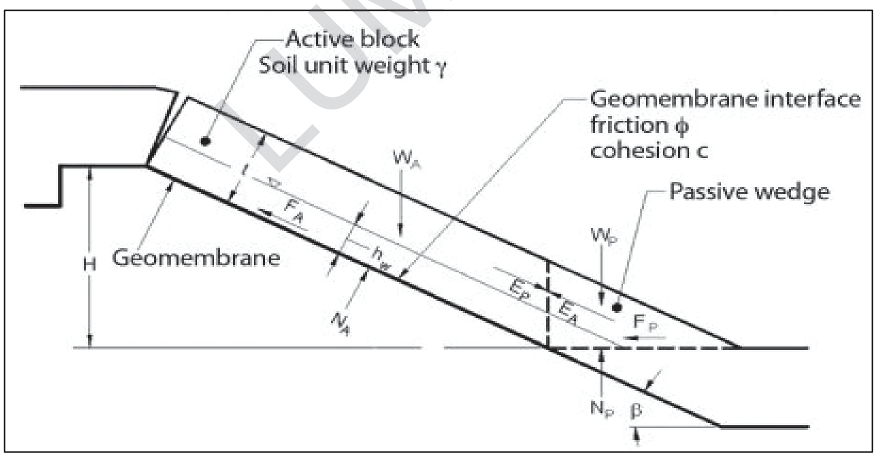
Wp= Yh^2/Sin2B (3.17)

a=(Wa-NaCosB)CosB

b=-[(Wa-NaCosB)sinB*tanPhi+(NaTanDelta+Ca)SinBCosB+sinB(C+WpTanPhi)]

c=(NaTanDelta+Ca)Sin^2BTanPhi

$$FS = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad (3.22)$$



FREE BODY DIAGRAM

LANDFILL COVER SLOPE STABILITY ANALYSIS - PDP-5
Martin Lake Steam Electric Station, near Beckville, Texas

INPUT PARAMETERS:

Delta	19	21	23	25	27	degrees
Y	115	115	115	115	115	pcf
Phi	15	15	15	15	15	degrees
h	1.5	1.5	1.5	1.5	1.5	feet
L	500	500	500	500	500	feet
B	5.7	5.7	5.7	5.7	5.7	degrees
Ca	0	0	0	0	0	
ca	0	0	0	0	0	
C	0	0	0	0	0	
c	0	0	0	0	0	

CALCULATIONS:

Wa	83,631.86	83,631.86	83,631.86	83,631.86	83,631.86	lb/ft
Wp	1,309.08	1,309.08	1,309.08	1,309.08	1,309.08	lb/ft
Na	83,218.35	83,218.35	83,218.35	83,218.35	83,218.35	lb/ft
a	820.92	820.92	820.92	820.92	820.92	
b	-2,888.67	-3,213.83	-3,547.83	-3,891.87	-4,247.31	
c	75.99	84.71	93.67	102.91	112.44	
FS	**3.49**	**3.89**	**4.30**	**4.71**	**5.15**	

NOTES/ASSUMPTIONS:

- Assumes cap system includes, from bottom to top: 1 foot compacted clay subgrade, 40 mil textured FML, double-sided geocomposite drainage layer (geotextile on both sides), and 1.5 feet of vegetative cover soil.
- Assumes slopes of 10(h):1(v) (5.7deg).
- Assumes solid waste is stable (stability of waste not evaluated).
- Dynamic loading associated with construction or operations equipment were not evaluated. Use of construction methods protective of the liner system are assumed.
- Assumes effective lateral drainage layer and drained cover soil conditions prevents excess pore water pressure.
- Assumes no landfill gas migration into cap components.
- Interface friction angles between geotextile and soil, and between FML and geotextile are considered. For conservative evaluation purposes, no contribution of material tensile strengths, adhesion, or cohesion are considered for increased stability.
- Sensitivity analysis indicates very little effect on FS with moderate (plus or minus 10 pcf) change in soil unit weight and soil friction angle (plus or minus 10 degrees) parameters, but is very sensitive to variation in interface friction angles therefore, 5 different interface friction angles (19, 21, 23, 25, and 27) were evaluated. Typical values for interface friction angle are provided in attachments. GRI30 - Appendix Table 1 (Geosynthetics Research Institute, Direct Shear Database of Geosynthetic-to-Geosynthetic and Geosynthetic-to-Soil Interfaces - Koerner, Narejo, June 14, 2005) is attached.
- Assumes cover soil of uniform thickness and constant unit weight. Unit weight of 115 pcf, and friction angle of 15 degrees assumed.
- Due to lack of available on-site soil data, generalized soil engineering properties were assumed. A general range of synthetic material interface friction angles (with soil and other synthetic materials) were also assumed. Use of actual on-site soil materials and proposed synthetic materials for follow up laboratory testing and slope stability analysis is recommended prior to construction. Testing should include interface friction angle (and internal friction angle, as appropriate) measurements for all materials.
- Maximum slope length of less than 500 feet measured from preliminary design drawings, 500 feet was conservatively used in calculations.

ATTACHMENT 2

GRI30 – Appendix Table 1

Geosynthetic Research Institute
475 Kedron Avenue
Folsom, PA 19033-1208 USA
TEL (610) 522-8440
FAX (610) 522-8441

Direct Shear Database of Geosynthetic-to-Geosynthetic and Geosynthetic-to-Soil Interfaces

by

George R. Koerner, Ph.D., P.E.
Geosynthetic Research Institute
Folsom, PA 19033-1208
gkoerner@dca.net

and

Dhani Narejo, Ph.D.
GSE Lining Technology, Inc.
Houston, TX 77073
dnarejo@gseworld.com

GRI Report #30

June 14, 2005

Appendix Table 1. Summary of interface shear strengths.

Interface 1*	Interface 2*	Peak Strength					Residual Strength				
		Fig. No.	δ (deg)	Ca (kPa)	Points	R^2	Fig. No.	δ (deg)	Ca (kPa)	Points	R^2
HDPE-S	Granular Soil	1a	21	0	162	0.93	1b	17	0	128	0.92
HDPE-S	Cohesive Soil										
	Saturated	1c	11	7	79	0.94	1d	11	0	59	0.95
	Unsaturated	1c	22	0	44	0.93	1d	18	0	32	0.93
HDPE-S	NW-NP GT	1e	11	0	149	0.93	1f	9	0	82	0.96
HDPE-S	Geonet	1g	11	0	196	0.90	1h	9	0	118	0.93
HDPE-S	Geocomposite	1i	15	0	36	0.97	1j	12	0	30	0.93
HDPE-T	Granular Soil	2a	34	0	251	0.98	2b	31	0	239	0.96
HDPE-T	Cohesive Soil										
	~~Saturated~~	~~2c~~	~~18~~	~~10~~	~~167~~	~~0.93~~	~~2d~~	~~16~~	~~0~~	~~150~~	~~0.90~~
	Unsaturated	2c	19	23	62	0.91	2d	22	0	35	0.93
HDPE-T	NW-NP GT	2e	25	8	254	0.96	2f	17	0	217	0.95
HDPE-T	Geonet	2g	13	0	31	0.99	2h	10	0	27	0.99
HDPE-T	Geocomposite	2i	26	0	168	0.95	2j	15	0	164	0.94
LLDPE-S	Granular Soil	3a	27	0	6	1.00	3b	24	0	9	1.00
LLDPE-S	Cohesive Soil	3c	11	12.4	12	0.94	3d	12	3.7	9	0.93
LLDPE-S	NW-NP GT	3e	10	0	23	0.63	3f	9	0	23	0.49
LLDPE-S	Geonet	3g	11	0	9	0.99	3h	10	0	9	1.00
LLDPE-T	Granular Soil	4a	26	7.7	12	0.95	4b	25	5.2	12	0.95
LLDPE-T	Cohesive Soil	4c	21	5.8	12	1.00	4d	13	7.0	9	0.98
LLDPE-T	NW-NP GT	4e	26	8.1	9	1.00	4f	17	9.5	9	0.96
LLDPE-T	Geonet	4g	15	3.6	6	0.97	4h	11	0	6	0.98
PVC-S	Granular Soil	5a	26	0.4	6	0.99	5b	19	0	6	0.99
PVC-S	Cohesive Soil	5c	22	0.9	11	0.88	5d	15	0	9	0.95
PVC-S	NW-NP GT	5e	20	0	89	0.91	5f	16	0	83	0.74
PVC-S	NW-HB GT	5g	18	0	3	1.00	5h	12	0.1	3	1.00
PVC-S	Woven GT	5i	17	0	6	0.54	5j	7	0	6	0.93
PVC-S	Geonet	5k	18	0.1	3	1.00	5l	16	0.6	3	1.00

Appendix Table 1. (continued)

Interface 1*	Interface 2*	Peak Strength					Residual Strength				
		Fig. No.	δ (deg)	Ca (kPa)	Points	R^2	Fig. No.	δ (deg)	Ca (kPa)	Points	R^2
PVC-F	NW-NP GT	6a	27	0.2	26	0.95	6b	23	0	26	0.95
PVC-F	NW-HB GT	6c	30	0	8	0.97	6d	27	0	8	0.90
PVC-F	Woven GT	6e	15	0	6	0.78	6f	10	0	6	0.76
PVC-F	Geonet	6g	25	0	11	1.00	6h	19	0	11	0.99
PVC-F	Geocomposite	6i	27	1.1	5	1.00	6j	22	4.7	6	1.00
CSPE-R	Granular Soil	7a	36	0	3	1.00	7b	16	0	3	1.00
CSPE-R	Cohesive Soil	7c	31	5.7	6	0.71	7d	18	0	6	0.99
CSPE-R	NW-NP GT	7e	14	0	6	0.97	7f	10	0	6	0.98
CSPE-R	NW-HB GT	7g	21	0	3	1.00	7h	10	0	3	1.00
CSPE-R	Woven GT	7i	11	0	6	0.92	7j	11	0	3	1.00
CSPE-R	Geonet	7k	28	0	9	0.87	7l	16	0	9	0.80
NW-NP GT	Granular Soil	8a	33	0	290	0.97	8b	33	0	117	0.96
NW-HB GT	Granular Soil	8c	28	0	6	0.99	8d	16	0	6	0.91
Woven GT	Granular Soil	8e	32	0	81	0.99	8f	29	0	28	0.98
NW-NP GT	Cohesive Soil	9a	30	5	79	0.96	9b	21	0	28	0.79
NW-HB GT	Cohesive Soil	9c	29	0.9	15	0.71	9d	10	0	15	0.83
Woven GT	Cohesive Soil	9e	29	0	34	0.94	9f	19	0	16	0.86
GCL Reinforced (internal)	N/A	10a	16	38	406	0.85	10b	6	12	182	0.91
GCL (NW-NP GT)	HDPE-T	11a	23	8	180	0.95	11b	13	0	157	0.90
GCL (W-SF GT)	HDPE-T	11c	18	11	196	0.96	11d	12	0	153	0.92
Geonet	NW-NP GT	12a	23	0	52	0.97	12b	16	0	32	0.97
Geocomposite (NW-NP GT)	Granular Soil	13a	27	14	14	0.86	13b	21	8	10	0.92

APPENDIX D

STORMWATER HYDROLOGY CALCULATIONS

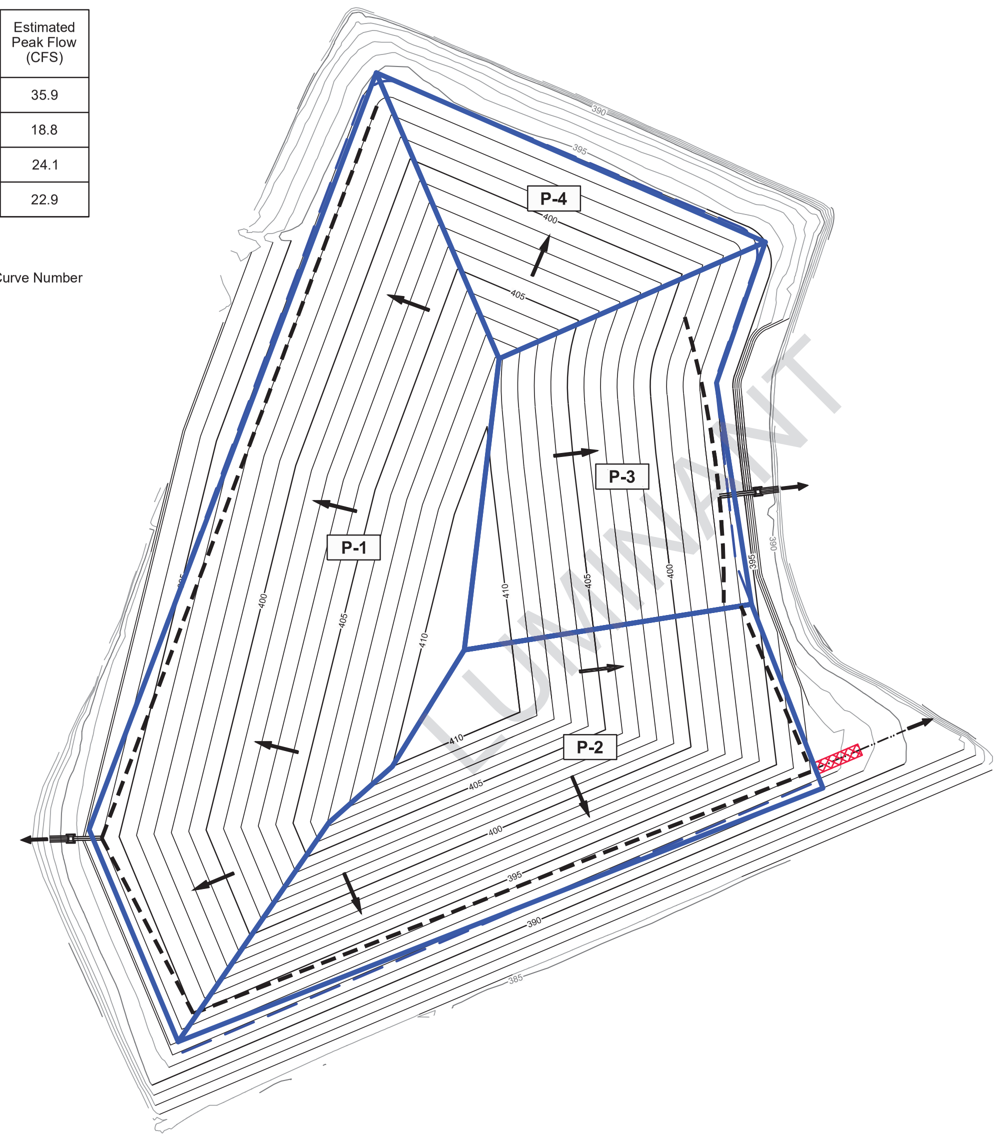
Summary of Peak Flow Estimate - SCC TR-55 Method
Luminant - PDP-5 - MLSES

SCS TR-55 Equation & Variables	
Q_p= Qu*Area (miles2)* Q*Fp	
Q_p= Estimated Peak Discharge (cfs)	Q= $(P-I_a)^2/(P-I_a) + S)$
Q_u=Unit Peak Discharge (cfs/mile2-inch)	P= Design Storm Rainfall (inches)
A= Area (square miles)	Ia=0.2S (Initial abstractions; inches)
Q= Rainfall Excess (Depth of Runoff Over Watershed)	S= 1000/CN-10
F_p= Ponding Factor (% of ponds/swamps)	CN= SCS Curve Number

Drainage Area I.D.	Area (acres)	Area (mi^2)	Composite Curve Number	Estimated Peak Flow (CFS) Q_p	P (25yr,24hr)	S	I_a	Q	I_a/P	TIME OF CONCENTRATION ESTIMATE							Q_u	F_p
										v1=aS^.5 fps	v2	Cap/Overland Flow T_t (Min.)	Estimated Time of Concen. (Min.)	CAP Roughness Coeff (Table 3.20)	Cap Slope (ft/ft)	Conc. Flow Slope (ft/ft)		
P-1	17.36	0.0271	86	35.9	8.6	1.63	0.33	6.91	0.04	0.43	0.18	129	129	2.5	0.03	0.005	191.5	1
P-2	10.98	0.0172	86	18.8	8.6	1.63	0.33	6.91	0.04	0.56	0.11	172	172	2.5	0.05	0.002	158.8	1
P-3	7.49	0.0117	86	24.1	8.6	1.63	0.33	6.91	0.04	0.43	0.18	60	60	2.5	0.03	0.005	297.9	1
P-4	4.2	0.0066	86	22.9	8.6	1.63	0.33	6.91	0.04	0.43	-	17	17	2.5	0.03	-	504.9	1

Drainage Area I.D.	Area (Acres)	Composite Curve No.	Estimated Peak Flow (CFS)
P-1	17.36	86	35.9
P-2	10.98	86	18.8
P-3	7.49	86	24.1
P-4	4.2	86	22.9

Note:
Estimated Peak Discharge based on SCS Curve Number Method for 25-year/24-hour storm event.



EXPLANATION

- Proposed Finished Grade Contour 1 ft Interval
- Proposed Finished Grade Contour 5 ft Interval
- Limits of CAP
- Sheet Flow
- Concentration Flow Path
- Storm Water Drainage Divide

N

Scale in Feet
0 125 250

LUMINANT GENERATION COMPANY, LLC
MARTIN LAKE STEAM ELECTRIC STATION

Appendix D

CCR COVER SYSTEM DRAINAGE AREAS AND ESTIMATED PEAK DISCHARGE

PROJECT: 5196B	BY: AJD	REVISIONS
DATE: SEPT., 2016	CHECKED: BDT	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS

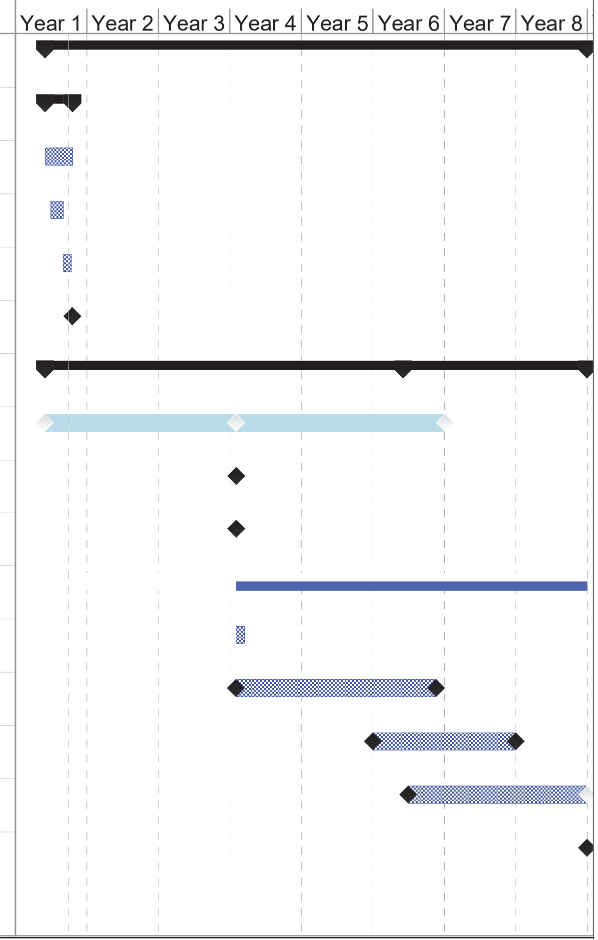
APPENDIX E

PROJECT SCHEDULE – CCR CLOSURE PROCESS

Thu 9/29/16

APPENDIX E
PROJECT SCHEDULE - CCR UNIT CLOSURE PROCESS

ID	Task Name
1	**MLSES PERMANENT DISPOSAL POND-5 - CLOSURE PLAN**
2	**TASK-1 257.102 Closure Planning for CCR Units**
3	**Preparation of Closure Plan**
4	Review Draft Closure Plan
5	Revise Draft Closure Plan
6	Finalize Closure Plan
7	**Task 2 - 257.102 (d) Closure In-Place of CCR Unit (Permanent Disposal Pond-5)**
8	**Closure Triggers**
9	Closure Initiated within 2-years of Last Receipt of Waste
10	Closure Initiated within 2-years of Last Beneficial Use of CCR
11	**Closure Sequence**
12	TPDES Storm Water Construction General Permit NOI
13	CCR Dewatering
14	CCR Grading/Bridging Lift Placement
15	Construct Final Cover System
16	Closure Completion Deadline or 2-year Extension Note - Extension requires demonstration of infeasibility 257.102(f)(2))



Page 1

Task	Inactive Task	Manual Summary
Split	Inactive Task	Start-only
Milestone	Inactive Milestone	Finish-only
Summary	Inactive Summary	Progress
Project Summary	Manual Task	Deadline
External Tasks	Duration-only	
External Milestone	Manual Summary Rollup	

Notes: Schedule does not include administrative/legal/receiver activities. Closure initiation will be determined in accordance with the CCR Rule and this timeline only illustrates the anticipated construction sequencing following closure initiation.

REPORT

CLOSURE PLAN ADDENDUM NO. 1

Martin Lake Steam Electric Station - PDP-5
Rusk County, Texas

Submitted to:

Luminant Generation Company LLC

Submitted by:

WSP GOLDER

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Suite 325D
Austin, Texas, USA 78746
+1 737 703 3900

31404097.007

December 2022

PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by WSP Golder under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I hereby certify that Addendum No.1 to the Closure Plan for PDP-5 at the Martin Lake Steam Electric Station has been prepared in accordance with the requirements of 40 C.F.R. §257.102(b).

Patrick J. Behling, P.E.
Principal Engineer
WSP Golder
Texas Firm Registration No. 22771

Table of Contents

DOCUMENT REVISION RECORD

Issue No.	Date	Details of Revisions
Revision 0	October 2016	Original Document
Addendum 1	December 2022	Revised configuration of final cap/cover system for PDP-5, added equivalency determination for proposed alternative final cover system, added cap settlement evaluation, added confirmation that cap slope stability will be modeled using site-specific geotechnical data during final closure design, removal of HELP Modeling from Closure Plan, revised closure schedule to state closure will be completed within five years and add estimated completion year, added section addressing the initiation of closure, and added section to address notification citations.

1.0 INTRODUCTION

On behalf of Luminant Generation Company LLC (Luminant), WSP Golder (Golder) has prepared this Addendum No. 1 to the Closure Plan for Permanent Disposal Pond No. 5 (PDP-5) located at the Martin Lake Steam Electric Station (MLSES) in Rusk County, Texas (hereafter, the "Site"). Coal Combustion Residuals (CCR) including flue gas desulfurization (FGD) wastewater and bottom ash generated as part of MLSES operation are managed in PDP-5. PDP-5 is regulated as an Existing CCR Impoundment under 40 C.F.R. § 257, Subpart D (the "CCR Rule").

The original Closure Plan for PDP-5 was prepared in October 2016 in accordance with 40 C.F.R. §257.102(b) and placed in the MLSES operating record in accordance with 40 C.F.R. §257.105(h)(10) (PBW, 2016). This Addendum No. 1 updates the Closure Plan to reflect the following:

- Revisions to the configuration of the PDP-5 final cap/cover system;
- Addition of equivalency determination for proposed alternative final cover system for PDP-5;
- Addition of cap settlement evaluation;
- Confirmation that the slope stability of the PDP-5 cap/cover system will be modeled using site-specific geotechnical data during design of the final closure of the impoundment;
- Removal of HELP Modeling from Closure Plan;
- Revisions to the PDP-5 closure schedule to state closure will be completed within five years and add estimated completion year;
- Addition of section addressing the initiation of PDP-5 closure; and
- Addition of section to address notification citations.

2.0 PDP-5 FINAL CAP/COVER SYSTEM

PDP-5 is an approximately 31-acre surface impoundment that was constructed in 2010 over three closed PDPs. PDP-5 was constructed above grade and is surrounded by earthen embankments that extend approximately 10 to 15 feet above the adjacent ground surface.

PDP-5 is constructed with a compacted clay liner (CCL) measuring 3 feet thick on the sides of the perimeter berms and 2 feet thick on the bottom of the impoundment. The CCL exhibits a hydraulic conductivity of no more than 1 X 10^{-7} cm/sec. The PDP-5 CCL is:

- Not a composite liner that meets the requirements of 40 C.F.R. §257.70(b) as specified in §257.71(a)(1)(ii) of the CCR Rule; and
- Not an alternative composite liner that meets the requirements of 40 C.F.R. §257.70(c) as specified in §257.71(a)(1)(iii) of the CCR Rule.

In November 2021, pursuant to 40 C.F.R. §257.71(d)(1)(ii), Luminant submitted an Alternate Liner Demonstration (ALD) for PDP-5 to USEPA to demonstrate that, based on the construction of PDP-5 and surrounding site conditions, there is no reasonable probability that operation of PDP-5 will result in concentrations of Appendix IV constituents in the uppermost aquifer at levels above a groundwater protection standard beyond the boundaries of the CCR Unit (Golder, 2021). To date, Luminant has not received a response from USEPA regarding the ALD.

A final cap/cover system will be constructed over the CCR placed in PDP-5 as part of unit closure as described in the 2016 Closure Plan (PBW, 2016). The 2016 Closure Plan included two options for the final cap/cover system: a compacted clay cap system and a geosynthetic cap system; however, the final cap/cover system for PDP-5 has been revised to consist of the following (from bottom to top):

- a geosynthetic clay liner (GCL) with a maximum hydraulic conductivity of 5x10^{-9} cm/sec and a minimum thickness of 6 mm;
- a 40-mil linear low-density polyethylene (LLDPE) textured geomembrane;
- a geosynthetic drainage layer; and
- a 18-inch erosion layer consisting of 12 inches of general fill overlain with 6 inches of soil capable of supporting native vegetation.

The proposed final cap/cover system for PDP-5 is an alternative final cover system that must comply with the requirements of 40 C.F.R. §257.102(d)(3)(ii)(A) through (C):

(A) The design of the final cover system must include an infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified in paragraphs 40 C.F.R. §257.102(d)(3)(i)(A) and (B).

(B) The design of the final cover system must include an erosion layer that provides equivalent protection from wind or water erosion as the erosion layer specified in paragraph 40 C.F.R. §257.102(d)(3)(i)(C).

(C) The disruption of the integrity of the final cover system must be minimized through a design that accommodates settling and subsidence.

2.1 Equivalent Infiltration Reduction – PDP-5 Cap/Cover System

The final cap/cover system for PDP-5 must include an infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified in paragraphs 40 C.F.R. §257.102(d)(3)(i)(A) and (B):

(A) The permeability of the final cover system must be less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1×10^{-5} cm/sec, whichever is less.

(B) The infiltration of liquids through the closed CCR unit must be minimized by the use of an infiltration layer that contains a minimum of 18 inches of earthen material.

2.1.1 Permeability Comparison Between PDP-5 Cap System and Liner System

Compliance of the final cap/cover system to the requirements of 40 C.F.R. §257.102(d)(3)(i)(A) was determined by comparing the estimated liquid flow rate through the low permeability components of the PDP-5 final cap/cover system to the estimated liquid flow rate through the 2-feet thick PDP-5 CCL (The permeability of the GCL component of the PDP-5 cap/cover system is less than $1 \text{ X } 10^{-5}$ cm/sec, so this criterion is not applicable). The results of the comparison are presented below.

- Estimated Liquid Flow Through PDP-5 Final Cap/Cover System

  The low permeability components of the PDP-5 cap/cover system are a GCL with a maximum hydraulic conductivity of $5\text{x}10^{-9}$ cm/sec and a minimum thickness of 6 mm and a 40-mil LLDPE geomembrane. The liquid flow rate through the cap (per acre of cap area) was estimated using the Giroud Equation as follows (Giroud, 1997):

  - Giroud Equation: $Q = N \text{ X } C\ [1 + 0.1(h/t)^{0.95}] \text{ X } a^{0.1} \text{ X } h^{0.9} \text{ X } k^{0.74}$

    where: Q = flow rate through the liner (m^3/s)

    N = number of geomembrane defects per acre of cap area

    C = contact coefficient (0.05 for excellent, 0.21 for good, and 1.25 for poor)

    h = head above liner (m)

    t = thickness of soil portion of the liner (m)

    a = assumed area of defect in geomembrane through which leak occurs (m^2)

    k = hydraulic conductivity of the GCL portion of the liner (m/s)

  - Assumptions:

    1) The GCL is assumed to have a maximum hydraulic conductivity of $5\text{x}10^{-9}$ cm/sec and a minimum thickness of 6 mm.

    2) The hydraulic head above the cap geomembrane and GCL is assumed to be 12 inches (30.48 cm). This is a conservative assumption for the cap, since the final cap/cover system will be sloped and includes a geosynthetic drainage layer to divert water that infiltrates through the overlying erosion soil layer away from the cap.

    3) Geomembranes are nearly impermeable to liquids; however, liquids typically pass through holes/defects in the geomembrane. The area of a hole (defect) in the geomembrane was estimated to be 1 cm^2. For a typical geomembrane installed using good installation techniques, it is estimated that 4 defects (holes) occur per acre of geomembrane.

  - Liquid Flow Rate Through Cap Geomembrane and GCL

    N = 4 per acre (assume good geomembrane installation)

    C = 0.21 (assume good contact between geomembrane and GCL)

h = 1 foot x 30.48cm/ft = 30.48 cm (0.3048 m)

t = 6 mm x 0.001 m/mm = 0.006 m for GCL

a = 1 cm^2 (0.0001 m^2) for the area of the hole (defect) in the geomembrane

k = $5x10^{-9}$ cm/sec ($5 X 10^{-11}$ m/sec) for GCL

Q = 4 X 0.21 [1 + $0.1(0.3048/0.006)^{0.95}$] X $0.0001^{0.1}$ X $0.3048^{0.9}$ X $(5EE\text{-}11)^{0.74}$

= 0.84 [1 + 4.1742] X 0.3981 X 0.3433 X 2.38EE-8

= <u>$1.42 X 10^{-8}$ m^3/s per acre of cap or 0.32 gallons per day per acre of cap</u>

- <u>Estimated Liquid Flow Through PDP-5 CCL</u>

  PDP-5 is lined with a 2-feet thick CCL with a maximum hydraulic conductivity of $1x10^{-7}$ cm/sec. Flow rate through the PDP-5 CCL (per acre of cap area) was estimated using Darcy's Law for gravity flow through porous media as follows:

  - <u>Darcy Equation</u>: Q=A X k X (h/t+1)

    Where:

    Q = flow rate through the CCL (m^3/s)

    A = CCL area perpendicular to the flow (m^2)

    h = head above CCL (m)

    t = thickness of CCL (m)

    k = hydraulic conductivity of CCL (m/s)

  - <u>Assumptions</u>:

    1) The 2-feet thick CCL is assumed to have a maximum hydraulic conductivity of $1x10^{-7}$ cm/sec.

    2) The hydraulic head above the CCL was assumed to be 12 inches (30.48 cm). This is a reasonable assumption for the CCL, since the CCR in PDP-5 will be dewatered prior to capping/closure.

    3) CCL area is assumed to be 1 acre to match area used for the above PDP-5 geomembrane/GCL cap flow rate evaluation.

  - <u>Flow Rate Through 2-feet Thick CCL</u>

    A = 1 acre (4046.86 m^2)

    k = $1x10^{-7}$ cm/sec ($1 X 10^{-9}$ m/sec)

    h = 1 foot x 30.48 cm/ft = 30.48 cm (0.3048 m)

    t = 2 feet X 30.48 cm/ft = 60.96 cm (0.6096 m)

    Q = (4046.86 m^2) x ($1x10^{-9}$ m/sec) x ((0.3048 m / 0.6096 m) + 1)

    = <u>$6.07x10^{-6}$ m^3/s per acre of cap or 138 gallons per day per acre of cap</u>

The final cap/cover system for PDP-5 complies with the requirements of 40 C.F.R. §257.102(d)(3)(i)(A), since the estimated liquid flow rate through the final cap/cover system (0.32 gallons per acre per day) is significantly less than the estimated liquid flow rate through the 2-feet thick PDP-5 CCL (138 gallons per acre per day).

2.2.2 Infiltration Comparison of PDP-5 Cap to 18-Inch Earth Infiltration Layer

Compliance of the final cap/cover system to the requirements of 40 C.F.R. §257.102(d)(3)(i)(B) was determined by comparing the estimated liquid flow rate through the low permeability components of the PDP-5 final cap/cover system to the estimated liquid flow rate through the specified minimum of 18 inches of earthen material. The results of the comparison are presented below.

- Estimated Liquid Flow Through PDP-5 Final Cap/Cover System

  As shown above, the estimated liquid flow rate through the final cap/cover system is estimated to be 0.32 gallons per acre per day.

- Estimated Liquid Flow Through 18-inch Earthen Infiltration Layer

  The 18-inch earthen infiltration layer is assumed to consist of compacted clay with a maximum hydraulic conductivity of $1x10^{-7}$ cm/sec. Flow rate through the infiltration layer was calculated using Darcy's Law for gravity flow through porous media as follows:

  - Darcy Equation: $Q=A \times k \times (h/t+1)$

    Where:

    Q = flow rate through the Infiltration Layer (m^3/s)

    A = Cap area perpendicular to the flow (m^2)

    h = head above Infiltration Layer (m)

    t = thickness of Infiltration Layer (m)

    k = hydraulic conductivity of Infiltration Layer (m/s)

  - Assumptions:

    1) The 18-inch infiltration layer is assumed to have a maximum hydraulic conductivity of $1x10^{-7}$ cm/sec.
    2) The hydraulic head above the infiltration layer was assumed to be 12 inches (30.48 cm). This is a conservative assumption for the infiltration layer, since the final cap/cover system will be sloped to divert water that infiltrates through the overlying erosion soil layer away from the infiltration layer.
    3) Cap area for evaluation is assumed to be 1 acre to match area used for the above PDP-5 geomembrane/GCL cap evaluation.

  - Flow Rate Through 18-inch Infiltration Layer

    A = 1 acre (4046.86 m^2)

    k = $1x10^{-7}$ cm/sec (1×10^{-9} m/sec)

    h = 1 foot x 30.48 cm/ft = 30.48 cm (0.3048 m)

    t = 18 inches X 2.54 cm/in = 45.72 cm (0.4572 m)

$$Q = (4046.86\ m^2) \times (1\times10^{-9}\ m/sec) \times ((0.3048\ m / 0.4572\ m) + 1)$$

$$= \underline{6.75\times10^{-6}\ m^3/s \text{ per acre of cap or 154 gallons per day per acre of cap}}$$

The final cap/cover system for PDP-5 complies with the requirements of 40 C.F.R. §257.102(d)(3)(i)(B), since the estimated liquid flow rate through the final cap/cover system (0.32 gallons per acre per day) is significantly less than the estimated liquid flow rate through an 18-inch thick infiltration layer (154 gallons per acre per day).

2.2 Equivalent Erosion Protection – PDP-5 Cap/Cover System

The final cap/cover system for PDP-5 includes an 18-inch erosion layer consisting of 12 inches of general fill overlain with 6 inches of soil capable of supporting native vegetation. This complies with the requirements of 40 C.F.R. §257.102(d)(3)(ii)(B), which states that the final cover system must use of an erosion layer that contains a minimum of six inches of earthen material that is capable of sustaining native plant growth.

2.3 Settling and Subsidence – PDP-5 Cap/Cover System

40 C.F.R. §257.102(d)(3)(i)(D) states that the disruption of the integrity of the final cover system must be minimized through a design that accommodates settling and subsidence. An evaluation of potential settlement for the final cap/cover system for PDP-5 is attached as Appendix A to this Addendum. The PDP-5 Closure Plan will be updated to include a cap/cover system settlement evaluation using site-specific data during design of the final cap/closure system for PDP-5.

2.4 Slope Stability – PDP-5 Cap/Cover System

The PDP-5 Closure Plan will be updated to include cap/cover system slope stability modeling using site-specific geotechnical data during design of the final cap/closure system for PDP-5.

2.5 HELP Modeling in 2016 Closure Plan

The 2016 Closure Plan for PDP-5 included Hydrologic Evaluation of Landfill Performance (HELP) model evaluations to compare the permeability of the then-proposed cap options against each other and to the PDP-5 bottom liner system (PBW, 2016). The HELP model evaluations in the 2016 Closure Plan have been replaced by the infiltration evaluations presented above for the new cap/cover system and have been deleted from this amended Closure Plan.

2.6 Conclusions

The final cap/cover system for PDP-5 described above is an alternative final cover system that complies with the requirements of 40 C.F.R. §257.102(d)(3)(ii)(A) through (C).

3.0 PDP-5 CLOSURE SCHEDULE AND NOTIFICATION UPDATES

The closure schedule for PDP-5 is described in Section 2.7 and Appendix E of the 2016 Closure Plan (PBW, 2016). The 2016 PDP-5 Closure Schedule is updated as follows:

- Initiation of PDP-5 Closure. For the purposes of the PDP-5 Closure Schedule, Luminant estimates that the MLSES will cease operations in approximately 2045. However, CCR and related waste will continue to be generated after plant operation has terminated as part of facility decommissioning and demolition and the CCR and related waste may be managed in PDP-5. In accordance with 40 C.F.R. §257.102(e)(2)(i), PDP-5 will commence closure within two years of the date of final receipt of either CCR or non-CCR waste; however, in accordance with 40 C.F.R. §257.102(e)(2)(ii) an additional two years may be required to initiate closure provided Luminant provides written documentation that PDP-5 will continue to accept wastes beyond the original two-year period. For the purposes of the PDP-5 Closure Schedule, Luminant estimates that PDP-5 Closure will be initiated in approximately 2047.
- Completion of PDP-5 Closure. In accordance with 40 C.F.R. §257.102(f)(1)(ii), Luminant estimates that final closure of PDP-5 will be completed within 5 years of start of closure or in approximately 2052. It should be noted; however, that 40 CFR §257.102(f)(2) of the CCR Rule allow for extension of the closure schedule in the event that it is not feasible to complete closure of PDP-5 within the required timeframes due to factors beyond the facility's control.

Luminant will provide the following notifications related to closure of PDP-5:

- In accordance with 40 C.F.R. §257.102(g), Luminant will prepare a notification of intent to close PDP-5. The notice will be prepared no later than the date of closure initiation, will be sealed by a qualified professional engineer, and will be placed in the MLSES operating record as required by 40 C.F.R. §257.105(i)(7).
- In accordance with 40 C.F.R. §257.102(h), Luminant will prepare a notification of closure of PDP-5 within 30 days of completion of closure. The notice will be sealed by a qualified professional engineer and will be placed in the MLSES operating record as required by 40 C.F.R. §257.105(i)(8).
- In accordance with 40 C.F.R. §257.102(h) Luminant will provide deed notification for the PDP-5 Closure.

4.0 REFERENCES

Giroud, J.P., “Equations for Calculating the Rate of Liquid Migration Through Composite Liners Due to Geomembrane Defects”, Geosynthetics International, Vol. 4, Nos. 3-4, pp. 335-348, 1997.

Golder Associes (Golder), 2021. Alternate Liner Demonstration – Martin Lake Steam Electric Station PDP-5. November 30.

Pastor, Behling & Wheeler, LLC (PBW), 2016. CCR Closure Plan – Permanent Disposal Pond 5, Martin Lake Steam Electric Station. October.

APPENDIX A

Evaluation of Cap/Cover System Settlement

December 6, 2022

Mr. Pat Behling
WSP Golder
1601 S MoPac Expressway
Suite 325D
Austin, Texas, USA 78746

Re: Evaluation of Potential for Impoundment Cap Settlement, PDP-5 – Martin Lake Steam Electric Station, Rusk County, Texas

Dear Mr. Behling:

As requested by WSP Golder, Bullock, Bennett & Associates, LLC (BBA) has evaluated the proposed cap system at the PDP-5 surface impoundment at the Martin Lake Steam Electric Station (MLSES) located in Rusk County, Texas – specifically in regard to the suitability of the proposed cap system to accommodate anticipated settlement. This evaluation is based on the most recent design drawings dated September 2016, provided to BBA by WSP Golder. No site-specific geotechnical data for the coal combustion residuals (CCR) fill material was provided to BBA for this analysis, and no site-specific consolidation or settlement data for on-site soils were provided; therefore, general assumptions regarding typical soil and CCR properties are made in this evaluation. It is BBA's understanding that site-specific soils and CCRs will be tested for engineering properties and that a detailed engineering settlement analysis using the on-site data and final design criteria will be completed prior to final cap construction activities.

The original Closure Plan for PDP-5 was prepared in October 2016 (PBW, 2016). The 2016 Closure Plan included options for two different cap configurations, one including synthetic components and the other including use of a compacted clay liner system. On December 6, 2022, WSP Golder prepared Addendum No.1 to the PDP-5 Closure Plan and revised the PDP-5 final cap/cover system to be as follows, from bottom to top (WSP Golder, 2022):

- a geosynthetic clay liner (GCL) with a maximum hydraulic conductivity of 1×10^{-9} cm/sec and a minimum thickness of 6 mm;
- a 40-mil linear low-density polyethylene (LLDPE) textured geomembrane;
- a geosynthetic drainage layer; and
- an 18-inch-thick erosion layer consisting of 12 inches of general fill overlain with 6 inches of soil capable of supporting native vegetation.

The grades, slopes, etc. for the revised PDP-5 final cap/cover system will remain as presented in the 2016 PDP-5 Closure Plan.

The cap system will tie into the perimeter earth embankment system, which has a crest height of approximately 405.5 feet MSL, ranging from approximately 10- to 15- feet above the surrounding natural grades. The perimeter earth embankment was constructed in thin lifts of compacted embankment fill meeting engineering specifications.

Engineering Properties of CCR Fill Material Underlying the Proposed Cap System:

CCR fill materials for PDP-5 include bottom ash and flue gas desulfurization material (FGD, or gypsum). These CCRs are non-plastic and moderately to highly permeable (typically drain better than clays and silts) and are well suited as fill materials[1,2,3]. The coefficient of consolidation of bottom ash when compared to typical soils is typically low and decreases with incremental loading and time. This indicates the bottom ash possesses load taking ability and that structures, or in this case a cap system, lying above the ash will undergo gradual settling and not suffer large deformation - making ash well suited as a fill material.[1] According to the American Coal Ash Association approximately 3.63. million metric tons (4.0 million tons) of bottom ash were used in structural fill applications in 2006 (ACAA 2007). Structural fill and embankment material is the largest use of bottom ash in the US.[2] FGD material has engineering properties that also make it suitable for use as embankment fill.[3] BBA has experience in capping multiple impoundments and landfills in Texas containing bottom ash and gypsum and has performed annual engineering inspections for years following final capping activities at these facilities and has observed very little cap settlement.

Based upon review of the PDP-5 bottom and proposed cap elevations, it appears there will be a layer of CCRs approximately 10- to 15-feet thick under the proposed cap system. These CCR materials will be dewatered prior to initiating cap construction activities.

Subsurface Conditions:
PDP-5 was constructed above three closed in-place, non-CCR Rule regulated, former coal ash surface impoundments (PDP-1, PDP-2 and PDP-3) that historically received similar coal ash waste to that of PDP-5. The bottom liner system of PDP-5 is separated from the top of the underlying closed and capped PDP-1, 2 and 3 units by approximately 10- to 15-feet of compacted clay fill material. The closed PDP-1, 2 and 3 units contain ash up to 20-feet thick in areas (below their compacted clay caps) - the ash was dewatered prior to closure of PDP-1 and 2 in the early 1980s, and PDP-3 in approximately 2010.

Native soils underlying the former PDP-1, 2 and 3 appear to be compacted clay fill, silts and sand. Based on the description of subsurface conditions, large settlement of subsurface soils is not expected.

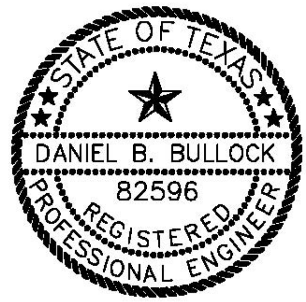
Based on review of the proposed cap system and technical specifications for materials and placement, evaluation of typical CCR engineering properties, the perimeter embankment system, and the site underlying subsurface conditions, it appears the cap design for PDP-5 is designed appropriately to accommodate settling and subsidence and will minimize the disruption of the integrity of the final capping system. Final cap grade designs include a 3% slope that will promote storm water drainage off the cap system, and these slopes appear sufficient to accommodate anticipated settlement while continuing to maintain positive surface water drainage. In addition, MLSES will conduct regularly scheduled cap inspections during post-closure care, and any settlement identified will be addressed to maintain cap design functions.

Please feel free to contact me at (512) 355-9198 if you have any questions about this submittal, or if I can be of any further assistance.

Sincerely,

Bullock, Bennett & Associates, LLC

Dan Bullock, PE (TX 82596)
Principal Engineer
Texas Professional Engineering Firm No. F-8542



12/06/2022

(1) One-Dimensional Consolidation of Sedimented Stowed Pond Ash, Devi Presad Mishra and Samir Kumar Das Document: Geotech Geol Eng (2012) 30:685-695 DOI 10.1007/s10706-011-9486-x
(2) User Guideline for Coal Bottom Ash and Boiler Slag in Green Infrastructure construction, Craig H. Benson and Sabrina Bradshaw. December 2011. Recycled Materials Resource Center, University of Wisconsin-Madison.
(3) User Guideline for Flue Gas Desulfurization Material in Green Infrastructure construction, Craig H. Benson and Sabrina Bradshaw. December 2011. Recycled Materials Resource Center, University of Wisconsin-Madison

CCR POST-CLOSURE PLAN
MARTIN LAKE STEAM ELECTRIC STATION
A-1 AREA LANDFILL
PANOLA COUNTY, TEXAS

October 2016

Prepared for:

LUMINANT GENERATION COMPANY, LLC
1601 Bryan Street (EP-27)
Dallas, Texas 75201

Prepared by:

PASTOR, BEHLING & WHEELER, LLC
5416 Plaza Drive
Texarkana, Texas 75503
Texas Engineering Firm No. 4760

PBW Project No. 5196B

PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by Pastor, Behling & Wheeler, LLC under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I hereby certify that this Post-Closure Plan has been prepared in accordance with the requirements of Section 257.104 of the CCR Rule.

STATE OF TEXAS
BRIAN D. THOMAS
91192
LICENSED
PROFESSIONAL ENGINEER
10/5/16

10/5/16
Brian Thomas, P.E.
Principal Engineer
PASTOR, BEHLING & WHEELER, LLC

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LIST OF FIGURES

1.0 INTRODUCTION

Luminant Generation Company, LLC (Luminant) owns and operates the Martin Lake Steam Electric Station (MLSES) located approximately five miles southwest of Tatum in Rusk County, Texas. The power plant and related support areas occupy approximately 700 acres on a peninsula on the southwest side of Martin Lake (Figure 1). The MLSES consists of three coal/lignite-fired units with a combined operating capacity of approximately 2,250 megawatts. Coal Combustion Residuals (CCR) including fly ash, bottom ash, gypsum are generated as part of MLSES unit operation. The CCRs are transported off-site for beneficial use by third-parties, are managed by Luminant on-site at Permanent Disposal Pond No. 5 (PDP-5) or are disposed at Luminant's A-1 Area Landfill.

The CCR Rule (40 CFR 257 Subpart D - *Standards for the Receipt of Coal Combustion Residuals in Landfills and Surface Impoundments*) has been promulgated by EPA to regulate the management and disposal of CCRs as solid waste under Resource Conservation and Recovery Act (RCRA) Subtitle D. The final CCR Rule was published in the Federal Register on April 17, 2015. The effective date of the CCR Rule was October 19, 2015.

The CCR Rule establishes national operating criteria for existing CCR surface impoundments and landfills, including development of post-closure plans (PCP) for all CCR impoundments and landfills. Pastor, Behling & Wheeler, LLC (PBW) was retained by Luminant to develop this PCP for the A-1 Area Landfill, which is located approximately 2.5 miles southwest of the MLSES within a reclaimed section of the Luminant Beckville Mine.

1.1 CCR Impoundment Post-Closure Care Requirements

Section 257.104 of the CCR Rule specifies the post-closure care requirements for existing CCR landfills that have been closed in accordance with 40 CFR 257.102 of the Rule. Following closure of the landfill, the owner/operator must conduct post-closure care for the unit, consisting of at least the following:

- Maintaining the integrity and effectiveness of the final cover system, including making repairs to the final cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover; and

- Maintaining the groundwater monitoring system for the unit and monitoring the groundwater in accordance with the requirements of 40 CFR 257.90 through 257.98 of the CCR Rule.

Post-closure care must be conducted for 30 years after the CCR landfill has been closed. If at the end of the 30-year post-closure care period, groundwater assessment monitoring is being performed at the unit in accordance with 40 CFR 257.95 of the CCR Rule, post-closure care of the unit must continue until the unit has returned to groundwater detection monitoring under 40 CFR 257.95.

Once the post-closure care period has been completed, the owner/operator of the CCR landfill must prepare a notification verifying that post-closure care has been completed. The notification must include certification by a qualified professional engineer verifying that post-closure care has been completed in accordance with the written closure plan for the unit. The notification must be placed in the facility operating record within 60 days of the completion of post-closure care.

40 CFR 257.104(d) of the CCR Rule specifies that a written PCP must be prepared for each existing CCR unit that describes the post-closure care activities for the unit. The PCP must include, at a minimum, the following information:

- A description of the required post-closure monitoring and maintenance activities and the frequency at which these activities will be performed;
- The name, address, telephone number, and email address of the person or office to contact about the facility during the post-closure care period; and
- A description of the planned uses of the closed unit property during the post-closure period. Post-closure use of the property must not disturb the integrity of the final cover, liner, or any other component of the unit containment system, or the function of the monitoring systems.

If the owner/operator of the unit desires to disturb any of the components of the closure during the post-closure care period, a qualified professional engineer must certify that the disturbance of the final cover, liner, or other component of the containment system, including any removal of CCR, will not increase the potential threat to human health or the environment. The certification must be placed in the facility operating record and the Texas Commission on Environmental Quality (TCEQ) must be notified.

The PCP must be certified by a qualified professional engineer and must document how the PCP has been designed and constructed to comply with the requirements of 40 CFR 257.104.

In accordance with 40 CFR 257.104(d)(2) of the CCR Rule, the initial PCP for an existing CCR landfill must be completed and placed in the facility operating record no later than October 17, 2016. The PCP must be amended whenever:

- There is a change in the operation of the landfill that would substantially affect the written PCP in effect; or
- After post-closure activities have commenced, unanticipated events necessitate a revision of the written PCP.

The PCP must be amended at least 60 days prior to a planned change in the operation of the facility or CCR unit, or no later than 60 days after an unanticipated event requires the need to revise an existing PCP. If the PCP is revised after post-closure activities have commenced for a CCR unit, the PCP must be amended no later than 30 days following the triggering event. The owner or operator of the CCR unit must obtain a written certification from a qualified professional engineer that the initial and any amendment of the PCP plan meets the requirements of 40 CFR 257.104 of the CCR Rule.

1.2 MLSES Units Subject to PCP Requirements

The CCR Rule defines coal combustion residuals such as fly ash, bottom ash, boiler slag, flue gas desulfurization (FGD) materials (gypsum), and related solids generated from burning coal for the purpose of generating electricity by electric utilities and independent power producers. The PCP requirements of the CCR Rule apply to existing and new CCR landfills that dispose or otherwise engage in solid waste management of CCR.

The only CCR unit at the MLSES that meets the definition of an existing CCR landfill is the A-1 Area Landfill. The A-1 Area Landfill is considered an “existing CCR landfill” under 40 CFR 257.53, since:

- Continuous construction of the A-1 Area Landfill commenced prior to October 19, 2015; and
- The landfill received CCR before and after October 19, 2015

This PCP was prepared for the A-1 Area Landfill at the MLSES. In accordance with 40 CFR 257.104 of the CCR Rule, the PCP must be amended when future landfill units or lateral expansions of the A-1 Area Landfill are constructed at the MLSES.

1.3 Description of the A-1 Area Landfill

The A-1 Area Landfill is located approximately 2.5 miles southeast of the MLSES (Figure 2). The A-1 Area Landfill is the only dry disposal facility for CCR generated at the MLSES. The registered boundary of the landfill covers an area of approximately 986 acres and is located within a reclaimed section of the Luminant Beckville Mine. The A-1 Area Landfill is surrounded by and underlain by spoil material that was previously excavated during lignite mining operations. The A-1 Area Landfill is registered with the Texas Commission on Environmental Quality under SWR31277 (WMU002) and began receiving CCR in 1980.

The active portion of the A-1 Area Landfill is surrounded by earthen embankments constructed of mine spoil. Prior to placement of CCRs, a 1-foot thick compacted clay bottom liner is constructed over prepared subgrade (clay-rich mine spoil 70-100 feet in thickness). Hence, the bottom liner consists of clay scarified and re-compacted to achieve the design specification of 95 percent of maximum density and an in-place permeability of 1×10^{-7} cm/sec or less. Specifications for the construction of the perimeter embankments include placement of a 3-foot thick compacted clay liner on the interior slope of the embankment, which was specified not to exceed a 3:1 (horizontal:vertical) sideslope. Approximately 450-acres of the A-1 Area landfill has been closed by placement of a 3-foot thick compacted clay cap with a minimum 2-foot thick vegetative cover layer. Progressive capping/closure of the A-1 Area Landfill is performed as placement of CCR reaches the target cap subgrade elevations.

2.0 POST-CLOSURE INSPECTION AND MAINTENANCE PLAN

Monitoring and maintenance activities will be performed to maintain the integrity and effectiveness of the final cover system as specified in 40 CFR 257.104(b)(1). During the post-closure monitoring and maintenance period at the site, the final cover of the closed CCR unit will be inspected at the frequency indicated in Table 1 below:

Table 1 – Post-Closure Care Maintenance

Post-Closure Care Maintenance Item	Frequency of Inspections	Types of Deficiency Conditions to be looked for during inspections
Final Cover Condition	Annually	Inspection for vegetation, erosion, settlement, ponding water, and functionality and the surface water drainage system
Vegetation	Annually	Erosion rills and depressions, vegetative stress
Drainage structures	Annually	Sediment and debris build up, component damage, blockages, erosion, ponding of water in non-designated areas, excessive vegetative growth

Each monitoring and maintenance activity will be documented and include the date, components and items monitored, name of the individual performing the monitoring/maintenance, a description of the deficiencies observed (if any), maintenance/repairs performed (if any), and related information.

At a minimum, maintenance will be performed as needed prior to the next scheduled inspection.

3.0 GROUNDWATER MONITORING

As specified in 40 CFR 257.104(b)(3), groundwater monitoring activities will continue throughout the post-closure care period in accordance with 40 CFR 257.90 through 40 CFR 257.98. All groundwater monitoring wells that are part of the groundwater monitoring network will be monitored and maintained during the post-closure care period in accordance with the Groundwater Sampling and Analysis Plan, which will be finalized and placed in the Operating Record by October 17, 2017.

If at the end of the 30-year post-closure care period, groundwater assessment monitoring is being performed at the unit in accordance with 40 CFR 257.95, post-closure care of the unit must continue until the unit has returned to groundwater detection monitoring under 40 CFR 257.95.

4.0 FACILITY CONTACT INFORMATION

Table 2: Contact Information

Name	Luminant - Environmental Services
Address	1601 Bryan St., Dallas, Texas 75201
Telephone Number	214-875-8654
Email	CCRPostClosurePlan@Luminant.com

5.0 POST-CLOSURE LAND USE

Post-closure use of the property will not disturb the integrity of the final cover, liner system, or any other component of the containment system, or function of the monitoring system in accordance with §257.104(d)(1)(iii) unless necessary to comply with the maintenance requirements of this subpart or as otherwise provided as allowed under this subpart.

Post-closure land use is anticipated to be undeveloped/unchanged and the area will be deed recorded and deed restricted to prevent disturbance of the closed waste management unit.

6.0 NOTIFICATION OF COMPLETION OF POST-CLOSURE CARE PERIOD

No later than 60 days following completion of the post-closure care period, a certification will be prepared by a qualified professional engineer verifying that the post-closure care has been completed in accordance with this Post-Closure Plan.

7.0 REFERENCES

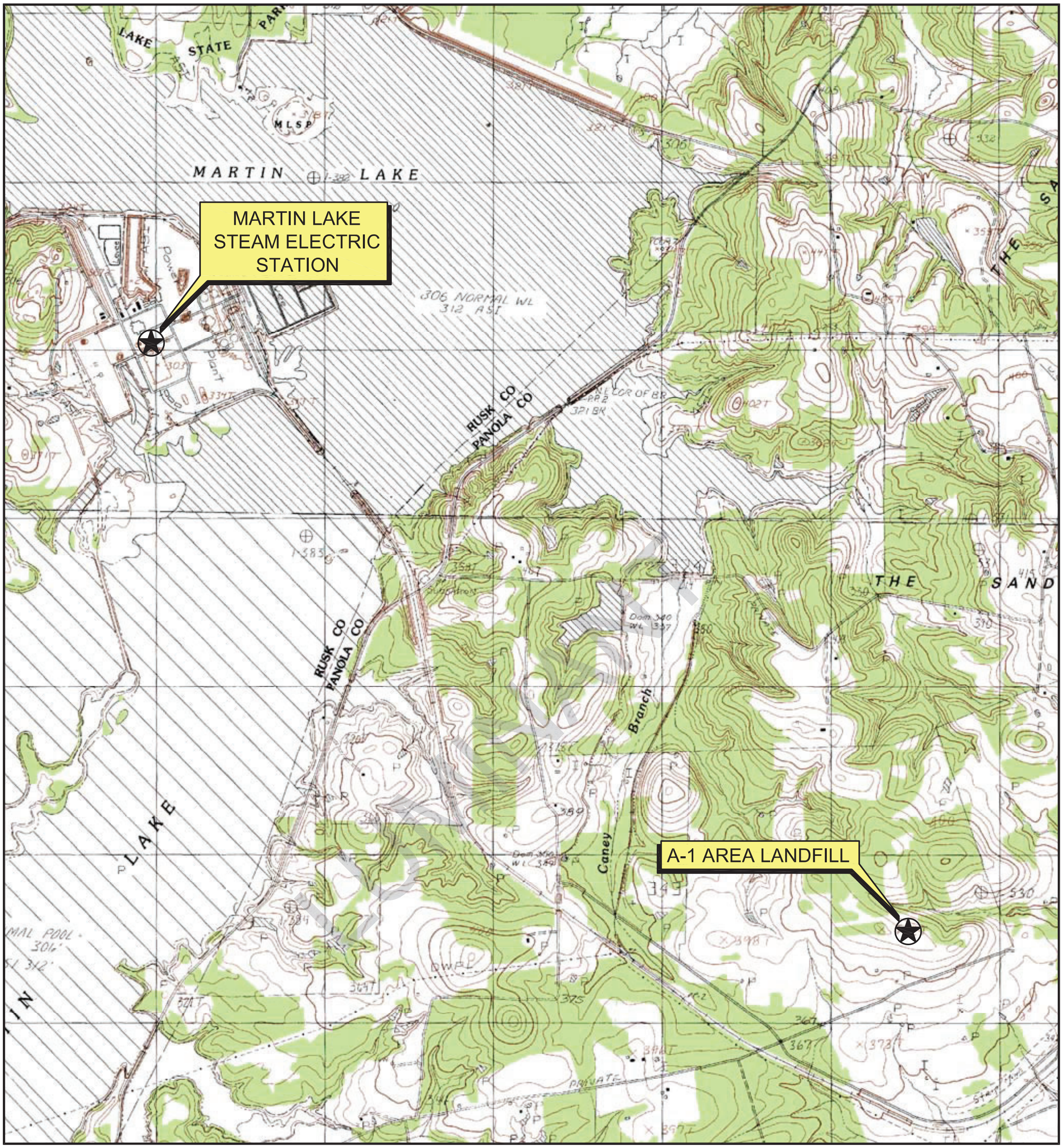
McCulley, Frick & Gillman, Inc (MFG), 1991. *Hydrogeologic/Geotechnical Evaluation A-1 Expansion Area. November.*

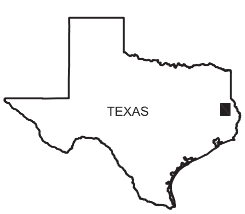
United States Geological Survey (U.S.G.S.), 1983, 7.5-*Minute Series Topographic Map, Fair Play, TX Quadrangle.*

Pastor, Behling & Wheeler, LLC. , 2016. *Annual CCR Unit Inspection Report, Luminant – Martin Lake Steam Electric Station Ash Pond Area, Permanent Disposal Pond No.5 & A-1 Area Landfill, Rusk and Panola County, Texas*, January 16.

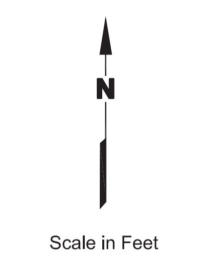
Pastor, Behling, & Wheeler, LLC (PBW), 2016A. *CCR Closure Plan – Martin Lake Electric Station A-1 Area Landfill, Panola County, Texas*. October.

Figures





QUADRANGLE LOCATION



SOURCE:
Base map from www.tnris.gov, Tatum, TX 7.5 min. USGS quadrangle dated 1983.

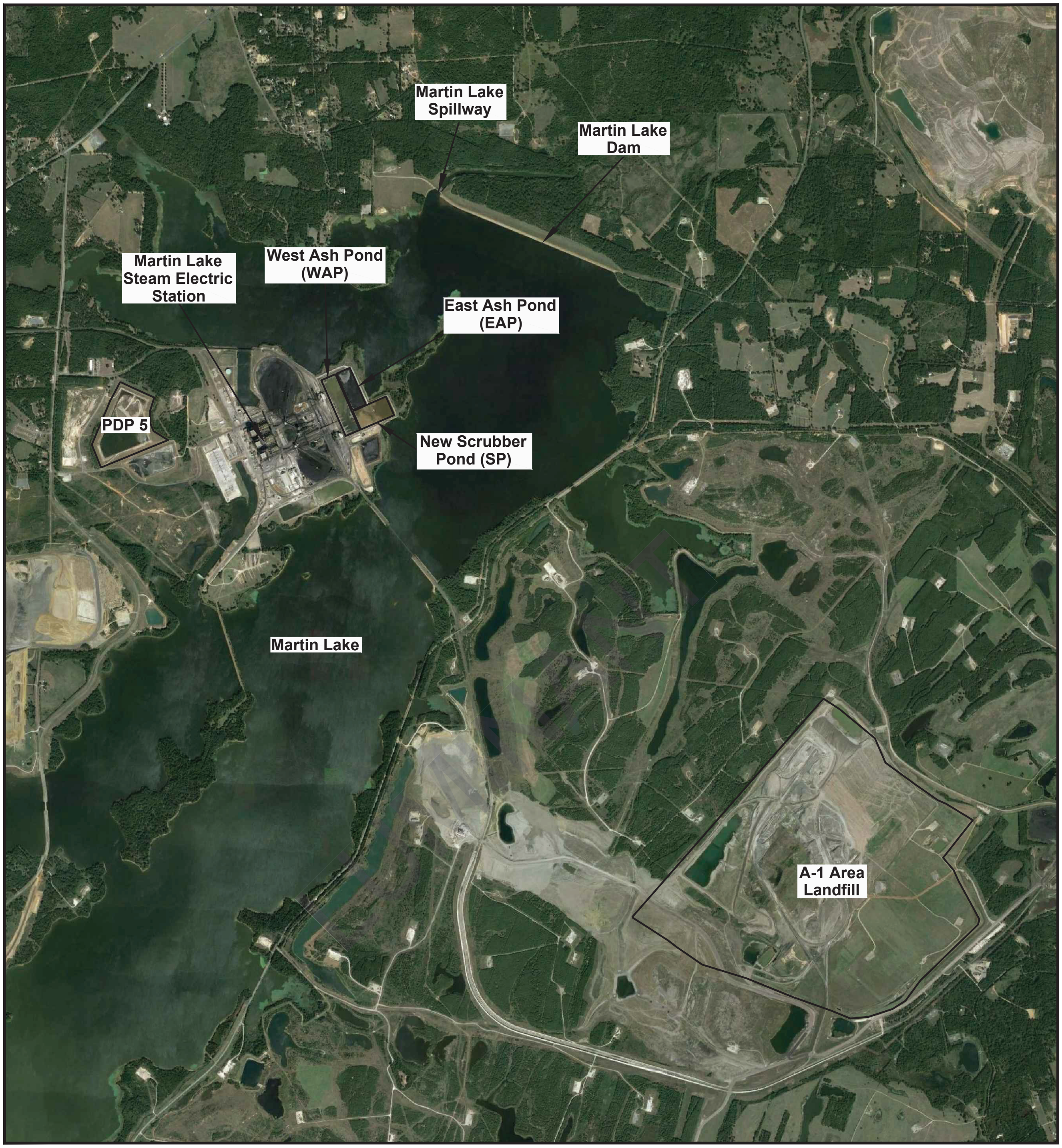
LUMINANT GENERATION COMPANY, LLC
MARTIN LAKE STEAM ELECTRIC STATION

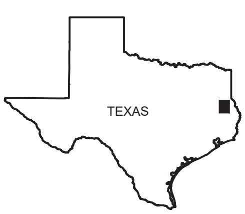
Figure 1

SITE LOCATION MAP

PROJECT: 5196B	BY: AJD	REVISIONS
DATE: SEPT., 2016	CHECKED: BDT	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS





PHOTOGRAPH LOCATION

N

Scale in Feet

0 2000 4000

SOURCE:
Imagery from Google Earth, photography dated October 1, 2015.

LUMINANT GENERATION COMPANY, LLC

MARTIN LAKE STEAM ELECTRIC STATION

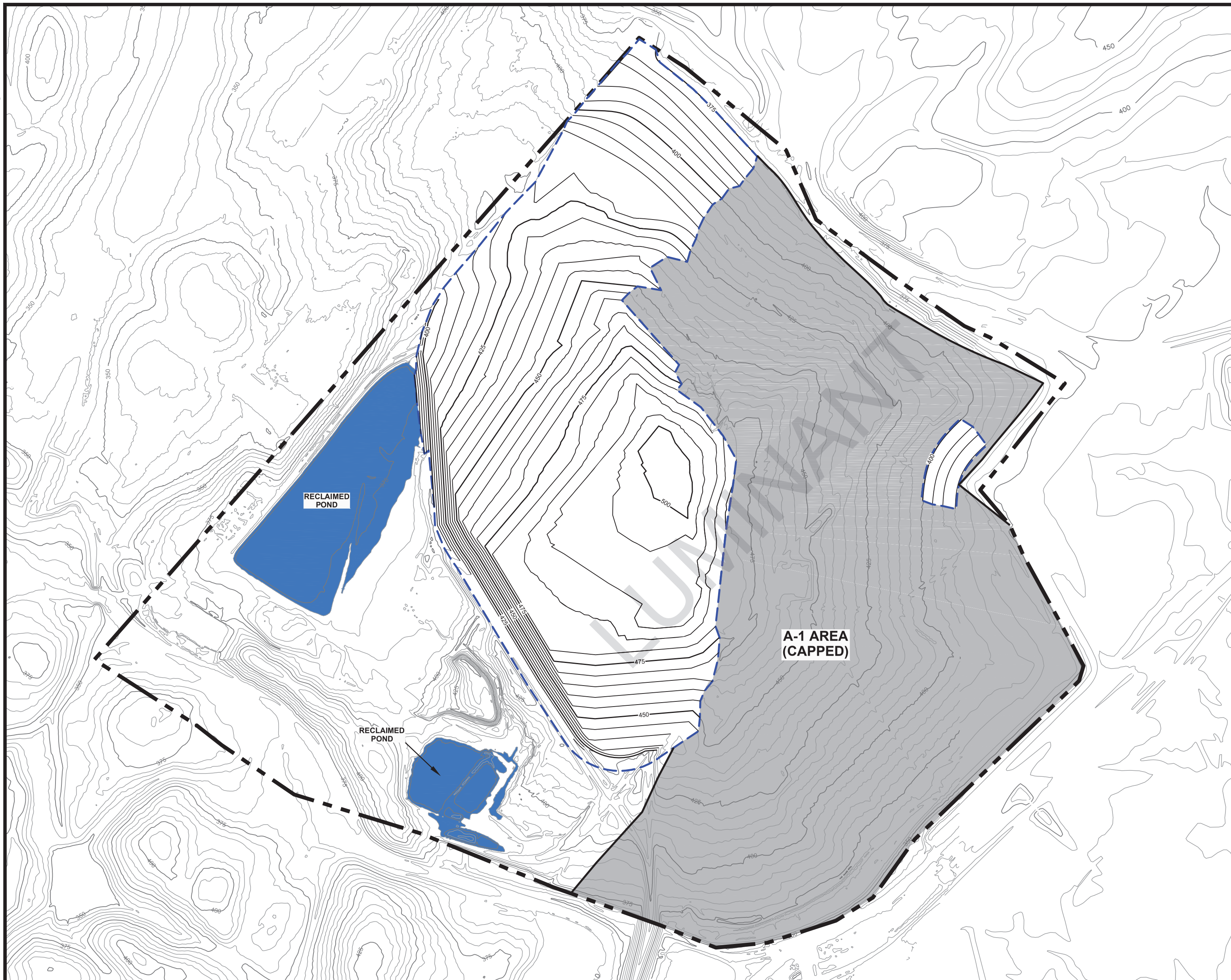
Figure 2

SITE VICINITY MAP

PROJECT: 5196B	BY: AJD	REVISIONS
DATE: SEPT., 2016	CHECKED: BDT	

PASTOR, BEHLING & WHEELER, LLC

CONSULTING ENGINEERS AND SCIENTISTS



EXPLANATION

- Landfill Registration Boundary
- Existing Grade Contour 5 ft Interval
- Existing Grade Contour 25 ft Interval
- Proposed Finished Grade Contour 5 ft Interval
- Proposed Finished Grade Contour 25 ft Interval
- Proposed Limits of CAP
- Capped Area (Existing)

LUMINANT GENERATION COMPANY, LLC
MARTIN LAKE STEAM ELECTRIC STATION

Figure 3

PROPOSED FINAL COVER GRADING PLAN

PROJECT: 5196B	BY: AJD	REVISIONS
DATE: SEPT., 2016	CHECKED: BDT	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS

REPORT

POST CLOSURE PLAN
ADDENDUM NO. 1

Martin Lake Steam Electric Station - A1 Area Landfill
Panola County, Texas

Submitted to:

Luminant Generation Company LLC

Submitted by:

WSP GOLDER
1601 S MoPac Expressway
Suite 325D
Austin, Texas, USA 78746
+1 737 703 3900

31404097.007

December 2022

PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by WSP Golder under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I hereby certify that Addendum No.1 to the Post Closure Plan for the A1 Area Landfill at the Martin Lake Steam Electric Station has been prepared in accordance with the requirements of 40 C.F.R. §257.104.

Patrick J. Behling, P.E.
Principal Engineer
WSP Golder
Texas Firm Registration No. 22771

Table of Contents

DOCUMENT REVISION RECORD

Issue No.	Date	Details of Revisions
Revision 0	October 2016	Original Document
Addendum 1	December 2022	Updated configuration of final cap/cover system for A1 Area Landfill and updated Facility contact information.

1.0 INTRODUCTION

On behalf of Luminant Generation Company LLC (Luminant), WSP Golder (Golder) has prepared this Addendum No. 1 to the Post Closure Plan for the A1 Area Landfill (A1 LF) located at the Martin Lake Steam Electric Station (MLSES) in Rusk County, Texas (hereafter, the “Site”). Coal Combustion Residuals (CCR) including fly ash, bottom ash, and gypsum generated as part of MLSES operation are disposed in the A1 LF. The A1 LF is regulated as an Existing CCR Landfill under 40 C.F.R. § 257, Subpart D (the “CCR Rule”).

The original Post Closure Plan for the A1 LF was prepared in October 2016 in accordance with 40 C.F.R. §257.102(b) and placed in the MLSES operating record in accordance with 40 C.F.R. §257.105(h)(10) (PBW, 2016). This Addendum No. 1 updates the Post Closure Plan to reflect the following:

- Revisions to the configuration of the A1 LF cap/cover system to be consistent with recent Texas Commission on Environmental Quality (TCEQ) approved cap modifications; and
- Update to the Facility contact information.

2.0 A1 AREA LANDFILL FINAL CAP/COVER SYSTEM

The A1 LF is the primary disposal facility for CCR generated at the MLSES and is located within a reclaimed section of the nearby Luminant Beckville Mine. The A1 LF is an above grade landfill surrounded by earthen embankments constructed of mine spoil that extend approximately 10 to 20 feet or more above surrounding grade. The A1 LF has been in operation since 1980 and progressive capping/closure of the A1 LF has been performed as placement of CCR in the landfill reached design elevations. Through 2019, capped/closed areas of the landfill have been covered with a 3-foot thick compacted mine spoil cap (in-place permeability of $1x10^{-7}$ cm/sec or less) covered with a 2-foot thick vegetative cover layer. This cap configuration was referenced in the 2016 A1 LF Post Closure Plan (PBW, 2016).

In 2019, Luminant proposed a modification of the A1 LF cap/cover configuration to close future landfill areas to TCEQ (Golder, 2019). The proposed cap modification consisted of the following (from bottom to top):

- a 2-foot thick compacted mine spoil liner layer (in-place permeability of $1x10^{-7}$ cm/sec or less); and
- a 1.5-foot thick vegetative soil cover layer.

TCEQ approved the proposed cap modification in 2020.

The Post Closure Plan for the A1 LF is hereby modified to reflect that future landfill areas will be closed using the following final cap/cover system (from bottom to top):

- a 2-foot thick compacted mine spoil liner layer (in-place permeability of $1x10^{-7}$ cm/sec or less); and
- a 1.5-foot thick vegetative soil cover layer.

3.0 FACILITY CONTACT INFORMATION

The Facility Contact Information in Table 2 of Section 4 of the Post Closure Care Plan is updated as follows:

Table 2: Contact Information

Name	Luminant-Environmental Services
Address	6555 Sierra Drive, Irving, TX 75039
Telephone Number	214-875-8654
E-mail	CCRinfo@luminant.com

4.0 REFERENCES

Golder Associates (Golder), 2019. TCEQ Registration Update – A1 Area Landfill, Martin Lake Steam Electric Station. December.

Pastor, Behling & Wheeler, LLC (PBW), 2016. CCR Post Closure Plan – A1 Area Landfill, Martin Lake Steam Electric Station. October.

CCR POST-CLOSURE PLAN
MARTIN LAKE STEAM ELECTRIC STATION
BOTTOM ASH PONDS AND NEW SCRUBBER POND
RUSK COUNTY, TEXAS

October 2016

Prepared for:

LUMINANT GENERATION COMPANY, LLC
1601 Bryan Street (EP-27)
Dallas, Texas 75201

Prepared by:

PASTOR, BEHLING & WHEELER, LLC
5416 Plaza Drive
Texarkana, Texas 75503
Texas Engineering Firm No. 4760

PBW Project No. 5196B

PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by Pastor, Behling & Wheeler, LLC under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I hereby certify that this Post-Closure Plan has been prepared in accordance with the requirements of 40 CFR 257.104 of the CCR Rule.

STATE OF TEXAS
BRIAN D. THOMAS
91192
LICENSED
PROFESSIONAL ENGINEER
10/5/16

10/5/16

Brian Thomas, P.E.
Principal Engineer
PASTOR, BEHLING & WHEELER, LLC

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1.0 INTRODUCTION

Luminant Generation Company, LLC (Luminant) owns and operates the Martin Lake Steam Electric Station (MLSES) located approximately five miles southwest of Tatum in Rusk County, Texas. The power plant and related support areas occupy approximately 700 acres on a peninsula on the southwest side of Martin Lake (Figure 1). The MLSES consists of three coal/lignite-fired units with a combined operating capacity of approximately 2,250 megawatts. Coal Combustion Residuals (CCR) including fly ash, bottom ash, and gypsum are generated as part of MLSES unit operation. The CCRs are transported off-site for beneficial use by third-parties, are managed by Luminant on-site at Permanent Disposal Pond No. 5 (PDP-5) or are disposed at Luminant's A-1 Area Landfill.

The CCR Rule (40 CFR 257 Subpart D - *Standards for the Receipt of Coal Combustion Residuals in Landfills and Surface Impoundments*) has been promulgated by EPA to regulate the management and disposal of CCRs as solid waste under Resource Conservation and Recovery Act (RCRA) Subtitle D. The final CCR Rule was published in the Federal Register on April 17, 2015. The effective date of the CCR Rule was October 19, 2015.

The CCR Rule establishes national operating criteria for existing CCR surface impoundments and landfills, including development of post-closure plans (PCP) for all CCR impoundments and landfills. Pastor, Behling & Wheeler, LLC (PBW) was retained by Luminant to develop this PCP for the CCR Unit Closure Area at the MLSES.

1.1 CCR Impoundment Post-Closure Care Requirements

40 CFR 257.104 of the CCR Rule specifies the post-closure care requirements for existing CCR impoundments that have been closed in accordance with 40 CFR 257.102 of the Rule. Following closure of the impoundment, the owner/operator must conduct post-closure care for the unit, consisting of at least the following:

- Maintaining the integrity and effectiveness of the final cover system, including making repairs to the final cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover; and

- Maintaining the groundwater monitoring system for the unit and monitoring the groundwater in accordance with the requirements of 40 CFR 257.90 through 257.98 of the CCR Rule.

Post-closure care must be conducted for 30 years after the CCR impoundment has been closed. If at the end of the 30-year post-closure care period, groundwater assessment monitoring is being performed at the unit in accordance with 40 CFR 257.95 of the CCR Rule, post-closure care of the unit must continue until the unit has returned to groundwater detection monitoring under 40 CFR 257.95.

Once the post-closure care period has been completed, the owner/operator of the CCR impoundment must prepare a notification verifying that post-closure care has been completed. The notification must include certification by a qualified professional engineer verifying that post-closure care has been completed in accordance with the written closure plan for the unit. The notification must be placed in the facility operating record within 60 days of the completion of post-closure care.

40 CFR 257.104(d) of the CCR Rule specifies that a written PCP must be prepared for each existing CCR unit that describes the post-closure care activities for the unit. The PCP must include, at a minimum, the following information:

- A description of the required post-closure monitoring and maintenance activities and the frequency at which these activities will be performed;
- The name, address, telephone number, and email address of the person or office to contact about the facility during the post-closure care period; and
- A description of the planned uses of the closed unit property during the post-closure period. Post-closure use of the property must not disturb the integrity of the final cover, liner, or any other component of the unit containment system, or the function of the monitoring systems.

If the owner/operator of the unit desires to disturb any of the components of the closure during the post-closure care period, a qualified professional engineer must certify that the disturbance of the final cover, liner, or other component of the containment system, including any removal of CCR, will not increase the potential threat to human health or the environment. The certification must be placed in the facility operating record and the Texas Commission on Environmental Quality (TCEQ) must be notified.

The PCP must be certified by a qualified professional engineer and must document how the PCP has been designed and constructed to comply with the requirements of 40 CFR 257.104.

In accordance with 40 CFR 257.104(d)(2) of the CCR Rule, the initial PCP for an existing CCR unit must be completed and placed in the facility operating record no later than October 17, 2016. The PCP must be amended whenever:

- There is a change in the operation of the unit that would substantially affect the written PCP in effect; or

- After post-closure activities have commenced, unanticipated events necessitate a revision of the written PCP.

The PCP must be amended at least 60 days prior to a planned change in the operation of the facility or CCR unit, or no later than 60 days after an unanticipated event requires the need to revise an existing PCP. If the PCP is revised after post-closure activities have commenced for a CCR unit, the PCP must be amended no later than 30 days following the triggering event. The owner or operator of the CCR unit must obtain a written certification from a qualified professional engineer that the initial and any amendment of the PCP meets the requirements of 40 CFR 257.104 of the CCR Rule.

1.2 MLSES Units Subject to PCP Requirements

The CCR Rule defines coal combustion residuals such as fly ash, bottom ash, boiler slag, flue gas desulfurization (FGD) materials (gypsum), and related solids generated from burning coal for the purpose of generating electricity by electric utilities and independent power producers. The PCP requirements of the CCR Rule apply to existing and new CCR impoundments that dispose or otherwise engage in solid waste management of CCR. The surface impoundments at the MLSES that meet the definition of an existing CCR unit are the West Ash Pond (WAP), East Ash Pond (EAP), New Scrubber Pond (SP), and Permanent Disposal Pond-5 (PDP-5).

This PCP addresses the following CCR surface impoundments at the MLSES:

- West Ash Pond (WAP);
- East Ash Pond (EAP); and
- New Scrubber Pond (SP).

Due to their proximity to each other, the BAPs and SP will be considered one CCR surface impoundment (identified as the “CCR Unit Closure Area”) for the purposes of this PCP.

1.3 Description of the CCR Unit Closure Area

1.3.1 Description of BAPs

The WAP and EAP (collectively “Bottom Ash Ponds” or “BAPs”) are located approximately 2,000 feet east of the MLSES power plant (Figure 2). A site plan for the BAPs is shown on Figure 3.

The BAPs receive recovered overflow from bottom ash dewatering bins and other MLSES process wastewater sources that typically include bottom ash fines. The ponds also act as surge basins for various water streams in the ash-water system. Recovered sluice water, process waters and storm water runoff from the MLSES ash-water system are pumped to each pond through a series of above grade pipes. The BAPs are constructed partially above and partially below grade and all material that enters the ponds is pumped into the impoundments. There are no gravity discharges to the BAPs.

The BAPs share an interior embankment and cover areas of approximately 14.6 acres and 9.6 acres, respectively, and are surrounded by engineered earthen dikes that extend above grade, typically less than 20 feet. The BAPs are constructed partially above and partially below grade and are surrounded by earthen embankments that extend approximately 10 to 20 feet above grade depending on surrounding topography. The exterior slopes of the embankments are rolled soil cement.

The BAPs were originally constructed in 1977 with an in-situ compacted clay liner. The WAP was removed from service in March 1988 and re-lined with a double 60-mil high density polyethylene (HDPE) liner system overlain with a concrete revetment mat. The EAP was dredged and removed from service in 1989, and a new south embankment was constructed to allow for an increase in the size of the SP. The EAP remained inactive until the installation of a new double 60-mil HDPE liner system with concrete revetment mat was completed in February 2010. The crest elevation of the BAP embankment is 330 feet above MSL and the EAP borders Martin Lake. Based on available construction data, the BAPs were constructed to provide 232.6 and 125.8 acre-feet of storage capacity for the WAP and EAP, respectively. The total design capacity of the BAPs is approximately 116,764,000 gallons or approximately 358.4 acre-feet.

1.3.2 Description of SP

The SP is an approximately 12.5-acre surface impoundment located immediately south of the EAP and east of the WAP. A site plan for the SP is shown on Figure 3.

The SP is used to manage FGD wastes as well as discharge from the sludge thickener sumps, the plant yard sumps, and storm water management areas. Process wastewater can be transferred from the SP to the BAPs and PDP-5, or used as makeup water to the scrubber systems. The SP is located partially above and partially below grade and all material that enters the ponds is pumped into the impoundment. There are no gravity discharges to the SP.

The west embankment of the SP is an internal/shared embankment with the WAP and a portion of the northern embankment is an internal/shared embankment with the EAP. The SP is constructed partially below grade and is surrounded by engineered earthen embankments that extend above grade (typically less than 20 feet). The exterior slopes of the embankments are rolled soil cement.

The SP was originally constructed in the 1977 and was expanded to its current size in 1989. The SP was relined in 1989 with a double 60-mil HDPE liner system, overlain with a concrete revetment mat. The crest elevation of the SP embankments is 330 feet MSL and borders Martin Lake on portions of both the north and south embankments. Based on available construction data, the SP was constructed to provide 198.9 acre-feet or approximately 64,800,000 gallons of storage capacity.

Total design capacity of the CCR impoundments located within the CCR Unit Closure Area (WAP, EAP and SP) is 557.3 acre-feet or approximately 181,597,000 gallons. The CCR Unit Closure Area is classified as a low hazard potential impoundment in accordance with the requirements of 40 CFR 257.73(a)(2) of the CCR Rule (PBW, 2016A).

As described in the CCR Closure Plan prepared for the CCR Unit Closure Area, Luminant plans to close the CCR Unit Closure Area in accordance with 40 CFR 257.102(d) by leaving CCR in-place and constructing a final cover system over the CCR located within the combined footprint of the three surface impoundments (PBW, 2016B). The proposed final grading plan for the final cover system is illustrated in Figure 3. Additional details regarding the final cover system are described in the CCR Closure Plan (PBW, 2016B).

2.0 POST-CLOSURE INSPECTION AND MAINTENANCE PLAN

Monitoring and maintenance activities will be performed to maintain the integrity and effectiveness of the final cover system as specified in 40 CFR 257.104(b)(1). During the post-closure monitoring and maintenance period at the CCR Unit Closure Area, the final cover of the closed CCR unit will be inspected at the frequency indicated in Table 1 below:

Table 1 – Post-Closure Care Maintenance

Post-Closure Care Maintenance Item	Frequency of Inspections	Types of Deficiency Conditions to be looked for during inspections
Final Cover Condition	Annually	Inspection for vegetation, erosion, settlement, ponding water, and functionality and the surface water drainage system
Vegetation	Annually	Erosion rills and depressions, vegetative stress
Drainage structures	Annually	Sediment and debris build up, component damage, blockages, erosion, ponding of water in non-designated areas, excessive vegetative growth

Each monitoring and maintenance activity will be documented and include the date, components and items monitored, name of the individual performing the monitoring/maintenance, a description of the deficiencies observed (if any), maintenance/repairs performed (if any), and related information.

At a minimum, maintenance will be performed as needed prior to the next scheduled inspection.

3.0 GROUNDWATER MONITORING

As specified in 40 CFR 257.104(b)(3), groundwater monitoring activities will continue throughout the post-closure care period in accordance with 40 CFR 257.90 through 40 CFR 257.98. All groundwater monitoring wells that are part of the groundwater monitoring network will be monitored and maintained during the post-closure care period in accordance with the Groundwater Sampling and Analysis Plan, which will be finalized and placed in the Operating Record by October 17, 2017.

If at the end of the 30-year post-closure care period, groundwater assessment monitoring is being performed at the unit in accordance with 40 CFR 257.95, post-closure care of the unit must continue until the unit has returned to groundwater detection monitoring under 40 CFR 257.95.

4.0 FACILITY CONTACT INFORMATION

Table 2: Contact Information

Name	Luminant - Environmental Services
Address	1601 Bryan St., Dallas, Texas 75201
Telephone Number	214-875-8654
Email	CCRPostClosurePlan@Luminant.com

5.0 POST-CLOSURE LAND USE

Post-closure use of the property will not disturb the integrity of the final cover, liner system, or any other component of the containment system, or function of the monitoring system in accordance with §257.104(d)(1)(iii) unless necessary to comply with the maintenance requirements of this subpart or as otherwise provided as allowed under this subpart.

Post-closure land use is anticipated to be undeveloped/unchanged and the area will be deed recorded and deed restricted to prevent disturbance of the closed waste management unit.

6.0 NOTIFICATION OF COMPLETION OF POST-CLOSURE CARE PERIOD

No later than 60 days following completion of the post-closure care period, a certification will be prepared by a qualified professional engineer verifying that the post-closure care has been completed in accordance with this Post-Closure Plan.

7.0 REFERENCES

Burns & McDonnell Engineering Company, Inc., 2016. *History of Construction – Martin Lake Steam Electric Station CCR Surface Impoundment*s. August 16.

Pastor, Behling & Wheeler, LLC (PBW) , 2011. *Revised Affected Property Assessment Report – Martin Lake Steam Electric Station – Ash Pond Area, Tatum, Texas*. May 3.

Pastor, Behling & Wheeler, LLC (PBW), 2016. *Annual CCR Unit Inspection Report, Luminant – Martin Lake Steam Electric Station Ash Pond Area, Permanent Disposal Pond No.5 & A-1 Area Landfill, Rusk and Panola County, Texas*. January 16.

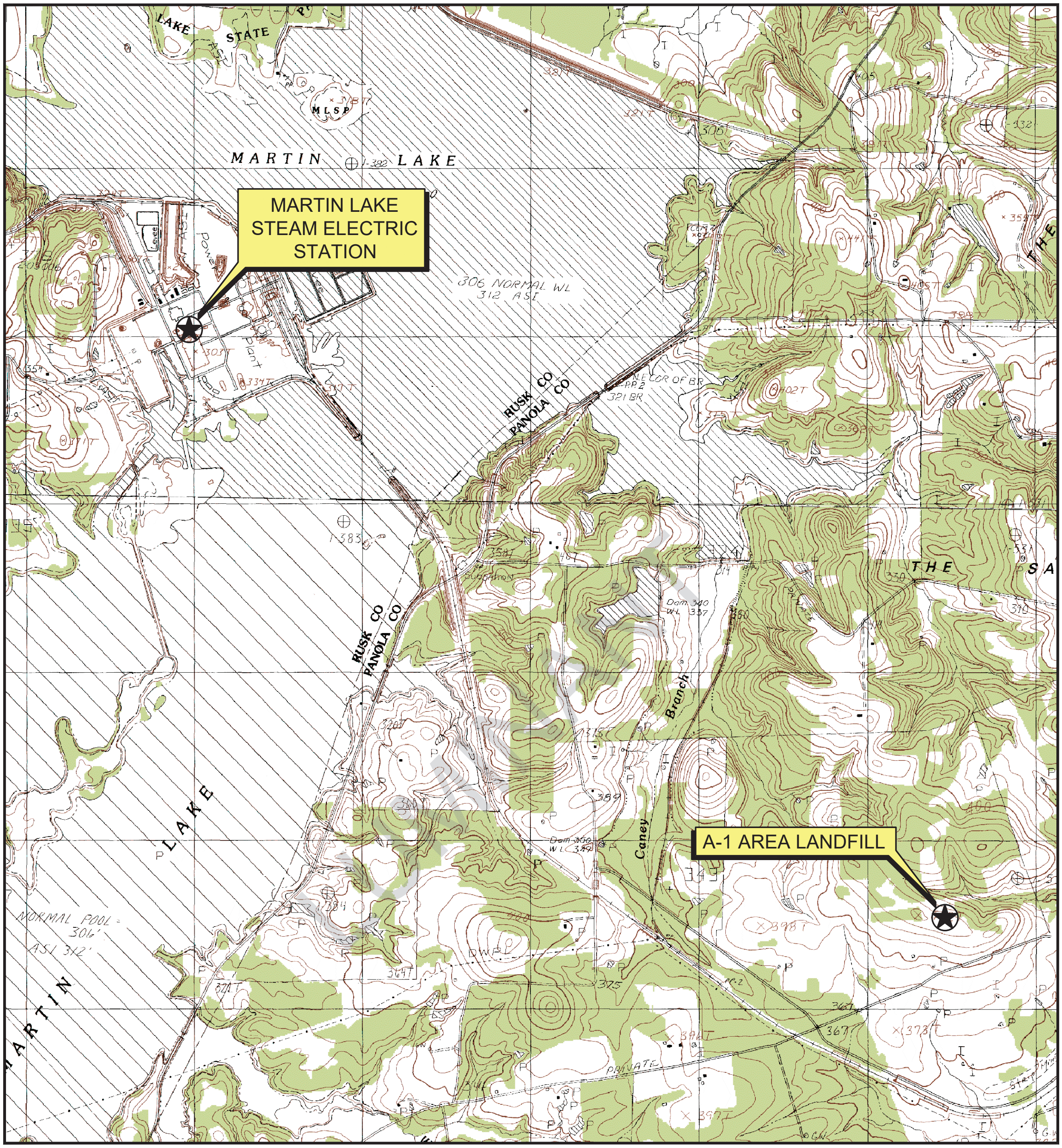
Pastor, Behling & Wheeler, LLC (PBW), 2016A. *Hazard Classification Assessment – Martin Lake Steam Electric Station Ash Pond Area and Permanent Disposal Pond No. 5, Rusk County, Texas*. October.

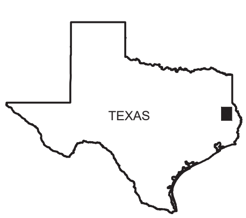
Pastor, Behling & Wheeler, LLC (PBW), 2016B. *CCR Closure Plan – Martin Lake Steam Electric Station Bottom Ash Ponds and New Scrubber Pond, Rusk County, Texas*. October.

United States Geological Survey (U.S.G.S.), 1983, 7.5-*Minute Series Topographic Map, Tatum, TX Quadrangle.*

United States Geological Survey (U.S.G.S.), 1983, 7.5-*Minute Series Topographic Map, Fair Play, TX Quadrangle.*

FIGURES





SOURCE:
Base map from www.tnris.gov, Tatum, TX 7.5 min. USGS Quadrangle dated 1983.

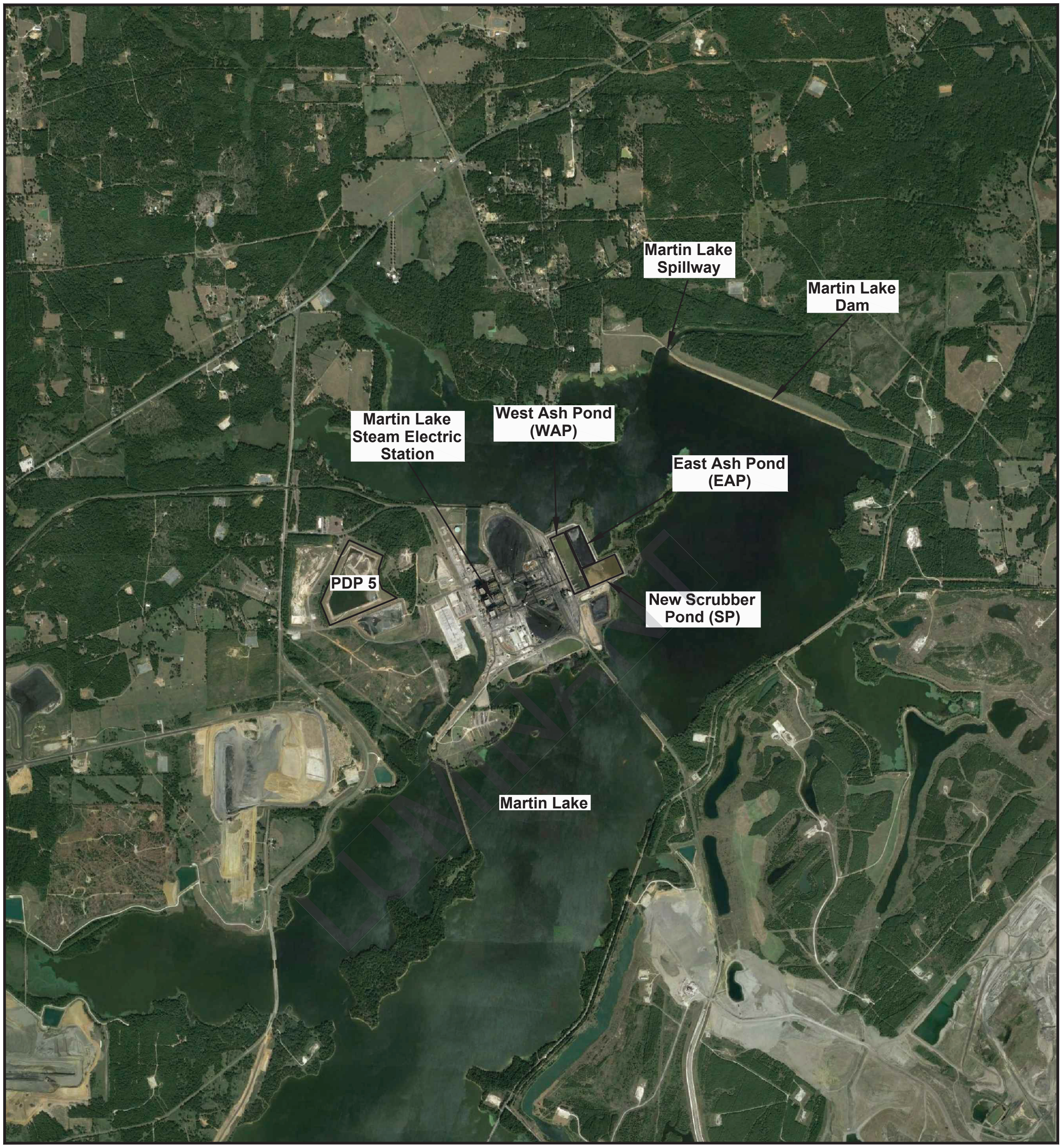
LUMINANT GENERATION COMPANY, LLC
MARTIN LAKE STEAM ELECTRIC STATION

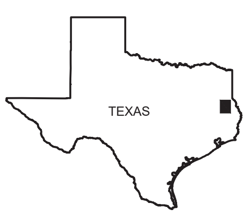
Figure 1

SITE LOCATION MAP

PROJECT: 5196B	BY: AJD	REVISIONS
DATE: SEPT., 2016	CHECKED: BDT	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS





PHOTOGRAPH LOCATION

N

Scale in Feet

0 2000 4000

SOURCE:
Imagery from Google Earth, photography dated October 1, 2015.

LUMINANT GENERATION COMPANY, LLC
MARTIN LAKE STEAM ELECTRIC STATION

Figure 2

SITE VICINITY MAP

PROJECT: 5196B	BY: AJD	REVISIONS
DATE: SEPT., 2016	CHECKED: BDT	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS

EXPLANATION

- Proposed Finished Grade Contour 1 ft Interval
- Proposed Finished Grade Contour 5 ft Interval
- Limits of CAP
- Estimated Limits of CCR (Elev. 320.5)
- Drainage Ditch Center Line
- Approx. Limits of Existing Roller Compacted Cement

N

Scale in Feet
0 110 220

LUMINANT GENERATION COMPANY, LLC
MARTIN LAKE STEAM ELECTRIC STATION

Figure 3

PROPOSED FINAL COVER GRADING PLAN

PROJECT: 5196B	BY: AJD	REVISIONS
DATE: SEPT., 2016	CHECKED: BDT	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS

REPORT

POST CLOSURE PLAN ADDENDUM NO. 1

Martin Lake Steam Electric Station - Ash Ponds
Rusk County, Texas

Submitted to:

Luminant Generation Company LLC

Submitted by:

WSP GOLDER
1601 S MoPac Expressway
Suite 325D
Austin, Texas, USA 78746
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31404097.007

December 2022

PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by WSP Golder under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I hereby certify that Addendum No.1 to the Post Closure Plan for the Ash Ponds at the Martin Lake Steam Electric Station has been prepared in accordance with the requirements of 40 C.F.R. §257.104.

Patrick J. Behling, P.E.
Principal Engineer
WSP Golder
Texas Firm Registration No. 22771

STATE OF TEXAS
PATRICK J. BEHLING
79872
LICENSED
PROFESSIONAL ENGINEER
12/15/22

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DOCUMENT REVISION RECORD

Issue No.	Date	Details of Revisions
Revision 0	October 2016	Original Document
Addendum 1	December 2022	Updated configuration of liner systems for Ash Ponds, updated configuration of final cap/cover system for Ash Ponds and updated Facility contact information.

1.0 INTRODUCTION

On behalf of Luminant Generation Company LLC (Luminant), WSP Golder (Golder) has prepared this Addendum No. 1 to the Post Closure Plan for the East Ash Pond (EAP), West Ash Pond (WAP), and New Scrubber Pond (NSP) (collectively referred to as the "Ash Ponds") located at the Martin Lake Steam Electric Station (MLSES) in Rusk County, Texas (hereafter, the "Site"). Coal Combustion Residuals (CCR) including flue gas desulfurization (FGD) wastewater and bottom ash generated as part of MLSES operation are managed in the Ash Ponds. The Ash Ponds are regulated as Existing CCR Impoundments under 40 C.F.R. § 257, Subpart D (the "CCR Rule").

The original Post Closure Plan for the Ash Ponds was prepared in October 2016 in accordance with 40 C.F.R. §257.102(b) and placed in the MLSES operating record in accordance with 40 C.F.R. §257.105(h)(10) (PBW, 2016). This Addendum No. 1 updates the Post Closure Plan to reflect the following:

- Revisions to the configuration of the Ash Pond liner systems to reflect liner system retrofits in the impoundments;
- Revisions to the configuration of the Ash Pond final cap/cover systems due to the impoundment liner retrofits; and
- Update to the Facility contact information.

2.0 ASH POND LINER SYSTEM RETROFITS

The EAP, WAP and NSP are constructed partially above and partially below grade and are surrounded by engineered earthen dikes that extend above surrounding ground level. The EAP and WAP share an interior embankment and cover areas of approximately 10 acres and 15 acres, respectively. The NSP is an approximately 13 acre surface impoundment.

At the time the 2016 Post Closure Plan was prepared, the configuration of the liner systems in the EAP, WAP and NSP consisted of the following (from bottom to top):

- 18-inch thick compacted clay layer with a hydraulic conductivity of $1x10^{-7}$ cm/sec;
- a 60-mil HDPE geomembrane;
- a geosynthetic drainage layer;
- a second 60-mil HDPE geomembrane; and
- a 4-inch thick concrete revetment mat.

From 2020 through 2022, the EAP and WAP were each retrofitted with a new composite liner system meeting the alternative composite liner requirements of 40 CFR § 257.70(c) (HDR, 2021; HDR, 2022). The retrofitted liner system was installed on top of the existing liner system in each pond and consisted of the following (from bottom to top):

- a 6-inch thick layer of general soil fill material placed over the existing liner system;
- a polymer-enhanced geosynthetic clay liner (GCL) with a maximum hydraulic conductivity of $1x10^{-9}$ cm/sec and a minimum thickness of 6 mm; and
- a 60-mil HDPE geomembrane.

A similar composite liner system is currently being installed in the NSP.

3.0 ASH POND FINAL CAP/COVER SYSTEMS

Due to the retrofits of the Ash Pond liner systems described above, the final cap/cover systems for the EAP, WAP and NSP have been revised to consist of the following (from bottom to top):

- a geosynthetic clay liner (GCL) with a maximum hydraulic conductivity of 1×10^{-9} cm/sec and a minimum thickness of 6 mm;
- a 40-mil linear low-density polyethylene (LLDPE) textured geomembrane;
- a geosynthetic drainage layer; and
- a 18-inch erosion layer consisting of 12 inches of general fill overlain with 6 inches of soil capable of supporting native vegetation.

4.0 FACILITY CONTACT INFORMATION

The Facility Contact Information in Table 2 of Section 4 of the Post Closure Care Plan is updated as follows:

Table 2: Contact Information

Name	Luminant-Environmental Services
Address	6555 Sierra Drive, Irving, TX 75039
Telephone Number	214-875-8654
E-mail	CCRinfo@luminant.com

5.0 REFERENCES

HDR (2021). Construction Completion and Construction Quality Assurance Report, CCR Impoundment Reline East Ash Pond, Martin Lake Steam Electric Station, May.

HDR (2022). Construction Completion and Construction Quality Assurance Report, CCR Impoundment Reline West Ash Pond, Martin Lake Steam Electric Station, June.

Pastor, Behling & Wheeler, LLC (PBW), 2016. CCR Post Closure Plan – Bottom Ash Ponds and New Scrubber Pond, Martin Lake Steam Electric Station. October.

CCR POST-CLOSURE PLAN
MARTIN LAKE STEAM ELECTRIC STATION
PERMANENT DISPOSAL POND - 5
RUSK COUNTY, TEXAS

October 2016

Prepared for:

LUMINANT GENERATION COMPANY, LLC
1601 Bryan Street (EP-27)
Dallas, Texas 75201

Prepared by:

PASTOR, BEHLING & WHEELER, LLC
5416 Plaza Drive
Texarkana, Texas 75503
Texas Engineering Firm No. 4760

PBW Project No. 5196B

PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by Pastor, Behling & Wheeler, LLC under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I hereby certify that this Post-Closure Plan has been prepared in accordance with the requirements of 40 CFR 257.104 of the CCR Rule.

STATE OF TEXAS
BRIAN D. THOMAS
91192
LICENSED
PROFESSIONAL ENGINEER
10/5/16

10/5/16
Brian Thomas, P.E.
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PASTOR, BEHLING & WHEELER, LLC

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LIST OF FIGURES

1.0 INTRODUCTION

Luminant Generation Company, LLC (Luminant) owns and operates the Martin Lake Steam Electric Station (MLSES) located approximately five miles southwest of Tatum in Rusk County, Texas. The power plant and related support areas occupy approximately 700 acres on a peninsula on the southwest side of Martin Lake (Figure 1). The MLSES consists of three coal/lignite-fired units with a combined operating capacity of approximately 2,250 megawatts. Coal Combustion Residuals (CCR) including fly ash, bottom ash, and gypsum are generated as part of MLSES unit operation. The CCRs are transported off-site for beneficial use by third-parties, are managed by Luminant on-site at Permanent Disposal Pond No. 5 (PDP-5) or are disposed at Luminant's A-1 Area Landfill.

The CCR Rule (40 CFR 257 Subpart D - *Standards for the Receipt of Coal Combustion Residuals in Landfills and Surface Impoundments*) has been promulgated by EPA to regulate the management and disposal of CCRs as solid waste under Resource Conservation and Recovery Act (RCRA) Subtitle D. The final CCR Rule was published in the Federal Register on April 17, 2015. The effective date of the CCR Rule was October 19, 2015.

The CCR Rule establishes national operating criteria for existing CCR surface impoundments and landfills, including development of post-closure plans (PCP) for all CCR impoundments and landfills. Pastor, Behling & Wheeler, LLC (PBW) was retained by Luminant to develop this PCP for PDP-5 at the MLSES.

1.1 CCR Impoundment Post-Closure Care Requirements

40 CFR 257.104 of the CCR Rule specifies the post-closure care requirements for existing CCR impoundments that have been closed in accordance with 40 CFR 257.102 of the Rule. Following closure of the impoundment, the owner/operator must conduct post-closure care for the unit, consisting of at least the following:

- Maintaining the integrity and effectiveness of the final cover system, including making repairs to the final cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover; and

- Maintaining the groundwater monitoring system for the unit and monitoring the groundwater in accordance with the requirements of 40 CFR 257.90 through 257.98 of the CCR Rule.

Post-closure care must be conducted for 30 years after the CCR impoundment has been closed. If at the end of the 30-year post-closure care period, groundwater assessment monitoring is being performed at the unit in accordance with 40 CFR 257.95 of the CCR Rule, post-closure care of the unit must continue until the unit has returned to groundwater detection monitoring under 40 CFR 257.95.

Once the post-closure care period has been completed, the owner/operator of the CCR impoundment must prepare a notification verifying that post-closure care has been completed. The notification must include certification by a qualified professional engineer verifying that post-closure care has been completed in accordance with the written closure plan for the unit. The notification must be placed in the facility operating record within 60 days of the completion of post-closure care.

40 CFR 257.104(d) of the CCR Rule specifies that a written PCP must be prepared for each existing CCR unit that describes the post-closure care activities for the unit. The PCP must include, at a minimum, the following information:

- A description of the required post-closure monitoring and maintenance activities and the frequency at which these activities will be performed;
- The name, address, telephone number, and email address of the person or office to contact about the facility during the post-closure care period; and
- A description of the planned uses of the closed unit property during the post-closure period. Post-closure use of the property must not disturb the integrity of the final cover, liner, or any other component of the unit containment system, or the function of the monitoring systems.

If the owner/operator of the unit desires to disturb any of the components of the closure during the post-closure care period, a qualified professional engineer must certify that the disturbance of the final cover, liner, or other component of the containment system, including any removal of CCR, will not increase the potential threat to human health or the environment. The certification must be placed in the facility operating record and the Texas Commission on Environmental Quality (TCEQ) must be notified.

The PCP must be certified by a qualified professional engineer and must document how the PCP has been designed and constructed to comply with the requirements of 40 CFR 257.104.

In accordance with 40 CFR 257.104(d)(2) of the CCR Rule, the initial PCP for an existing CCR unit must be completed and placed in the facility operating record no later than October 17, 2016. The PCP must be amended whenever:

- There is a change in the operation of the unit that would substantially affect the written PCP in effect; or

- After post-closure activities have commenced, unanticipated events necessitate a revision of the written PCP.

The PCP must be amended at least 60 days prior to a planned change in the operation of the facility or CCR unit, or no later than 60 days after an unanticipated event requires the need to revise an existing PCP. If the PCP is revised after post-closure activities have commenced for a CCR unit, the PCP must be amended no later than 30 days following the triggering event. The owner or operator of the CCR impoundment must obtain a written certification from a qualified professional engineer that the initial and any amendment of the PCP plan meets the requirements of 40 CFR 257.104 of the CCR Rule.

1.2 MLSES Units Subject to PCP Requirements

The CCR Rule defines coal combustion residuals such as fly ash, bottom ash, boiler slag, flue gas desulfurization (FGD) materials (gypsum), and related solids generated from burning coal for the purpose of generating electricity by electric utilities and independent power producers. The PCP requirements of the CCR Rule apply to existing and new CCR impoundments that dispose or otherwise engage in solid waste management of CCR.

This PCP addresses PDP-5 at the MLSES.

1.3 Description of PDP-5

PDP-5 is located approximately 3,000 feet west-northwest of the MLSES power plant (Figure 2). A site plan for PDP-5 is shown on Figure 3. PDP-5 is an approximately 40-acre surface impoundment that is constructed above grade and is surrounded by engineered earthen embankments that extend approximately 10 to 15 feet above surrounding grade. The exterior slopes of the embankments are vegetated with grass and similar vegetation.

PDP-5 is primarily used to manage excess liquids, including storm water from large precipitation events and excess process wastewater from both the FGD and bottom ash loops. Recovered CCR wastewaters are received in PDP-5 during cleaning cycles for the BAPs and SP. Process wastewater can be transferred between the BAPs, SP, or used as makeup water for specific CCR related systems. Process wastewater can be transferred from PDP-5 to the BAPs and the SP. PDP-5 is located above grade and all material that enters the pond is pumped into the impoundment. There are no gravity discharges to PDP-5.

PDP-5 was constructed in 2010 over three closed PDPs (PDPs 1-3). The impoundment was constructed with a compacted clay liner that consisted of a six-inch thick soil layer over the closed PDPs (in-place permeability of $1x10^{-5}$ cm/sec), a two-foot thick compacted clay liner (in-place permeability of $1x10^{-7}$ cm/sec), and a three-foot thick compacted clay interior/exterior embankment liner (minimum in-place permeability of $1x10^{-7}$ cm/sec). The crest elevation of the PDP-5 embankments is 405.5 feet MSL. Based on available construction data PDP-5, the total design operating capacity of the impoundment is approximately 62,000,000 gallons or 190.3 acre-feet. PDP-5 is classified as a low hazard potential impoundment in accordance with the requirements of 40 CFR 257.73(a)(2) of the CCR Rule (PBW, 2016A).

As described in the CCR Closure Plan prepared for PDP-5, Luminant plans to close PDP-5 in accordance with 40 CFR 257.102(d) by leaving CCR in-place and constructing a final cover system over the CCR located within the footprint of the surface impoundment (PBW, 2016A). The proposed final grading plan for the final cover system is illustrated in Figure 4. Additional details regarding the final cover system are described in the CCR Closure Plan (PBW, 2016B)

2.0 POST-CLOSURE INSPECTION AND MAINTENANCE PLAN

Monitoring and maintenance activities will be performed to maintain the integrity and effectiveness of the final cover system as specified in 40 CFR 257.104(b)(1). During the post-closure monitoring and maintenance period at PDP-5, the final cover of the closed CCR unit will be inspected at the frequency indicated in Table 1 below:

Table 1 – Post-Closure Care Maintenance

Post-Closure Care Maintenance Item	Frequency of Inspections	Types of Deficiency Conditions to be looked for during inspections
Final Cover Condition	Annually	Inspection for vegetation, erosion, settlement, ponding water, and functionality and the surface water drainage system
Vegetation	Annually	Erosion rills and depressions, vegetative stress
Drainage structures	Annually	Sediment and debris build up, component damage, blockages, erosion, ponding of water in non-designated areas, excessive vegetative growth

Each monitoring and maintenance activity will be documented and include the date, components and items monitored, name of the individual performing the monitoring/maintenance, a description of the deficiencies observed (if any), maintenance/repairs performed (if any), and related information.

At a minimum, maintenance will be performed as needed prior to the next scheduled inspection.

3.0 GROUNDWATER MONITORING

As specified in 40 CFR 257.104(b)(3), groundwater monitoring activities will continue throughout the post-closure care period in accordance with 40 CFR 257.90 through 257.98. All groundwater monitoring wells that are part of the groundwater monitoring network will be monitored and maintained during the post-closure care period in accordance with the Groundwater Sampling and Analysis Plan, which will be finalized and placed in the Operating Record by October 17, 2017.

If at the end of the 30-year post-closure care period, groundwater assessment monitoring is being performed at the unit in accordance with 40 CFR 257.95, post-closure care of the unit must continue until the unit has returned to groundwater detection monitoring under 40 CFR 257.95.

4.0 FACILITY CONTACT INFORMATION

Table 2: Contact Information

Name	Luminant - Environmental Services
Address	1601 Bryan St., Dallas, Texas 75201
Telephone Number	214-875-8654
Email	CCRPostClosurePlan@Luminant.com

5.0 POST-CLOSURE LAND USE

Post-closure use of the property will not disturb the integrity of the final cover, liner system, or any other component of the containment system, or function of the monitoring system in accordance with §257.104(d)(1)(iii) unless necessary to comply with the maintenance requirements of this subpart or as otherwise provided as allowed under this subpart.

Post-closure land use is anticipated to be undeveloped/unchanged and the area will be deed recorded and deed restricted to prevent disturbance of the closed waste management unit.

6.0 NOTIFICATION OF COMPLETION OF POST-CLOSURE CARE PERIOD

No later than 60 days following completion of the post-closure care period, a certification will be prepared by a qualified professional engineer verifying that the post-closure care has been completed in accordance with this Post-Closure Plan.

7.0 REFERENCES

Burns & McDonnell Engineering Company, Inc., 2016. *History of Construction – Martin Lake Steam Electric Station CCR Surface Impoundment*s. August 16.

Pastor, Behling & Wheeler, LLC. , 2014. *Affected Property Assessment Report Martin Lake Steam Electric Station Permanent Disposal Pond Area*. May 13.

Pastor, Behling & Wheeler, LLC. , 2016. *Annual CCR Unit Inspection Report, Luminant – Martin Lake Steam Electric Station Ash Pond Area, Permanent Disposal Pond No.5 & A-1 Area Landfill, Rusk and Panola County, Texas*. January 16.

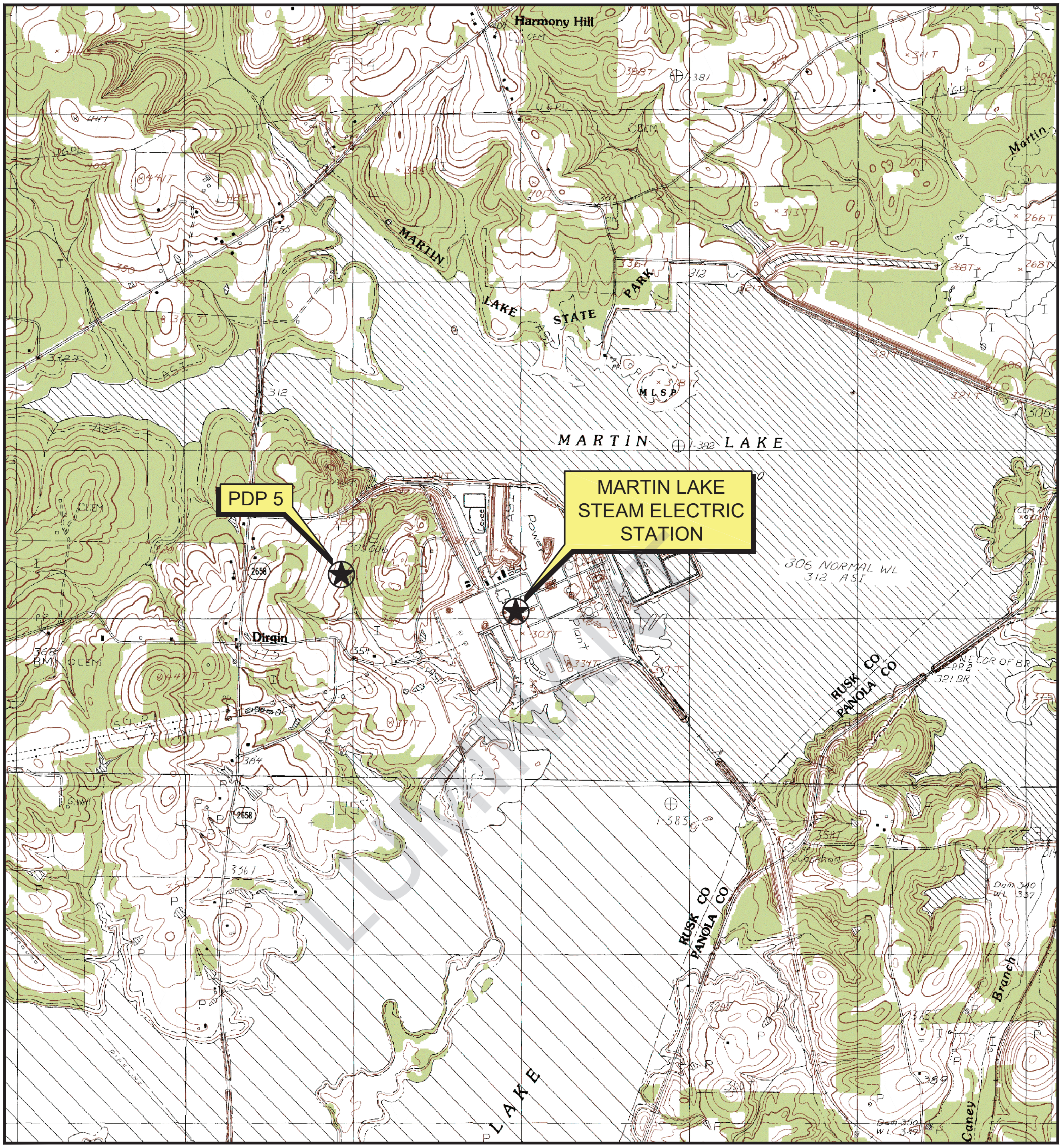
Pastor, Behling & Wheeler, LLC (PBW), 2016A. *Hazard Classification Assessment – Martin Lake Steam Electric Station Ash Pond Area and Permanent Disposal Pond No. 5, Rusk County, Texas*. October.

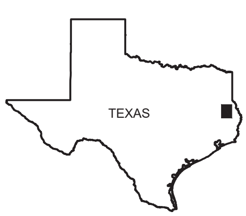
Pastor, Behling & Wheeler, LLC (PBW), 2016B. *CCR Closure Plan – Martin Lake Steam Electric Station Permanent Disposal Pond No. 5, Rusk County, Texas*. October.

United States Geological Survey (U.S.G.S.), 1983, 7.5-*Minute Series Topographic Map, Tatum, TX Quadrangle.*

United States Geological Survey (U.S.G.S.), 1983, 7.5-*Minute Series Topographic Map, Fair Play, TX Quadrangle.*

FIGURES





□UADRANGLE LOCATION

N

Scale in Feet

0 1500 3000

SOURCE:
Base map from www.tnris.gov, Tatum, TX 7.5 min. USGS □uadrangle dated 1983.

LUMINANT GENERATION COMPANY, LLC

MARTIN LAKE STEAM ELECTRIC STATION

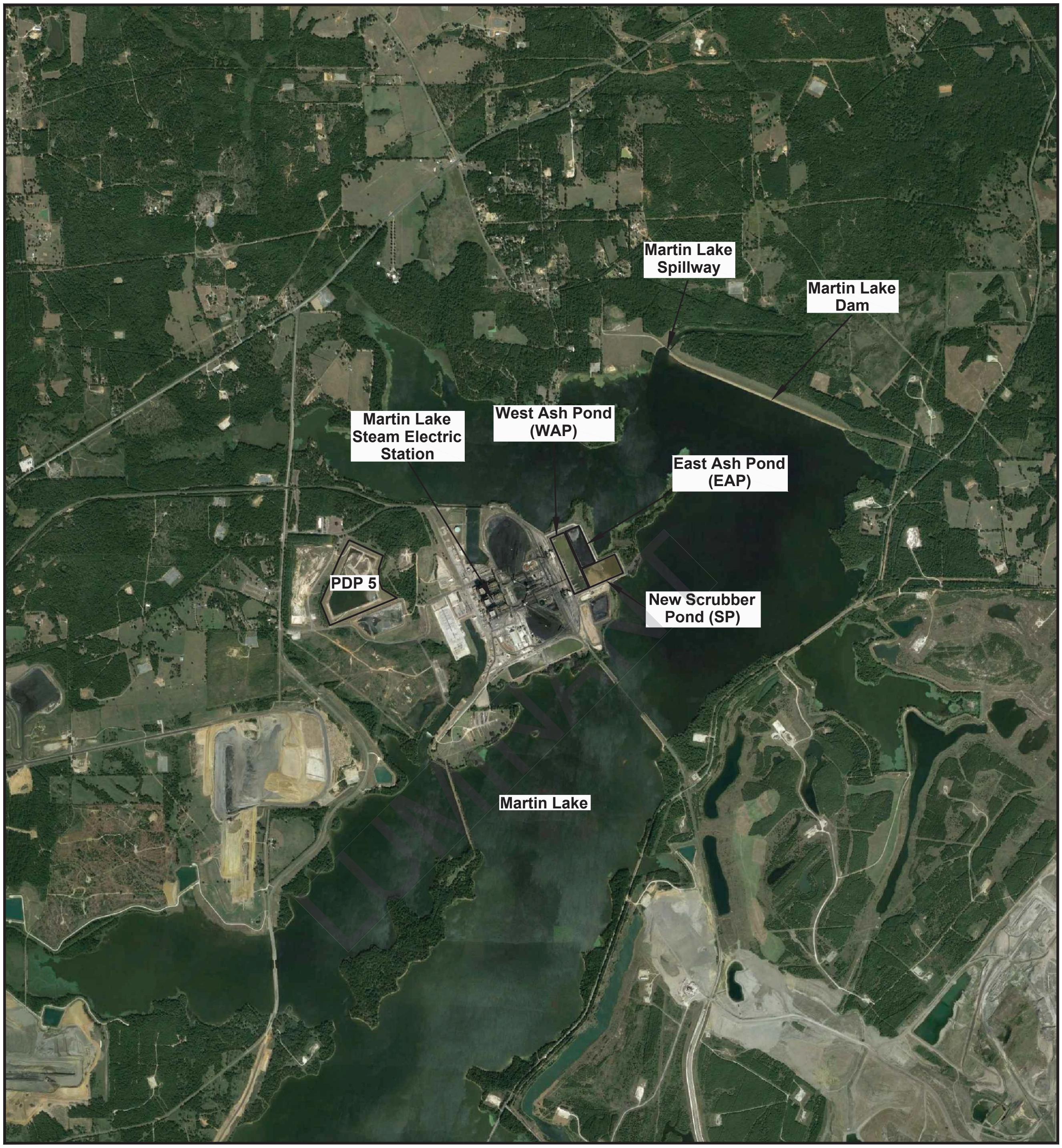
Figure 1

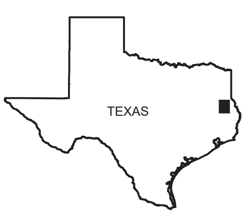
SITE LOCATION MAP

PROJECT: 5196B	BY: AJD	REVISIONS
DATE: SEPT., 2016	CHECKED: BDT	

PASTOR, BEHLING & WHEELER, LLC

CONSULTING ENGINEERS AND SCIENTISTS





PHOTOGRAPH LOCATION

N

Scale in Feet

0 2000 4000

SOURCE:
Imagery from Google Earth, photography dated October 1, 2015.

LUMINANT GENERATION COMPANY, LLC

MARTIN LAKE STEAM ELECTRIC STATION

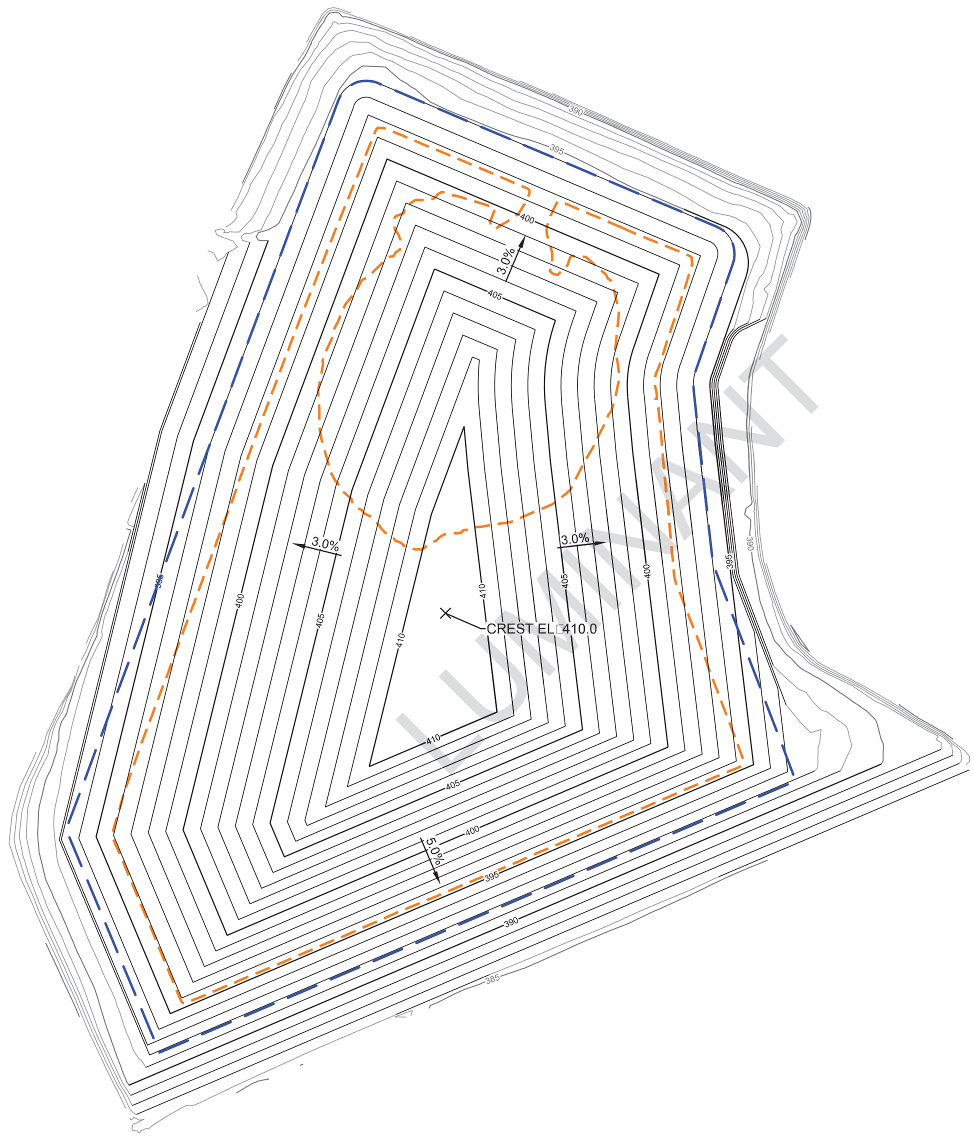
Figure 2

SITE VICINITY MAP

PROJECT: 5196B	BY: AJD	REVISIONS
DATE: SEPT., 2016	CHECKED: BDT	

PASTOR, BEHLING & WHEELER, LLC

CONSULTING ENGINEERS AND SCIENTISTS



EXPLANATION

- Proposed Finished Grade Contour 1 ft Interval
- Proposed Finished Grade Contour 5 ft Interval
- Proposed Limits of CAP
- Estimated Limits of CCR (Elev. 400.5)

N

Scale in Feet
0 125 250

LUMINANT GENERATION COMPANY, LLC
MARTIN LAKE STEAM ELECTRIC STATION

Figure 3

PROPOSED FINAL COVER GRADING PLAN

PROJECT: 5196B	BY: AJD	REVISIONS
DATE: SEPT., 2016	CHECKED: BDT	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS

REPORT

POST CLOSURE PLAN ADDENDUM NO. 1

Martin Lake Steam Electric Station - PDP-5
Rusk County, Texas

Submitted to:

Luminant Generation Company LLC

Submitted by:

WSP GOLDER

1601 S MoPac Expressway
Suite 325D
Austin, Texas, USA 78746
+1 737 703 3900

31404097.007

December 2022

PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by WSP Golder under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I hereby certify that Addendum No.1 to the Post Closure Plan for PDP-5 at the Martin Lake Steam Electric Station has been prepared in accordance with the requirements of 40 C.F.R. §257.104.

Patrick J. Behling, P.E.
Principal Engineer
WSP Golder
Texas Firm Registration No. 22771

Table of Contents

DOCUMENT REVISION RECORD

Issue No.	Date	Details of Revisions
Revision 0	October 2016	Original Document
Addendum 1	December 2022	Updated configuration of final cap/cover system for PDP-5 and updated Facility contact information.

1.0 INTRODUCTION

On behalf of Luminant Generation Company LLC (Luminant), WSP Golder (Golder) has prepared this Addendum No. 1 to the Post Closure Plan for Permanent Disposal Pond No. 5 (PDP-5) located at the Martin Lake Steam Electric Station (MLSES) in Rusk County, Texas (hereafter, the “Site”). Coal Combustion Residuals (CCR) including flue gas desulfurization (FGD) wastewater and bottom ash generated as part of MLSES operation are managed in PDP-5. PDP-5 is regulated as an Existing CCR Impoundment under 40 C.F.R. § 257, Subpart D (the “CCR Rule”).

The original Post Closure Plan for PDP-5 was prepared in October 2016 in accordance with 40 C.F.R. §257.102(b) and placed in the MLSES operating record in accordance with 40 C.F.R. §257.105(h)(10) (PBW, 2016). This Addendum No. 1 updates the Post Closure Plan to reflect the following:

- Revisions to the configuration of the PDP-5 final cap/cover system; and
- Update to the Facility contact information.

2.0 PDP-5 FINAL CAP/COVER SYSTEM

PDP-5 is an approximately 31-acre surface impoundment that was constructed in 2010 over three closed PDPs. PDP-5 was constructed above grade and is surrounded by earthen embankments that extend approximately 10 to 15 feet above the adjacent ground surface.

A final cap/cover system will be constructed over the CCR placed in PDP-5 as part of unit closure as referenced in the 2016 Post Closure Plan (PBW, 2016). However, the Post Closure Plan for PDP-5 is hereby modified to reflect that the final cap/cover system for PDP-5 will consist of the following (from bottom to top):

- a geosynthetic clay liner (GCL) with a maximum hydraulic conductivity of $5x10^{-9}$ cm/sec and a minimum thickness of 6 mm;
- a 40-mil linear low-density polyethylene (LLDPE) textured geomembrane;
- a geosynthetic drainage layer; and
- an 18-inch erosion layer consisting of 12 inches of general fill overlain with 6 inches of soil capable of supporting native vegetation.

3.0 FACILITY CONTACT INFORMATION

The Facility Contact Information in Table 2 of Section 4 of the Post Closure Care Plan is updated as follows:

Table 2: Contact Information

Name	Luminant-Environmental Services
Address	6555 Sierra Drive, Irving, TX 75039
Telephone Number	214-875-8654
E-mail	CCRinfo@luminant.com

4.0 REFERENCES

Pastor, Behling & Wheeler, LLC (PBW), 2016. CCR Post Closure Plan – Permanent Disposal Pond 5, Martin Lake Steam Electric Station. October.

Cynthia Vodopivec
Luminant Generation Company LLC
Luminant
6555 Sierra Dr.
Irving, TX 75039

November 25, 2020

Sent via email

Mr. Andrew R. Wheeler, EPA Administrator
Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Mail Code 5304-P
Washington, DC 20460

Re: Martin Lake Steam Electric Station Revised Alternative Closure Demonstration

Dear Administrator Wheeler:

Luminant Generation Company LLC (Luminant) submits this revised request to the U.S. Environmental Protection Agency (EPA) for approval of a site-specific alternative deadline to initiate closure pursuant to 40 C.F.R. § 257.103(f)(1) for the Ash Pond Area and Permanent Disposal Pond 5 (PDP5) located at the Martin Lake Steam Electric Station near Tatum, Texas. Luminant's request seeks an extension pursuant to 40 C.F.R. § 257.103(f)(1) to allow the Ash Pond Area and PDP5 to continue to receive CCR and non-CCR wastestreams after April 11, 2021, such that retrofit activity can be undertaken. As noted in our submission, PDP5 is an eligible unlined CCR surface impoundment as defined under 40 C.F.R. § 257.53.

The enclosed demonstration prepared by Burns & McDonnell replaces the demonstration that was previously submitted by Luminant to EPA on October 23, 2020. This demonstration addresses all of the criteria in 40 C.F.R. § 257.103(f)(1)(i)-(iii) and contains the documentation required by 40 C.F.R. § 257.103(f)(1)(iv). As allowed by the agency, in lieu of hard copies of these documents, electronic files were submitted to Kirsten Hillyer, Frank Behan, and Richard Huggins via email. The demonstration is also available on Luminant's publicly available website: https://www.luminant.com/ccr/

Sincerely,

Cynthia Vodopivec
VP - Environmental Health & Safety

Enclosure

cc: Kirsten Hillyer
Frank Behan
Richard Huggins

Martin Lake CCR Surface Impoundments Demonstration for a Site-Specific Alternative to Initiation of Closure Deadline

Luminant Generation Company LLC

Martin Lake Steam Electric Station
Project No. 122702

Revision 2
November 25, 2020

Burns & McDonnell
Engineering Firm F-845

Martin Lake CCR Surface Impoundments Demonstration for a Site-Specific Alternative to Initiation of Closure Deadline

Prepared for

Luminant Generation Company LLC
Martin Lake Steam Electric Station
Project No. 122702
Tatum, Texas

Revision 2
November 25, 2020

Prepared by

Burns & McDonnell Engineering Company, Inc.
Kansas City, Missouri

INDEX AND CERTIFICATION

Luminant Generation Company LLC
Martin Lake CCR Surface Impoundments
Demonstration for a Site-Specific Alternative to Initiation of Closure Deadline

Report Index

Certification

I hereby certify, as a Professional Engineer in the state of Texas, that the information in this document as noted in the above Report Index was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by the Luminant Generation Company LLC or others without specific verification or adaptation by the Engineer.

STATE OF TEXAS
RANDELL LEE SEDLACEK
99056
LICENSED
PROFESSIONAL ENGINEER
Randell Lee Sedlacek
11/25/20

Randell Lee Sedlacek

Randell Lee Sedlacek, P.E. (Texas License No. 99506)

Date: November 25, 2020

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LIST OF ABBREVIATIONS

Abbreviation	Term/Phrase/Name
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
CY	Cubic Yards
EAP	East Ash Pond
ELG	Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category
ERCOT	Electric Reliability Council of Texas
EPA	Environmental Protection Agency
FGD	Flue Gas Desulfurization
gal	Gallons
GCL	Geosynthetic Clay Liner
gpm	Gallons Per Minute
GWPS	Groundwater Protection Standards
HDPE	High Density Polyethylene
Luminant	Luminant Generation Company, LLC
Martin Lake	Martin Lake Steam Electric Station
MGD	Million Gallons Per Day
NSP	New Scrubber Pond
PDP5	Permanent Disposal Pond 5
RCRA	Resource Conservation and Recovery Act
SAP	Sampling and Analysis Plan
SSI(s)	Statistically Significant Increases

Abbreviation	Term/Phrase/Name
SSL(s)	Statistically Significant Levels
TPDES	Texas Pollutant Discharge Elimination System
WAP	West Ash Pond

EXECUTIVE SUMMARY

Luminant Generation Company LLC (Luminant) submits this request to the U.S. Environmental Protection Agency (EPA) for approval of a site-specific alternative deadline to initiate retrofit or closure pursuant to 40 C.F.R. § 257.103(f)(1) for the Ash Pond Area and Permanent Disposal Pond 5 (PDP5) located at the Martin Lake Steam Electric Station (Martin Lake). Luminant is requesting an alternative site-specific deadline of June 29, 2022, for the Ash Pond Area, to allow for the continued placement of CCR and non-CCR wastestreams in the Ash Pond Area while the remaining impoundments are sequentially retrofitted. In addition, Luminant is requesting an alternative site-specific deadline of July 1, 2023, for PDP5, to allow for the continued placement of CCR and non-CCR wastestreams in PDP5 during the Ash Pond Area retrofit project and thereafter to begin retrofit of PDP5 (if necessary following an EPA decision on an alternative liner application and demonstration expected to be submitted for PDP5 under the Part B Rule prior to November 30, 2020, and November 30, 2021, respectively).

Martin Lake is a three-unit 2,250-nominal megawatt coal-fired facility located near Tatum, Texas. Martin Lake utilizes the Ash Pond Area (consisting of the East Ash Pond, West Ash Pond, and New Scrubber Pond) and PDP5 to manage sluiced bottom ash, mill rejects, FGD blowdown and non-CCR wastestreams. The various non-CCR wastestreams managed in the impoundments include air pre-heater wash water, boiler non-chemical metal cleaning wastewater, boiler chemical cleaning wastewater, boiler blowdown and boiler sump area flows, and miscellaneous wastewater processes and stormwater. Martin Lake recycles and reuses wastewater stored in the impoundments as makeup water in the plant's operational processes. As a result, Martin Lake also utilizes the CCR surface impoundments to assist in maintaining the site's water balance. To ensure reliable generation and sufficient water storage for plant operations, and to minimize discharge to meet the site's aggressive mass limit of 17.5 pounds of selenium per calendar year into the adjacent Martin Creek Reservoir (combined discharge of all outfalls except for the once-through cooling water (Outfall 001) and discharges from the sewage treatment plant (Outfall 101)), the plant must have access to operate all four of the site's CCR surface impoundments from November through June, and must operate a minimum of three out of the four CCR surface impoundments from July through October. Therefore, Martin Lake has elected to sequentially retrofit its existing CCR surface impoundments, which consists of removing CCR materials from the impoundment to be retrofitted, taking the impoundment out of service and rerouting all wastestreams from the impoundment to the in-service impoundments, relining the impoundment, returning the impoundment to service, and starting the next impoundment retrofit. The retrofit for the East Ash Pond is complete, and Luminant is currently proceeding with the removal of CCR to allow for retrofit of the West Ash Pond before moving to the New Scrubber Pond and potentially PDP5.

1.0 INTRODUCTION

On April 17, 2015, the Environmental Protection Agency (EPA) issued the federal Coal Combustion Residual (CCR) Rule, 40 C.F.R. Part 257, Subpart D, to regulate the disposal of CCR materials generated at coal-fueled electric generating units. The rule is being administered under Subtitle D of the Resource Conservation and Recovery Act (RCRA, 42 U.S.C. § 6901 *et seq*.).

On August 28, 2020, the EPA Administrator issued revisions to the CCR Rule that require all unlined surface impoundments to cease receipt of CCR and non-CCR waste and initiate closure by April 11, 2021, unless an alternative deadline is requested and approved. 40 C.F.R. § 257.101(a)(1) (85 Fed. Reg. 53,516 (Aug. 28, 2020)). Specifically, owners and operators of a CCR surface impoundment may seek and obtain an alternative closure deadline by demonstrating that there is currently no alternative capacity available on or off-site and that it is not technically feasible to complete the development of alternative capacity prior to April 11, 2021. 40 C.F.R. § 257.103(f)(1). To make this demonstration, the facility is required to provide detailed information regarding the process the facility is undertaking to develop the alternative capacity. 40 C.F.R. § 257.103(f)(1). Any extensions granted cannot extend past October 15, 2023, except an extension can be granted until October 15, 2024, if the impoundment qualifies as an "eligible unlined CCR surface impoundment" as defined by the rule. 40 C.F.R. § 257.103(f)(1)(vi). Regardless of the maximum time allowed under the rule, EPA explains in the preamble to the Part A rule that each impoundment "must still cease receipt of waste as soon as feasible, and may only have the amount of time [the owner/operator] can demonstrate is genuinely necessary." 85 Fed. Reg. at 53,546.

This document serves as Luminant's Demonstration for a site-specific alternative deadline to initiate retrofit or closure pursuant to 40 C.F.R. § 257.103(f)(1) for the CCR surface impoundments at the Martin Lake Steam Electric Station (Martin Lake), located near Tatum, Texas, which include the following:

- Ash Pond Area:
  - East Bottom Ash Pond (EAP)
  - West Bottom Ash Pond (WAP)
  - New Scrubber Pond (NSP)
- Permanent Disposal Pond 5 (PDP5) – this impoundment qualifies as an "eligible unlined CCR surface impoundment" as defined under § 40 C.F.R. 257.53

To obtain an alternative closure deadline under 40 C.F.R. § 257.103(f)(1), a facility must meet the following three criteria:

1. **§ 257.103(f)(1)(i)** - There is no alternative disposal capacity available on-site or off-site. An increase in costs or the inconvenience of existing capacity is not sufficient to support qualification;
2. **§ 257.103(f)(1)(ii) -** Each CCR and/or non-CCR wastestream must continue to be managed in that CCR surface impoundment because it was technically infeasible to complete the measures necessary to obtain alternative disposal capacity either on or off-site of the facility by April 11, 2021; and
3. **§ 257.103(f)(1)(iii) -** The facility is in compliance with all the requirements of the CCR rule.

To demonstrate that the first two criteria above have been met, 40 C.F.R. § 257.103(f)(1)(iv)(A) requires the owner or operator to submit a work plan that contains the following elements:

- A written narrative discussing the options considered both on and off-site to obtain alternative capacity for each CCR and/or non-CCR wastestream, the technical infeasibility of obtaining alternative capacity prior to April 11, 2021, and the option selected and justification for the alternative capacity selected. The narrative must also include all of the following:
    - An in-depth analysis of the site and any site-specific conditions that led to the decision to select the alternative capacity being developed;
    - An analysis of the adverse impact to plant operations if the CCR surface impoundment in question were to no longer be available for use; and
    - A detailed explanation and justification for the amount of time being requested and how it is the fastest technically feasible time to complete the development of the alternative capacity.
- A detailed schedule of the fastest technically feasible time to complete the measures necessary for alternate capacity to be available, including a visual timeline representation. The visual timeline must clearly show all of the following:
    - How each phase and the steps within that phase interact with or are dependent on each other and the other phases;
    - All of the steps and phases that can be completed concurrently;
    - The total time needed to obtain the alternative capacity and how long each phase and step within each phase will take; and
    - At a minimum, the following phases: engineering and design, contractor selection, equipment fabrication and delivery, construction, and start up and implementation.
- A narrative discussion of the schedule and visual timeline representation, which must discuss the following:

  - Why the length of time for each phase and step is needed and a discussion of the tasks that occur during the specific step;
  - Why each phase and step shown on the chart must happen in the order it is occurring;
  - The tasks that occur during each of the steps within the phase; and
  - Anticipated worker schedules.
- A narrative discussion of the progress the owner or operator has made to obtain alternative capacity for the CCR and/or non-CCR wastestreams. The narrative must discuss all the steps taken, starting from when the owner or operator initiated the design phase up to the steps occurring when the demonstration is being compiled. It must discuss where the facility currently is on the timeline and the efforts that are currently being undertaken to develop alternative capacity.

To demonstrate that the third criterion above has been met, 40 C.F.R. § 257.103(f)(1)(iv)(B) requires the owner or operator to submit the following information:

- A certification signed by the owner or operator that the facility is in compliance with all of the requirements of 40 C.F.R. Part 257, Subpart D;
- Visual representation of hydrogeologic information at and around the CCR unit(s) that supports the design, construction and installation of the groundwater monitoring system. This includes all of the following:
  - Map(s) of groundwater monitoring well locations in relation to the CCR unit(s);
  - Well construction diagrams and drilling logs for all groundwater monitoring wells; and
  - Maps that characterize the direction of groundwater flow accounting for seasonal variations.
- Constituent concentrations, summarized in table form, at each groundwater monitoring well monitored during each sampling event;
- A description of site hydrogeology including stratigraphic cross-sections;
- Any corrective measures assessment conducted as required at § 257.96;
- Any progress reports on corrective action remedy selection and design and the report of final remedy selection required at § 257.97(a);
- The most recent structural stability assessment required at § 257.73(d); and
- The most recent safety factor assessment required at § 257.73(e).

2.0 WORKPLAN

To demonstrate that the criteria in 40 C.F.R. § 257.103(f)(1)(i) and (ii) have been met, the following is a workplan consisting of the elements required by § 257.103(f)(1)(iv)(A). This workplan documents that there is no alternative capacity available on or off-site for each of the CCR and/or non-CCR wastestreams that Luminant plans to continue to manage in the Martin Lake CCR surface impoundments and discusses the options considered for alternative disposal capacity. As discussed in more detail below, **Luminant has elected to retrofit its existing CCR surface impoundments.** The workplan provides a detailed schedule for the retrofit project, including a narrative description of the schedule and an update on the progress already made toward retrofit of the CCR surface impoundments. In addition, the narrative includes an analysis of the site-specific conditions that led to the decision to retrofit the impoundments and an analysis of the adverse impact to plant operations if Martin Lake were no longer able to use the CCR surface impoundments.

2.1 No Alternative Disposal Capacity and Approach to Obtain Alternative Capacity - § 257.103(f)(1)(iv)(A)(1)

Luminant owns and operates Martin Lake, a three-unit 2,250-nominal megawatt coal-fired facility located near Tatum, Texas, that burns a mixture of locally mined lignite and Powder River Basin coal. Martin Lake has four CCR surface impoundments (listed in Table 2-1) that receive both CCR and non-CCR wastestreams. An aerial view of the Martin Lake site and the CCR surface impoundments can be found on Figure 1 in Appendix A. The first three impoundments listed (EAP, WAP, and NSP) in Table 2-1 are part of the Ash Pond Area referenced on Luminant's CCR website. This area is equipped with a multi-unit groundwater monitoring network. The fourth, PDP5, is located separately from the Ash Pond Area (as shown in Figure 1 in Appendix A) and has its own groundwater monitoring network. As described in more detail below, Martin Lake does not have alternate onsite or offsite storage capacity that would allow the site to continue to operate safely with more than one CCR impoundment out of service at one time (concurrent with summer peak operation) and maintain compliance with environmental permits and obligations.

Table 2-1: Martin Lake CCR Surface Impoundment Summary

CCR Surface Impoundment Name	Year Placed in Service	Impoundment Size (acres) / Storage Volume (acre-feet) [1]	Lined?	Complies with Location Restrictions?	Groundwater Status
East Bottom Ash Pond (EAP)	1977	9.6 / 125.8	No	Yes	Assessment Monitoring was initiated in June 2018. SSLs were identified for beryllium, cobalt, and lithium in January 2019. The Assessment of corrective measures was completed in September 2019. Impoundment retrofit is underway for source control, while selection of the groundwater remedy is currently in the feasibility study phase.
West Bottom Ash Pond (WAP)	1977	14.6 / 232.6	No	Yes	
New Scrubber Pond (NSP)	1989	12.5 / 198.9	No	Yes	
Permanent Disposal Pond 5 (PDP5)	2010	40 / 190.3	Yes[2]	Yes	SSIs have been identified with successful Alternate Source Demonstrations completed in 2018 and 2019. Remains in Detection Monitoring.

[1]Values listed in Inflow Design Flood Control System Plan prepared by Pastor, Behling & Wheeler, LLC in October 2016.

[2]PDP5 was originally classified as lined per 40 C.F.R. § 257.71(a)(1)(i), which was subsequently vacated by the U.S. Court of Appeals for the D.C. Circuit. This impoundment now qualifies as an eligible unlined CCR surface impoundment per § 257.53.

The Martin Lake facility is unique because it operates its CCR-related outfalls essentially as zero discharge facilities to maintain a negative or neutral water balance for the plant. For Martin Lake's CCR related processes the term "water balance" means managing the inflow of water and wastewater into the impoundments to equal or exceed the outflow(s). This is expressed as:

$$(S \pm \Delta I) - (E+O+C) \leq 0$$

Where:
Sources (from reservoir and/or groundwater supply wells or rainfall)
Inventory (ponds, volume in process, etc.)
Evaporation (forced and natural)
Output (discharge)
Consumption (moisture in products)

To achieve the negative/neutral water balance, Martin Lake utilizes the CCR surface impoundments, the low volume wastewater retention pond, and the stormwater retention pond to assist in the storage and management of all the remaining water process flows and stormwater on the plant site. These ponds are inter-connected with pumps and piping systems to allow transport of the non-CCR wastestreams to the CCR surface impoundments as make-up water. There are permitted outfalls for discharge from the wastewater recycling plant (Outfall 201), stormwater retention pond (Outfall 301), low volume wastewater pond (Outfall 401), and from the solid waste disposal area (Outfall 501); however, these outfalls typically do not discharge and the wastewaters are used to support water reuse at the site. The existing site water balance flow diagram is included in Appendix A of this demonstration (see Figure 2) and discussed further in Sections 2.1.1-2.1.2.

The water recycling practices discussed above are both necessary and extremely beneficial from an environmental perspective, minimizing both the discharge of wastewater into and the withdrawal of freshwater from waters of the U.S. Recycling is also necessary because of several factors related to the water quality limitations found in the facility's TPDES wastewater permit. The most restrictive permit requirement is a mass limit of 17.5 pounds for the discharge of selenium per calendar year (2 pounds per rolling 30 days per the selenium monitoring program) into Martin Creek Reservoir, which means that the volume of discharge is inverse to the concentration of selenium in the wastewater. The mass limit applies at all Outfalls combined except for the once-through cooling water (Outfall 001) and discharges from the sewage treatment plant (Outfall 101), which are discharged daily. Further, Outfall 301 (stormwater) and Outfall 401 (low volume wastewater) have daily average limits for selenium of 0.02 and 0.05 parts per million, respectively. Per the TPDES permit for Outfall 401, discharges are authorized only when accumulations of wastewater exceed normal, safe operating water levels as a result of any one or combination of the following:

- Recycle equipment outage, or
- Generating unit outage, or
- A rainfall event or consecutive events equal to or greater than the 10-year/24-hour rainfall event

Due to the combined selenium discharge limitation, and the restrictions on discharge from Outfall 401, Martin Lake is generally limited to discharges of stormwater only via Outfall 301 when the ponds are nearing their maximum capacity. This has not occurred in decades due to the recycling and reuse of stormwater at the site as described further in the sections below.

Rainfall: The largest single input into the site water balance is typically rainfall, which is generally unpredictable for both frequency and volume. The Martin Lake facility is located near the eastern border of Texas in a region known as the Piney Woods. This region is characterized by wet springs, then dry summers with rainfall returning in the fall. The annual rainfall for the area can be highly variable from year to year because of the inflow of the humid Gulf Coast air from the south, dry and/or cool frontal activity from the north, and the occasional hurricane or tropical storm. Located ~12 miles from the nearest weather station at the East Texas Regional Airport, and subject to locally heavy rainfalls, the Martin Lake facility has monitored and recorded its own rainfall data since 1978. In the 41+ year site rainfall record (1978 – September 2020), the average annual rainfall is 48.02 inches, with a minimum of 27.34 inches in 2010, and a maximum of 74.40 inches in 2018.

The site pond system captures rainfall and runoff from approximately 180 acres of the plant site. This includes 97 acres of direct rainfall into the ponds and 83 acres from areas that have exposed materials such as coal or other industrial activity, including the solids handling area, certain piping routes, secondary containments, and buildings, roads, etc. Of the 83 non-pond acres, the runoff coefficient is normally estimated at 85%. For a 1-inch rainfall, the Martin Lake site usually gains ~ 4.6 million gallons of water into its wastewater management systems. This flow is collected in the low volume wastewater retention pond and stormwater retention pond before being routed to the CCR surface impoundments onsite. Over an average year (e.g., ~48 inches of rainfall), the site gains approximately 675-acre feet of water or 220 million gallons, which depending on the volume and frequency of events, can at times utilize a significant portion of the total operational volume of all ponds on-site.

For reference, the rainfall event most often identified as the standard for water management purposes is the "10-year, 24-hour rainfall event," as defined by the National Weather Service in Technical Paper No. 40, "Rainfall Frequency Atlas of the United States," May 1961. This flow statistically has a 10% chance of occurring each year. For the Martin Lake site, the 10-year/24-hour event is estimated at 7.1 inches, which equates to approximately 34 million gallons of runoff.

Reuse: The wastewater permit limitations at Martin Lake greatly inhibit the management of the captured stormwater in an efficient manner. If it were possible for the site to discharge the captured stormwater in real-time at the permitted daily average limit for selenium (i.e., 0.020 parts per million at Outfall 301), it would reach the mass limit at approximately 105 million gallons, or <48% of the estimated average annual rainfall; however, that same volume would have to be released slowly at 0.40 MGD over a period of 262 days to stay below the 2 pounds per rolling 30 days limitation in the selenium monitoring program. Consequently, due to the discharge limits in the TPDES permit it is not considered feasible for Martin Lake to discharge this stormwater as it is collected (average monthly rainfall equates to 18 million gallons, with a maximum allowable discharge equal to approximately 12 million gallons per month capped at the maximum of 105 million gallons per year assuming the stormwater meets the selenium concentration and any other applicable limits). The water must be incorporated into the site's CCR surface impoundments to provide adequate storage of this water, particularly during significant rain events that would overwhelm the site stormwater and lignite area runoff ponds. Once this water is comingled with the CCR wastestreams, it can no longer be discharged and must be reused within the plant process systems. It should also be noted that since the stormwater is normally used for make-up to the various systems, that volume would have to be replaced by freshwater.

Martin Lake does have the capability to treat its captured stormwater to a value well below the permitted daily average concentration limit(s), but the treatment processes are physically limited to a rate that is slower than the rate of use of the wastewater as make-up to the CCR systems (an approximately 250 gallons per minute (gpm) treated product water rate vs. an estimated average make-up rate of 2,000 gpm with all units online). The treatment process to produce the lowest selenium concentration achievable involves utilization of multiple water treatment systems in a sequence. These include micro-filtration, reverse osmosis, and demineralizers. This process, however, produces wastestreams of equal volume (approximately 50% of the feed rate) that are essentially untreatable. Introduction of these high concentrate wastestreams back into the wastewater inventory is counter-productive and limits the recycle uses to consumption (i.e., the bottom ash and FGD systems).

<u>Water Availability:</u> The negative/neutral water balance method of operation has also become necessary because of the limited availability of surface water in the State of Texas. Texas is a water rights state, and surface water withdrawals and use are highly regulated. Groundwater is separate but similar issue, with groundwater conservation also highly regulated.

Over the past several decades the addition of new pollution control devices has increased the water consumption at the facility. The use of non-CCR wastewater and site stormwater as make-up to the CCR systems has prevented the need for a large increase in the volume of freshwater needed.

<u>Evaporation:</u> Evaporation, both natural and forced, is another important component of a water balance. Evaporation is the conversion of water from a liquid to a gas. This process is driven by the difference in temperature between the water and the atmosphere and the surface area of the water exposed to the atmosphere.

Natural evaporation occurs at the ambient temperatures for both the water and the air where they interface (i.e., a pond surfaces) and is basically the absorption of heat. Cloud cover is an important factor that slows evaporation, and so is wind which usually enhances evaporation as the wind speed increases. Natural evaporation is highly localized and changes daily, monthly, and yearly. It is most often measured as "pan-evaporation", which is a measurement of the water lost from a "Class A evaporation pan", as used by the National Weather Service. Data from that apparatus cannot, however, be directly correlated to waterbodies such as reservoirs or wastewater ponds because of several factors including wind exposure, water depth, water clarity, and other siting conditions. For the Martin Lake site, historical experience has shown that pond evaporation rates are approximately 75% of the Class A pan evaporation rate.

Forced evaporation is water that is consumed through a process due to contact or exposure to above ambient temperatures. At Martin Lake, this is either in the form of hot gases through the FGD system or the hot ash in the bottom ash system. The amount of water lost due to forced evaporation is dependent on operation of the generating units and the amount of electricity produced. A generating unit operating at a 75% load evaporates roughly 25% less than one operating at 100%, or a full load. This is because the unit is consuming less fuel, producing less hot gas that goes through the FGD system and less ash to the bottom ash system, both of which result in less forced evaporation. The Martin Lake site is dispatched by the Electric Reliability Council of Texas (ERCOT), and the level or rate of generation (i.e., forced evaporation), is set by the ERCOT system supply and demand. The changes in the rate of generation are variable, occur in real time, and can have a range of several hundred megawatts over the course of a day. As an industry standard (and consistent with historical calculations for the Martin Lake site), the forced evaporation rate is approximately equal to one gpm per megawatt, or 60 gallons per megawatt hour.

Together, forced and natural evaporation is critical to the water balance at Martin Lake, representing the highest demand and largest consumers of water and wastewater. It is most noticeable during the hot summer season when all generating units are operating, both forced and natural evaporation rates are at their highest, and wastewater inventories decline daily.

<u>Other factors:</u> The third component of water consumption is the percent moisture that is in the products (e.g., bottom ash and scrubber solids or gypsum), that are either sold or properly disposed of in a landfill. This is a relatively constant value, typically around 10 – 12 percent, with the total volume dependent on amount of the materials that are disposed offsite. This is estimated at approximately 13 gpm and 119 gpm for bottom ash and scrubber solids, respectively, in 2019.

The low chloride content of the fuel used at the site is also an important factor in Martin Lake's ability to reuse its wastewater. Chlorides in the water of a mechanical or biological system can quickly become a problem and damage the metallurgy of the FGD equipment requiring frequent purging of the water. The low chlorides in the Martin Lake fuels help to maximize the reuse and recycling of the CCR system wastewaters.

Water Management: Intensive water management is a practice to minimize the amount of stormwater that is required to be captured and maximize the reuse of all water wastestreams produced at the site. This practice also makes it possible to minimize the input of new freshwater to only what is needed for specific processes, help to balance the equation, and avoid discharge of wastewater. At Martin Lake it requires constant diligence since so many of the large inputs and consumptive uses are highly variable and controlled by outside forces (e.g., rainfall, natural evaporation, and unit operation/generation (i.e., forced evaporation)).

These factors allow the Martin Lake site to use its non-CCR wastewater (e.g., low volume wastewater, boiler water treatment wastewater, lignite and coal pile runoff, captured stormwater, etc.) as sources of make-up water. The wastewaters are continuously recycled into the CCR systems which are large consumers of water, that require constant make-up, and that would otherwise require like volumes of freshwater (surface and/or groundwater).

All of this has led Martin Lake to adopt the reuse of wastewater and captured stormwater as make-up to the CCR systems in order to maintain the negative/neutral water balance. These practices are feasible at Martin Lake because of three factors: a generally favorable climate (long, hot summers with high evaporation rate), the use of low chloride fuel sources (lignite & western coal), and intensive wastewater management focused on recycling and reuse of wastewater.

2.1.1 CCR Wastestreams

Luminant evaluated each CCR wastestream generated at Martin Lake (See Table 2-2). The existing site water balance is included in Appendix A of this demonstration (see Figure 2). Fly ash is collected dry and disposed in A-1 Area Landfill, therefore it is not part of this extension request. For the reasons discussed below in Table 2-2, the following CCR wastestreams must continue to be placed in the CCR surface impoundments due to the lack of alternative capacity both on and off-site.

Table 2-2: Martin Lake CCR Wastestreams

CCR Wastestream	Estimated Average Flow (MGD)	Description	Luminant Notes
Bottom Ash (and non-CCR mill reject) sluice	13.14	Operated as closed-loop system with CCR sluiced to dewatering bins for solids removal before collecting flow in Ash Pond Area for reuse.	The water in this system is recycled from the Ash Pond Area (with makeup from the onsite non-CCR ponds) or sent to PDP5 as required to maintain the overall site water balance and avoid discharge of wastewater and site stormwater into Martin Creek Reservoir.
FGD Blowdown	4 (3.3 as overflow, 0.69 as underflow and filtrate)	Purged to thickeners. Overflow returned to FGD system. Underflow can be routed to NSP but is typically routed to solid waste handling system with solids removed and hauled to A-1 Area Landfill. The filtrate (non-CCR) is then returned to the NSP. Underflow can be routed to PDP5 from the NSP when solid waste handling system is down for maintenance or when upset conditions occur in the process.	Water from the NSP is currently recycled to the FGD system through the wastewater recycling facility. The intermittent purges of CCR solids from the system during upsets or maintenance events cannot be routed to another location onsite outside the Ash Pond Area or PDP5. Prior to the April 11, 2021 deadline, Luminant will reroute the filtrate to the retrofitted EAP rather than the unlined NSP during normal operation; however, this wastestream will be comingled with other flows that must be managed in the other unlined portions of the Ash Pond Area and PDP5 to prevent discharges that exceed the permitted limits.

Since these wastestreams contain CCR material, they cannot be routed to any location onsite other than the existing CCR surface impoundments and the volume is too large to be managed onsite in temporary tanks. If 24 hours would provide sufficient residence time for the settling of the fine solids in these wastestreams, approximately 650 frac tanks would be required to store and treat the bottom ash transport water and an additional 35 frac tanks would be required for the FGD wastewater underflow (if the solids handling system is down for maintenance). These tanks would cover approximately 10 acres of the site, and even if there were enough flat area available with truck access for these tanks, they would require significant amounts of interconnecting piping and an unacceptable number of potential leaks. Furthermore, assuming a solids content of 3% in the comingled wastestreams, approximately 20 of these frac tanks would need to be removed and replaced each day. Because of the effluent limits at 40 C.F.R. § 423.16(e)(1), the FGD wastewater cannot be discharged and may require significant pretreatment prior to being hauled offsite for disposal, for which the treatment systems currently do not exist onsite and would take over two years to design and install. This treatment system is not required for ELG compliance at Martin Lake and has not been initiated to date since Luminant plans to comply with ELG using their historical water management practices to maintain zero discharge of CCR wastestreams. Trucking the bottom ash and FGD wastewater offsite for disposal would require increased water use and a significant number of trucks (over 1,900 per day assuming 7,500 gallons per truck) driving an unknown distance across rural Texas roadways. Consequently, the options considered to install temporary tanks to store and reuse this wastewater onsite or to install pipelines or mobilize trucking for offsite disposal of these CCR wastestreams is not considered a feasible alternative at Martin Lake.

2.1.2 Non-CCR Wastestreams

Luminant evaluated each non-CCR wastestream placed in the Martin Lake CCR surface impoundments. For the reasons discussed below in Table 2-3, each of the following non-CCR wastestreams must continue to be placed in the CCR surface impoundments due to lack of alternative capacity both on and off-site.

Table 2-3: Martin Lake Non-CCR Wastestreams

Non-CCR Wastestream	Estimated Average Flow (MGD)	Description	Luminant Notes
Air Pre-Heater Wash Water	Outage Only	Wash water	Prior to the April 11, 2021 deadline, Luminant will reroute this wash water to the retrofitted EAP; however, these wastestreams will be sourced from or comingled with other CCR wastestreams that must be managed in the other unlined portions of the Ash Pond Area and PDP5 to prevent discharges that exceed the permitted limits.
Boiler Non-Chemical Metal Cleaning Wastewater	Outage Only	Wash water from fireside and back-pass washes. Typically sluiced to dewatering bins for solids removal before collecting flow in Ash Pond Area for reuse.	
Boiler Blowdown and Boiler Area Sump Flows	0.186	Boiler Blowdown and Wash Water (this is an estimate of water added to the system and does not include recycled portion of the CCR wastestreams in the sumps from hopper and boiler seal trough overflows which cannot be segregated)	Prior to the April 11, 2021 deadline, Luminant will reroute these flows to the retrofitted EAP; however, these wastestreams will be comingled with other CCR wastestreams that must be managed in the other unlined portions of the Ash Pond Area and PDP5 to prevent discharges that exceed the permitted limits.

Non-CCR Wastestream	Estimated Average Flow (MGD)	Description	Luminant Notes
Miscellaneous Plant Drains and Wash Water	0.836 to EAP/WAP, 0.438 to NSP	Estimated flow of wash water incorporated into Ash Pond Area from boiler area and FGD solids handling area wash flows. The wastewater permit does not allow these contact waste streams to be routed to the Low Volume Retention Pond (Outfall 401).	
Misc. Process Wastewater (includes water pumped from Low Volume Retention Pond for Reuse)	Estimated at 0.448 (including service water contributions for wash activities and excluding stormwater contributions which are intermittent)	Includes, Demineralizer Regeneration Flows, Reverse Osmosis System Reject Flows, Other Water Treatment Wastewaters, Miscellaneous Plant Drains (wash water), and Oil Water Separator discharge.	These flows are routed to the Ash Pond Area (and potentially from the Ash Pond Area to PDP5) via yard sumps and drains. If these wastestreams are no longer managed in the CCR impoundments, major modifications to the wastewater permit would be required as well as the development of additional storage and treatment system capacity, extending the overall compliance schedule. The site is only able to purge low volume wastewater via Outfall 401 under specific permit conditions coincident with equipment/unit outages and/or significant rain events (greater than 10-yr/24-hr storm event). Maximum flow would be at 0.16 MGD after treatment to achieve the permitted daily average selenium concentration allowed, capped at an annual maximum of 4.8 million gallons. Treatment of these flows concentrates the contaminants present in the CCR impoundments and reduces the site's ability to discharge stormwater (due to the combined 17.5-pound maximum annual limit for selenium). The peak flows from rain events cannot feasibly be discharged based on this restriction, and once comingled with CCR wastestreams in the CCR impoundments cannot be discharged at all. The forced evaporation at the site allows for reuse and elimination of this wastewater faster than it can be discharged and prevents the discharge of selenium to the captive biological species in the Martin Creek Reservoir which is open to the public.

Non-CCR Wastestream	Estimated Average Flow (MGD)	Description	Luminant Notes
Captured Site Stormwater (falls directly in the CCR impoundments or is pumped from Low Volume Retention and Stormwater Retention Ponds)	0.6 (based on daily average of average annual precipitation/run off captured; however, this flow is intermittent and has significant peak flow events throughout the year)	Stormwater that falls directly in impoundments (97 acres) or that is captured from solids handling area and the plant yard drains (83 acres)	These flows are routed to the Ash Pond Area (and potentially from the Ash Pond Area to PDP5) via yard sumps and drains. If these wastestreams are no longer managed in the CCR impoundments, major modifications to the wastewater permit would be required as well as the development of additional storage and treatment system capacity, extending the overall compliance schedule. Only able to purge stormwater via Outfall 301 at 0.4 MGD at the permitted daily average selenium concentration allowed, capped at an annual maximum of 105 million gallons per year. The peak flows from rain events cannot feasibly be discharged based on this restriction, and once comingled with CCR wastestreams in the CCR impoundments cannot be discharged at all. The forced evaporation at the site allows for reuse and elimination of this wastewater faster than it can be discharged and prevents the discharge of selenium to the captive biological species in the Martin Creek Reservoir which is open to the public.

2.1.3 Site-Specific Conditions Supporting Alternative Capacity Approach – § 257.103(f)(1)(iv)(A)(1)(i)

The four CCR surface impoundments at Martin Lake receive both the CCR sluice flows and the various non-CCR wastestreams produced onsite. In addition to providing treatment for the reduction of total suspended solids, the CCR impoundments are also a critical component in the management of the overall site water balance as described in Section 2.1.

The design storage and operational capacity of the Martin Lake CCR impoundments are summarized in Table 2-4. Each of these ponds, with the exceptions of PDP5 and the stormwater retention pond, require approximately 40% of the design volume to operate (i.e., the “operational volume” in Table 2-4). This volume is needed to provide suction to the pumps that recirculate the water back to the plant for re-use. Accordingly, only approximately 60% of the design volume of these ponds is available to manage the inflow of water and wastewater into the ponds. The available storage capacity at any point in time is impacted by the accumulation of solids in the impoundments, as well as the ever-changing amount of stormwater and process water contained in the pond system.

Table 2-4: Summary of Pond Design Storage & Operational Capacity

Impoundment	Design Volume (gal)	Operational Volume (gal)
EAP	43,000,000	25,800,000
WAP	70,000,000	42,000,000
NSP	58,000,000	34,800,000
PDP5*	66,000,000	66,000,000
Low Volume Retention Pond	49,550,000	29,730,000
Storm Water Retention Pond*	34,300,000	34,300,000
Total Capacity (gal)	320,850,000	232,630,000

* Surge ponds

Luminant considered the possibility of simultaneously retrofitting two ponds, but an evaluation of the construction complexity, logistical and technical issues for scheduling for two ponds that physically share many common utilities, many of the same dikes, the same roads, and the same access/egress points with the adjacent pond that must remain in-service to support power plant operations, presented unacceptable risk to operation of the generating units. It also presented significant water balance, water management, and wastewater permit compliance risks, even under normal rainfall conditions.

The typical operation and management of the CCR ponds for the past several decades has been that one pond is generally considered out-of-service to allow for solids removal. Ordinarily, it takes 6-8 months of out-of-service time to complete solids removal. If additional work for maintenance or repairs is needed, the out-of-service period is often extended.

If a pond is out-of-service for a simple clean-out, the clean-out operations can be stopped and the pond quickly returned to service temporarily if necessary due to unplanned operational events or heavy rainfall; however, if the pond requires liner repairs or replacement it is critical to the project to complete all the necessary repairs or replacement before the pond is returned to service. This means that during a project involving a liner retrofit, water balance becomes critical and sometimes requires extraordinary management effort.

Figure 2-1 below shows a five-year forecast of the pond levels onsite, assuming all ponds are in service. This figure is based on the average annual rainfall (48 inches per year, distributed on an average monthly basis), the last five years of average monthly generation (from EIA data), forced evaporation at one gpm per megawatt (or 60 gallons per megawatt hour), natural evaporation at 75% of the Class A pan evaporation rate for the pond areas, 50 million gallons per month of boiler blowdown, service water, and low volume wastewater contributions (approximately 1.908 MGD excluding outage flows and stormwater per Table 2-3), pond storage volumes per Table 2-4, and using a starting pond available capacity consistent with measurements at the site on October 20, 2020 (approximately 50% of the pond operational capacity available). As shown, the minimum available pond capacity over the next few years is forecasted to be approximately 48 million gallons in May of 2021, increasing to 73 million gallons in May of 2022, and 97 million gallons in May of 2023 (assuming all of the ponds are in service). Again, these reserve limits are based on average rainfall only, but clearly demonstrate that removing even the smallest remaining CCR impoundment from service for retrofit (the NSP at approximately 35 million gallons of operational volume) significantly compromises the site's storage capacity. Removing two impoundments from service concurrently is not feasible based on average rainfall, historical average monthly evaporation, and the estimated average plant process water contributions.

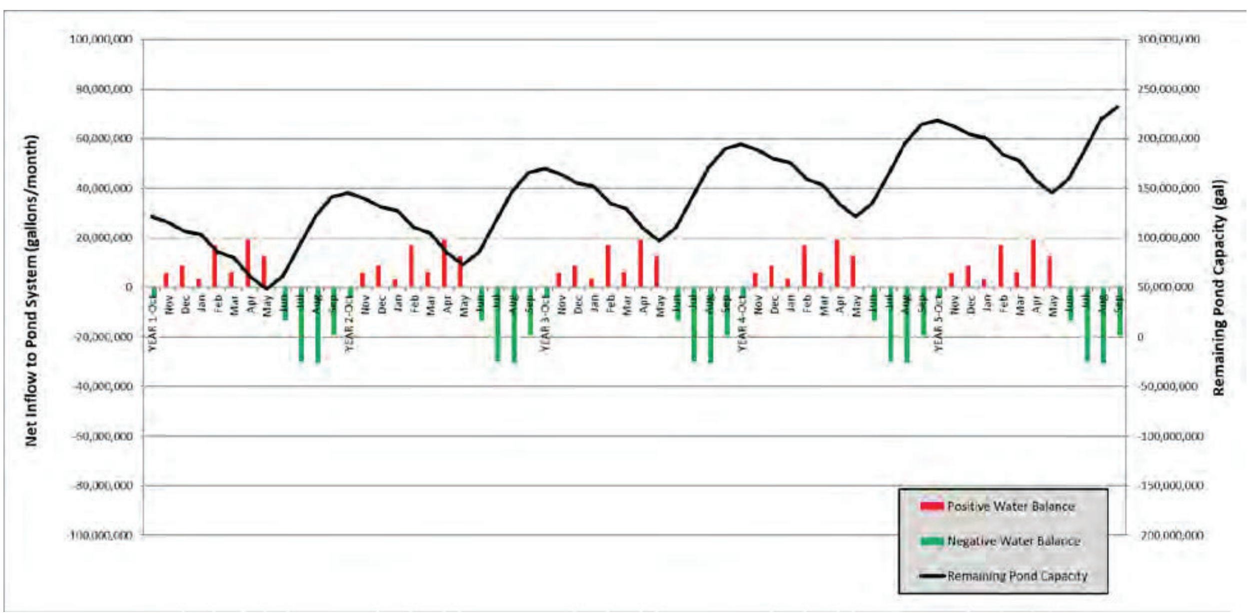

Figure 2-1: Average Monthly Plant Water Balance vs Impoundment Storage Capacity

The current plan involves removing the WAP (70 million gallons of total volume) from service on July 5, 2021, at which point the site is forecasted to have 21 million gallons of remaining storage capacity (not including the WAP). Martin Lake intends to remove solids from the NSP concurrently with the WAP retrofit; however, the NSP will not be removed from service and will remain available to receive additional water as required to maintain the site water balance. If the site were to attempt to remove two ponds from service simultaneously for retrofits, any number of single events such as an unplanned unit outage, equipment failure for the one in-service pond, along with above average rainfall could very likely create wastewater management issues that would require the temporary placement of wastewater back into one of the ponds.

Average rainfall at the site for April through June is 13.12 inches (approximately 190 acre-feet or 62 million gallons of water). These wet months are also coincident with spring outages, representing some of the lower forced evaporation rates for the site. Per Figure 2-1, these months represent the periods with the minimum available storage capacity in the site pond system. The following summer months provide the best conditions for earthwork construction, particularly pond work, and consequently, Martin Lake must perform the retrofit activities in the summer months (ideally July through October) during periods with reduced rainfall and peak unit operations. As described in Section 2.1, a 10-year 24-hour storm event at Martin Lake (7.1 inches of rainfall) would contribute approximately 34 million gallons of stormwater runoff which could not be discharged at a rate higher than 0.4 MGD (2 pounds per rolling 30 days per the selenium monitoring program). If this event occurs at any point during the retrofit cycle, the plant's ability to continue operations without discharging would be compromised. Performing the retrofit operations sequentially to have one pond out-of-service at any given time in the summer months provides the operational flexibility and adequate pond space required for upset conditions, such as above average rainfall events or periods or unscheduled unit shutdowns.

2.1.4 Impact to Plant Operations if Alternative Capacity Not Obtained – § 257.103(f)(1)(iv)(A)(1)(ii)

As indicated in Table 2-4 and Figure 2-1, removing any more than one of the CCR impoundments from service would significantly reduce the storage capacity of the site pond system by over 30%. The remaining impoundments onsite (low volume wastewater retention pond, and stormwater retention pond) do not typically have space to independently store and/or treat a 10-year/24-hour rainfall event (due to water already present in the ponds that are never emptied, and due to routine solids accumulation and management) with more than one of the CCR ponds out-of-service. The loss of storage space from any one CCR pond adds to the volume that must be handled by the remaining ponds. Any significant rainfall during the period where more than one impoundment is out of service for retrofit construction would create insurmountable water balance concerns and wastewater management/permit issues.

In addition to the TPDES wastewater permit limitation on selenium (discussed in Section 2.1), there are also other permit limitations that do not allow the reroute of certain non-CCR wastestreams from the CCR ponds to the non-CCR ponds. From a risk and a wastewater compliance standpoint, it is basically untenable to remove more than one of the CCR ponds at the same time while a generating unit is in operation. If the plants were required to cease operation on April 11, 2021, to retrofit the impoundments and maintain CCR compliance, the site's evaporation capacity would be significantly reduced, the rainfall would overwhelm the impoundments, and the site would be forced to discharge wastestreams in potential violation of the permit. Consequently, the requested extension is necessary to allow continued operation of the plant during the retrofit activities.

To maintain reliable generation and sufficient water storage to sustain zero discharge during average and heavy rainfall events, the plant must operate a minimum of three out of the four CCR surface impoundments.[1] Specifically, for the plant to continue operating and generating electricity during retrofit work, the CCR impoundments will require sequential retrofitting to consist of diverting all wastestreams from the impoundment to be retrofitted by pumping water to the other impoundments, removing CCR materials (bottom ash or FGD solids) for disposal in the A-1 Area landfill, relining the impoundment, returning the impoundment to service, and starting the next impoundment retrofit. All of this must take into consideration typical and possibly atypical wet weather conditions.

2.1.5 Options Considered Both On and Off-Site to Obtain Alternative Capacity

As EPA explained in the preamble of the 2015 rule, it is not possible for sites that sluice CCR material to an impoundment to eliminate the impoundment and dispose of the material offsite. *See* 80 Fed. Reg. 21,301, 21,423 (Apr. 17, 2015) ("[W]hile it is possible to transport dry ash off-site to [an] alternate disposal facility that is simply not feasible for wet-generated CCR. Nor can facilities immediately convert to dry handling systems."). Luminant agrees with EPA in this assessment and confirms that off-site alternatives are not an option for wet-generated CCR and wet-generated non-CCR wastestreams. At Martin Lake, all dry-handled CCR wastestreams are currently disposed of in the A-1 Area landfill. The wet-generated CCR wastestreams are comingled with non-CCR wastestreams in the site impoundments and reused within the plant process. If the excess comingled water generated at the site were able to be collected in tanks and trucked offsite, approximately 250 trucks would be required per day driving an unknown distance across rural Texas roads. This significant daily tanker truck volume would result in increased potential for safety and noise impacts and further increases in greenhouse gas emissions and carbon footprint and would not be feasible to manage.

[1] As EPA recognized in the final rule, "[t]he Martin Lake circumstances are unique in that the facility plans to retrofit four impoundments, and each retrofit must occur sequentially because the facility requires a minimum of three impoundments to be operating at any one time in order for the plant to operate." 85 Fed. Reg. at 53,528.

Furthermore, the ELG rules will not allow offsite discharge of FGD blowdown without pretreatment to meet the effluent limits at 40 C.F.R. § 423.16(e)(1), for which treatment systems do not currently exist and would likely take longer to install than the time expected to retrofit the remaining site impoundments. The ELG rules (at 40 C.F.R. § 423.16(g)(1)) will forbid the discharge of bottom ash transport water to publicly owned treatment works (including the waters comingled with the bottom ash transport water). Consequently, there are no feasible offsite-disposal options for the wet-generated wastestreams at Martin Lake. The only feasible onsite alternatives involve continued use of the CCR surface impoundments at Martin Lake.

Martin Lake evaluated the construction of new impoundments as a potential solution for CCR compliance. As shown on Figure 3 in Appendix A, Martin Lake is landlocked with the Martin Creek Reservoir located on the north, east, and south sides of the plant. The western boundary is formed by residential properties and mining operations as shown in Figure 3. Much of the site that is outside the floodplain is occupied with critical infrastructure including the lignite/coal storage piles, the switchyard, transmission lines, railroad lines, the solids handling area, and the existing site impoundments. The limited space and congestion in and around the plant and the solids handling areas does not provide sufficient space for the construction of a new pond(s) or temporary tanks to manage and store the CCR and non-CCR wastestreams. The other areas adjacent to PDP5 are not considered technically feasible to support the construction of new impoundments due to potential wetlands impacts, location restrictions concerns, proximity to the plant boundary and adjacent private water supply wells, acquisition of water rights, and permitting concerns as noted on Figure 3 in Appendix A. Furthermore, additional impoundments would only increase the amount of stormwater captured and managed on the site.

The other options considered for alternative disposal capacity of the wastestreams currently routed to the Martin Lake CCR surface impoundments are summarized in Table 2-5. Additional details on the CCR and non-CCR wastestreams included in this demonstration request are found in Table 2-2 and Table 2-3, respectively.

Table 2-5: Martin Lake Alternatives for Disposal Capacity

Alternative Capacity Technology	Average Time (Months)[1]	Feasible at Martin Lake?	Selected?	Luminant Notes
Conversion to dry handling	33.8	Yes	No	A dry bottom ash conversion could be performed; however, the duration is expected to take longer than the CCR impoundment retrofits and would delay the removal of CCR materials from the unlined impoundments until this conversion is completed. Furthermore, Martin Lake would still require large volumes of storage for the stormwater and other non-CCR wastestreams onsite, which would require the use of real estate currently occupied by the CCR surface impoundments.
Non-CCR wastewater basin	23.5	No	No	This option only provides a partial solution since the CCR wastestreams cannot be directed to non-CCR basins. Furthermore, the volume of non-CCR wastestreams and stormwater cannot be contained within the non-CCR basins that exist onsite and cannot be fully discharged according to the mass selenium limits in the discharge permit. Additional ponds would increase the amount of stormwater captured onsite, and there is not suitable real estate onsite to construct additional non-CCR basins for the storage of non-CCR wastestreams without significant grading and permitting efforts that would likely extend this average timeline estimated by EPA (see Figure 3 in Appendix A).
Wastewater treatment facility	22.3	No	No	Due to Martin Lake practices for recycling water within the plant, building a treatment system (such as chemical precipitation, settling ponds, or concrete tanks) to remove solids would not assist with overall storage volume needs for stormwater and process water management at the Martin Lake site (hundreds of millions of gallons required). The combined mass limit on selenium restricts the potential to discharge this water to the adjacent Martin Creek Reservoir, so water treatment alone would not provide adequate compliance. The site must capture and reuse the vast majority of its wastewater and stormwater.

Alternative Capacity Technology	Average Time (Months)[1]	Feasible at Martin Lake?	Selected?	Luminant Notes
New CCR surface impoundment	31	No	No	There is not suitable real estate onsite to construct a new CCR surface impoundment that could manage and store the plant's wastestreams (see Figure 3 in Appendix A). The individual USACE 404 permitting activities associated with the remaining areas of the site (or the construction to fill the area and provide adequate aquifer separation) are expected to increase the average time estimated by EPA. This option would also delay the removal of CCR materials from the unlined impoundments until this impoundment construction is completed.
Retrofit of a CCR surface impoundment	29.8	Yes	Yes	This alternative maintains required water storage onsite and accelerates the removal of CCR material from the unlined impoundments earlier than all other options considered.
Multiple technology system	39.1	No	No	Any multi-technology solution would require hundreds of millions of gallons of storage for non-CCR wastestreams and stormwater management. This is not considered technically feasible at Martin Lake as previously discussed.
Temporary treatment system	Not defined	No	No	Treatment and discharge of the water is not an option for the wastestreams at Martin Lake due to the combined mass limit on the discharge of selenium from the Martin Lake outfalls. Luminant would need to provide 35,000,000 gallons of storage to replace the operational volume of the smallest CCR impoundment onsite and allow for continued operation while retrofitting two impoundments simultaneously. Given the size of the wastestreams that would need to be managed and the non-CCR wastewater storage capacity needed to replace the CCR surface impoundments at Martin Lake, temporary treatment systems are not practical. Luminant has chosen to focus on implementing the necessary measures for the retrofit of the Martin Lake CCR surface impoundments rather than try to develop temporary tank-based storage for all wastestreams.

[1]From Table 3. See 85 Fed. Reg. at 53,534.

2.1.6 Approach to Obtain Alternative Capacity

Due to the overall water management needs of the facility, including storage of CCR and non-CCR wastestreams generated at the site, the only viable solution for alternative disposal capacity involves a sequential retrofit of the existing CCR surface impoundments pursuant to the retrofit criteria in 40 C.F.R.

§ 257.102(k). As discussed in more detail in Section 2.1.5 and shown in Figure 3 in Appendix A, there is not enough site footprint available to construct a new CCR surface impoundment outside the boundary of the existing impoundments, and even if dry bottom ash handling systems were installed at Martin Lake, the plant would continue to require the surface area and the volume of the existing impoundments for evaporation and water management at the site. Consequently, even if a dry bottom ash handling system was installed, a similar retrofit activity (removal of CCR material and installation of a new liner system) to manage non-CCR wastestreams would still be required and the dry ash conversion project would likely only extend the schedule required for the overall project.

As shown on the schedule in Appendix B, Luminant has been taking steps to address the CCR surface impoundments at Martin Lake since 2015. Luminant hired Burns & McDonnell to evaluate the steps necessary to comply with the CCR Rule published in April 2015. Burns & McDonnell also evaluated the overall plant water balance to estimate the impacts associated with taking impoundments out of operation during various operational scenarios. Luminant cannot remove more than one of its CCR surface impoundments from service at a time to perform retrofit activities (see Section 2.1.4).

Luminant installed monitoring wells in September of 2015 and performed background groundwater sampling from October of 2015 to December of 2016. During this time, several engineering firms assisted Luminant in preparing the required CCR compliance documentation, which Luminant posted on its public CCR website. Key information is summarized in Table 2-1. As indicated in Luminant's CCR compliance documents, the Martin Lake CCR impoundments comply with the location restrictions, the required safety factors and stability assessments were satisfied, and the impoundments were deemed to be low hazard facilities.

In February 2019, after beryllium, cobalt, and lithium were first identified at statistically significant levels (SSL) above the groundwater protection standards (GWPS), Luminant issued an RFP for engineering services to support the retrofit activities of the Ash Pond Area. HDR was awarded the scope to evaluate retrofit alternatives and design the selected solution. HDR investigated alternatives to perform the retrofit as follows:

1. Retrofit the EAP, Subdivide and Retrofit the WAP, and Decommission the NSP
2. Retrofit the EAP, Subdivide and Retrofit the NSP, and Decommission the WAP
3. Retrofit the EAP, WAP, and NSP (maintaining the existing footprint/storage capacity)
4. Retrofit the EAP, Subdivide and Retrofit the WAP, and Cap-in-Place the NSP

Each alternative, except for Alternative 3, requires elimination of a portion of the CCR surface impoundment area available to the plant, which would reduce the water storage capacity and result in water balance issues, as summarized in Section 2.1.4. Each alternative, except for Alternate 3, also requires construction of intermediate berms within the CCR impoundment footprint, which would extend the permitting and construction schedule for the project and further reduce the usable volume of the impoundments. Consequently, Luminant has selected Alternative 3 to retrofit all three impoundments in the Ash Pond Area in sequence. Each of these impoundments are currently lined with a 4" concrete revetment mat, two layers of HDPE geomembrane material that sandwich a drainage net or geocomposite material, and various thicknesses of underlying clay soils. As discussed in the retrofit plan prepared by HDR pursuant to 40 C.F.R. § 257.102(k), and posted to Luminant's CCR website, the retrofit project includes leaving this existing liner system in place and retrofitting in the following general sequence for each impoundment, beginning with the EAP in 2020, and then progressing to the WAP in 2021 and the NSP in 2022:

- Remove any CCR material, rocks, and other sediment from the pond. The material will be loaded on railcars for transport to the Martin Lake A-1 Area Landfill.
- Clean the existing concrete revetment mat surface, by washing with water from the adjacent operating ponds and returning both the wash water and sediment to the operating ponds.
- Load and haul general soil fill material from the Owner's stockpile located at Liberty Mine. This stockpile is located approximately 4.5 miles from the Ash Pond Area. This pile may be relocated as required to support mining operations.
- Place the general fill material over the existing concrete revetment to a depth of at least six (6) inches, nominally compact it, and smooth roll to finish the installation. This material will provide the soil buffer/grading layer above the existing concrete surface as referenced in the written retrofit plan.
- Install a composite liner system including a geosynthetic clay liner (GCL) with a maximum hydraulic conductivity of 1×10^{-9} cm/sec overlain by a 60-mil high-density polyethylene (HDPE) geomembrane, as specified in 40 C.F.R. § 257.70(b).

As shown in Table 2-4, PDP5 provides a significant amount of the excess site storage capacity and must be used to receive CCR and non-CCR wastestreams during the retrofit of the Ash Pond Area. Once the Ash Pond Area is retrofitted and returned to service, PDP5 may be retrofitted beginning in July of 2023 (following the wet spring months and spring outage season that requires increased water storage capacity compared to the summer months at Martin Lake) or, alternatively, PDP5 may qualify for the alternate liner demonstration under the Part B CCR Rule.

2.1.7 Technical Infeasibility of Obtaining Alternative Capacity prior to April 11, 2021

Luminant began designing the retrofit of the Ash Pond Area impoundments in early 2019. The retrofit of the first of three impoundments (EAP) was completed in early October 2020. The remaining two impoundments within the Ash Pond Area will be completed sequentially after the first retrofit is complete, and Luminant and its contractors are anticipating this work to be completed for one pond in each calendar year. PDP5 will be retrofitted with a composite liner following completion of the Ash Pond Area retrofit (unless it qualifies for an alternate liner demonstration under the Part B Rule). No more than one impoundment can be removed from service at a time without reducing the site water storage capacity below the necessary minimum levels for continued intermittent operation without discharge from the site pond system, and additional storage and treatment system capacity would need to be installed and the discharge permit modified if continued discharge were required. Consequently, it is not possible to implement the measures discussed above in a way that would likely be successful by April 11, 2021.[2]

2.1.8 Justification for Time Needed to Complete Development of Alternative Capacity Approach – § 257.103(f)(1)(iv)(A)(1)(iii)

The schedule for developing alternative disposal capacity is described in more detail in Sections 2.2 and 2.3. The milestones for progress are summarized in Table 2-6 below. Luminant is requesting an alternative site-specific deadline of June 29, 2022, for the Ash Pond Area, to allow for the continued placement of CCR and non-CCR wastestreams in the Ash Pond Area while the remaining impoundments are retrofitted. In addition, Luminant is requesting an alternative site-specific deadline of July 1, 2023, for PDP5, to allow for the continued placement of CCR and non-CCR wastestreams in PDP5 during the Ash Pond Area retrofit project and thereafter to initiate retrofit of PDP5 (if necessary following an EPA decision on the alternate liner application and demonstration expected to be submitted for PDP5 under the Part B Rule prior to November 30, 2020, and November 30, 2021, respectively). As discussed above in Section 0, the primary factor affecting the time needed to complete the retrofit project at Martin Lake is the fact that the facility was designed and experience has shown that no more than one impoundment at a time can be removed from service at a time. The removal of an impoundment for retrofit activities must occur in the summer months, when historically the rainfall volumes are reduced coincident with peak unit operations and evaporation capacity; therefore minimizing the facility's water storage requirements and minimizing the potential discharge from the facility (as well as any potential exceedances of the permitted selenium limit).

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[2] As EPA recognized in the final rule, "[t]he Agency intends for unique circumstances like Martin Lake to be addressed through the alternative closure provisions of the final rule." 85 Fed. Reg. at 53,528.

If Luminant were to consider alternative temporary solutions to allow for more than one impoundment to be removed from service at a time, such a measure would require the use of approximately 1,700 frac tanks to provide similar storage capacity to the operational volume of the smallest impoundment requiring retrofit onsite (the NSP at 34.8 million gallons) simultaneously with the WAP or with PDP5. These tanks would cover over 25 acres of the site, and even if there were enough flat area available with truck access for these tanks, they would require significant amounts of interconnecting piping and an unacceptable number of potential leaks. Furthermore, assuming a solids content of 1% in the comingled wastestreams, approximately 17 of these frac tanks would need to be removed and replaced each day. Luminant expects considerable challenges with removing the solids from these frac tanks at the site landfill.

Because of the high risk of leakage from the tank piping and the need for daily tank removal and replacement due to solid accumulation, the tank site would cover at least 25 acres plus an estimated 10 acres for the roads and pipeline corridors to and from the tank array. As a result, at least 35 acres of controlled stormwater drainage (~45 million gallons) would have to be added to the current 180 acres that is managed in the ponds. Temporary tanks for storage of millions of gallons of stormwater are not considered technically feasible to mobilize and allow for simultaneous retrofit of two site impoundments. Consequently, Luminant believes this requested schedule showing sequential annual retrofits for each of the remaining two (or potentially three) CCR surface impoundments onsite represents the fastest technically feasible timeframe for compliance at Martin Lake, and these durations are consistent with EPA's assessment that 12 months accurately reflects the amount of time needed to retrofit a single surface impoundment. *See* 85 Fed. Reg. at 53,529.

Table 2-6: Retrofit Project Progress Milestones

Year or Progress Reporting Period	Status	Milestone Description	Luminant Notes
2019	Completed	Evaluate retrofit scenarios, Complete Design Activities	Luminant began design of the retrofit solution in early 2019.

Year or Progress Reporting Period	Status	Milestone Description	Luminant Notes
2020	Completed	Bid and Award construction contract for EAP retrofit, complete the EAP retrofit, begin CCR removal from the WAP, submit Demonstration under 257.103(f)(1) requesting extension of the deadline to cease placing wastestreams into Ash Pond Area and PDP5	The construction of the first pond retrofit (EAP) has been completed as of early October 2020.
April 30, 2021	Scheduled	Bid and Award construction contract for WAP retrofit, Continue removal of CCR from WAP	The WAP will remain in service during CCR removal to receive excess rainfall and prevent unnecessary discharge until late June 2021. On July 5, 2021, flows will cease to the WAP and will be routed to the retrofitted EAP and the unlined NSP, and PDP5 will remain in service to continue to provide storage capacity for excess CCR and non-CCR wastestreams and stormwater. In the event the site experiences heavy rain events during the unit outages when the WAP is scheduled to be retrofitted, temporary use of the WAP for wastewater or stormwater storage may be necessary.
October 31, 2021	Scheduled	Complete removal of CCR from WAP, Complete construction of WAP retrofit (other than punchlist items), Begin Dewatering/CCR Removal from NSP	The WAP construction is forecasted to be completed within calendar year 2021. Concurrent with the WAP retrofit, NSP CCR removal operations will be initiated; however, the NSP will remain in service to receive excess rainfall and prevent unnecessary discharge until late June 2022.
April 30, 2022	Scheduled	Continued CCR Removal from NSP, Bid and Award construction contract for NSP retrofit	On June 29, 2022, flows will cease to the NSP and will be routed to the retrofitted EAP and WAP. PDP5 will remain in service to continue to provide storage capacity for excess CCR and non-CCR wastestreams and stormwater. In the event the site experiences heavy rain events during the planned unit outages prior to when the NSP is scheduled to be retrofitted, the temporary use of the NSP for wastewater or stormwater storage may be necessary.

Year or Progress Reporting Period	Status	Milestone Description	Luminant Notes
October 31, 2022	Scheduled	Complete construction of NSP retrofit and begin potential detailed design for PDP5 retrofit	Luminant is projecting that retrofit activities for the Ash Pond Area can be completed by November 1, 2022.This is subject to delays primarily associated with the unknown efficiency of dewatering/dredging of scrubber solids from the NSP. At this point, flows will be concentrated to the retrofitted Ash Pond Area and Luminant will begin removing CCR material from PDP5 if required; however, PDP5 must remain in service to receive excess rainfall and prevent unnecessary discharge until July 1, 2023.
July 1, 2023	TBD (depends on alternate liner status under Part B Rule)	Begin retrofit for PDP5	PDP5 would cease receiving all wastestreams on July 1, 2023 and begin retrofit if it does not qualify for alternate liner demonstration.

2.2 Detailed Schedule to Obtain Alternative Disposal Capacity - § 257.103(f)(1)(iv)(A)(2)

The required visual timeline representation of the schedule is included in Appendix B of this demonstration and described further in Section 2.3 below.

2.3 Narrative of Schedule and Visual Timeline - § 257.103(f)(1)(iv)(A)(3)

The third section for the workplan is a "detailed narrative of the schedule and the timeline discussing all the necessary phases and steps in the workplan, in addition to the overall timeframe that will be required to obtain capacity and cease receipt of waste." 85 Fed. Reg. at 53,544. As EPA explained in the preamble to the Part A rule, this section of the workplan must discuss "why the length of time for each phase and step is needed, including a discussion of the tasks that occur during the specific stage of obtaining alternative capacity. It must also discuss the tasks that occur during each of the steps within the phase." 85 Fed. Reg. at 53,544. In addition, the schedule should "explain why each phase and step shown on the chart must happen in the order it is occurring and include a justification for the overall length of the phase" and the "anticipated worker schedule." 85 Fed. Reg. at 53,544. EPA notes the overall "discussion of the schedule assists EPA in understanding why the time requested is accurate." 85 Fed. Reg. at 53,544.

As described in Section 2.1.6, the CCR surface impoundments must be retrofitted sequentially, with no more than one impoundment undergoing retrofit at any point in time, and preferably during the summer months while the units are operating and evaporating any excess water that could accumulate. These periods require the least total water storage capacity to maintain zero discharge operations at the site. This start date is subject to delays caused by significant rain events as well as any prolonged outages at the plant.

Based on the estimated durations shown in Appendix B, each impoundment retrofit will require a minimum of one construction season for completion. The following paragraphs outline the scope required for the retrofit of each impoundment in the Ash Pond Area. The design drawings, which include additional scope definition for each impoundment, are included in Appendix C (EAP), Appendix D (WAP), and Appendix E (NSP). The design for the PDP5 retrofit will be completed if necessary, following the determination of the unit's alternate liner status under the Part B Rule. The construction activities for the PDP5 retrofit are not included within this Demonstration as they will occur after the requested alternative deadline for PDP5 (if retrofit is necessary following EPA's review of PDP5's alternate liner status under the Part B Rule).

<u>EAP Retrofit Activities:</u> As noted on the schedule in Appendix B, the construction for the EAP retrofit has been completed; however, the sequence of activities is included in this narrative as it provides context for the remaining facilities that will rely on similar activities and sequence to this completed project. Luminant removed nearly all the CCR material in 2019. The durations shown on the project schedule match both the estimates developed by the selected construction contractor and experienced on the EAP retrofit. These durations are based on an average work schedule of six days per week, are subject to delays caused by significant rain events, and are based on the following scope of work which must be performed in the sequence listed below:

- Contractor shall order necessary materials and mobilize to the site. The lead time for the liner materials and the piping are shown on the Appendix B schedule and are based on feedback from suppliers and confirmed by the construction contractor.
- Contractor shall remove any remaining CCR material, rocks, and sediment from the EAP, and haul and stockpile this material at the Decant Basin. Luminant will load the stockpiled material onto rail cars for disposal at the Martin Lake A-1 Area Landfill. This effort is referred to as Site Preparation on the Appendix B schedule.
- Contractor shall use water from the adjacent WAP or NSP to wash remaining CCR material off the sides and floor of the EAP and remove the material. The existing revetment mat within the EAP will be visually inspected to confirm CCR material, rocks and sediment have been removed.

- Contractor shall load and haul general soil fill material from the stockpile located at Liberty Mine. This stockpile is located approximately 4.5 miles from the EAP. Contractor shall place the general fill material over the existing concrete revetment to a depth of at least six (6) inches, nominally compact it, and smooth roll to finish the installation.
- Contractor shall load and haul general soil fill material from the stockpile located at Liberty Mine to the location identified as the "Temporary Stockpile Location" south of PDP 5 (see Appendix C Drawings). Upon completion, Contractor shall seed the stockpile and install erosion control measures, such as silt fencing, at the stockpile. The stockpiled material, either from the mine or this temporary location, will be used to support the subsequent WAP and NSP retrofit activities.
- Contractor shall install a GCL over the sides and floor of the EAP and secure it in a perimeter anchor trench.
- Contractor shall install a 60-mil HDPE liner directly on the GCL and secure it in a perimeter anchor trench. This occurred at the same time as the GCL placement, lagging slightly behind it but overlapping. Consequently, these activities are shown on the same timeline in Appendix B. As shown in Appendix C, the GCL and the membrane are also attached to piping (air vents and dewatering line) with pipe boots and are battened to the concrete structures within the impoundment during this installation period.
- Contractor shall modify the existing 48-inch suction line on the south end of the pond by increasing the screened area as shown in the plans (see Appendix C Drawings). This activity is complete.
- Contractor shall install all 12-inch HDPE pipe as shown in the plans. Each pipeline will start at its corresponding isolation valve previously installed by Luminant. This work has been completed so the new lines can be placed into service prior to returning any water to the EAP and to allow for full function of the plant recycle systems once the WAP and eventually NSP are removed from service for retrofitting. As shown in Appendix C, this piping is anchored to a concrete slab that is tied into the new EAP impoundment liner and will not create a new liner penetration. Approximately 5,400 linear feet of piping was rerouted or added as part of this project.
- The Contractor shall pump off stormwater as necessary from the EAP to the WAP during construction. This is an ongoing activity that will be required following each rain event during the construction period. Consequently, it is not shown on the construction schedule.
- Upon completion, Luminant will resume operation of the EAP by transferring a portion of the water from the WAP so CCR material removal efforts can progress more efficiently at that unit.

<u>WAP Retrofit Activities:</u> As noted on the schedule in Appendix B, the design is completed for the WAP retrofit; however, the construction contract has not been bid or awarded at this time. This procurement effort

will be completed in time to support construction of the WAP retrofit (planned for July 2021), after the spring rainfall periods when the storage capacity required at Martin Lake is reduced by the peak summer operation of the generating units. Luminant began removing a majority of the CCR material during the 2020 summer operational period and those efforts are continuing; however, any significant rain events that occur in the fall of 2020 through the spring of 2021 may need to be diverted to the WAP as required. The remaining durations shown on the project schedule are based on the estimated durations and work schedule received from the EAP construction contractor and have been adjusted based on the estimated quantity differences between the EAP and the WAP. The WAP retrofit includes the following scope of work, which must be performed in the sequence listed below:

- Contractor shall order necessary materials and mobilize to the site.
- Contractor shall remove any remaining CCR material, rocks, and sediment from the WAP, and haul and stockpile this material at the Decant Basin. Luminant will load the stockpiled material onto rail cars for disposal at the Martin Lake A-1 Area Landfill.
- Contractor shall use water from the adjacent EAP or NSP to wash remaining CCR material off the sides and floor of the WAP and remove the material. The WAP will be visually inspected to confirm CCR material, rocks and sediment have been removed.
- Contractor shall load and haul general soil fill material from the stockpile, which will have been relocated adjacent to PDP5. Contractor shall place the general fill material over the existing concrete revetment to a depth of at least six (6) inches, nominally compact it, and smooth roll to finish the installation. This activity must be completed after the existing revetment mat is inspected and confirmed to be free of CCR material but before the liner system can be placed.
- Contractor shall install a GCL over the sides and floor of the WAP and secure it in a perimeter anchor trench.
- Contractor shall install a 60-mil HDPE liner directly on the GCL and secure it in a perimeter anchor trench. This will occur at the same time as the GCL placement, lagging slightly behind it but overlapping. Consequently, these activities are shown on the same timeline. As shown in Appendix D, the GCL and the membrane will also be attached to piping (air vents and standpipe) with pipe boots and will be battened to the concrete structures within the impoundment during this installation period.
- The Contractor shall pump off storm water as necessary from the WAP to the EAP during construction. This is an ongoing activity that will be required following each rain event during the construction period. Consequently, it is not shown on the construction schedule.

- Upon completion, Luminant will resume operation of the WAP, likely by transferring the water from the NSP so that CCR material removal efforts can progress more efficiently at that unit.

NSP Retrofit Activities: As noted on the schedule in Appendix B, the design is completed for the NSP retrofit; however, the construction contract has not been bid or awarded at this time. This procurement effort will be completed in time to support construction of the NSP retrofit beginning approximately July 2022, when the storage capacity required at Martin Lake is reduced by the peak summer operation of the generating units. Luminant will begin removing the CCR material during the summer 2021 operational period and the impoundment will be dewatered once the WAP is placed into service; however, any significant rain events that occur through the spring of 2022 will be diverted to the NSP as required to prevent discharge from the site. The durations shown on the project schedule are based on the estimated durations and work schedule developed by the EAP construction contractor and have been adjusted based on the estimated quantity differences between the EAP and the NSP. The contractor scope for the NSP retrofit is identical to the WAP except for the quantity differences and an additional pipe rack liner attachment. The design drawings for the NSP retrofit are included in Appendix E.

The CCR removal efforts at the NSP will be different than at the WAP. There is a similar amount of material in each pond; however, the scrubber sludge will be significantly more challenging to dewater and decant than the bottom ash fines. This leads to a longer removal schedule necessary to drain the material for excavation and decant the material (at the Decant Pad/Basins) prior to loading on rail cars. Even when dewatered, this material will be significantly wetter than the ash fines which may impact landfill operations during disposal. This operation will likely require a larger surface area to promote spreading and drying of the material prior to compaction, and that could impact the rate at which material can be hauled to the landfill. Luminant will provide ongoing schedule updates in the required semi-annual progress reports; however, this activity, along with any anticipated delays due to rain or delayed starts due to increased demand for water storage onsite, are the primary factors that could extend the schedule for this retrofit project.

PDP5 Retrofit Activities: Luminant has evaluated the Part B Rule requirements and anticipates applying for the alternate liner demonstration for PDP5 prior to or on November 30, 2020. For purposes of this request, Luminant has included the construction sequence for a potential PDP5 retrofit that may follow the NSP retrofit in the same sequence described for the Ash Pond Area above if the EPA denies the application or the ensuing demonstration. PDP5 cannot be removed from service until approximately July 1, 2023, following the spring outage season and typically wet spring months and coincident with summer peak operation so that plant operations can be sustained with the reduced pond capacity during the retrofit project.

The schedule in Appendix B shows the design and construction procurement efforts being completed as required to meet this allowable construction period.

2.4 Progress Towards Obtaining Alternative Capacity - § 257.103(f)(1)(iv)(A)(4)

In the preamble to the final Part A rule, EPA explains that this "section [of the workplan] must discuss all of the steps taken, starting from when the owner or operator initiated the design phase all the way up to the current steps occurring while the workplan is being drafted." 85 Fed. Reg. at 53,544. The discussion also must indicate where the facility currently is on the timeline and the processes that are currently being undertaken at the facility to develop alternative capacity. 85 Fed. Reg. at 53,545.

As shown in Appendix B and described in Section 2.1.6 and Table 2-6, Luminant has made considerable progress toward creating alternative disposal capacity for the CCR and non-CCR wastestreams at Martin Lake, specifically the Ash Pond Area units. Design for the retrofit project is complete, the required notification of intent to retrofit has been posted to Luminant's CCR website for the Ash Pond Area, and construction of the EAP retrofit has been completed as shown in Appendix B, prior to the April 11, 2021, deadline. Luminant has also started removing the CCR material from the WAP, and that effort is anticipated to be completed early next year.

3.0 DOCUMENTATION AND CERTIFICATION OF COMPLIANCE

To demonstrate that the criteria in 40 C.F.R. § 257.103(f)(1)(iii) has been met, the following information and submissions are submitted pursuant to 40 C.F.R. § 257.103(f)(1)(iv)(B) to demonstrate that Martin Lake facility is in compliance with the CCR rule, including the following CCR units:

- Ash Pond Area:
  - East Bottom Ash Pond
  - West Bottom Ash Pond
  - New Scrubber Pond
- Permanent Disposal Pond 5
- A-1 Area Landfill

The A-1 Area Landfill referenced on the Martin Lake CCR compliance website is located over 3 miles from the Martin Lake site on the other side of the Martin Creek Reservoir. The A-1 Area Landfill is surrounded by mine property owned by Luminant Mining Company LLC. For informational purposes, Luminant is including the compliance documents for this unit as part of this submittal for the Martin Lake facility. Detail on the A-1 Area Landfill compliance documentation is included in Section 3.9.

3.1 Owner's Certification of Compliance - § 257.103(f)(1)(iv)(B)(1)

In accordance with 40 C.F.R. § 257.103(f)(1)(iv)(B)(1), I hereby certify that, based on my inquiry of those persons who are immediately responsible for compliance with environmental regulations for Martin Lake, the facility is in compliance with all of the requirements contained in 40 C.F.R. Part 257, Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments. Martin Lake's CCR compliance website is up-to-date and contains all the necessary documentation and notification postings.

LUMINANT GENERATION COMPANY LLC

Cynthia E. Vodopivec

Cynthia Vodopivec
VP - Environmental Health & Safety
November 25, 2020

3.2 Visual Representation of Hydrogeologic Information - § 257.103(f)(1)(iv)(B)(2)

Consistent with the requirements of § 257.103(f)(1)(iv)(B)(2)(i) – (iii), Luminant has attached the following items to this demonstration:

- Map(s) of groundwater monitoring well locations in relation to the CCR unit (Appendix F1)
- Well construction diagrams and drilling logs for all groundwater monitoring wells (Appendix F2)
- Maps that characterize the direction of groundwater flow accounting for seasonal variations (Appendix F3)

3.3 Groundwater Monitoring Results - § 257.103(f)(1)(iv)(B)(3)

Tables summarizing constituent concentrations at each groundwater monitoring well for the Ash Pond Area and PDP5, along with alternate source demonstrations (ASDs) for PDP5, are included as Appendix F4. The second round of data for 2020 was collected on October 6, 2020. The data is still being finalized.

3.4 Description of Site Hydrogeology - § 257.103(f)(1)(iv)(B)(4)

A description of site hydrogeology and stratigraphic cross-sections of the site (including the Ash Pond Area and PDP5) are included as Appendix F5.

3.5 Corrective Measures Assessment - § 257.103(f)(1)(iv)(B)(5)

For the Ash Pond Area, the first assessment monitoring samples were collected in June 2018. The results, through the first 2020 semi-annual monitoring period, indicate the Ash Pond area is currently in assessment monitoring, with exceedances of the groundwater protection standards (GWPS) for beryllium, cobalt, and lithium first determined in January of 2019. Accordingly, pursuant to § 257.96, a corrective measures assessment report was prepared for the Ash Pond Area in September 2019 and is included as Appendix F6. For PDP5, detection monitoring has indicated statistically significant increases (SSIs) above the background concentrations; however, as noted above, Luminant completed successful ASDs in 2018, 2019, and 2020 and the unit remains in detection monitoring. These ASDs are included in Appendix F4. The most recent ASD for PDP5 for the 2020 monitoring data will be included in the 2020 Annual Groundwater Monitoring and Corrective Action Report to be prepared in January 2021. Accordingly, an assessment of corrective measures is not required for PDP5.

3.6 Remedy Selection Progress Reports - § 257.103(f)(1)(iv)(B)(6)

For the Ash Pond Area, selection of a remedy is underway. Accordingly, pursuant to § 257.97(a), semi-annual remedy selection progress reports were prepared for the Ash Pond Area on March 4, 2020, and

September 3, 2020, and are included as Appendix F7. As noted above, an assessment of corrective measures and the resulting remedy selection efforts are not currently required for PDP5.

3.7 Structural Stability Assessment - § 257.103(f)(1)(iv)(B)(7)

Pursuant to § 257.73(d), the initial structural stability assessment report for Martin Lake was prepared in October 2016 and is included as Appendix F8. As required for compliance, another stability assessment will be completed in October 2021.

3.8 Safety Factor Assessment - § 257.103(f)(1)(iv)(B)(8)

Pursuant to § 257.73(e), the initial safety factor assessment report for Martin Lake was prepared in October 2016 and is included as Appendix F9. As required for compliance, another safety factor assessment will be completed in October 2021.

3.9 Landfill Compliance Documentation[3]

The A-1 Area Landfill Groundwater Monitoring System Certification document is included as Appendix F10 and includes: Map(s) of groundwater monitoring well locations in relation to the CCR unit (Figure 2); Well construction diagrams and drilling logs for all groundwater monitoring wells (Appendix A); Maps that characterize the direction of groundwater flow accounting for seasonal variations (Appendix C); A description of site hydrogeology (Section 2.2); and Stratigraphic cross-sections of the site (Figures 3-7).

Tables summarizing constituent concentrations at each groundwater monitoring well for the A-1 Area Landfill are included as Appendix F11. The second round of data for 2020 was collected on October 6, 2020. The data is still being finalized.

For the A-1 Area Landfill, the first assessment monitoring samples were collected in June 2018. The results, through the first 2020 semi-annual monitoring period, indicate the A-1 Area Landfill is currently in assessment monitoring, with exceedances of the groundwater protection standards (GWPS) for arsenic, barium, cobalt, and lithium were first determined in January of 2019. Accordingly, pursuant to § 257.96, a corrective measures assessment report was prepared for the A-1 Area Landfill in September 2019 and is included as Appendix F12. Selection of a remedy is underway. Accordingly, pursuant to § 257.97(a), semi-annual remedy selection progress reports were prepared for the A-1 Area Landfill on March 4, 2020,

[3] As noted above, the A-1 Area Landfill referenced on the Martin Lake CCR compliance website is located over 3 miles from the Martin Lake site on the other side of the Martin Creek Reservoir. The A-1 Area Landfill is surrounded by mine property owned by Luminant Mining Company LLC. For informational purposes, Luminant is including the compliance documents for this unit as part of this submittal for the Martin Lake facility.

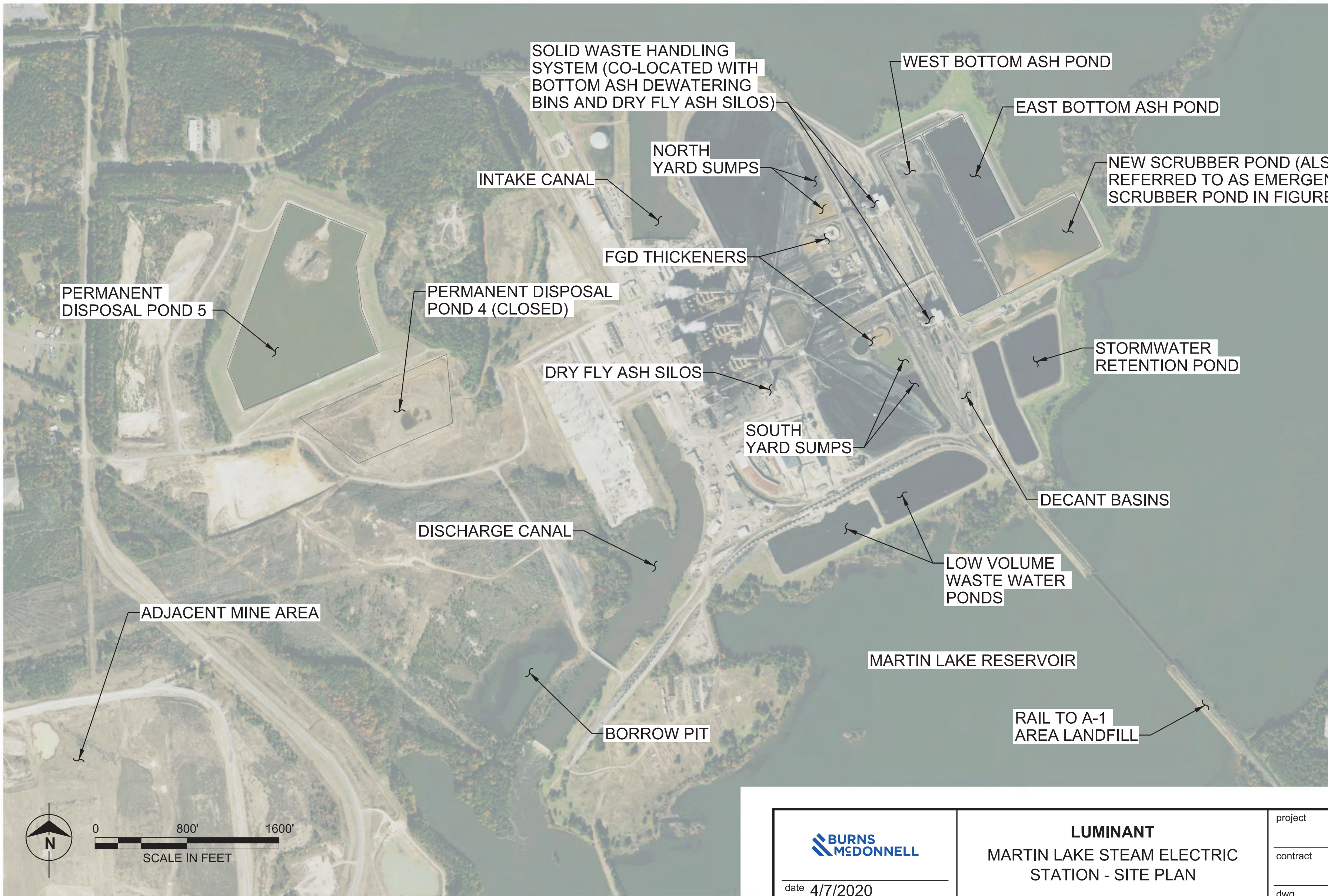
and September 3, 2020, and are included as Appendix F13. Note that periodic structural stability assessments and safety factor assessments are not required for landfills.

4.0 CONCLUSION

Based upon the information submitted in this demonstration, the Ash Pond Area and PDP5 at Martin Lake qualify for the site-specific alternative deadline for the initiation of closure as allowed by 40 C.F.R. § 257.103(f)(1).

Therefore, Luminant requests that EPA approve the demonstration and grant an alternative deadline of June 29, 2022, for the Ash Pond Area, to allow for the continued placement of CCR and non-CCR wastestreams in the Ash Pond Area while the remaining impoundments are sequentially retrofitted. In addition, Luminant is requesting an alternative site-specific deadline of July 1, 2023, for PDP5, to allow for the continued placement of CCR and non-CCR wastestreams in PDP5 during the Ash Pond Area retrofit project and thereafter to begin retrofit of PDP5 (if necessary following an EPA decision on the alternate liner application and demonstration expected to be submitted for PDP5 under the Part B Rule prior to November 30, 2020, and November 30, 2021, respectively). If retrofit of PDP5 is necessary, the retrofit work would initiate on July 1, 2023, following the wet spring months coincident with the spring outages when the maximum site water storage capacity is required. Luminant will update EPA on the project and any potential schedule impacts as part of the semi-annual progress reports required at 40 C.F.R. § 257.103(f)(1)(x), and if a need for a later compliance deadline is determined, Luminant will seek additional time as described in 40 C.F.R. § 257.103(f)(1)(vii).

APPENDIX A – SITE PLAN AND WATER BALANCE DIAGRAM



BURNS McDONNELL

date 4/7/2020

designed A. MYERS

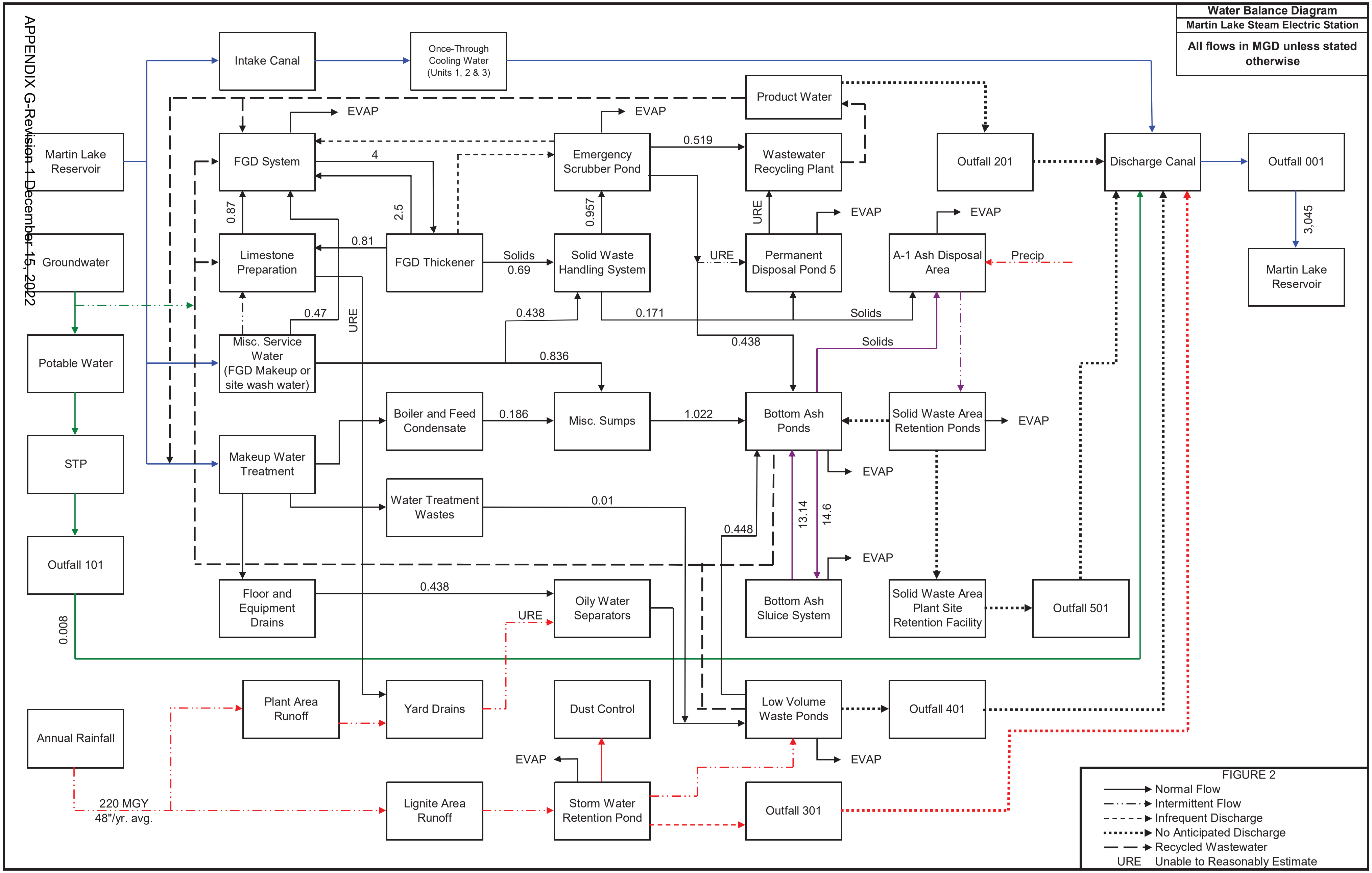
LUMINANT

MARTIN LAKE STEAM ELECTRIC STATION - SITE PLAN

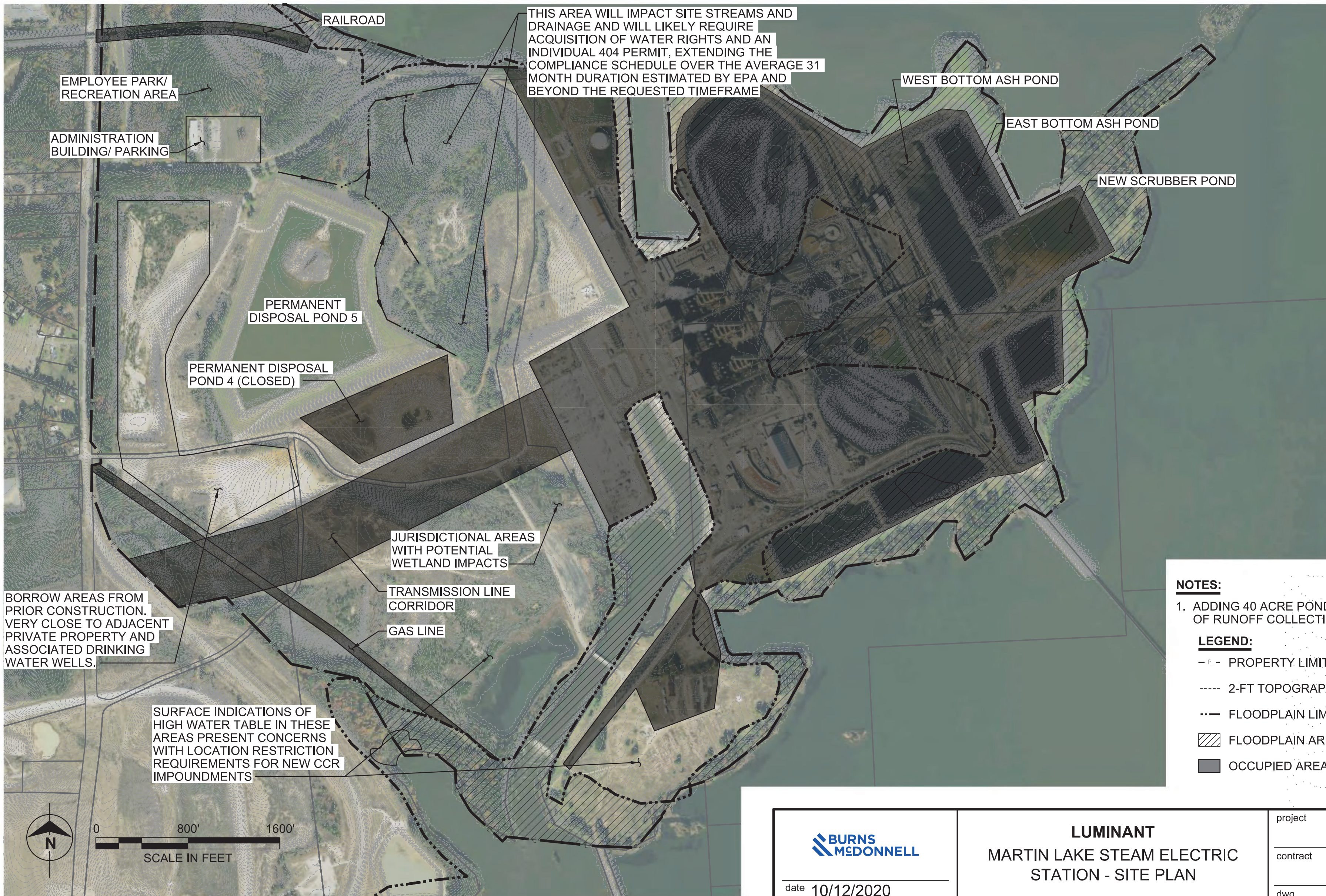
project 122702

contract -

dwg **FIGURE 1**



Water Balance Diagram
Martin Lake Steam Electric Station
All flows in MGD unless stated otherwise
Martin Lake Reservoir
Groundwater
Potable Water
STP
Outfall 101
0.008
Annual Rainfall
220 MGY
48"/yr. avg.
Intake Canal
Once-Through Cooling Water (Units 1, 2 & 3)
FGD System
EVAP
4
0.87
Limestone Preparation
0.81
2.5
FGD Thickener
Solids
0.69
Misc. Service Water (FGD Makeup or site wash water)
0.47
URE
Makeup Water Treatment
Floor and Equipment Drains
Plant Area Runoff
Emergency Scrubber Pond
EVAP
0.957
0.519
Solid Waste Handling System
0.438
0.171
0.836
Boiler and Feed Condensate
0.186
Misc. Sumps
1.022
Water Treatment Wastes
0.01
0.438
Oily Water Separators
URE
Yard Drains
Lignite Area Runoff
Dust Control
EVAP
Storm Water Retention Pond
Product Water
Wastewater Recycling Plant
URE
Permanent Disposal Pond 5
EVAP
0.438
Bottom Ash Ponds
EVAP
0.448
13.14
14.6
Bottom Ash Sluice System
EVAP
Low Volume Waste Ponds
EVAP
Outfall 301
Outfall 201
A-1 Ash Disposal Area
EVAP
Precip
Solids
Solids
Solid Waste Area Retention Ponds
EVAP
Solid Waste Area Plant Site Retention Facility
Outfall 501
Outfall 401
Discharge Canal
Outfall 001
3,045
Martin Lake Reservoir
FIGURE 2
Normal Flow
Intermittent Flow
Infrequent Discharge
No Anticipated Discharge
Recycled Wastewater
URE Unable to Reasonably Estimate



NOTES:

1. ADDING 40 ACRE POND ADDS 60 ACRES OF RUNOFF COLLECTION.

LEGEND:

- PROPERTY LIMITS
- 2-FT TOPOGRAPHIC CONTOURS
- FLOODPLAIN LIMITS
- FLOODPLAIN AREA
- OCCUPIED AREA

BURNS McDONNELL

date 10/12/2020
designed A. MYERS

LUMINANT
MARTIN LAKE STEAM ELECTRIC STATION - SITE PLAN

project 122702
contract -
dwg **FIGURE 3**

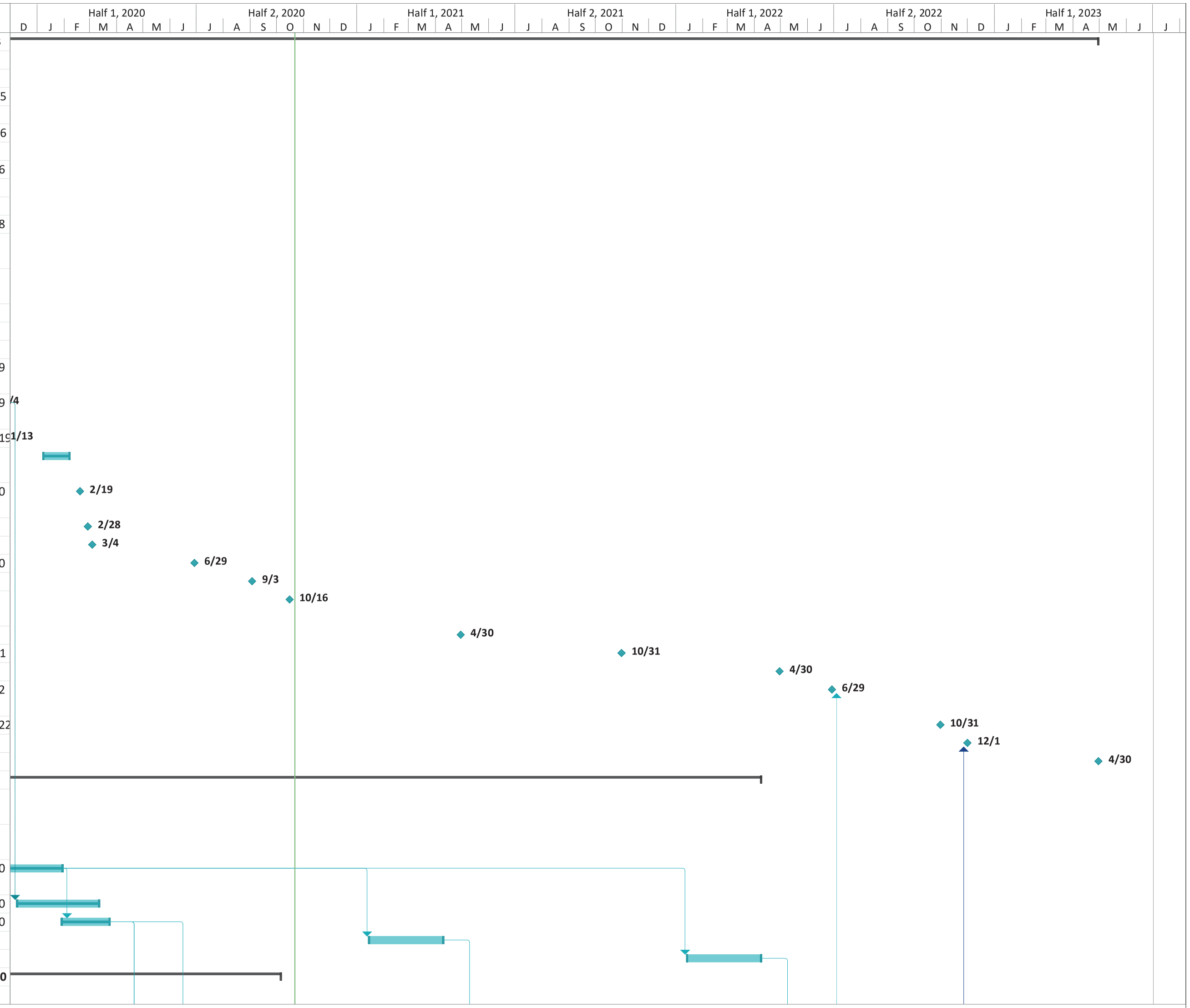
10/20/2020

\\bmcd\dfs\Clients\ENR\VistraEnergy\122702_ALTuseDisposal\Design\Civil\Dwgs\Sketches\Martin Lake_Figure3.dgn

APPENDIX B – SCHEDULE

APPENDIX G-Revision 1 December 15, 2022

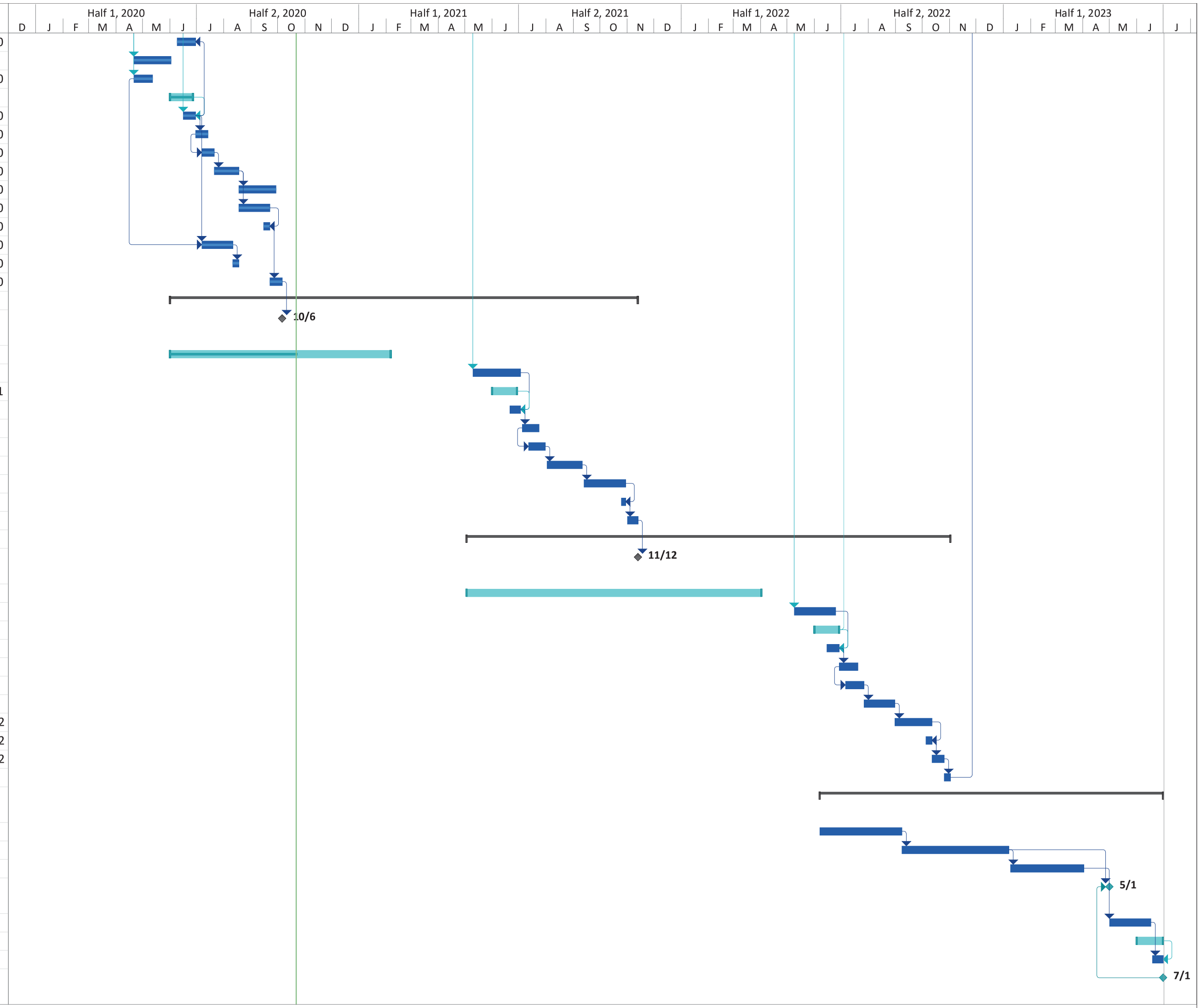
ID	Task Name	Duration	Start	Finish
	CCR Compliance Efforts	**2116 days**	**Mon 3/23/15**	**Sun 4/30/23**
	BMcD Retained by Luminant to Review CCR Compliance Impacts	95 days	Mon 3/23/15	Fri 7/31/15
	Final CCR Rule Published in Federal Register	0 days	Fri 4/17/15	Fri 4/17/15
	BMcD Completed Initial Water Balance Evaluation	94 days	Thu 7/2/15	Tue 11/10/15
	Luminant Installed Groundwater Monitoring Wells	12 days	Wed 9/9/15	Thu 9/24/15
	Background Groundwater Sampling	302 days	Mon 10/19/15	Tue 12/13/16
	BMcD Completed Liner Documentation	0 days	Fri 9/16/16	Fri 9/16/16
	BMcD Prepared Surface Impoundment History of Construction	0 days	Wed 10/5/16	Wed 10/5/16
	First Detection Monitoring Samples	0 days	Thu 9/21/17	Thu 9/21/17
	Ash Pond Area Assessment Monitoring Program - First Round	34 days	Tue 6/12/18	Fri 7/27/18
	Ash Pond Area Assessment Monitoring Program - Second Round	22 days	Fri 9/7/18	Mon 10/8/18
	Golder completed Successful Location Restriction Demonstration for Ash Pond Area and PDP 5	0 days	Wed 10/10/18	Wed 10/10/18
	SSL Determination/Notification - Ash Pond Area - Beryllium, Cobalt, and Lithium	23 days	Mon 1/7/19	Wed 2/6/19
	Ash Pond Area Assessment Monitoring Program - Third Round	24 days	Tue 5/14/19	Fri 6/14/19
	Ash Pond Area Assessment Monitoring Program - Fourth Round	24 days	Tue 9/10/19	Fri 10/11/19
	Corrective Measures Assessment for Ash Pond Area	87 days	Wed 5/8/19	Thu 9/5/19
	SSL Determination/Notification - Ash Pond Area - Beryllium and Cobalt	23 days	Thu 9/5/19	Mon 10/7/19
18	EPA Released Proposed Draft ELG Rule and CCR Holistic Approach to Closure Part A Rule	0 days	Mon 11/4/19	Mon 11/4/19
19	Public Meeting to review Corrective Measures Assessment	0 days	Wed 11/13/19	Wed 11/13/19
20	SSL Determination/Notification - Ash Pond Area - Beryllium and Cobalt	22 days	Wed 1/8/20	Thu 2/6/20
21	EPA Released Proposed Draft CCR Holistic Approach to Closure Part B Rule	0 days	Wed 2/19/20	Wed 2/19/20
22	Retrofit Plan Published	0 days	Fri 2/28/20	Fri 2/28/20
23	Semiannual Remedy Selection Progress Report Posted	0 days	Wed 3/4/20	Wed 3/4/20
24	Notification of Intent to Retrofit the Ash Pond Area	0 days	Mon 6/29/20	Mon 6/29/20
25	Semiannual Remedy Selection Progress Report Posted	0 days	Thu 9/3/20	Thu 9/3/20
26	EPA Released Pre-published version of Final CCR Holistic Approach to Closure Part B Rule	0 days	Fri 10/16/20	Fri 10/16/20
27	Semi-Annual Progress Report #1	0 days	Fri 4/30/21	Fri 4/30/21
28	Semi-Annual Progress Report #2	0 days	Sun 10/31/21	Sun 10/31/21
29	Semi-Annual Progress Report #3	0 days	Sat 4/30/22	Sat 4/30/22
30	Cease Placing Wastestreams in Unlined Portions of the Ash Pond Area	0 days	Wed 6/29/22	Wed 6/29/22
31	Semi-Annual Progress Report #4 (if required for PDP5)	0 days	Mon 10/31/22	Mon 10/31/22
32	Notification of Completion of Retrofit - Ash Pond Area	0 days	Thu 12/1/22	Thu 12/1/22
33	Semi-Annual Progress Report #5 (if required for PDP5)	0 days	Sun 4/30/23	Sun 4/30/23
34	**Impoundment Retrofit - Engineering and Procurement Efforts**	**823 days**	**Wed 2/13/19**	**Fri 4/8/22**
35	Bid and Award Engineering Services for Ash Pond Area Retrofit Project	67 days	Wed 2/13/19	Thu 5/16/19
36	HDR Performed Alternatives Analysis for Ash Pond Area Retrofit Project	98 days	Fri 5/17/19	Tue 10/1/19
37	HDR Detailed Design: Prepared Ash Pond Area (EAP, WAP, and NSP) Retrofit Bid Documents	87 days	Tue 10/1/19	Wed 1/29/20
38	HDR Performed Alternatives Analysis for PDP 5 Retrofit Project	68 days	Mon 12/9/19	Wed 3/11/20
39	Bid/Award East Ash Pond Retrofit Construction Contract	39 days	Wed 1/29/20	Mon 3/23/20
40	Bid/Award West Ash Pond Retrofit Construction Contract	61 days	Fri 1/15/21	Fri 4/9/21
41	Bid/Award New Scrubber Pond Retrofit Construction Contract	61 days	Fri 1/14/22	Fri 4/8/22
42	**East Ash Pond Retrofit Construction**	**351 days**	**Mon 6/3/19**	**Mon 10/5/20**
43	Luminant Removal of Ponded CCR Material during Operations	90 days	Mon 6/3/19	Fri 10/4/19



Project: Martin Lake CCR Surface Impoundment Extension Demonstration	Task		Project Summary		Inactive Milestone		Manual Summary Rollup		Deadline
Date: Thu 10/22/20	Split		External Tasks		Inactive Summary		Manual Summary		Progress
	Milestone		External Milestone		Manual Task		Start-only		Manual Progress
	Summary		Inactive Task		Duration-only		Finish-only		

APPENDIX G-Revision 1 December 15, 2022

ID	Task Name	Duration	Start	Finish
44	Dewatering of EAP to other CCR impoundments	15 days	Tue 6/9/20	Mon 6/29/20
45	Liner Material Acquisition	30 days	Tue 4/21/20	Mon 6/1/20
46	Piping Material Acquisition	15 days	Tue 4/21/20	Mon 5/11/20
47	Dewatering to remove Accumulated Spring Rainfall	20 days	Mon 6/1/20	Fri 6/26/20
48	Contractor Mobilization to Site	10 days	Tue 6/16/20	Mon 6/29/20
49	Site Preparation	10 days	Tue 6/30/20	Mon 7/13/20
50	Clean Existing Concrete Revetment Mat	10 days	Tue 7/7/20	Mon 7/20/20
51	Place 6" General Soil Fill Layer	20 days	Tue 7/21/20	Mon 8/17/20
52	Stockpile Soils Material	30 days	Tue 8/18/20	Mon 9/28/20
53	GCL & HDPE Liner Installation	25 days	Tue 8/18/20	Mon 9/21/20
54	Pipe Rack - Liner Attachment	5 days	Tue 9/15/20	Mon 9/21/20
55	12" HDPE Yard Pipe Installation	25 days	Tue 7/7/20	Mon 8/10/20
56	48" Suction Line	5 days	Tue 8/11/20	Mon 8/17/20
57	Punchlist and Contract Closeout	10 days	Tue 9/22/20	Mon 10/5/20
58	**West Ash Pond Retrofit Construction**	**380 days**	**Mon 6/1/20**	**Fri 11/12/21**
59	Potential further reduction in WAP water levels (as water balance allows) to facilitate more efficient CCR removal operations	0 days	Tue 10/6/20	Tue 10/6/20
60	Luminant Removal of Ponded CCR Material during Operations	180 days	Mon 6/1/20	Fri 2/5/21
61	Liner Material Acquisition	40 days	Mon 5/10/21	Fri 7/2/21
62	Dewatering to remove Accumulated Spring Rainfall	20 days	Tue 6/1/21	Mon 6/28/21
63	Contractor Mobilization to Site	10 days	Mon 6/21/21	Fri 7/2/21
64	Site Preparation	15 days	Mon 7/5/21	Fri 7/23/21
65	Clean Existing Concrete Revetment Mat	15 days	Mon 7/12/21	Fri 7/30/21
66	Place 6" General Soil Fill Layer	30 days	Mon 8/2/21	Fri 9/10/21
67	GCL & HDPE Liner Installation	35 days	Mon 9/13/21	Fri 10/29/21
68	Pipe Rack - Liner Attachment	5 days	Mon 10/25/21	Fri 10/29/21
69	Punchlist and Contract Closeout	10 days	Mon 11/1/21	Fri 11/12/21
70	**New Scrubber Pond Retrofit Construction**	**392 days**	**Mon 5/3/21**	**Tue 11/1/22**
71	Potential further reduction in NSP water levels (as water balance allows) to facilitate more efficient CCR removal operations	0 days	Fri 11/12/21	Fri 11/12/21
72	Luminant Removal of Ponded CCR Material during Operations	240 days	Mon 5/3/21	Fri 4/1/22
73	Liner Material Acquisition	35 days	Mon 5/9/22	Fri 6/24/22
74	Dewatering to remove Accumulated Spring Rainfall	20 days	Wed 6/1/22	Tue 6/28/22
75	Contractor Mobilization to Site	10 days	Wed 6/15/22	Tue 6/28/22
76	Site Preparation	15 days	Wed 6/29/22	Tue 7/19/22
77	Clean Existing Concrete Revetment Mat	15 days	Wed 7/6/22	Tue 7/26/22
78	Place 6" General Soil Fill Layer	25 days	Wed 7/27/22	Tue 8/30/22
79	GCL & HDPE Liner Installation	30 days	Wed 8/31/22	Tue 10/11/22
80	Pipe Rack - Liner Attachment	5 days	Wed 10/5/22	Tue 10/11/22
81	Punchlist and Contract Closeout	10 days	Wed 10/12/22	Tue 10/25/22
82	Return Flows to NSP (Ash Pond Area Retrofit Complete)	5 days	Wed 10/26/22	Tue 11/1/22
83	**PDP5 Evaluation and Initiation of Potential Retrofit Project (if required)**	**280 days**	**Tue 6/7/22**	**Sat 7/1/23**
84	Bid and Award Engineering Services for PDP5 Retrofit Project	67 days	Tue 6/7/22	Wed 9/7/22
85	Detailed Design: PDP5 Retrofit Bid Documents	87 days	Thu 9/8/22	Fri 1/6/23
86	Luminant Bid/Award PDP5 Retrofit Construction Contract	61 days	Mon 1/9/23	Sat 4/1/23
87	PDP5 Retrofit Plan Published (if Required after Part B alternate liner demonstration efforts)	0 days	Mon 5/1/23	Mon 5/1/23
88	Liner Material Acquisition	35 days	Mon 5/1/23	Fri 6/16/23
89	Dewatering to remove Accumulated Spring Rainfall	22 days	Thu 6/1/23	Fri 6/30/23
90	Contractor Mobilization to Site	10 days	Mon 6/19/23	Fri 6/30/23
91	Remove PDP5 from Service and Initiate Retrofit (if Required after Part B alternate liner demonstration efforts)	0 days	Sat 7/1/23	Sat 7/1/23



Project: Martin Lake CCR Surface Impoundment Extension Demonstration
Date: Thu 10/22/20

Legend: Task; Split; Milestone; Summary; Project Summary; External Tasks; External Milestone; Inactive Task; Inactive Milestone; Inactive Summary; Manual Task; Duration-only; Manual Summary Rollup; Manual Summary; Start-only; Finish-only; Deadline; Progress; Manual Progress

APPENDIX C – EAST ASH POND RETROFIT DESIGN DRAWINGS

HDR
Firm Registration No. F-754
17111 Preston Road, Suite 300
Dallas, Texas 75248-1229
972.960.4400

Luminant

Construction Drawings For

Martin Lake
Steam Electric Station

CCR Impoundment Reline
East Ash Pond

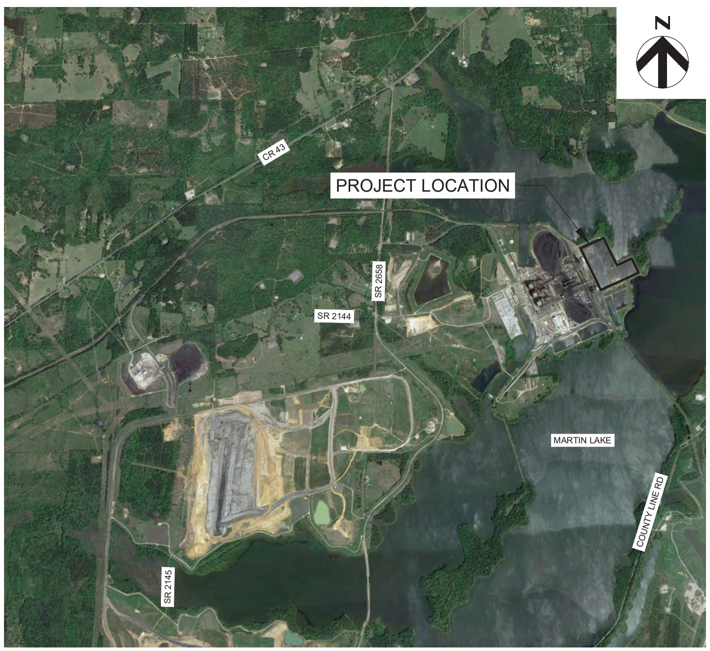
Project No.
10172630

Rusk County, Texas
January 2020

INDEX OF DRAWINGS

STATE OF TEXAS
DAVID C. VOGT
93905
LICENSED
PROFESSIONAL ENGINEER

1/29/2020

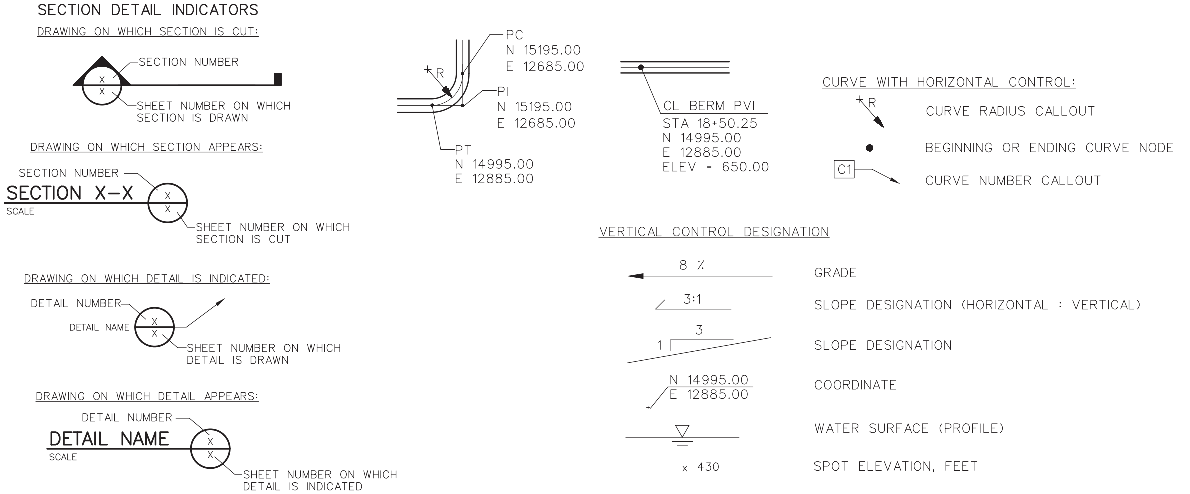


VICINITY MAP
NOT TO SCALE

STANDARD ABBREVIATIONS

&	AND
APPROX	APPROXIMATELY
@	AT
AVG	AVERAGE
BOE	BOTTOM OF EXCAVATION
BOL	BOTTOM OF LINER
X	BY
CL	CENTERLINE
CMP	CORRUGATED METAL PIPE
CO	CLEAN OUT
CY	CUBIC YARD
DIA	DIAMETER
DET	DETAIL
DWG	DRAWING
E	EAST
EAP	EAST ASH POND
ELEV	ELEVATION
EW	EACH WAY
EXIST	EXISTING
EXC	EXCAVATION
FGD	FLUE GAS DESULFICATION
FML	FLEXIBLE MEMBRANE LINER
FT	FEET
GAL	GALLON
GND	GROUND
GDL	GRAVEL DRAINAGE LAYER
GNDL	GEONET DRAINAGE LAYER
HDPE	HIGH DENSITY POLYETHYLENE
HORIZ	HORIZONTAL
ID	INSIDE DIAMETER
IN	INCHES
IE	INVERT ELEVATION
LCRS	LEACHATE COLLECTION AND REMOVAL SYSTEM
LCS	LEACHATE COLLECTION SYSTEM
LCP	LEACHATE COLLECTION PIPE
LCPR	LEACHATE COLLECTION PIPE RISER
LF	LINEAR FEET
LB	POUND
MH	MANHOLE
MAX	MAXIMUM
MIL	.001 INCHES
MIN	MINIMUM
MW	MONITOR WELL
MLSES	MARTIN LAKE STEAM ELECTRIC STATION
MSL	MEAN SEA LEVEL
N	NORTH
NIC	NOT IN CONTRACT
NO	NUMBER
NTS	NOT TO SCALE
NTYS	NORTH THICKENER YARD SUMP
OC	ON CENTER
OZ	OUNCE
%	PERCENT
PLCP	PERFORATED LEACHATE COLLECTION PIPE
PERF	PERFORATED
PGL	PROFILE GRADE LINE
PDP	PERMANENT DISPOSAL POND
PC	POINT OF CURVATURE
PI	POINT OF INTERSECTION
PVI	POINT OF VERTICAL INTERSECTION
PT	POINT OF TANGENT
PZ	PIEZOMETER
Q	FLOW
QTY	QUANTITY
R	RADIUS
RCP	REINFORCED CONCRETE PIPE
REF	REFERENCE
REQ	REQUIRED
RD	ROAD
SCH	SCHEDULE
SDL	SAND DRAINAGE LAYER
SEC	SECTION
SHT	SHEET
S	SOUTH
SDR	STANDARD DIMENSION RATIO
SLQCP	SOIL LINER QUALITY CONTROL PLAN
SP	STEEL PIPE
SQ	SQUARE
SS	SIDE SLOPE
STA	STATION
STYS	SOUTH THICKENER YARD SUMP
T.A.S.	TERMINAL ANCHOR SECTION
TL	TANGENT LENGTH
TOC	TOP OF COVER
TOFC	TOP OF FINAL COVER
TOL	TOP OF LINER
TOS	TOE OF SLOPE
TS	TOP SLOPE
TEMP	TEMPORARY
TYP	TYPICAL
UNO	UNLESS NOTED OTHERWISE
VERT	VERTICAL
W	WEST
W/	WITH
WAP	WEST ASH POND
WW	WETWELL
YD	YARD

SYMBOLS



CONSTRUCTION SEQUENCE

A. CONTRACTOR SHALL REMOVE EXISTING CCR MATERIAL, ROCKS AND SEDIMENT FROM THE EAP, HAUL AND STOCKPILE IT AT THE DECANT BASIN. LUMINANT WILL LOAD THE STOCKPILED MATERIAL ONTO RAIL CARS FOR DISPOSAL AT THE MARTIN LAKE A-1 AREA LANDFILL.

B. CONTRACTOR SHALL USE WATER FROM THE ADJACENT WEST ASH POND (WAP) OR NEW SCRUBBER POND (SP) TO WASH REMAINING CCR MATERIAL OFF THE SIDES AND FLOOR OF THE EAP AND REMOVE IT. EAP WILL BE VISUALLY INSPECTED BY OWNER'S CQA CONSULTANT TO CONFIRM CCR MATERIAL, ROCKS, AND SEDIMENT HAVE BEEN REMOVED.

C. CONTRACTOR SHALL MODIFY THE EXISTING 48-INCH SUCTION LINE ON THE SOUTH END OF THE POND BY INCREASING THE SCREENED AREA AS SHOWN IN THE PLANS.

D. CONTRACTOR SHALL LOAD AND HAUL GENERAL SOIL FILL MATERIAL FROM THE OWNER'S STOCKPILE LOCATED AT LIBERTY MINE, A LOCATION UNDER THE PROVISIONS OF THE MINE SAFETY AND HEALTH ADMINISTRATION (MSHA) AND APPROXIMATELY 4.5 MILES FROM EAP.

E. CONTRACTOR SHALL PLACE THE GENERAL FILL MATERIAL OVER THE EXISTING CONCRETE REVETMENT TO A DEPTH OF AT LEAST SIX (6) INCHES, NOMINALLY COMPACT, AND SMOOTH ROLL TO FINISH THE INSTALLATION.

F. CONTRACTOR SHALL INSTALL A GEOSYNTHETIC CLAY LINER (GCL) OVER THE SIDES AND FLOOR OF THE EAP AND SECURE IT IN A PERIMETER ANCHOR TRENCH/BATTEN AND STRIP.

G. CONTRACTOR SHALL INSTALL A 60-MIL HDPE LINER DIRECTLY ON THE GCL AND SECURE IT IN A PERIMETER ANCHOR TRENCH/BATTEN AND STRIP.

H. CONTRACTOR SHALL INSTALL 12-INCH HDPE YARD PIPE AS SHOWN IN THE PLANS.

GENERAL NOTES

1. ALL WORK UNDER THIS CONTRACT SHALL BE PERFORMED IN ACCORDANCE WITH THE PLANS AND PROJECT SPECIFICATIONS. IN THE EVENT OF A DISCREPANCY BETWEEN THE PLANS AND THE PROJECT SPECIFICATIONS, THE SPECIFICATIONS SHALL GOVERN.
2. COORDINATE SYSTEM IS BASED ON LOCAL SURVEY. THE BENCHMARKS TO BE USED FOR CONSTRUCTION ARE LOCATED AS SHOWN ON DRAWING NO. 00C-01. EXISTING CONTOURS ARE BASED ON TOPOGRAPHICAL SURVEY PERFORMED FEBRUARY 12-20, 2019 BY LACY SURVEYING. CURRENT GROUND ELEVATIONS MAY VARY FROM THOSE SHOWN DUE TO SITE WORK THAT HAS BEEN PERFORMED SINCE THE SURVEY WAS PERFORMED.
3. THE CONTRACTOR SHALL VERIFY EXISTING CONTOURS PRIOR TO THE START OF WORK.
4. THERE SHALL NOT BE ANY ADDITIONAL PAYMENT OR EXTENSION OF CONTRACT TIME FOR WORKING WITH SATURATED SOILS OR HANDLING WATER SEEPAGE DUE TO RAINFALL, RUNOFF AND INFILTRATION.
5. THE CONTRACTOR SHALL TAKE ALL NECESSARY PRECAUTIONS TO PROTECT EXISTING ROADS, BENCHMARKS AND EXISTING GROUNDWATER MONITOR WELLS DURING THE CONSTRUCTION PERIOD. THE CONTRACTOR SHALL BE SOLEY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE INCURRED BY THE CONTRACTOR'S FAILURE TO EXACTLY LOCATE AND PROTECT THE GROUNDWATER MONITOR WELLS, BENCHMARKS AND EXISTING ROADS.
6. THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES HAVE NOT BEEN ESTABLISHED BY THE OWNER OR ENGINEER. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK, AND AGREES TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY THE CONTRACTORS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UTILITIES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING PROPER SAFE WORKING DISTANCE FROM ALL UTILITY EASEMENTS OR LINES.
7. EXCAVATION BY "BLASTING" IS NOT PERMITTED ON THIS PROJECT.
8. FINISHED GROUND ELEVATIONS SHALL MATCH EXISTING GROUND ELEVATIONS EXCEPT AS SHOWN ON THE PLANS. ALL EXCESS SOIL FROM THE EXCAVATION AND GRADING SHALL BE PLACED IN DESIGNATED STOCKPILE LOCATIONS AS APPROVED BY THE OWNER. IF WASTE IS ENCOUNTERED DURING EXCAVATION, THE OWNER SHALL BE NOTIFIED AND THE WASTE REMOVED AND PLACED IN AREAS DESIGNATED AS APPROVED BY THE OWNER. TRANSPORT OF SOIL TO FILL AREAS SHALL BE CONDUCTED BY THE CONTRACTOR AT NO ADDITIONAL EXPENSE TO THE OWNER.
9. GEOTECHNICAL INVESTIGATION REPORTS FOR THE SITE ARE AVAILABLE FOR REVIEW AT LUMINANT'S DALLAS OFFICES. THE CONTRACTOR MAY PERFORM ADDITIONAL GEOTECHNICAL INVESTIGATIONS, AS DEEMED NECESSARY FOR CONSTRUCTION ACTIVITIES, PROVIDED ALL NECESSARY PERMITS AND APPROVALS ARE OBTAINED FROM LUMINANT PRIOR TO INITIATING SUCH WORK. HOWEVER, THERE SHALL BE NO ADDITIONAL PAYMENT TO THE CONTRACTOR FOR ADDITIONAL GEOTECHNICAL INVESTIGATIONS.
10. THE CONTRACTOR SHALL CONSTRUCT, AND UPON COMPLETION OF THE PROJECT, REMOVE TEMPORARY CONSTRUCTION ACCESS ROADS. SUCH ROADS SHALL BE LOCATED AS APPROVED BY THE OWNER. DRAINAGE PATTERNS AT THE SITE SHALL NOT BE ALTERED BY ROAD CONSTRUCTION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONSTRUCTION AND MAINTENANCE OF TEMPORARY DRAINAGE STRUCTURES, INCLUDING CULVERTS, AT NO ADDITIONAL COST TO THE OWNER.
11. THE CONTRACTOR SHALL INSTALL, MAINTAIN, AND UPON COMPLETION OF THE PROJECT, REMOVE TEMPORARY EROSION AND SEDIMENT CONTROLS AS APPROVED BY LUMINENT ENVIRONMENTAL SERVICES AND IN ACCORDANCE WITH THE SITE SWPPP AND PURSUANT TO TPDES REQUIREMENTS. SUCH CONTROLS SHALL BE PLACED AT THE LIMITS OF DISTURBED AREAS AND AT INTERMEDIATE LOCATIONS WHERE CONCENTRATED FLOW IS LIKELY.
12. TEMPORARY CONSTRUCTION SLOPES SHALL NOT BE GREATER THAN 2H:1V. STEEPER SLOPES WILL ONLY BE ALLOWED IF THE CONTRACTOR PROVIDES A GEOTECHNICAL ENGINEERING REPORT SPECIFYING MAXIMUM SLOPES AND THE DURATION FOR WHICH SUCH SLOPES SHALL REMAIN IN PLACE.
13. THE CONTRACTOR SHALL REMOVE ALL VEGETATION WITHIN THE CONSTRUCTION LIMITS AS REQUIRED TO CONSTRUCT THE PROJECT. ALL VEGETATION SHALL BE REMOVED BY CONTRACTOR AT NO ADDITIONAL EXPENCE TO OWNER.
14. THE CONTRACTOR SHALL OBTAIN AND CONDUCT WORK CONSISTENT WITH A TPDES PERMIT FOR CONSTRUCTION, REFER TO TECHNICAL SPECIFICATIONS. PREPARATION OF A SWPPP AND OBTAINING THE TPDES PERMIT ARE THE CONTRACTORS RESPONSIBILITY.
15. THE CONTRACTOR SHALL IMMEDIATELY REPORT TO THE ENGINEER ANY ERROR OR DISCREPANCY FOUND ONCE THE CONTRACT DOCUMENT IS CAREFULLY REVIEWED AND ALL ASPECTS OF FIELD WORK HAVE BEEN VERIFIED. IN THE EVENT THE CONTRACTOR CONTINUES TO WORK ON AN ITEM WHERE AN ERROR EXISTS, IT SHALL BE DEEMED THAT THE CONTRACTOR BID AND INTENDED TO EXECUTE THE MORE STRINGENT OR HIGHER QUALITY REQUIREMENT WITHOUT AN INCREASE IN CONTRACT SUM OR TIME. THE CONTRACTOR SHALL ALSO BE RESPONSIBLE TO CORRECT ANY FAILURE OF COMPANY PARTS TO COORDINATE OR FIT PROPERLY INTO FINAL POSITION, AS A RESULT OF CONTRACTOR FAILURE TO RAISE OR RESOLVE A DISCREPANCY.
16. THE DRAWINGS AND SPECIFICATIONS SHOULD AGREE WITH EACH OTHER, AND WORK CALLED FOR BY DRAWINGS AND NOT MENTIONED IN SPECIFICATION, OR VICE VERSA, SHALL BE FURNISHED BY BOTH. WHEN DISCREPANCIES EXIST BETWEEN SCALE AND DIMENSIONS, THE DIMENSIONED FIGURE SHALL BE USED.
17. CONTRACTOR AND EACH SUBCONTRACTOR SHALL VERIFY ALL GRADES, LINES, LEVELS, AND DIMENSIONS AS INDICATED ON DRAWINGS, AND HE SHALL REPORT ERRORS TO THE ENGINEER BEFORE COMMENCING WORK. THE CONTRACTOR SHALL ESTABLISH BENCHMARKS IN AT LEAST TWO WIDELY SEPARATED PLACES, AND AS WORK PROGRESSES THE CONTRACTOR WILL MAINTAIN ADEQUATE HORIZONTAL AND VERTICAL CONTROL.
18. CONTRACTOR SHALL PROVIDE EROSION CONTROL BY SEEDING FOR ALL AREAS DISTURBED BY CONTRACTOR DURING THE CONSTRUCTION OF THIS PROJECT. THE CONTRACTOR SHALL NOT DISTURB ANY AREA WITHOUT THE APPROVAL OF THE ENGINEER. EROSION CONTROL BY SEEDING SHALL CONFORM TO STANDARD SPECIFICATION 02930.
19. CONTRACTOR SHALL INSTALL EROSION AND SEDIMENT CONTROLS AS PER SPECIFICATIONS DURING CONSTRUCTION. SUCH CONTROLS SHALL BE PLACED AT LIMITS OF DISTURBED AREAS AND AT INTERMEDIATE LOCATIONS WHERE CONCENTRATED FLOW IS LIKELY.
20. STORMWATER THAT HAS COME INTO CONTACT WITH THE ASH WITHIN THE EXCAVATED POND IS TO BE CONSIDERED CONTACT STORMWATER. CONTRACTOR WILL CONTROL THE WATER ON SITE IN COMPLIANCE WITH THE TPDES PERMIT.
21. THE CONTRACTOR IS REQUIRED TO PRESENT THE SWPPP TO LUMINANT ENVIRONMENTAL SERVICES FOR APPROVAL PRIOR TO THE COMMENCEMENT OF CONSTRUCTION ACTIVITIES.
22. THE CONTRACTOR IS REQUIRED TO SUBMIT THE NOTICE OF INTENT AND NOTICE OF TERMINATION FOR THE TPDES PERMIT.
23. THE CONTRACTOR IS TO ACQUIRE A DIGGING PERMIT FROM THE PLANT BEFORE COMMENCING ANY EXCAVATION ACTIVITY.

HDR

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A	11/12/2019	ISSUED FOR CLIENT REVIEW

PROJECT MANAGER	D. VOGT, P.E.
DESIGNED BY	K. PERERA
DRAWN BY	J. RAYMOND
CHECKED BY	M. ROBERTS
PROJECT NUMBER	10172630

STATE OF TEXAS
DAVID C. VOGT
93905
LICENSED
PROFESSIONAL ENGINEER
1/29/2020

MARTIN LAKE STEAM ELECTRICAL STATION
EAST ASH POND RELINE
RUSK COUNTY, TEXAS

Luminant

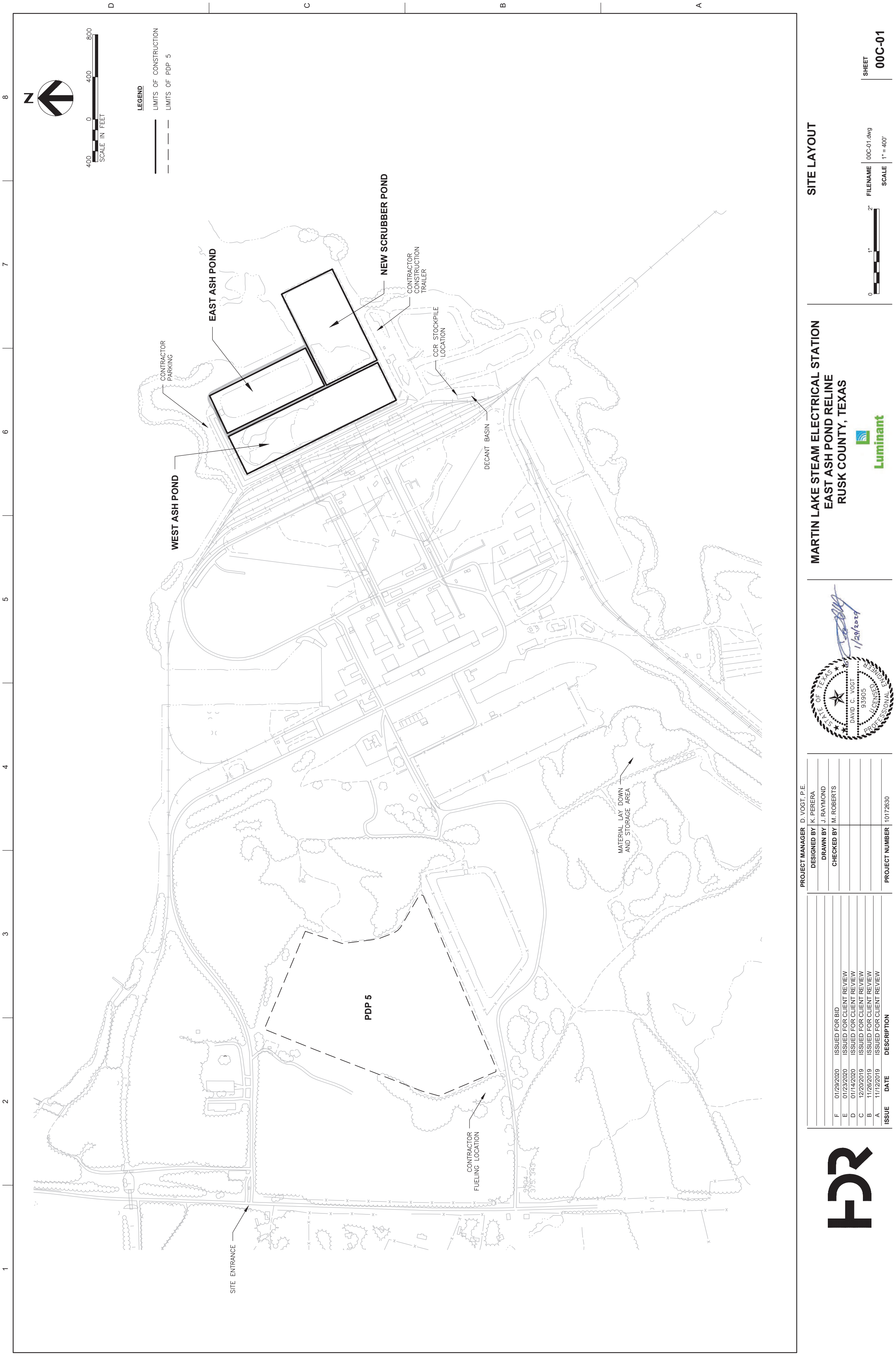
ABBREVIATIONS AND GENERAL NOTES

0 1" 2"

FILENAME 00G-02.dwg
SCALE

SHEET
00G-02

APPENDIX G-Revision 1 December 15, 2022



SITE LAYOUT
MARTIN LAKE STEAM ELECTRICAL STATION
EAST ASH POND RELINE
RUSK COUNTY, TEXAS
Luminant
EAST ASH POND
NEW SCRUBBER POND
WEST ASH POND
PDP 5
CONTRACTOR PARKING
CONTRACTOR CONSTRUCTION TRAILER
CCR STOCKPILE LOCATION
DECANT BASIN
MATERIAL LAY DOWN AND STORAGE AREA
CONTRACTOR FUELING LOCATION
SITE ENTRANCE
LEGEND
LIMITS OF CONSTRUCTION
LIMITS OF PDP 5
SCALE IN FEET
PROJECT MANAGER D. VOGT, P.E.
DESIGNED BY K. PERERA
DRAWN BY J. RAYMOND
CHECKED BY M. ROBERTS
PROJECT NUMBER 10172630
F 01/29/2020 ISSUED FOR BID
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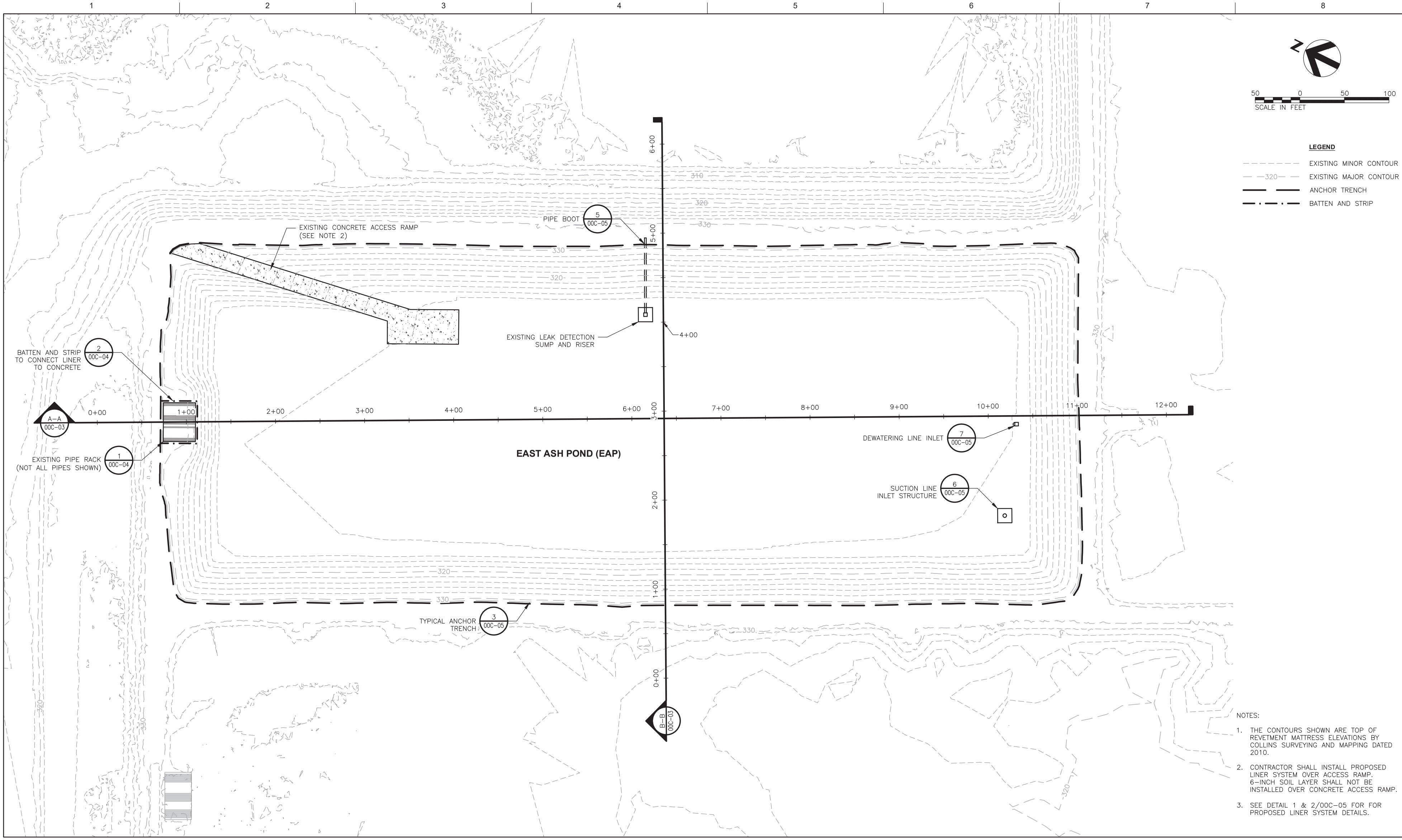
C 12/20/2019 ISSUED FOR CLIENT REVIEW
B 11/26/2019 ISSUED FOR CLIENT REVIEW
A 11/12/2019 ISSUED FOR CLIENT REVIEW
ISSUE DATE DESCRIPTION
FILENAME 00C-01.dwg
SCALE 1" = 400'
SHEET 00C-01



NOTES:

1. THE CONTOURS SHOWN ARE TOP OF REVETMENT MATTRESS ELEVATIONS BY COLLINS SURVEYING AND MAPPING DATED 2010.
2. CONTRACTOR SHALL INSTALL PROPOSED LINER SYSTEM OVER ACCESS RAMP. 6-INCH SOIL LAYER SHALL NOT BE INSTALLED OVER CONCRETE ACCESS RAMP.
3. SEE DETAIL 1 & 2/00C-05 FOR FOR PROPOSED LINER SYSTEM DETAILS.

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PROJECT MANAGER	D. VOGT, P.E.
DESIGNED BY	K. PERERA
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STATE OF TEXAS
DAVID C. VOGT
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LICENSED
PROFESSIONAL ENGINEER
1/29/2020

MARTIN LAKE STEAM ELECTRICAL STATION
EAST ASH POND RELINE
RUSK COUNTY, TEXAS

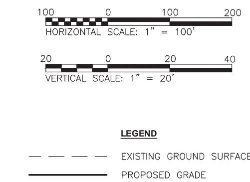
Luminant

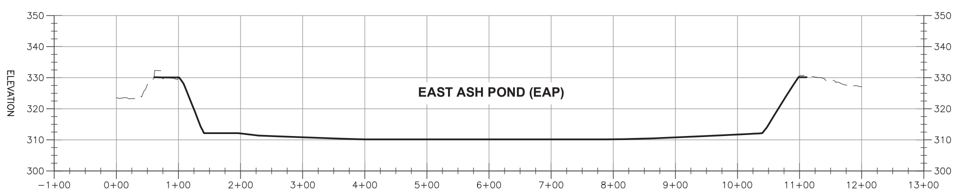
EAST ASH POND

0 1" 2"

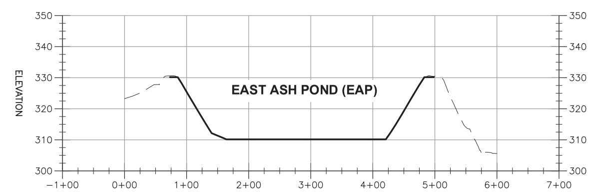
FILENAME 00C-02.dwg
SCALE 1" = 50'

SHEET 00C-02





SECTION A–A
HORIZONTAL SCALE: 1" = 100' ; VERTICAL SCALE: 1" = 20'
A–A 00C-02



SECTION B–B
HORIZONTAL SCALE: 1" = 100' ; VERTICAL SCALE: 1" = 20'
B–B 00C-02

HDR

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DESIGNED BY	K. PERERA
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CHECKED BY	M. ROBERTS
PROJECT NUMBER	10172630

STATE OF TEXAS
DAVID C. VOGT
93905
LICENSED
PROFESSIONAL ENGINEER
1/29/2020

MARTIN LAKE STEAM ELECTRICAL STATION
EAST ASH POND RELINE
RUSK COUNTY, TEXAS

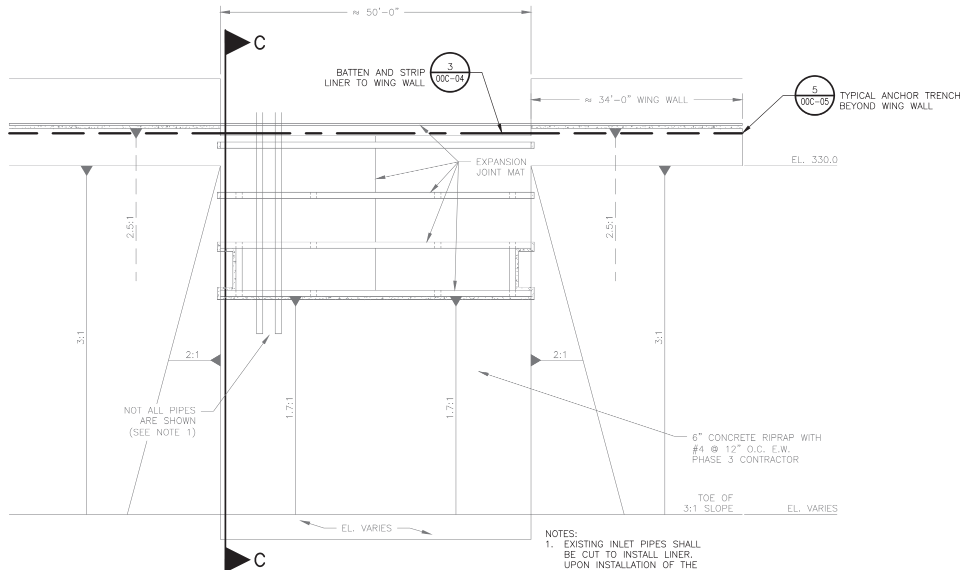
Luminant

CROSS SECTIONS

0 1" 2"

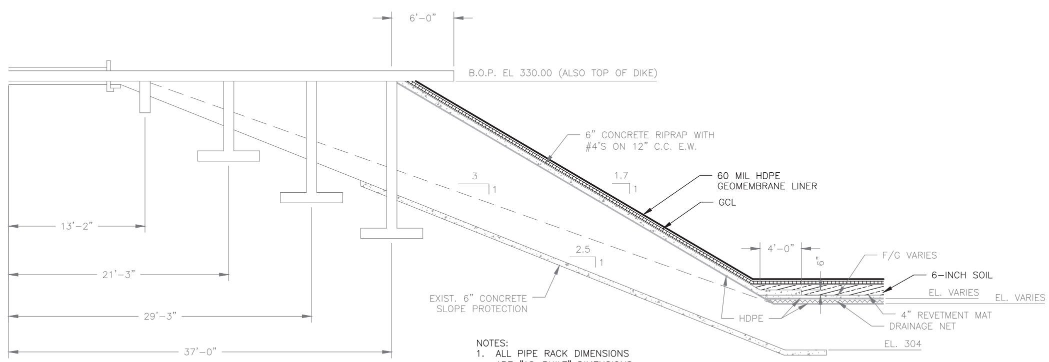
FILENAME 00C-03.dwg
SCALE H: 1" = 100' ; V: 1" = 20'

SHEET 00C-03



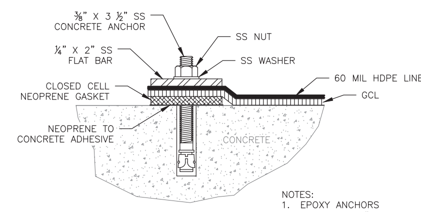
NOTES:
1. EXISTING INLET PIPES SHALL BE CUT TO INSTALL LINER. UPON INSTALLATION OF THE LINER, PIPES SHALL BE REINSTALLED.

TYPICAL PIPE RACK (1 / 00C-02)
NOT TO SCALE



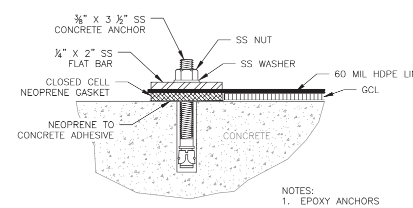
NOTES:
1. ALL PIPE RACK DIMENSIONS ARE "AS-BUILT" DIMENSIONS FOR EAST ASH POND.

SECTION C–C
NOT TO SCALE



NOTES:
1. EPOXY ANCHORS SPACED AT 6" O.C.

BATTEN AND STRIP CONNECTION AT ANCHOR TRENCH (2A / 00C-06)
NOT TO SCALE



NOTES:
1. EPOXY ANCHORS SPACED AT 6" O.C.

BATTEN AND STRIP CONNECTION BELOW WATER SURFACE (2B / 00C-06)
NOT TO SCALE

HDR

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PROJECT MANAGER	D. VOGT, P.E.
DESIGNED BY	K. PERERA
DRAWN BY	J. RAYMOND
CHECKED BY	M. ROBERTS
PROJECT NUMBER	10172630

STATE OF TEXAS
DAVID C. VOGT
93905
LICENSED PROFESSIONAL ENGINEER
1/29/2020

MARTIN LAKE STEAM ELECTRICAL STATION
EAST ASH POND RELINE
RUSK COUNTY, TEXAS

Luminant

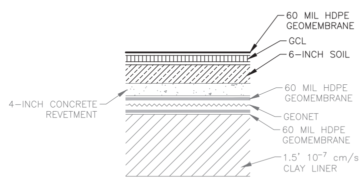
DETAILS
(1 OF 2)

0 1" 2"

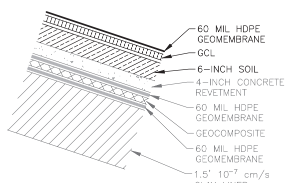
FILENAME 00C-04.dwg
SCALE

SHEET **00C-04**

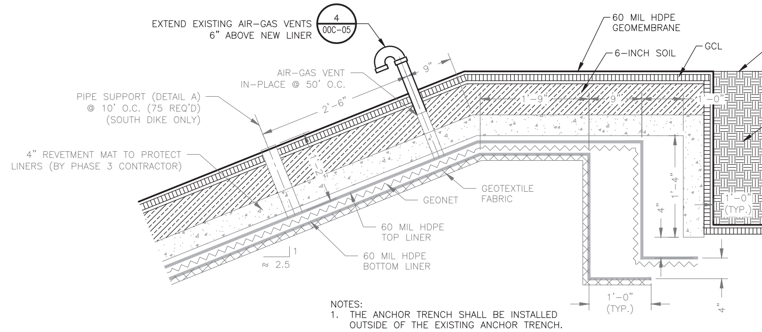
APPENDIX G-Revision 1 December 15, 2022



PROPOSED
EAP RETROFIT SECTION (FLOOR) 1 / 00C-05
NOT TO SCALE

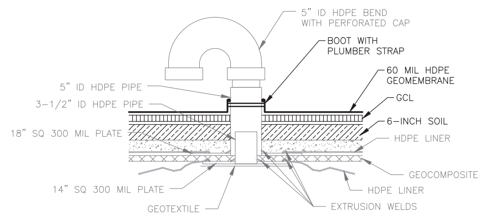


PROPOSED
EAP RETROFIT SECTION (SIDESLOPE) 2 / 00C-05
NOT TO SCALE

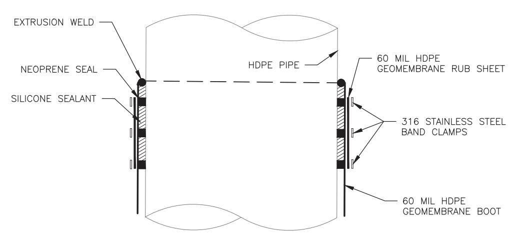


NOTES:
1. THE ANCHOR TRENCH SHALL BE INSTALLED OUTSIDE OF THE EXISTING ANCHOR TRENCH.

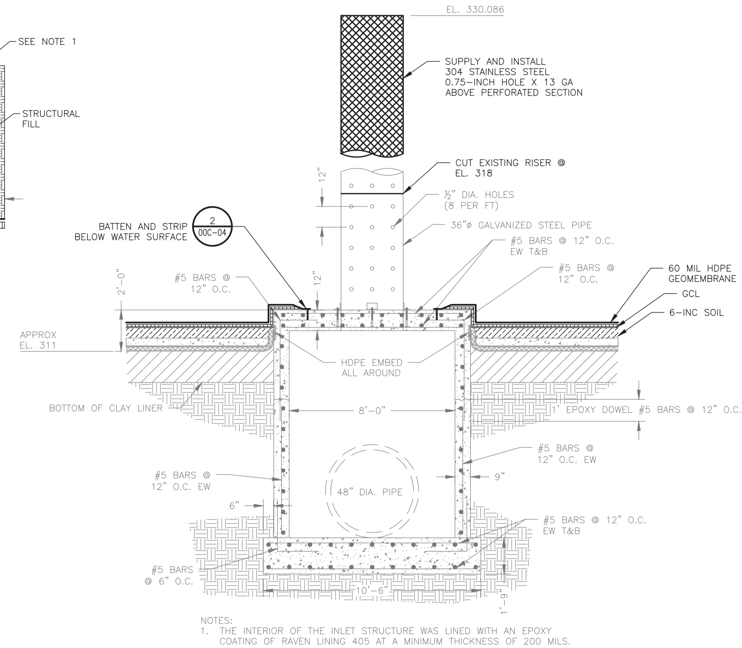
ANCHOR TRENCH 3 / 00C-02
NOT TO SCALE



TYPICAL AIR-GAS VENT 4 / 00C-05
NOT TO SCALE

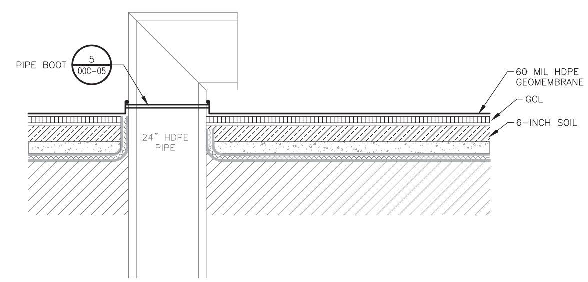


PIPE BOOT 5 / 00C-02
NOT TO SCALE



NOTES:
1. THE INTERIOR OF THE INLET STRUCTURE WAS LINED WITH AN EPOXY COATING OF RAVEN LINING 405 AT A MINIMUM THICKNESS OF 200 MILS.

SUCTION LINE
INLET STRUCTURE 6 / 00C-02
NOT TO SCALE



24" DEWATERING LINE INLET 7 / 00C-02
NOT TO SCALE

HDR

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PROJECT MANAGER	D. VOGT, P.E.
DESIGNED BY	K. PERERA
DRAWN BY	J. RAYMOND
CHECKED BY	M. ROBERTS
PROJECT NUMBER	10172630

STATE OF TEXAS
DAVID C. VOGT
93905
LICENSED PROFESSIONAL ENGINEER
1/29/2020

MARTIN LAKE STEAM ELECTRICAL STATION
EAST ASH POND RELINE
RUSK COUNTY, TEXAS

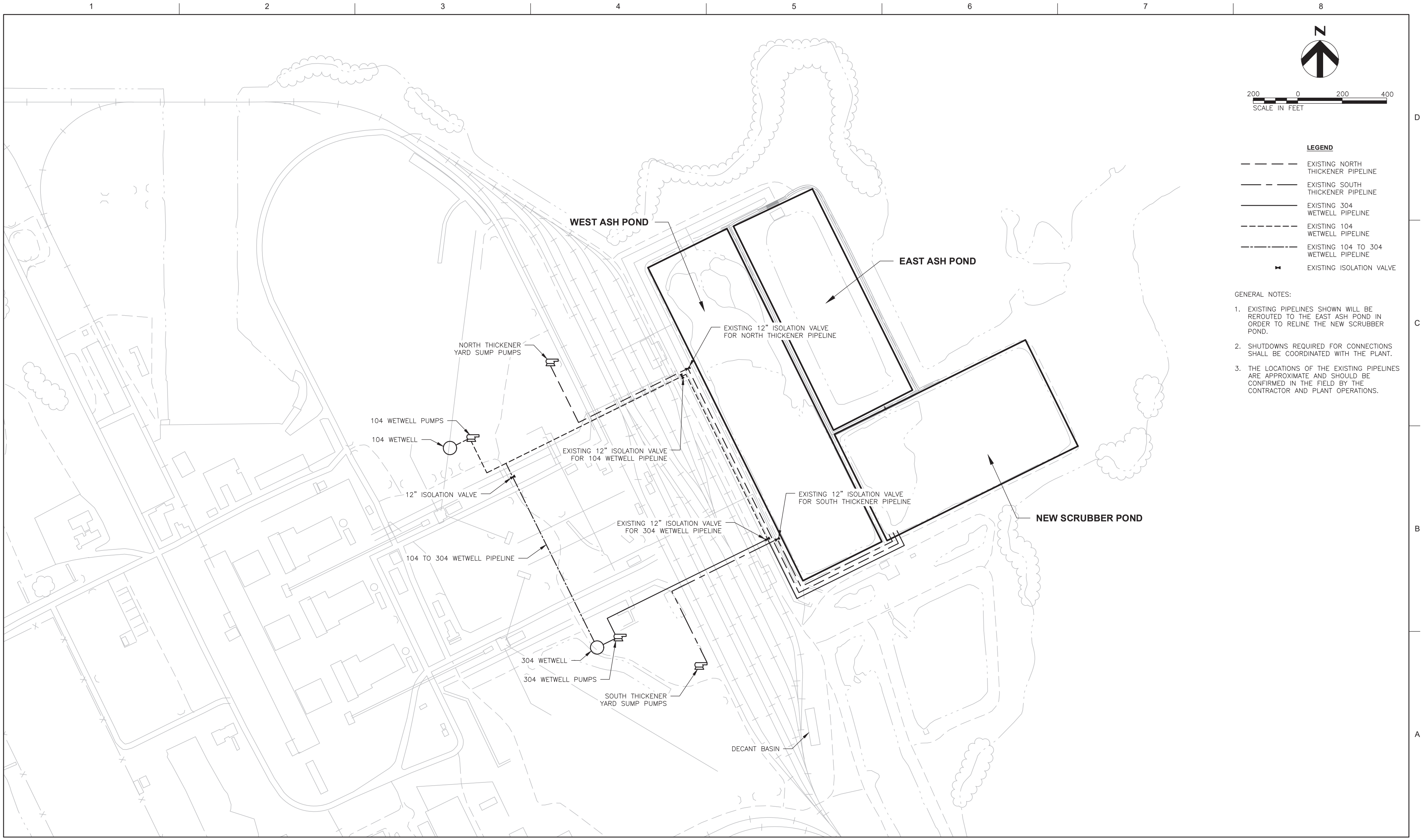
Luminant

DETAILS
(2 OF 2)

0 1" 2"

FILENAME 00C-05.dwg
SCALE NOT TO SCALE

SHEET
00C-05



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ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	D. VOGT, P.E.
DESIGNED BY	J. ORDONEZ, P.E.
DRAWN BY	J. RAYMOND
CHECKED BY	D. VOGT, P.E.
PROJECT NUMBER	10172630

STATE OF TEXAS
JAIME ORDONEZ
124838
LICENSED
PROFESSIONAL ENGINEER

MARTIN LAKE STEAM ELECTRICAL STATION
EAST ASH POND RELINE
RUSK COUNTY, TEXAS

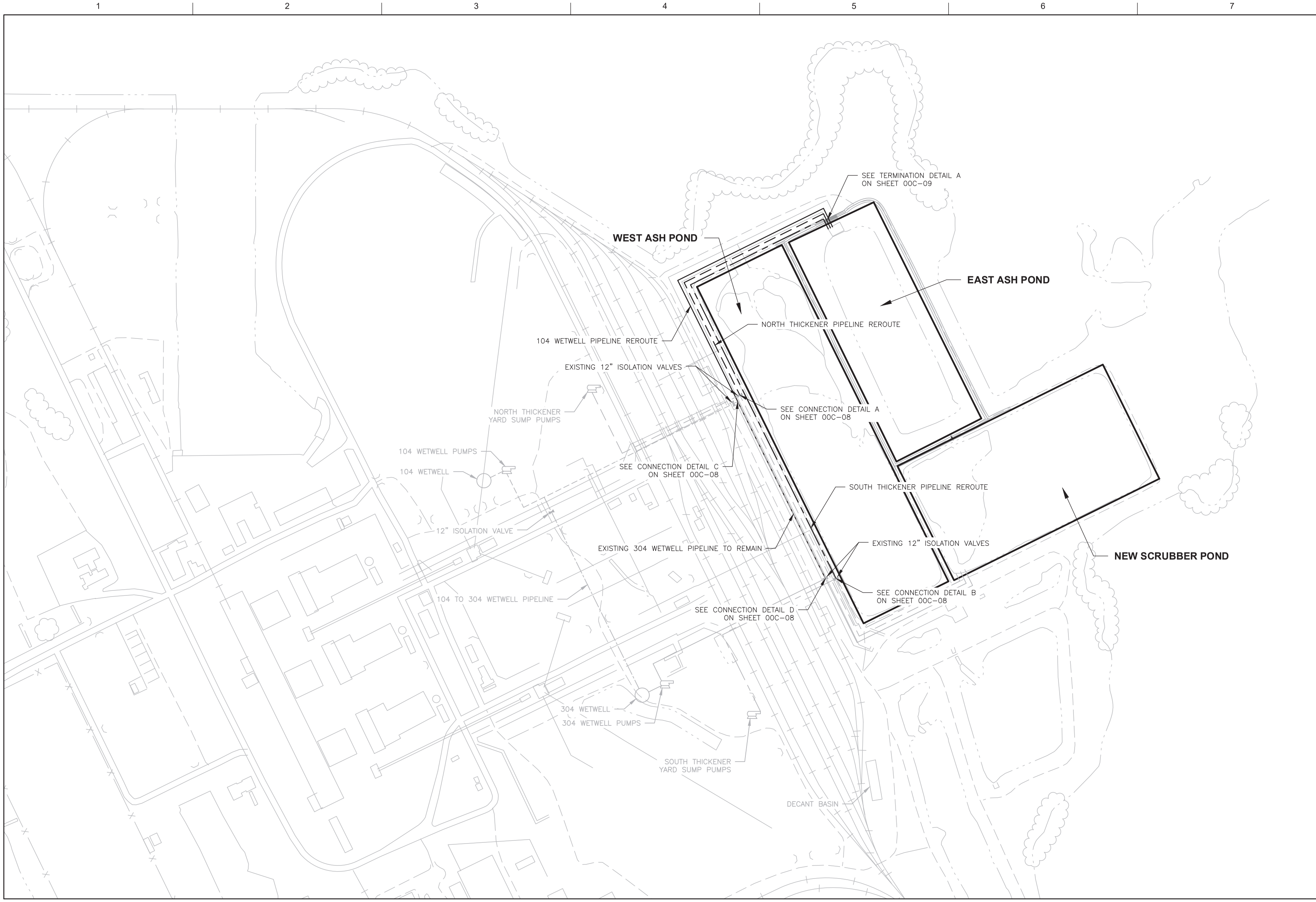
Luminant

EXISTING YARD PIPING

0 1" 2"

FILENAME 00C-06.dwg
SCALE 1" = 200'

SHEET
00C-06



LEGEND

- EXISTING NORTH THICKENER PIPELINE
- EXISTING SOUTH THICKENER PIPELINE
- EXISTING 304 WETWELL PIPELINE
- EXISTING 104 WETWELL PIPELINE
- EXISTING 104 TO 304 WETWELL PIPELINE
- NORTH THICKENER PIPELINE REROUTE
- SOUTH THICKENER PIPELINE REROUTE
- 304 WETWELL PIPELINE REROUTE
- 104 WETWELL PIPELINE REROUTE
- EXISTING ISOLATION VALVE

GENERAL NOTES:

1. CONTRACTOR SHALL INSTALL THE 104 WETWELL PIPELINE REROUTE, THE NORTH THICKENER PIPELINE REROUTE AND THE SOUTH THICKENER PIPELINE REROUTE AS SHOWN. EACH PIPELINE STARTS AT ITS CORRESPONDING EXISTING ISOLATION VALVE.
2. SHUTDOWNS REQUIRED FOR CONNECTIONS SHALL BE COORDINATED WITH THE PLANT.
3. THE EXISTING VALVE CONNECTION LOCATIONS TO ALL EXISTING PIPELINES ARE APPROXIMATE AND SHOULD BE CONFIRMED IN THE FIELD BY THE CONTRACTOR AND PLANT OPERATIONS.
4. PIPELINES SHOULD BE INSTALLED FLUSH ON GRADE WITHOUT INTRODUCING INTERMEDIATE HIGH POINTS.
5. ALL JOINTS SHALL BE FUSION WELDED BUTT JOINTS IN ACCORDANCE WITH PROJECT SPECIFICATIONS.

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PROJECT MANAGER	D. VOGT, P.E.
DESIGNED BY	J. ORDONEZ, P.E.
DRAWN BY	J. RAYMOND
CHECKED BY	D. VOGT, P.E.
PROJECT NUMBER	10172630

STATE OF TEXAS
JAIME ORDONEZ
124838
LICENSED PROFESSIONAL ENGINEER

MARTIN LAKE STEAM ELECTRICAL STATION
EAST ASH POND RELINE
RUSK COUNTY, TEXAS

Luminant

MODIFIED YARD PIPING

0 1" 2"

FILENAME 00C-07.dwg
SCALE 1" = 200'

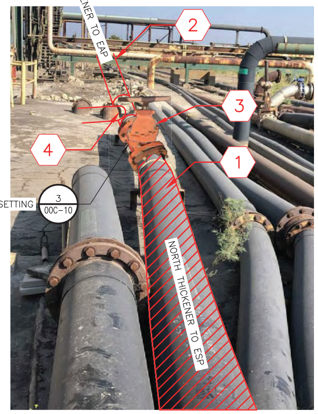
SHEET
00C-07

GENERAL NOTES:

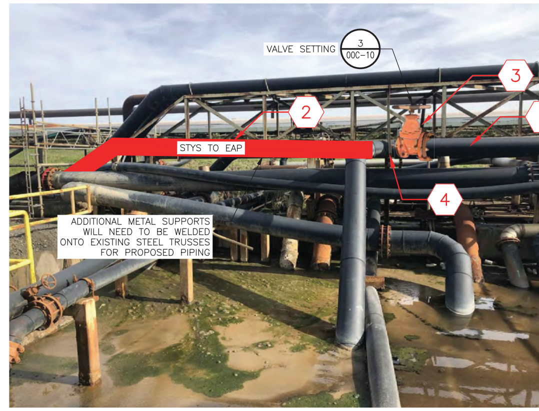
1. SHUTDOWNS REQUIRED FOR CONNECTIONS SHALL BE COORDINATED WITH THE PLANT.
2. THE CONNECTIONS LOCATION TO ALL EXISTING PIPELINES ARE APPROXIMATE AND SHOULD BE CONFIRMED IN THE FIELD BY THE CONTRACTOR AND PLANT OPERATIONS.
3. CONNECTIONS C AND D MUST BOTH BE COMPLETE BEFORE MAKING EITHER OF THESE LINES OPERATIONAL.
4. ALL PIPE AND FITTING SIZES SHALL BE CONFIRMED IN THE FIELD BY THE CONTRACTOR PRIOR TO ORDERING OR MANUFACTURING OF PIPE.

KEY NOTES:

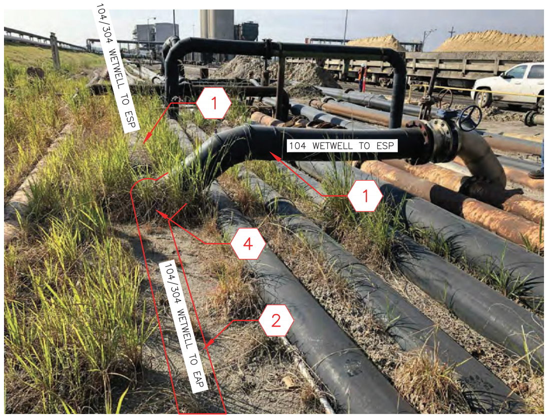
1. EXISTING TO REMAIN
2. PIPELINE REROUTE
3. 12" ISOLATION VALVE
4. INSTALL SIZE ON SIZE TEE



CONNECTION TO NORTH THICKENER PIPELINE (A / 00C-07)
NOT TO SCALE



CONNECTION TO SOUTH THICKENER PIPELINE (B / 00C-07)
NOT TO SCALE



CONNECTION TO 104 WETWELL TO ESP PIPELINE (C / 00C-07)
NOT TO SCALE

CONNECTION TO 304 WETWELL TO ESP PIPELINE (C / 00C-07)
NOT TO SCALE

HDR

ISSUE	DATE	DESCRIPTION
F	01/29/2020	ISSUED FOR BID
E	01/23/2020	ISSUED FOR CLIENT REVIEW
D	01/14/2020	ISSUED FOR CLIENT REVIEW
C	12/20/2019	ISSUED FOR CLIENT REVIEW
B	11/26/2019	ISSUED FOR CLIENT REVIEW
A	11/12/2019	ISSUED FOR CLIENT REVIEW

PROJECT MANAGER	D. VOGT, P.E.
DESIGNED BY	J. ORDONEZ, P.E.
DRAWN BY	J. RAYMOND
CHECKED BY	D. VOGT, P.E.
PROJECT NUMBER	10172630

STATE OF TEXAS JAIME ORDONEZ 124838 LICENSED PROFESSIONAL ENGINEER

MARTIN LAKE STEAM ELECTRICAL STATION
EAST ASH POND RELINE
RUSK COUNTY, TEXAS

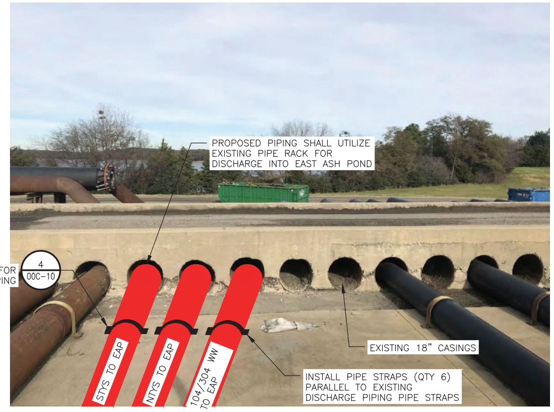
Luminant

YARD PIPING CONNECTIONS AND DETAILS

FILENAME 00C-08.dwg
SCALE NOT TO SCALE
SHEET 00C-08

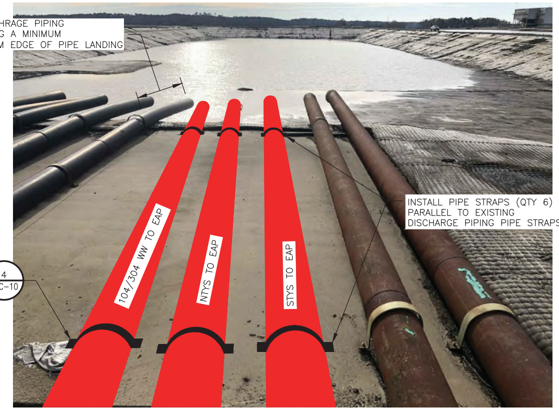
GENERAL NOTES:

1. EXISTING PIPELINES SHOWN SHALL BE REROUTED TO THE EAST ASH POND IN ORDER TO RELINE THE NEW SCRUBBER POND.
2. SHUTDOWNS REQUIRED FOR CONNECTIONS SHALL BE COORDINATED WITH THE PLANT.
3. THE CONNECTIONS LOCATION TO ALL EXISTING PIPELINES ARE APPROXIMATE AND SHOULD BE CONFIRMED IN THE FIELD BY THE CONTRACTOR AND PLANT OPERATIONS.
4. ALL JOINTS SHALL BE FUSION WELDED BUTT JOINTS IN ACCORDANCE WITH PROJECT SPECIFICATIONS, UNLESS OTHERWISE NOTED.
5. ALL PIPE AND FITTING SIZES SHALL BE CONFIRMED IN THE FIELD BY THE CONTRACTOR PRIOR TO ORDERING OR MANUFACTURING OF PIPE.



TERMINATION DETAIL A AT EXISTING PIPE RACK (A / 00C-08)

NOT TO SCALE

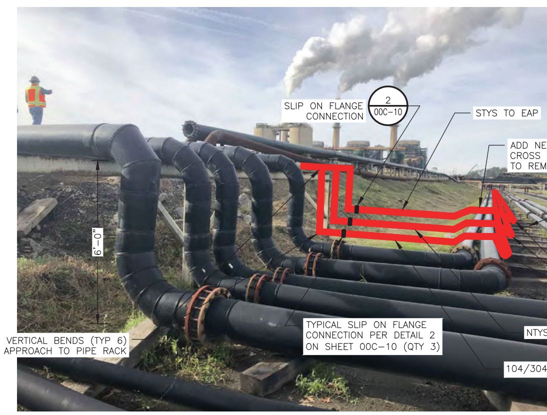


TERMINATION DETAIL B AT EXISTING PIPE RACK (B / 00C-09)

NOT TO SCALE

TERMINATION DETAIL C AT EXISTING PIPE RACK (C / 00C-09)

NOT TO SCALE



TERMINATION DETAIL D AT EXISTING PIPE RACK (D / 00C-09)

NOT TO SCALE

HDR

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PROJECT MANAGER	D. VOGT, P.E.
DESIGNED BY	J. ORDONEZ, P.E.
DRAWN BY	J. RAYMOND
CHECKED BY	D. VOGT, P.E.
PROJECT NUMBER	10172630

STATE OF TEXAS JAIME ORDONEZ 124838 LICENSED PROFESSIONAL ENGINEER

MARTIN LAKE STEAM ELECTRICAL STATION
EAST ASH POND RELINE
RUSK COUNTY, TEXAS

Luminant

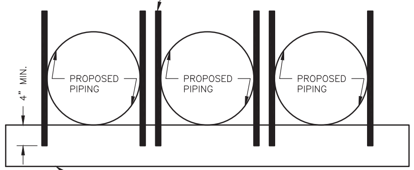
YARD PIPING CONNECTIONS AND DETAILS

0 1" 2"

FILENAME 00C-09.dwg

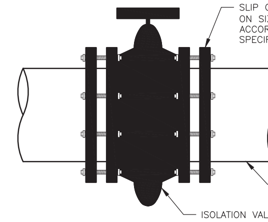
SCALE NOT TO SCALE

SHEET 00C-09

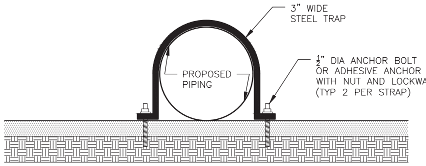


PIPE SUPPORT BLOCKING (1 / 00C-09)
NOT TO SCALE

SLIP ON FLANGE CONNECTION (2 / 00C-09)
NOT TO SCALE



VALVE SETTING (3 / 00C-08)
NOT TO SCALE



PIPE STRAP FOR DISCHARGE PIPING (4 / 00C-09)
NOT TO SCALE

ISSUE	DATE	DESCRIPTION
F	01/29/2020	ISSUED FOR BID
E	01/23/2020	ISSUED FOR CLIENT REVIEW
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C	12/20/2019	ISSUED FOR CLIENT REVIEW
B	11/26/2019	ISSUED FOR CLIENT REVIEW
A	11/12/2019	ISSUED FOR CLIENT REVIEW

PROJECT MANAGER	D. VOGT, P.E.
DESIGNED BY	J. ORDONEZ, P.E.
DRAWN BY	J. RAYMOND
CHECKED BY	D. VOGT, P.E.
PROJECT NUMBER	10172630

STATE OF TEXAS — JAIME ORDONEZ — 124838 — LICENSED PROFESSIONAL ENGINEER

MARTIN LAKE STEAM ELECTRICAL STATION
EAST ASH POND RELINE
RUSK COUNTY, TEXAS

Luminant

YARD PIPING DETAILS

0 1" 2"

FILENAME 00C-10.dwg
SCALE NOT TO SCALE
SHEET 00C-10

ISSUE	DATE	DESCRIPTION
F	01/29/2020	ISSUED FOR BID
E	01/23/2020	ISSUED FOR CLIENT REVIEW
D	01/14/2020	ISSUED FOR CLIENT REVIEW
C	12/20/2019	ISSUED FOR CLIENT REVIEW
B	11/26/2019	ISSUED FOR CLIENT REVIEW
A	11/12/2019	ISSUED FOR CLIENT REVIEW

PROJECT MANAGER	D. VOGT, P.E.
DESIGNED BY	K. PERERA
DRAWN BY	J. RAYMOND
CHECKED BY	M. ROBERTS
PROJECT NUMBER	10172630

STATE OF TEXAS
DAVID C. VOGT
93905
LICENSED
PROFESSIONAL ENGINEER
1/29/2020

MARTIN LAKE STEAM ELECTRICAL STATION
EAST ASH POND RELINE
RUSK COUNTY, TEXAS

Luminant

STOCKPILE AND HAUL ROUTE

0 1" 2"

FILENAME 00C-11.dwg
SCALE 1" = 600'
SHEET 00C-11

APPENDIX D – WEST ASH POND RETROFIT DESIGN DRAWINGS

HDR
Firm Registration No. F-754
17111 Preston Road, Suite 300
Dallas, Texas 75248-1229
972.960.4400

Construction Drawings For

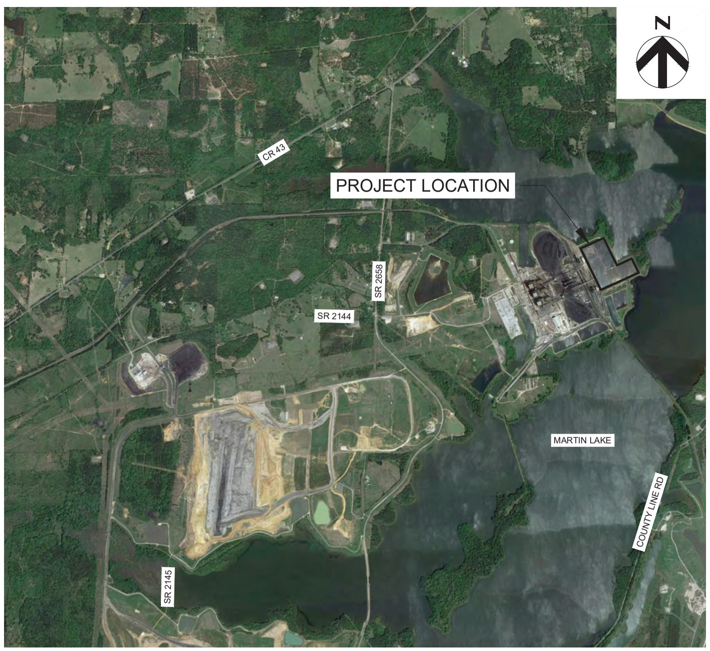
Martin Lake
Steam Electric Station

CCR Impoundment Reline
West Ash Pond

Project No.
10172630

Rusk County, Texas
January 2020

INDEX OF DRAWINGS



VICINITY MAP
NOT TO SCALE

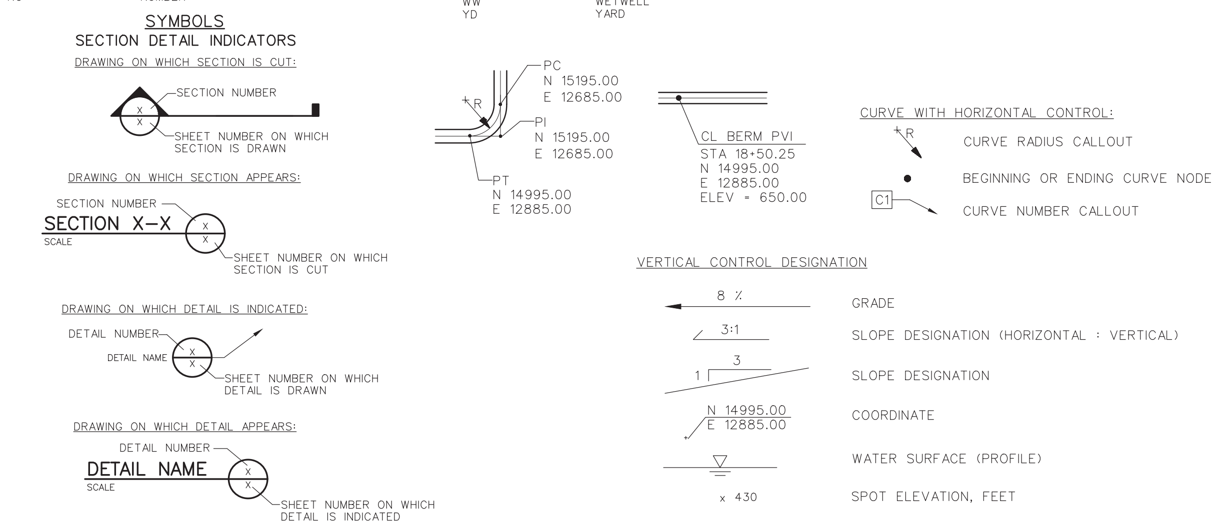
STATE OF TEXAS
DAVID C. VOGT
93905
LICENSED
PROFESSIONAL ENGINEER

1/31/2020

STANDARD ABBREVIATIONS

&	AND
APPROX	APPROXIMATELY
@	AT
AVG	AVERAGE
BOE	BOTTOM OF EXCAVATION
BOL	BOTTOM OF LINER
X	BY
CL	CENTERLINE
CMP	CORRUGATED METAL PIPE
CO	CLEAN OUT
CY	CUBIC YARD
DIA	DIAMETER
DET	DETAIL
DWG	DRAWING
E	EAST
EAP	EAST ASH POND
ELEV	ELEVATION
EW	EACH WAY
EXIST	EXISTING
EXC	EXCAVATION
FGD	FLUE GAS DESULFICATION
FML	FLEXIBLE MEMBRANE LINER
FT	FEET
GAL	GALLON
GND	GROUND
GDL	GRAVEL DRAINAGE LAYER
GNDL	GEONET DRAINAGE LAYER
HDPE	HIGH DENSITY POLYETHYLENE
HORIZ	HORIZONTAL
ID	INSIDE DIAMETER
IN	INCHES
IE	INVERT ELEVATION
LCRS	LEACHATE COLLECTION AND REMOVAL SYSTEM
LCS	LEACHATE COLLECTION SYSTEM
LCP	LEACHATE COLLECTION PIPE
LCPR	LEACHATE COLLECTION PIPE RISER
LF	LINEAR FEET
LB	POUND
MH	MANHOLE
MAX	MAXIMUM
MIL	.001 INCHES
MIN	MINIMUM
MW	MONITOR WELL
MLSES	MARTIN LAKE STEAM ELECTRIC STATION
MSL	MEAN SEA LEVEL
N	NORTH
NIC	NOT IN CONTRACT
NO	NUMBER
NTS	NOT TO SCALE
NTYS	NORTH THICKENER YARD SUMP
OC	ON CENTER
OZ	OUNCE
%	PERCENT
PLCP	PERFORATED LEACHATE COLLECTION PIPE
PERF	PERFORATED
PGL	PROFILE GRADE LINE
PDP	PERMANENT DISPOSAL POND
PC	POINT OF CURVATURE
PI	POINT OF INTERSECTION
PVI	POINT OF VERTICAL INTERSECTION
PT	POINT OF TANGENT
PZ	PIEZOMETER
Q	FLOW
QTY	QUANTITY
R	RADIUS
RCP	REINFORCED CONCRETE PIPE
REF	REFERENCE
REQ	REQUIRED
RD	ROAD
SCH	SCHEDULE
SDL	SAND DRAINAGE LAYER
SEC	SECTION
SHT	SHEET
S	SOUTH
SDR	STANDARD DIMENSION RATIO
SLQCP	SOIL LINER QUALITY CONTROL PLAN
SP	STEEL PIPE
SQ	SQUARE
SS	SIDE SLOPE
STA	STATION
STYS	SOUTH THICKENER YARD SUMP
T.A.S.	TERMINAL ANCHOR SECTION
TL	TANGENT LENGTH
TOC	TOP OF COVER
TOFC	TOP OF FINAL COVER
TOL	TOP OF LINER
TOS	TOE OF SLOPE
TS	TOP SLOPE
TEMP	TEMPORARY
TYP	TYPICAL
UNO	UNLESS NOTED OTHERWISE
VERT	VERTICAL
W	WEST
W/	WITH
WAP	WEST ASH POND
WW	WETWELL
YD	YARD

SYMBOLS



CONSTRUCTION SEQUENCE

A. CONTRACTOR SHALL CLEAN THE WAP BY REMOVING ANY REMAINING CCR MATERIAL, ROCKS, AND SEDIMENT.

B. CONTRACTOR SHALL USE WATER FROM THE ADJACENT EAST ASH POND (EAP) OR NEW SCRUBBER POND (SP) TO WASH REMAINING CCR MATERIAL OFF THE SIDES AND FLOOR OF THE WAP AND REMOVE IT. EAP WILL BE VISUALLY INSPECTED BY OWNER'S CQA CONSULTANT TO CONFIRM CCR MATERIAL, ROCKS, AND SEDIMENT HAVE BEEN REMOVED.

C. CONTRACTOR SHALL LOAD AND HAUL GENERAL SOIL FILL MATERIAL FROM THE OWNER'S STOCKPILE LOCATED AT LIBERTY MINE, A LOCATION UNDER THE PROVISIONS OF THE MINE SAFETY AND HEALTH ADMINISTRATION (MSHA) AND APPROXIMATELY 4.5 MILES FROM EAP.

D. CONTRACTOR SHALL PLACE THE GENERAL FILL MATERIAL OVER THE EXISTING CONCRETE REVETMENT TO A DEPTH OF AT LEAST SIX (6) INCHES, NOMINALLY COMPACT, AND SMOOTH ROLL TO FINISH THE INSTALLATION.

E. CONTRACTOR SHALL INSTALL A GEOSYNTHETIC CLAY LINER (GCL) OVER THE SIDES AND FLOOR OF THE WAP AND SECURE IT IN A PERIMETER ANCHOR TRENCH/BATTEN AND STRIP.

F. CONTRACTOR SHALL INSTALL A 60-MIL HDPE LINER DIRECTLY ON THE GCL AND SECURE IT IN A PERIMETER ANCHOR TRENCH/BATTEN AND STRIP.

GENERAL NOTES

1. ALL WORK UNDER THIS CONTRACT SHALL BE PERFORMED IN ACCORDANCE WITH THE PLANS AND PROJECT SPECIFICATIONS. IN THE EVENT OF A DISCREPANCY BETWEEN THE PLANS AND THE PROJECT SPECIFICATIONS, THE SPECIFICATIONS SHALL GOVERN.
2. COORDINATE SYSTEM IS BASED ON LOCAL SURVEY. THE BENCHMARKS TO BE USED FOR CONSTRUCTION ARE LOCATED AS SHOWN ON DRAWING NO. 00C-01. EXISTING CONTOURS ARE BASED ON TOPOGRAPHICAL SURVEY PERFORMED FEBRUARY 12-20, 2019 BY LACY SURVEYING. CURRENT GROUND ELEVATIONS MAY VARY FROM THOSE SHOWN DUE TO SITE WORK THAT HAS BEEN PERFORMED SINCE THE SURVEY WAS PERFORMED.
3. THE CONTRACTOR SHALL VERIFY EXISTING CONTOURS PRIOR TO THE START OF WORK.
4. THERE SHALL NOT BE ANY ADDITIONAL PAYMENT OR EXTENSION OF CONTRACT TIME FOR WORKING WITH SATURATED SOILS OR HANDLING WATER SEEPAGE DUE TO RAINFALL, RUNOFF AND INFILTRATION.
5. THE CONTRACTOR SHALL TAKE ALL NECESSARY PRECAUTIONS TO PROTECT EXISTING ROADS, BENCHMARKS AND EXISTING GROUNDWATER MONITOR WELLS DURING THE CONSTRUCTION PERIOD. THE CONTRACTOR SHALL BE SOLEY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE INCURRED BY THE CONTRACTOR'S FAILURE TO EXACTLY LOCATE AND PROTECT THE GROUNDWATER MONITOR WELLS, BENCHMARKS AND EXISTING ROADS.
6. THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES HAVE NOT BEEN ESTABLISHED BY THE OWNER OR ENGINEER. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK, AND AGREES TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY THE CONTRACTORS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UTILITIES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING PROPER SAFE WORKING DISTANCE FROM ALL UTILITY EASEMENTS OR LINES.
7. EXCAVATION BY "BLASTING" IS NOT PERMITTED ON THIS PROJECT.
8. FINISHED GROUND ELEVATIONS SHALL MATCH EXISTING GROUND ELEVATIONS EXCEPT AS SHOWN ON THE PLANS. ALL EXCESS SOIL FROM THE EXCAVATION AND GRADING SHALL BE PLACED IN DESIGNATED STOCKPILE LOCATIONS AS APPROVED BY THE OWNER. IF WASTE IS ENCOUNTERED DURING EXCAVATION, THE OWNER SHALL BE NOTIFIED AND THE WASTE REMOVED AND PLACED IN AREAS DESIGNATED AS APPROVED BY THE OWNER. TRANSPORT OF SOIL TO FILL AREAS SHALL BE CONDUCTED BY THE CONTRACTOR AT NO ADDITIONAL EXPENSE TO THE OWNER.
9. GEOTECHNICAL INVESTIGATION REPORTS FOR THE SITE ARE AVAILABLE FOR REVIEW AT LUMINANT'S DALLAS OFFICES. THE CONTRACTOR MAY PERFORM ADDITIONAL GEOTECHNICAL INVESTIGATIONS, AS DEEMED NECESSARY FOR CONSTRUCTION ACTIVITIES, PROVIDED ALL NECESSARY PERMITS AND APPROVALS ARE OBTAINED FROM LUMINANT PRIOR TO INITIATING SUCH WORK. HOWEVER, THERE SHALL BE NO ADDITIONAL PAYMENT TO THE CONTRACTOR FOR ADDITIONAL GEOTECHNICAL INVESTIGATIONS.
10. THE CONTRACTOR SHALL CONSTRUCT, AND UPON COMPLETION OF THE PROJECT, REMOVE TEMPORARY CONSTRUCTION ACCESS ROADS. SUCH ROADS SHALL BE LOCATED AS APPROVED BY THE OWNER. DRAINAGE PATTERNS AT THE SITE SHALL NOT BE ALTERED BY ROAD CONSTRUCTION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONSTRUCTION AND MAINTENANCE OF TEMPORARY DRAINAGE STRUCTURES, INCLUDING CULVERTS, AT NO ADDITIONAL COST TO THE OWNER.
11. THE CONTRACTOR SHALL INSTALL, MAINTAIN, AND UPON COMPLETION OF THE PROJECT, REMOVE TEMPORARY EROSION AND SEDIMENT CONTROLS AS APPROVED BY LUMINENT ENVIRONMENTAL SERVICES AND IN ACCORDANCE WITH THE SITE SWPPP AND PURSUANT TO TPDES REQUIREMENTS. SUCH CONTROLS SHALL BE PLACED AT THE LIMITS OF DISTURBED AREAS AND AT INTERMEDIATE LOCATIONS WHERE CONCENTRATED FLOW IS LIKELY.
12. TEMPORARY CONSTRUCTION SLOPES SHALL NOT BE GREATER THAN 2H:1V. STEEPER SLOPES WILL ONLY BE ALLOWED IF THE CONTRACTOR PROVIDES A GEOTECHNICAL ENGINEERING REPORT SPECIFYING MAXIMUM SLOPES AND THE DURATION FOR WHICH SUCH SLOPES SHALL REMAIN IN PLACE.
13. THE CONTRACTOR SHALL REMOVE ALL VEGETATION WITHIN THE CONSTRUCTION LIMITS AS REQUIRED TO CONSTRUCT THE PROJECT. ALL VEGETATION SHALL BE REMOVED BY CONTRACTOR AT NO ADDITIONAL EXPENCE TO OWNER.
14. THE CONTRACTOR SHALL OBTAIN AND CONDUCT WORK CONSISTENT WITH A TPDES PERMIT FOR CONSTRUCTION, REFER TO TECHNICAL SPECIFICATIONS. PREPARATION OF A SWPPP AND OBTAINING THE TPDES PERMIT ARE THE CONTRACTORS RESPONSIBILITY.
15. THE CONTRACTOR SHALL IMMEDIATELY REPORT TO THE ENGINEER ANY ERROR OR DISCREPANCY FOUND ONCE THE CONTRACT DOCUMENT IS CAREFULLY REVIEWED AND ALL ASPECTS OF FIELD WORK HAVE BEEN VERIFIED. IN THE EVENT THE CONTRACTOR CONTINUES TO WORK ON AN ITEM WHERE AN ERROR EXISTS, IT SHALL BE DEEMED THAT THE CONTRACTOR BID AND INTENDED TO EXECUTE THE MORE STRINGENT OR HIGHER QUALITY REQUIREMENT WITHOUT AN INCREASE IN CONTRACT SUM OR TIME. THE CONTRACTOR SHALL ALSO BE RESPONSIBLE TO CORRECT ANY FAILURE OF COMPANY PARTS TO COORDINATE OR FIT PROPERLY INTO FINAL POSITION, AS A RESULT OF CONTRACTOR FAILURE TO RAISE OR RESOLVE A DISCREPANCY.
16. THE DRAWINGS AND SPECIFICATIONS SHOULD AGREE WITH EACH OTHER, AND WORK CALLED FOR BY DRAWINGS AND NOT MENTIONED IN SPECIFICATION, OR VICE VERSA, SHALL BE FURNISHED BY BOTH. WHEN DISCREPANCIES EXIST BETWEEN SCALE AND DIMENSIONS, THE DIMENSIONED FIGURE SHALL BE USED.
17. CONTRACTOR AND EACH SUBCONTRACTOR SHALL VERIFY ALL GRADES, LINES, LEVELS, AND DIMENSIONS AS INDICATED ON DRAWINGS, AND HE SHALL REPORT ERRORS TO THE ENGINEER BEFORE COMMENCING WORK. THE CONTRACTOR SHALL ESTABLISH BENCHMARKS IN AT LEAST TWO WIDELY SEPARATED PLACES, AND AS WORK PROGRESSES THE CONTRACTOR WILL MAINTAIN ADEQUATE HORIZONTAL AND VERTICAL CONTROL.
18. CONTRACTOR SHALL PROVIDE EROSION CONTROL BY SEEDING FOR ALL AREAS DISTURBED BY CONTRACTOR DURING THE CONSTRUCTION OF THIS PROJECT. THE CONTRACTOR SHALL NOT DISTURB ANY AREA WITHOUT THE APPROVAL OF THE ENGINEER. EROSION CONTROL BY SEEDING SHALL CONFORM TO STANDARD SPECIFICATION 02930.
19. CONTRACTOR SHALL INSTALL EROSION AND SEDIMENT CONTROLS AS PER SPECIFICATIONS DURING CONSTRUCTION. SUCH CONTROLS SHALL BE PLACED AT LIMITS OF DISTURBED AREAS AND AT INTERMEDIATE LOCATIONS WHERE CONCENTRATED FLOW IS LIKELY.
20. STORMWATER THAT HAS COME INTO CONTACT WITH THE ASH WITHIN THE EXCAVATED POND IS TO BE CONSIDERED CONTACT STORMWATER. CONTRACTOR WILL CONTROL THE WATER ON SITE IN COMPLIANCE WITH THE TPDES PERMIT.
21. THE CONTRACTOR IS REQUIRED TO PRESENT THE SWPPP TO LUMINANT ENVIRONMENTAL SERVICES FOR APPROVAL PRIOR TO THE COMMENCEMENT OF CONSTRUCTION ACTIVITIES.
22. THE CONTRACTOR IS REQUIRED TO SUBMIT THE NOTICE OF INTENT AND NOTICE OF TERMINATION FOR THE TPDES PERMIT.
23. THE CONTRACTOR IS TO ACQUIRE A DIGGING PERMIT FROM THE PLANT BEFORE COMMENCING ANY EXCAVATION ACTIVITY.

HDR

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A	01/31/2020	ISSUED FOR BID

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DRAWN BY	J. RAYMOND
CHECKED BY	M. ROBERTS
PROJECT NUMBER	10172630

STATE OF TEXAS
DAVID C. VOGT
93905
LICENSED
PROFESSIONAL ENGINEER
1/31/2020

MARTIN LAKE STEAM ELECTRICAL STATION
WEST ASH POND RELINE
RUSK COUNTY, TEXAS

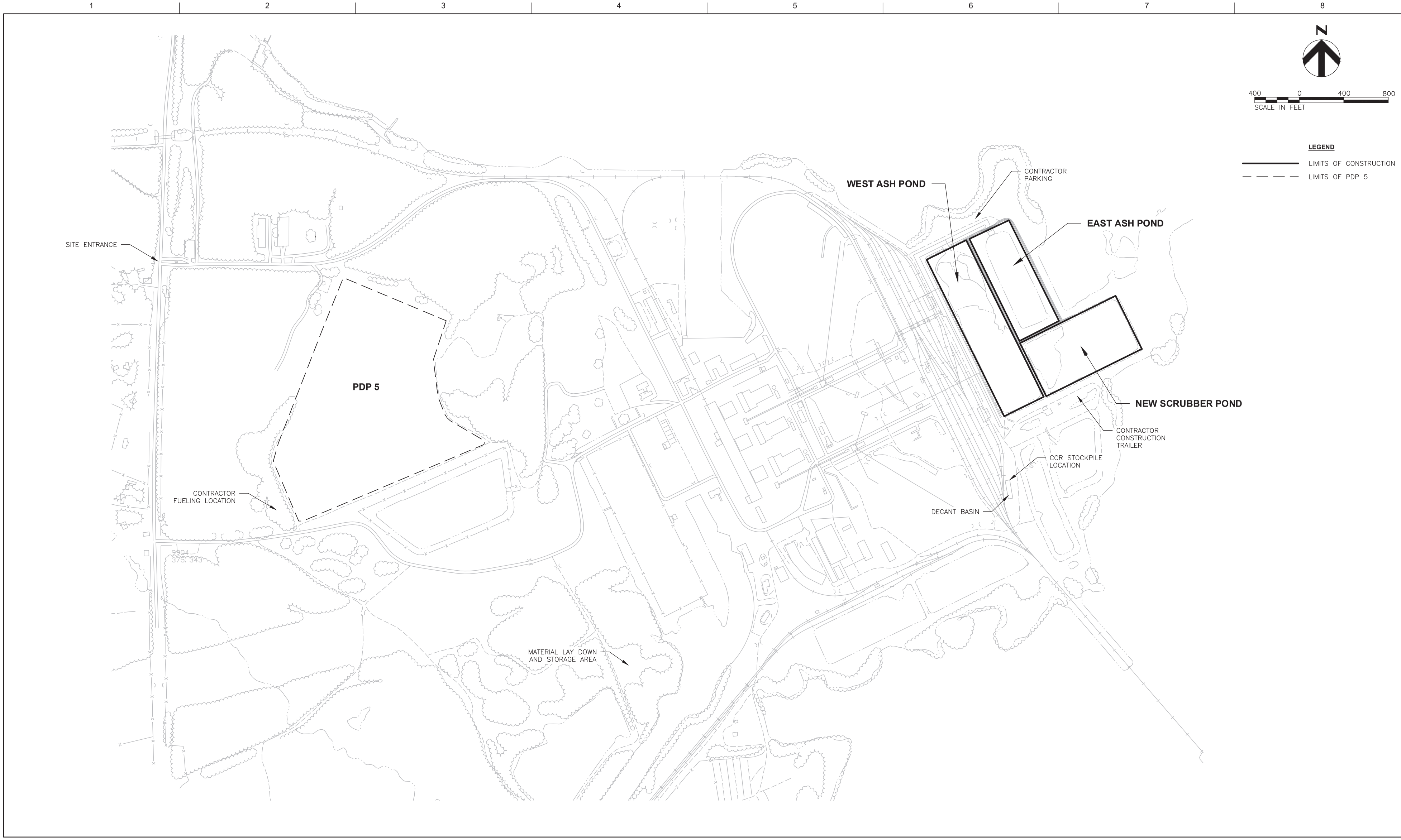
Luminant

ABBREVIATIONS AND GENERAL NOTES

0 1" 2"

FILENAME 00G-02.dwg
SCALE

SHEET **00G-02**



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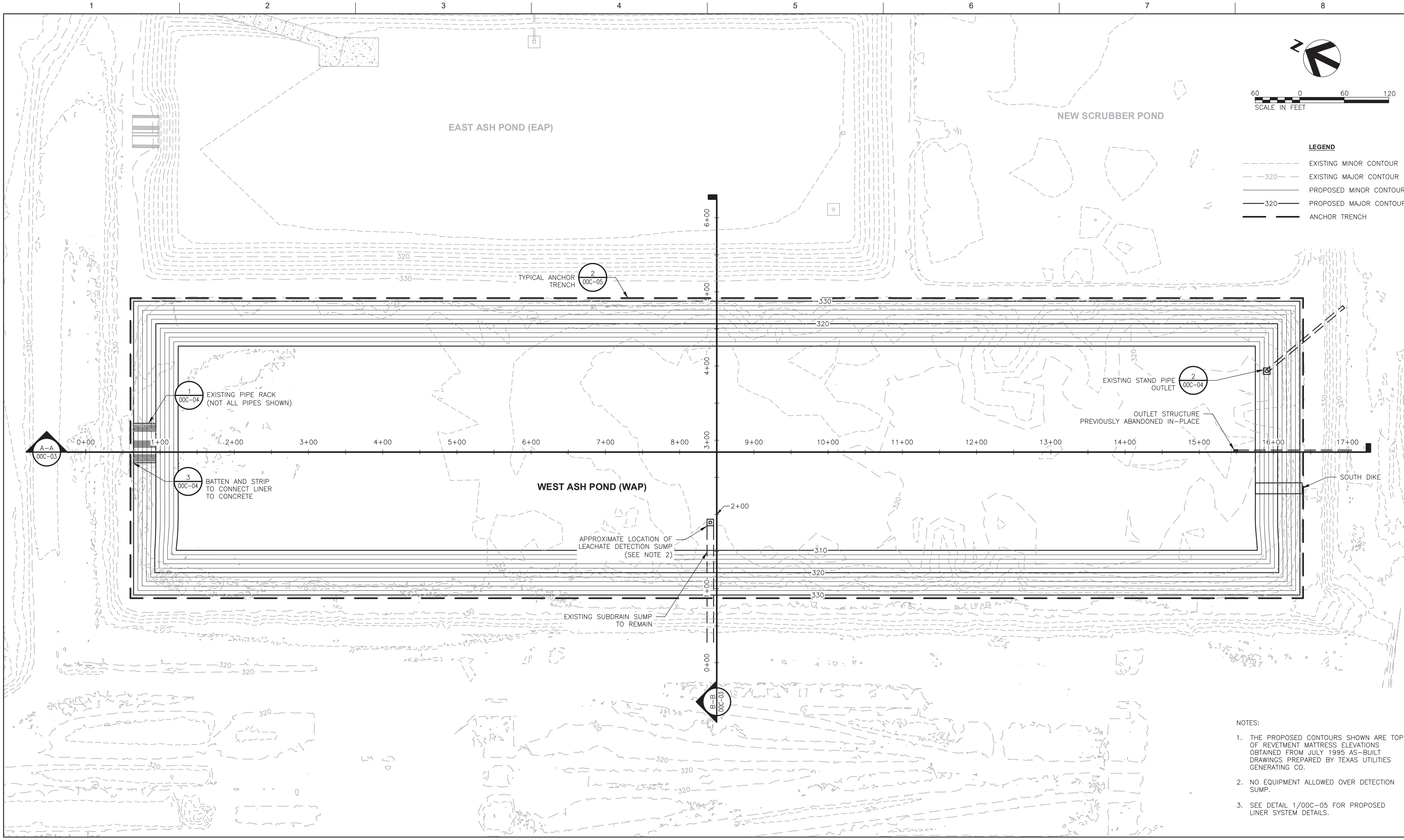
MARTIN LAKE STEAM ELECTRICAL STATION
WEST ASH POND RELINE
RUSK COUNTY, TEXAS

Luminant

SITE LAYOUT

FILENAME 00C-01.dwg
SCALE 1" = 400'
SHEET **00C-01**



NOTES:

1. THE PROPOSED CONTOURS SHOWN ARE TOP OF REVETMENT MATTRESS ELEVATIONS OBTAINED FROM JULY 1995 AS-BUILT DRAWINGS PREPARED BY TEXAS UTILITIES GENERATING CO.
2. NO EQUIPMENT ALLOWED OVER DETECTION SUMP.
3. SEE DETAIL 1/00C-05 FOR PROPOSED LINER SYSTEM DETAILS.

FDR

ISSUE	DATE	DESCRIPTION
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PROJECT MANAGER	D. VOGT, P.E.
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CHECKED BY	M. ROBERTS
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STATE OF TEXAS
DAVID C. VOGT
93905
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PROFESSIONAL ENGINEER

1/31/2020

MARTIN LAKE STEAM ELECTRICAL STATION
WEST ASH POND RELINE
RUSK COUNTY, TEXAS

Luminant

WEST ASH POND

0 1" 2"

FILENAME 00C-02.dwg
SCALE 1" = 60'

SHEET 00C-02

100 0 100 200
HORIZONTAL SCALE: 1" = 100'

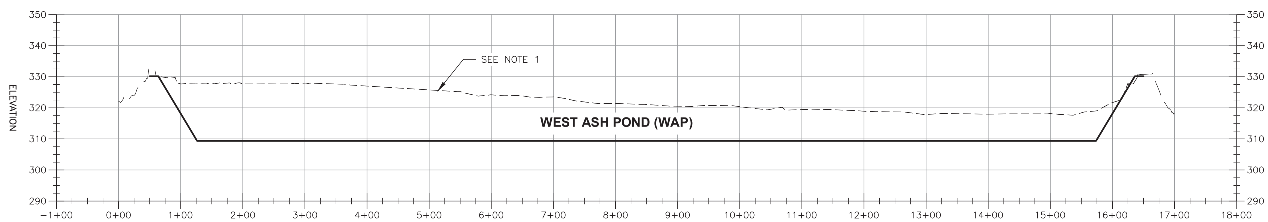
20 0 20 40
VERTICAL SCALE: 1" = 20'

LEGEND

- TOP OF CCR MATERIAL
- EXISTING GROUND SURFACE
- PROPOSED GRADE

NOTES:

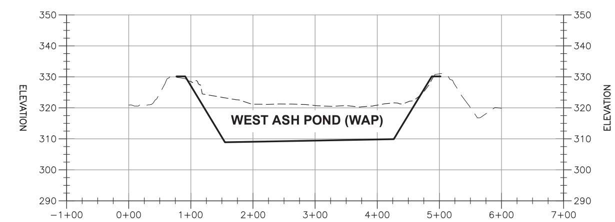
1. CCR ELEVATION FROM BATHYMETRIC SURVEY TAKEN FEBRUARY 2019 BY LACEY SURVEYING OF ARP, TEXAS. AT START OF PROJECT, OWNER WILL HAVE REMOVED BULK OF CCR MATERIAL FROM THE WEST ASH POND
2. CONTRACTOR WILL REMOVE REMAINING CCR MATERIAL, ROCKS AND SEDIMENT WITHIN POND BEFORE INSTALLATION OF THE LINER SYSTEM.



SECTION A–A

HORIZONTAL SCALE: 1" = 100' ; VERTICAL SCALE: 1" = 20'

A–A 00C-02



SECTION B–B

HORIZONTAL SCALE: 1" = 100' ; VERTICAL SCALE: 1" = 20'

B–B 00C-02

A	01/31/2020	ISSUED FOR BID
ISSUE	DATE	DESCRIPTION

PROJECT MANAGER	D. VOGT, P.E.
DESIGNED BY	K. PERERA
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CHECKED BY	M. ROBERTS
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STATE OF TEXAS
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1/31/2020

MARTIN LAKE STEAM ELECTRICAL STATION
WEST ASH POND RELINE
RUSK COUNTY, TEXAS

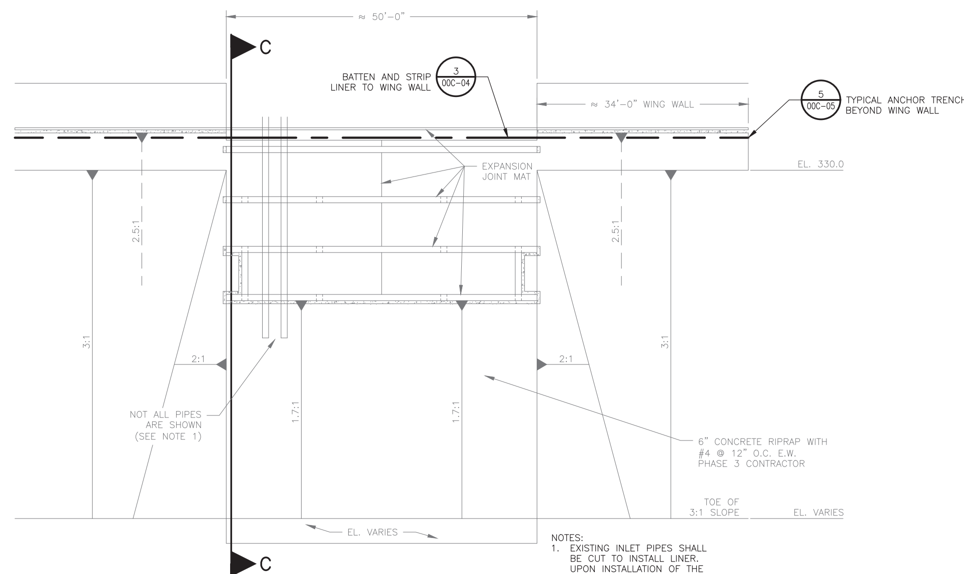
Luminant

CROSS SECTIONS

0 1" 2"

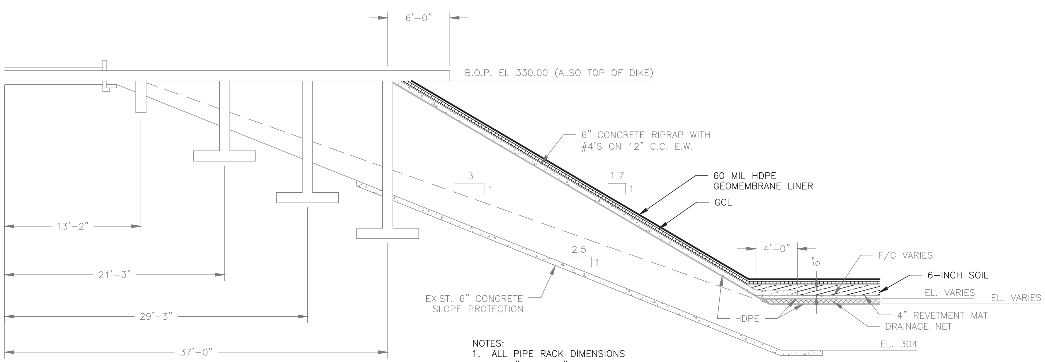
FILENAME 00C-03.dwg
SCALE H: 1" = 100' ; V: 1" = 20'

SHEET **00C-03**



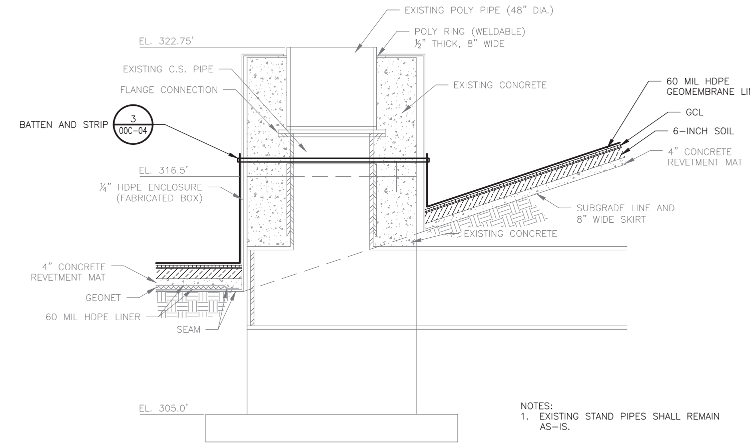
NOTES:
1. EXISTING INLET PIPES SHALL BE CUT TO INSTALL LINER. UPON INSTALLATION OF THE LINER, PIPES SHALL BE REINSTALLED.

TYPICAL PIPE RACK (1 / 00C-02)
NOT TO SCALE



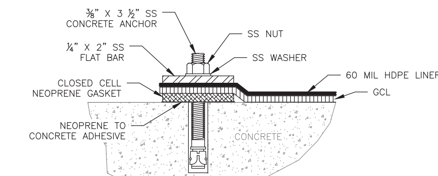
NOTES:
1. ALL PIPE RACK DIMENSIONS ARE "AS-BUILT" DIMENSIONS FOR EAST ASH POND.

SECTION C–C
NOT TO SCALE



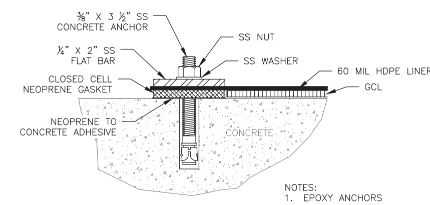
NOTES:
1. EXISTING STAND PIPES SHALL REMAIN AS-IS.

STANDPIPE ENCLOSURE (2 / 00C-02)
NOT TO SCALE



NOTES:
1. EPOXY ANCHORS SPACED AT 6" O.C.

BATTEN AND STRIP CONNECTION AT ANCHOR TRENCH (3A / 00C-04)
NOT TO SCALE



NOTES:
1. EPOXY ANCHORS SPACED AT 6" O.C.

BATTEN AND STRIP CONNECTION BELOW WATER SURFACE (3B / 00C-04)
NOT TO SCALE

HDR

ISSUE	DATE	DESCRIPTION
A	01/31/2020	ISSUED FOR BID

PROJECT MANAGER	D. VOGT, P.E.
DESIGNED BY	K. PERERA
DRAWN BY	J. RAYMOND
CHECKED BY	M. ROBERTS
PROJECT NUMBER	10172630

STATE OF TEXAS
DAVID C. VOGT
93905
LICENSED
PROFESSIONAL ENGINEER
1/31/2020

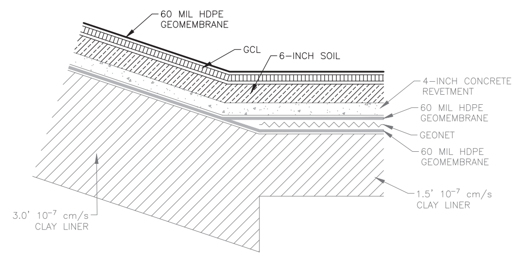
MARTIN LAKE STEAM ELECTRICAL STATION
WEST ASH POND RELINE
RUSK COUNTY, TEXAS

Luminant

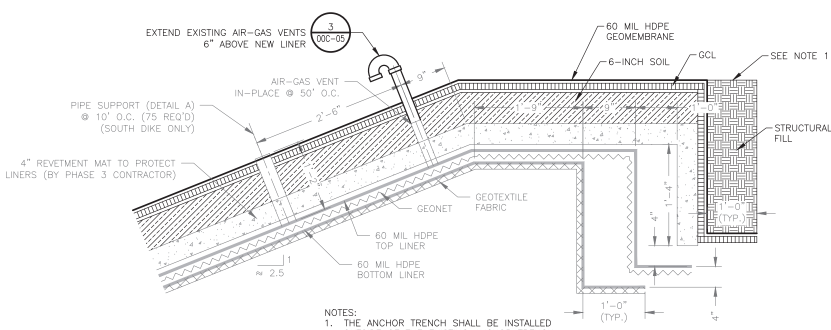
DETAILS
(1 OF 2)

0 1" 2"
FILENAME 00C-04.dwg
SCALE

SHEET
00C-04

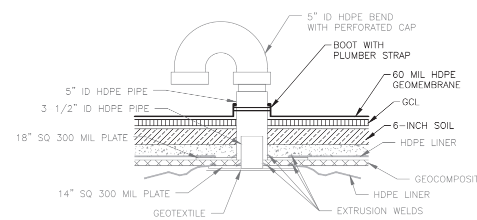


PROPOSED WAP SECTION (1 / 00C-05)
NOT TO SCALE



NOTES:
1. THE ANCHOR TRENCH SHALL BE INSTALLED OUTSIDE OF THE EXISTING ANCHOR TRENCH.

ANCHOR TRENCH (2 / 00C-02)
NOT TO SCALE



TYPICAL AIR-GAS VENT (3 / 00C-05)
NOT TO SCALE

A	01/31/2020	ISSUED FOR BID	
ISSUE	DATE	DESCRIPTION	

PROJECT MANAGER	D. VOGT, P.E.
DESIGNED BY	K. PERERA
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STATE OF TEXAS
DAVID C. VOGT
93905
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PROFESSIONAL ENGINEER
1/31/2020

MARTIN LAKE STEAM ELECTRICAL STATION
WEST ASH POND RELINE
RUSK COUNTY, TEXAS

Luminant

DETAILS
(2 OF 2)

0 1" 2"

FILENAME	00C-05.dwg
SCALE	NOT TO SCALE

SHEET
00C-05

HDR

A	01/31/2020	ISSUED FOR BID	
ISSUE	DATE	DESCRIPTION	

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MARTIN LAKE STEAM ELECTRICAL STATION
WEST ASH POND RELINE
RUSK COUNTY, TEXAS

Luminant

STOCKPILE AND HAUL ROUTE

0 1" 2"

FILENAME 00C-06.dwg
SCALE 1" = 600'
SHEET **00C-06**

APPENDIX E – NEW SCRUBBER POND RETROFIT DESIGN DRAWINGS

HDR ENGINEERING, INC.
76 SOUTH LAURA STREET, SUITE 1600
JACKSONVILLE, FL 32202
COA# 4213

Luminant

Construction Drawings For

Martin Lake
Steam Electric Station

CCR Impoundment Reline
New Scrubber Pond

Project No.
10172630

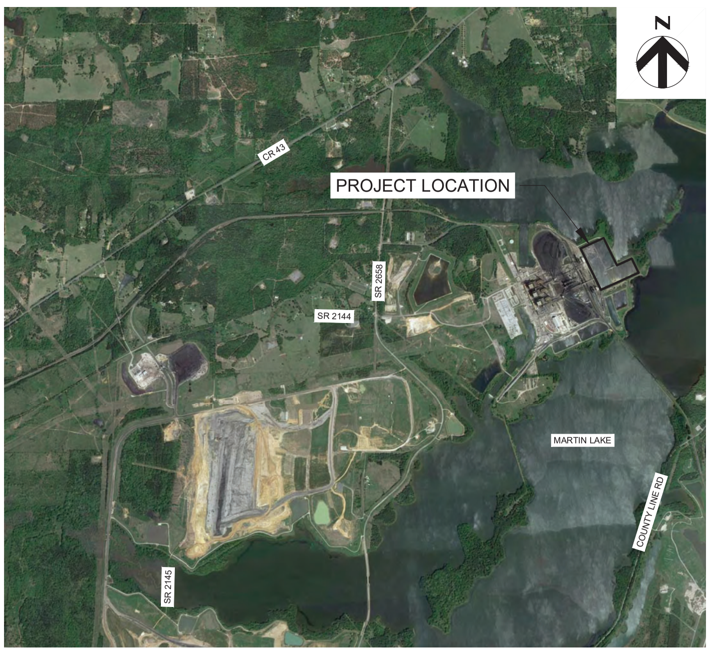
Rusk County, Texas
January 2020

INDEX OF DRAWINGS

GENERAL	
00G-01	COVER SHEET
00G-02	ABBREVIATIONS AND GENERAL NOTES
CIVIL	
00C-01	SITE LAYOUT
00C-02	NEW SCRUBBER POND
00C-03	ROSS SECTIONS
00C-04	DETAILS (1 OF 2)
00C-05	DETAILS (2 OF 2)
00C-06	STOCKPILE AND HAUL ROUTE

STATE OF TEXAS
DAVID C. VOGT
93905
LICENSED
PROFESSIONAL ENGINEER

1/31/2020



VICINITY MAP
NOT TO SCALE

STANDARD ABBREVIATIONS

&	AND
APPROX	APPROXIMATELY
@	AT
AVG	AVERAGE
BOE	BOTTOM OF EXCAVATION
BOL	BOTTOM OF LINER
X	BY
CL	CENTERLINE
CMP	CORRUGATED METAL PIPE
CO	CLEAN OUT
CY	CUBIC YARD
DIA	DIAMETER
DET	DETAIL
DWG	DRAWING
E	EAST
EAP	EAST ASH POND
ELEV	ELEVATION
EW	EACH WAY
EXIST	EXISTING
EXC	EXCAVATION
FGD	FLUE GAS DESULFICATION
FML	FLEXIBLE MEMBRANE LINER
FT	FEET
GAL	GALLON
GND	GROUND
GDL	GRAVEL DRAINAGE LAYER
GNDL	GEONET DRAINAGE LAYER
HDPE	HIGH DENSITY POLYETHYLENE
HORIZ	HORIZONTAL
ID	INSIDE DIAMETER
IN	INCHES
IE	INVERT ELEVATION
LCRS	LEACHATE COLLECTION AND REMOVAL SYSTEM
LCS	LEACHATE COLLECTION SYSTEM
LCP	LEACHATE COLLECTION PIPE
LCPR	LEACHATE COLLECTION PIPE RISER
LF	LINEAR FEET
LB	POUND
MH	MANHOLE
MAX	MAXIMUM
MIL	.001 INCHES
MIN	MINIMUM
MW	MONITOR WELL
MLSES	MARTIN LAKE STEAM ELECTRIC STATION
MSL	MEAN SEA LEVEL
N	NORTH
NIC	NOT IN CONTRACT
NO	NUMBER
NTS	NOT TO SCALE
NTYS	NORTH THICKENER YARD SUMP
OC	ON CENTER
OZ	OUNCE
%	PERCENT
PLCP	PERFORATED LEACHATE COLLECTION PIPE
PERF	PERFORATED
PGL	PROFILE GRADE LINE
PDP	PERMANENT DISPOSAL POND
PC	POINT OF CURVATURE
PI	POINT OF INTERSECTION
PVI	POINT OF VERTICAL INTERSECTION
PT	POINT OF TANGENT
PZ	PIEZOMETER
Q	FLOW
QTY	QUANTITY
R	RADIUS
RCP	REINFORCED CONCRETE PIPE
REF	REFERENCE
REQ	REQUIRED
RD	ROAD
SCH	SCHEDULE
SDL	SAND DRAINAGE LAYER
SEC	SECTION
SHT	SHEET
S	SOUTH
SDR	STANDARD DIMENSION RATIO
SLQCP	SOIL LINER QUALITY CONTROL PLAN
SP	STEEL PIPE
SQ	SQUARE
SS	SIDE SLOPE
STA	STATION
STYS	SOUTH THICKENER YARD SUMP
T.A.S.	TERMINAL ANCHOR SECTION
TL	TANGENT LENGTH
TOC	TOP OF COVER
TOFC	TOP OF FINAL COVER
TOL	TOP OF LINER
TOS	TOE OF SLOPE
TS	TOP SLOPE
TEMP	TEMPORARY
TYP	TYPICAL
UNO	UNLESS NOTED OTHERWISE
VERT	VERTICAL
W	WEST
W/	WITH
WAP	WEST ASH POND
WW	WETWELL
YD	YARD

SYMBOLS

SECTION DETAIL INDICATORS

DRAWING ON WHICH SECTION IS CUT:

SECTION NUMBER

SHEET NUMBER ON WHICH SECTION IS DRAWN

DRAWING ON WHICH SECTION APPEARS:

SECTION NUMBER

SECTION X–X

SCALE

SHEET NUMBER ON WHICH SECTION IS CUT

DRAWING ON WHICH DETAIL IS INDICATED:

DETAIL NUMBER

DETAIL NAME

SHEET NUMBER ON WHICH DETAIL IS DRAWN

DRAWING ON WHICH DETAIL APPEARS:

DETAIL NUMBER

DETAIL NAME

SCALE

SHEET NUMBER ON WHICH DETAIL IS INDICATED

PC N 15195.00 E 12685.00

PI N 15195.00 E 12685.00

PT N 14995.00 E 12885.00

CL BERM PVI STA 18+50.25 N 14995.00 E 12885.00 ELEV = 650.00

CURVE WITH HORIZONTAL CONTROL:

R	CURVE RADIUS CALLOUT
●	BEGINNING OR ENDING CURVE NODE
C1	CURVE NUMBER CALLOUT

VERTICAL CONTROL DESIGNATION

8 %	GRADE
3:1	SLOPE DESIGNATION (HORIZONTAL : VERTICAL)
1 / 3	SLOPE DESIGNATION
N 14995.00 E 12885.00	COORDINATE
▽	WATER SURFACE (PROFILE)
x 430	SPOT ELEVATION, FEET

CONSTRUCTION SEQUENCE

A. CONTRACTOR SHALL CLEAN THE NSP BY REMOVING ANY REMAINING CCR MATERIAL, ROCKS, AND SEDIMENT.

B. CONTRACTOR SHALL USE WATER FROM THE ADJACENT WEST ASH POND (WAP) OR EAST ASH POND (EAP) TO WASH REMAINING CCR MATERIAL OFF THE SIDES AND FLOOR OF THE NSP AND REMOVE IT. EAP WILL BE VISUALLY INSPECTED BY OWNER'S CQA CONSULTANT TO CONFIRM CCR MATERIAL, ROCKS, AND SEDIMENT HAVE BEEN REMOVED.

C. CONTRACTOR SHALL LOAD AND HAUL GENERAL SOIL FILL MATERIAL FROM THE OWNER'S STOCKPILE LOCATED AT LIBERTY MINE, A LOCATION UNDER THE PROVISIONS OF THE MINE SAFETY AND HEALTH ADMINISTRATION (MSHA) AND APPROXIMATELY 4.5 MILES FROM EAP.

D. CONTRACTOR SHALL PLACE THE GENERAL FILL MATERIAL OVER THE EXISTING CONCRETE REVETMENT TO A DEPTH OF AT LEAST SIX (6) INCHES, NOMINALLY COMPACT, AND SMOOTH ROLL TO FINISH THE INSTALLATION.

E. CONTRACTOR SHALL INSTALL A GEOSYNTHETIC CLAY LINER (GCL) OVER THE SIDES AND FLOOR OF THE NSP AND SECURE IT IN A PERIMETER ANCHOR TRENCH/BATTEN AND STRIP.

F. CONTRACTOR SHALL INSTALL A 60-MIL HDPE LINER DIRECTLY ON THE GCL AND SECURE IT IN A PERIMETER ANCHOR TRENCH/BATTEN AND STRIP.

GENERAL NOTES

1. ALL WORK UNDER THIS CONTRACT SHALL BE PERFORMED IN ACCORDANCE WITH THE PLANS AND PROJECT SPECIFICATIONS. IN THE EVENT OF A DISCREPANCY BETWEEN THE PLANS AND THE PROJECT SPECIFICATIONS, THE SPECIFICATIONS SHALL GOVERN.
2. COORDINATE SYSTEM IS BASED ON LOCAL SURVEY. THE BENCHMARKS TO BE USED FOR CONSTRUCTION ARE LOCATED AS SHOWN ON DRAWING NO. 00C-01. EXISTING CONTOURS ARE BASED ON TOPOGRAPHICAL SURVEY PERFORMED FEBRUARY 12-20, 2019 BY LACY SURVEYING. CURRENT GROUND ELEVATIONS MAY VARY FROM THOSE SHOWN DUE TO SITE WORK THAT HAS BEEN PERFORMED SINCE THE SURVEY WAS PERFORMED.
3. THE CONTRACTOR SHALL VERIFY EXISTING CONTOURS PRIOR TO THE START OF WORK.
4. THERE SHALL NOT BE ANY ADDITIONAL PAYMENT OR EXTENSION OF CONTRACT TIME FOR WORKING WITH SATURATED SOILS OR HANDLING WATER SEEPAGE DUE TO RAINFALL, RUNOFF AND INFILTRATION.
5. THE CONTRACTOR SHALL TAKE ALL NECESSARY PRECAUTIONS TO PROTECT EXISTING ROADS, BENCHMARKS AND EXISTING GROUNDWATER MONITOR WELLS DURING THE CONSTRUCTION PERIOD. THE CONTRACTOR SHALL BE SOLEY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE INCURRED BY THE CONTRACTOR'S FAILURE TO EXACTLY LOCATE AND PROTECT THE GROUNDWATER MONITOR WELLS, BENCHMARKS AND EXISTING ROADS.
6. THE LOCATIONS OF EXISTING UNDERGROUND UTILITIES HAVE NOT BEEN ESTABLISHED BY THE OWNER OR ENGINEER. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES BEFORE COMMENCING WORK, AND AGREES TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY THE CONTRACTORS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UTILITIES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING PROPER SAFE WORKING DISTANCE FROM ALL UTILITY EASEMENTS OR LINES.
7. EXCAVATION BY "BLASTING" IS NOT PERMITTED ON THIS PROJECT.
8. FINISHED GROUND ELEVATIONS SHALL MATCH EXISTING GROUND ELEVATIONS EXCEPT AS SHOWN ON THE PLANS. ALL EXCESS SOIL FROM THE EXCAVATION AND GRADING SHALL BE PLACED IN DESIGNATED STOCKPILE LOCATIONS AS APPROVED BY THE OWNER. IF WASTE IS ENCOUNTERED DURING EXCAVATION, THE OWNER SHALL BE NOTIFIED AND THE WASTE REMOVED AND PLACED IN AREAS DESIGNATED AS APPROVED BY THE OWNER. TRANSPORT OF SOIL TO FILL AREAS SHALL BE CONDUCTED BY THE CONTRACTOR AT NO ADDITIONAL EXPENSE TO THE OWNER.
9. GEOTECHNICAL INVESTIGATION REPORTS FOR THE SITE ARE AVAILABLE FOR REVIEW AT LUMINANT'S DALLAS OFFICES. THE CONTRACTOR MAY PERFORM ADDITIONAL GEOTECHNICAL INVESTIGATIONS, AS DEEMED NECESSARY FOR CONSTRUCTION ACTIVITIES, PROVIDED ALL NECESSARY PERMITS AND APPROVALS ARE OBTAINED FROM LUMINANT PRIOR TO INITIATING SUCH WORK. HOWEVER, THERE SHALL BE NO ADDITIONAL PAYMENT TO THE CONTRACTOR FOR ADDITIONAL GEOTECHNICAL INVESTIGATIONS.
10. THE CONTRACTOR SHALL CONSTRUCT, AND UPON COMPLETION OF THE PROJECT, REMOVE TEMPORARY CONSTRUCTION ACCESS ROADS. SUCH ROADS SHALL BE LOCATED AS APPROVED BY THE OWNER. DRAINAGE PATTERNS AT THE SITE SHALL NOT BE ALTERED BY ROAD CONSTRUCTION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONSTRUCTION AND MAINTENANCE OF TEMPORARY DRAINAGE STRUCTURES, INCLUDING CULVERTS, AT NO ADDITIONAL COST TO THE OWNER.
11. THE CONTRACTOR SHALL INSTALL, MAINTAIN, AND UPON COMPLETION OF THE PROJECT, REMOVE TEMPORARY EROSION AND SEDIMENT CONTROLS AS APPROVED BY LUMINENT ENVIRONMENTAL SERVICES AND IN ACCORDANCE WITH THE SITE SWPPP AND PURSUANT TO TPDES REQUIREMENTS. SUCH CONTROLS SHALL BE PLACED AT THE LIMITS OF DISTURBED AREAS AND AT INTERMEDIATE LOCATIONS WHERE CONCENTRATED FLOW IS LIKELY.
12. TEMPORARY CONSTRUCTION SLOPES SHALL NOT BE GREATER THAN 2H:1V. STEEPER SLOPES WILL ONLY BE ALLOWED IF THE CONTRACTOR PROVIDES A GEOTECHNICAL ENGINEERING REPORT SPECIFYING MAXIMUM SLOPES AND THE DURATION FOR WHICH SUCH SLOPES SHALL REMAIN IN PLACE.
13. THE CONTRACTOR SHALL REMOVE ALL VEGETATION WITHIN THE CONSTRUCTION LIMITS AS REQUIRED TO CONSTRUCT THE PROJECT. ALL VEGETATION SHALL BE REMOVED BY CONTRACTOR AT NO ADDITIONAL EXPENCE TO OWNER.
14. THE CONTRACTOR SHALL OBTAIN AND CONDUCT WORK CONSISTENT WITH A TPDES PERMIT FOR CONSTRUCTION, REFER TO TECHNICAL SPECIFICATIONS. PREPARATION OF A SWPPP AND OBTAINING THE TPDES PERMIT ARE THE CONTRACTORS RESPONSIBILITY.
15. THE CONTRACTOR SHALL IMMEDIATELY REPORT TO THE ENGINEER ANY ERROR OR DISCREPANCY FOUND ONCE THE CONTRACT DOCUMENT IS CAREFULLY REVIEWED AND ALL ASPECTS OF FIELD WORK HAVE BEEN VERIFIED. IN THE EVENT THE CONTRACTOR CONTINUES TO WORK ON AN ITEM WHERE AN ERROR EXISTS, IT SHALL BE DEEMED THAT THE CONTRACTOR BID AND INTENDED TO EXECUTE THE MORE STRINGENT OR HIGHER QUALITY REQUIREMENT WITHOUT AN INCREASE IN CONTRACT SUM OR TIME. THE CONTRACTOR SHALL ALSO BE RESPONSIBLE TO CORRECT ANY FAILURE OF COMPANY PARTS TO COORDINATE OR FIT PROPERLY INTO FINAL POSITION, AS A RESULT OF CONTRACTOR FAILURE TO RAISE OR RESOLVE A DISCREPANCY.
16. THE DRAWINGS AND SPECIFICATIONS SHOULD AGREE WITH EACH OTHER, AND WORK CALLED FOR BY DRAWINGS AND NOT MENTIONED IN SPECIFICATION, OR VICE VERSA, SHALL BE FURNISHED BY BOTH. WHEN DISCREPANCIES EXIST BETWEEN SCALE AND DIMENSIONS, THE DIMENSIONED FIGURE SHALL BE USED.
17. CONTRACTOR AND EACH SUBCONTRACTOR SHALL VERIFY ALL GRADES, LINES, LEVELS, AND DIMENSIONS AS INDICATED ON DRAWINGS, AND HE SHALL REPORT ERRORS TO THE ENGINEER BEFORE COMMENCING WORK. THE CONTRACTOR SHALL ESTABLISH BENCHMARKS IN AT LEAST TWO WIDELY SEPARATED PLACES, AND AS WORK PROGRESSES THE CONTRACTOR WILL MAINTAIN ADEQUATE HORIZONTAL AND VERTICAL CONTROL.
18. CONTRACTOR SHALL PROVIDE EROSION CONTROL BY SEEDING FOR ALL AREAS DISTURBED BY CONTRACTOR DURING THE CONSTRUCTION OF THIS PROJECT. THE CONTRACTOR SHALL NOT DISTURB ANY AREA WITHOUT THE APPROVAL OF THE ENGINEER. EROSION CONTROL BY SEEDING SHALL CONFORM TO STANDARD SPECIFICATION 02930.
19. CONTRACTOR SHALL INSTALL EROSION AND SEDIMENT CONTROLS AS PER SPECIFICATIONS DURING CONSTRUCTION. SUCH CONTROLS SHALL BE PLACED AT LIMITS OF DISTURBED AREAS AND AT INTERMEDIATE LOCATIONS WHERE CONCENTRATED FLOW IS LIKELY.
20. STORMWATER THAT HAS COME INTO CONTACT WITH THE ASH WITHIN THE EXCAVATED POND IS TO BE CONSIDERED CONTACT STORMWATER. CONTRACTOR WILL CONTROL THE WATER ON SITE IN COMPLIANCE WITH THE TPDES PERMIT.
21. THE CONTRACTOR IS REQUIRED TO PRESENT THE SWPPP TO LUMINANT ENVIRONMENTAL SERVICES FOR APPROVAL PRIOR TO THE COMMENCEMENT OF CONSTRUCTION ACTIVITIES.
22. THE CONTRACTOR IS REQUIRED TO SUBMIT THE NOTICE OF INTENT AND NOTICE OF TERMINATION FOR THE TPDES PERMIT.
23. THE CONTRACTOR IS TO ACQUIRE A DIGGING PERMIT FROM THE PLANT BEFORE COMMENCING ANY EXCAVATION ACTIVITY.

HDR

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A	01/31/2020	ISSUED FOR BID

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DRAWN BY	J. RAYMOND
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PROJECT NUMBER	10172630

STATE OF TEXAS
DAVID C. VOGT
93905
LICENSED
PROFESSIONAL ENGINEER

1/31/2020

MARTIN LAKE STEAM ELECTRICAL STATION
NEW SCRUBBER POND RELINE
RUSK COUNTY, TEXAS

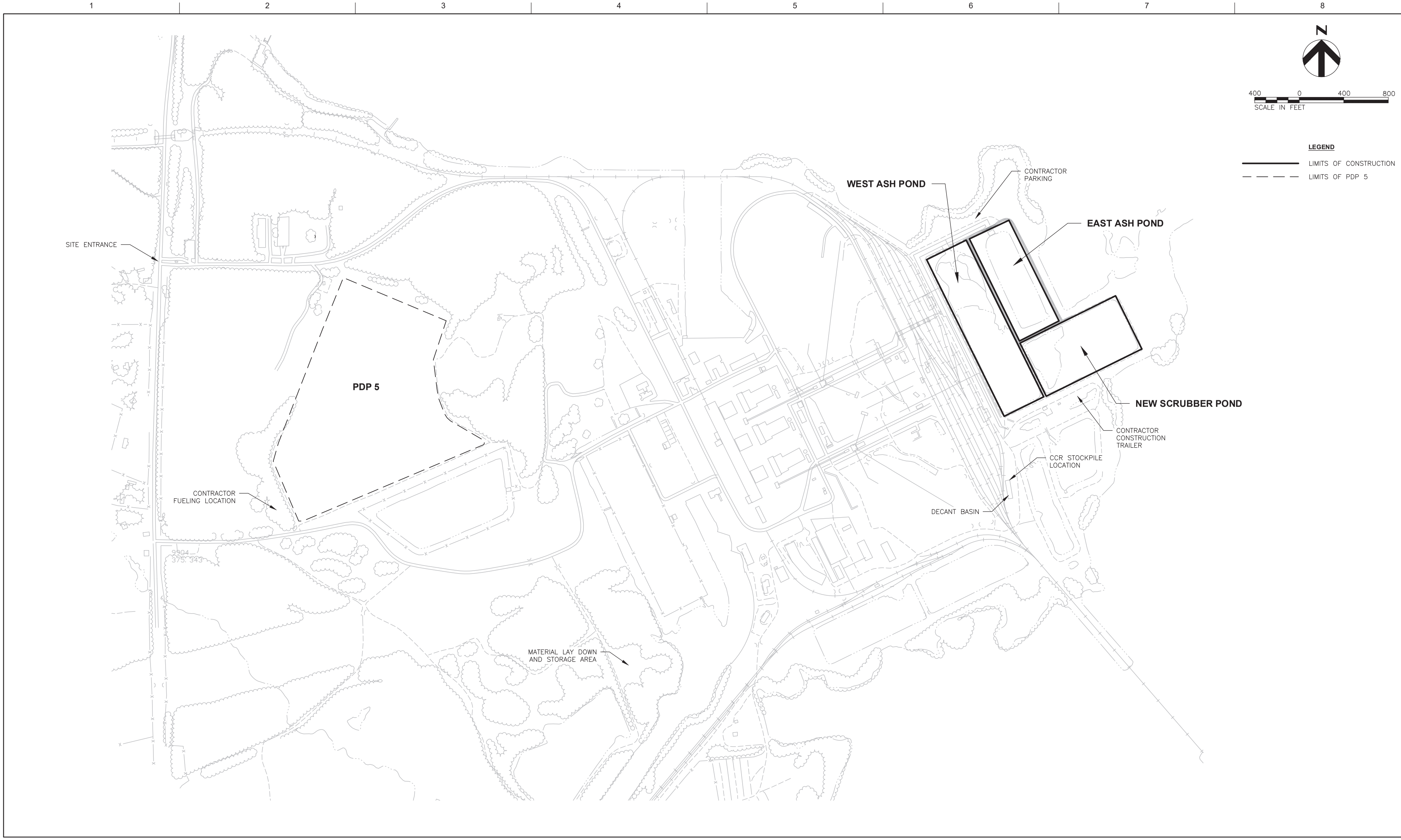
Luminant

ABBREVIATIONS AND GENERAL NOTES

SCALE 0 1" 2"

FILENAME 00G-02.dwg

SHEET **00G-02**



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PROFESSIONAL ENGINEER

1/31/2020

MARTIN LAKE STEAM ELECTRICAL STATION
NEW SCRUBBER POND RELINE
RUSK COUNTY, TEXAS

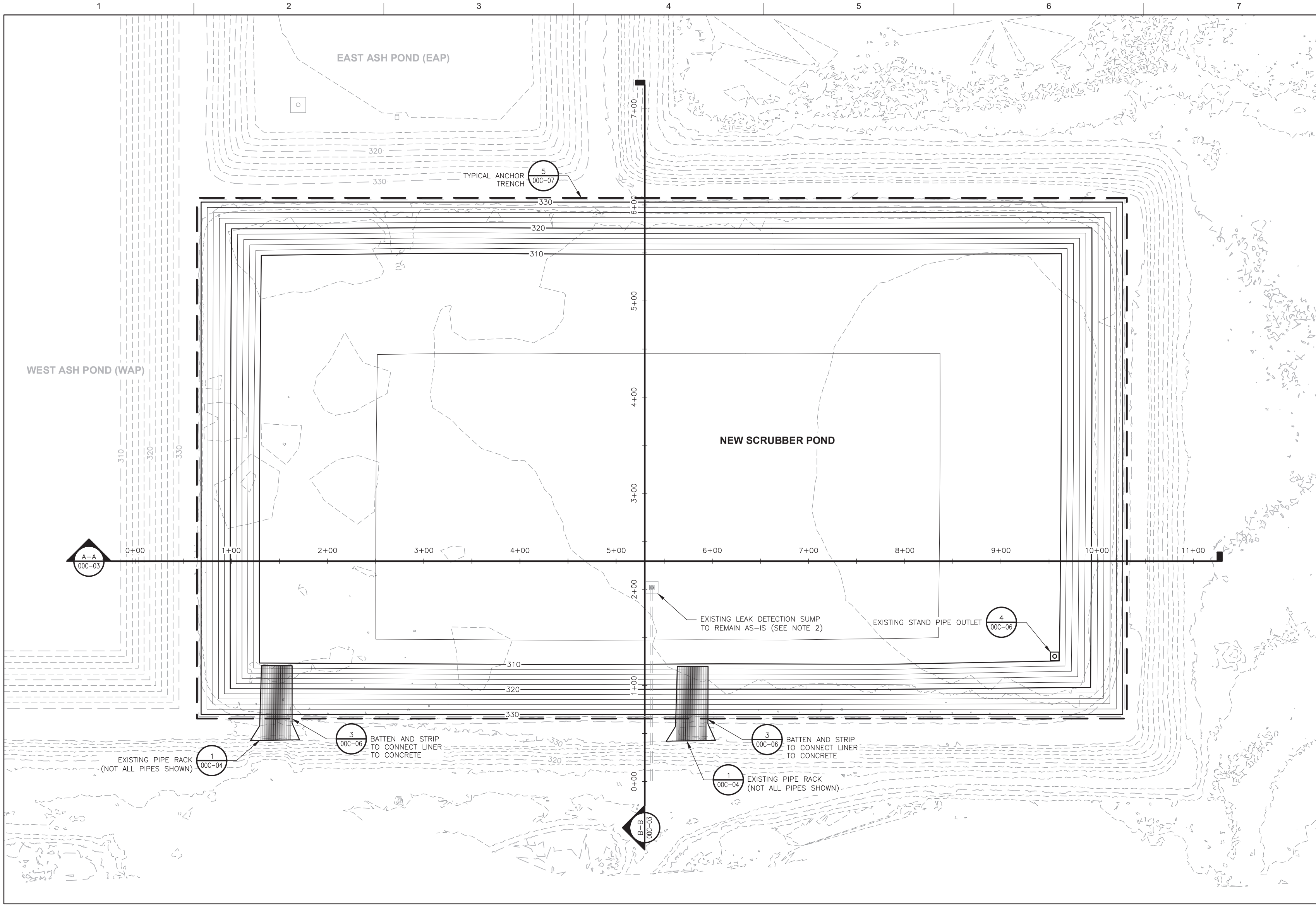
Luminant

SITE LAYOUT

0 1" 2"

FILENAME 00C-01.dwg
SCALE 1" = 400'

SHEET
00C-01



NOTES:

1. THE PROPOSED CONTOURS SHOWN ARE TOP OF REVETMENT MATTRESS ELEVATIONS OBTAINED FROM JULY 1995 AS-BUILT DRAWINGS PREPARED BY TEXAS UTILITIES GENERATING CO.
2. NO EQUIPMENT ALLOWED OVER DETECTION SUMP.
3. SEE DETAIL 1/00C-05 FOR PROPOSED LINER SYSTEM DETAILS.

HDR

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DESIGNED BY	K. PERERA
DRAWN BY	J. RAYMOND
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PROJECT NUMBER	10172630

STATE OF TEXAS
DAVID C. VOGT
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PROFESSIONAL ENGINEER
1/31/2020

MARTIN LAKE STEAM ELECTRICAL STATION
NEW SCRUBBER POND RELINE
RUSK COUNTY, TEXAS

Luminant

NEW SCRUBBER POND

FILENAME 00C-02.dwg
SCALE 1" = 50'
SHEET 00C-02

HORIZONTAL SCALE: 1" = 100'

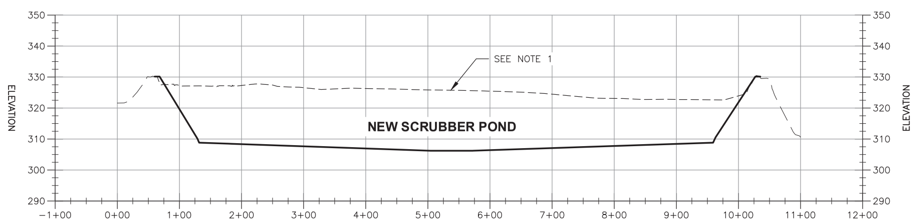
VERTICAL SCALE: 1" = 20'

LEGEND

- TOP OF CCR MATERIAL
- EXISTING GROUND SURFACE
- PROPOSED GRADE

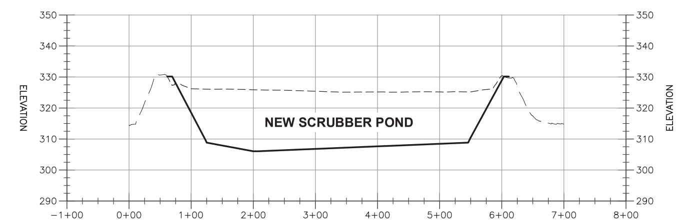
NOTES:

1. CCR ELEVATION FROM BATHYMETRIC SURVEY TAKEN FEBRUARY 2019 BY LACEY SURVEYING OF ARP, TEXAS. AT START OF PROJECT, OWNER WILL HAVE REMOVED BULK OF CCR MATERIAL FROM THE NEW SCRUBBER POND
2. CONTRACTOR WILL REMOVE REMAINING CCR MATERIAL, ROCKS AND SEDIMENT WITHIN POND BEFORE INSTALLATION OF THE LINER SYSTEM.



SECTION A–A (A–A / 00C–02)

HORIZONTAL SCALE: 1" = 100' ; VERTICAL SCALE: 1" = 20'



SECTION B–B (B–B / 00C–02)

HORIZONTAL SCALE: 1" = 100' ; VERTICAL SCALE: 1" = 20'

HDR

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A	01/31/2020	ISSUED FOR BID

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DRAWN BY	J. RAYMOND
CHECKED BY	M. ROBERTS
PROJECT NUMBER	10172630

STATE OF TEXAS
DAVID C. VOGT
93905
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PROFESSIONAL ENGINEER

1/31/2020

MARTIN LAKE STEAM ELECTRICAL STATION
NEW SCRUBBER POND RELINE
RUSK COUNTY, TEXAS

Luminant

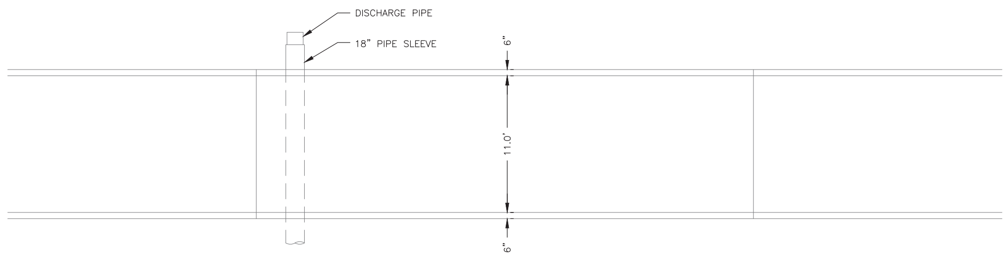
CROSS SECTIONS

0 1" 2"

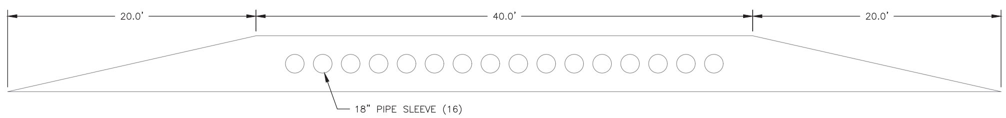
FILENAME 00C-03.dwg

SCALE H: 1" = 100' ; V: 1" = 20'

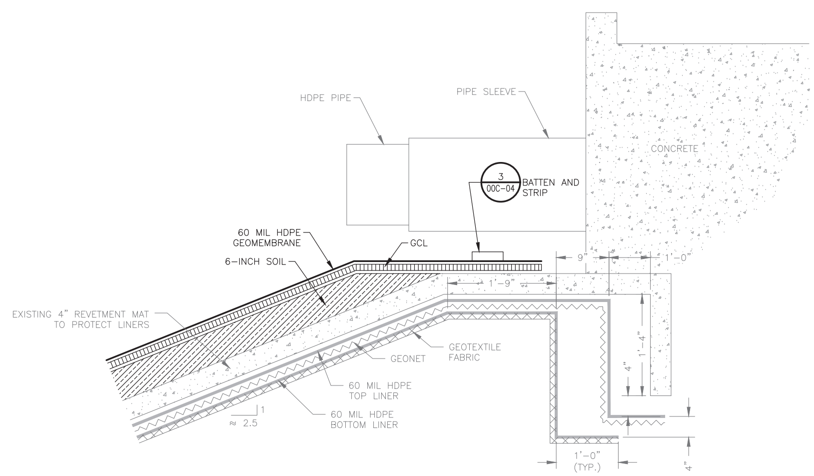
SHEET **00C-03**



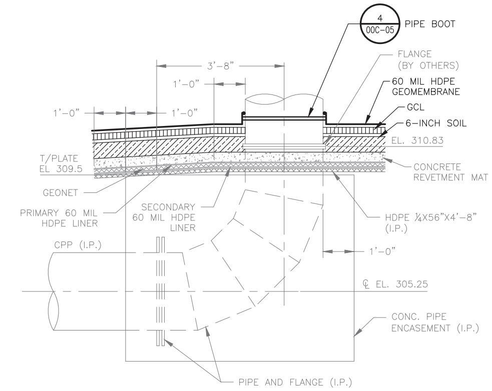
PIPE RACK PLAN VIEW
NOT TO SCALE
1 / 00C-02



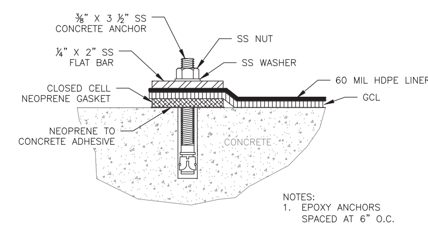
PIPE RACK PROFILE
NOT TO SCALE
1 / 00C-02



PIPE RACK SECTION
NOT TO SCALE
2 / 00C-04

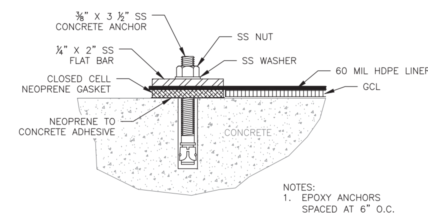


PIPE ENCASEMENT
NOT TO SCALE
2 / 00C-02



NOTES:
1. EPOXY ANCHORS SPACED AT 6" O.C.

BATTEN AND STRIP CONNECTION AT ANCHOR TRENCH
NOT TO SCALE
3A / 00C-02



NOTES:
1. EPOXY ANCHORS SPACED AT 6" O.C.

BATTEN AND STRIP CONNECTION BELOW WATER SURFACE
NOT TO SCALE
3B / 00C-02

HDR

ISSUE	DATE	DESCRIPTION
A	01/31/2020	ISSUED FOR BID

PROJECT MANAGER	D. VOGT, P.E.
DESIGNED BY	K. PERERA
DRAWN BY	J. RAYMOND
CHECKED BY	M. ROBERTS
PROJECT NUMBER	10172630

STATE OF TEXAS
DAVID C. VOGT
93905
LICENSED
PROFESSIONAL ENGINEER
1/31/2020

MARTIN LAKE STEAM ELECTRICAL STATION
NEW SCRUBBER POND RELINE
RUSK COUNTY, TEXAS

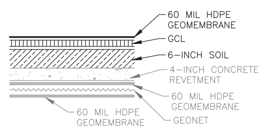
Luminant

DETAILS
(1 OF 2)

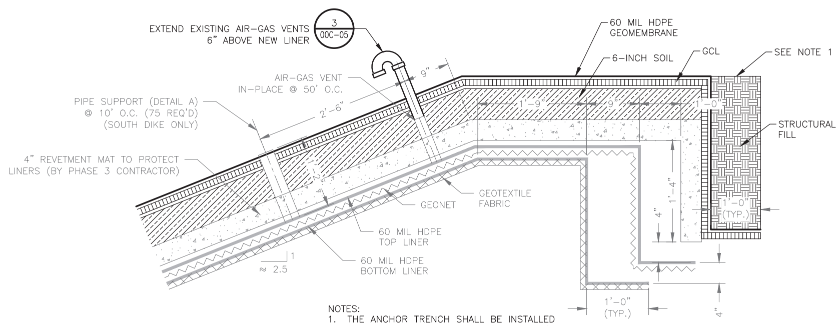
0 1" 2"

FILENAME 00C-04.dwg
SCALE

SHEET **00C-04**

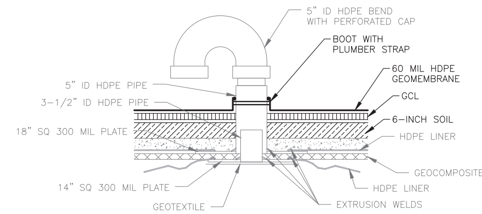


PROPOSED
NEW SCRUBBER POND RETROFIT SECTION (1 / 00C-05)
NOT TO SCALE

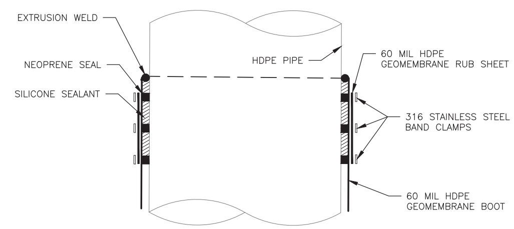


NOTES:
1. THE ANCHOR TRENCH SHALL BE INSTALLED OUTSIDE OF THE EXISTING ANCHOR TRENCH.

ANCHOR TRENCH (2 / 00C-02)
NOT TO SCALE



TYPICAL AIR-GAS VENT (3 / 00C-05)
NOT TO SCALE



PIPE BOOT (4 / 00C-04)
NOT TO SCALE

ISSUE	DATE	DESCRIPTION
A	01/31/2020	ISSUED FOR BID

PROJECT MANAGER	D. VOGT, P.E.
DESIGNED BY	K. PERERA
DRAWN BY	J. RAYMOND
CHECKED BY	M. ROBERTS
PROJECT NUMBER	10172630

STATE OF TEXAS
DAVID C. VOGT
93905
LICENSED
PROFESSIONAL ENGINEER
1/31/2020

MARTIN LAKE STEAM ELECTRICAL STATION
NEW SCRUBBER POND RELINE
RUSK COUNTY, TEXAS

DETAILS (2 OF 2)

FILENAME	00C-05.dwg
SCALE	NOT TO SCALE

SHEET **00C-05**

A	01/31/2020	ISSUED FOR BID	
ISSUE	DATE	DESCRIPTION	

PROJECT MANAGER	D. VOGT, P.E.
DESIGNED BY	K. PERERA
DRAWN BY	J. RAYMOND
CHECKED BY	M. ROBERTS
PROJECT NUMBER	10172630

STATE OF TEXAS
DAVID C. VOGT
93905
LICENSED
PROFESSIONAL ENGINEER
1/31/2020

MARTIN LAKE STEAM ELECTRICAL STATION
NEW SCRUBBER POND RELINE
RUSK COUNTY, TEXAS

Luminant

STOCKPILE AND HAUL ROUTE

FILENAME 00C-06.dwg
SCALE 1" = 600'

SHEET
00C-06

APPENDIX F – COMPLIANCE DOCUMENTS

APPENDIX F1 - MAP OF GROUNDWATER MONITORING WELL LOCATIONS

LEGEND

- DOWNGRADIENT CCR MONITORING WELL
- UPGRADIENT CCR MONITORING WELL

CLIENT
LUMINANT

PROJECT
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

TITLE
DETAILED SITE PLAN - ASH POND AREA

CONSULTANT

GOLDER

YYYY-MM-DD	2020-01-23
DESIGNED	AJD
PREPARED	AJD
REVIEWED	WFV
APPROVED	WFV

PROJECT NO.	REV.	FIGURE
19122262	0	1

REFERENCE(S)
BASE MAP TAKEN FROM GOOGLE EARTH, IMAGERY DATED 4/6/17.

EXPLANATION

CCR Monitoring Well

N

Scale in Feet

0 275 550

SOURCE:
Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

Figure 1

PDP 5 AREA
DETAILED SITE PLAN

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

APPENDIX F2 - WELL CONSTRUCTION DIAGRAMS AND DRILLING LOGS

Luminant

Log of Boring: H-26

Martin Lake Steam Electric Station Tatum, TX	Completion Date:	9/14/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	50
	Driller's License:	5814M	TOC Elevation (ft. AMSL):	
PBW Project No. 5164B	Logged By:	Ryan Francis	Northing:	
	Sampling Method:	4"x10' Core barrel	Easting:	

Depth (ft)	Well Materials	Recovery (ft/ft)	USCS	Lithologic Description
0–3		10.0/10.0	ML	(0 - 3) Silty CLAY, dark brown, dry, soft to firm, weak cementation, flat, low plasticity
3–7			SC	(3 - 7) Sandy CLAY, red/orange with gray clay ribbons, dry, soft to firm, weak cementation, medium plasticity, minor rounded pebbles
7–11		10.0/10.0		(7 - 11) Silty SAND, gray, dry, soft, weak cementation, subrounded, sharp contact
11–30		10.0/10.0	ML	(11 - 30) Clayey silty SAND, tan with red and gray ribbons, moist to wet, soft, weak cementation, medium plasticity
30–40		10.0/10.0	SP	(30 - 40) SAND, tan and orange, fine grained, higher clay content (31'-34'), wet, very soft to soft, low to medium plasticity
40–44		10.0/10.0	SW	(40 - 44) SAND, red, wet, soft to firm, moderate cementation, heavy iron content, iron concretions ("rocky" texture)
44–50			SP	(44 - 50) SAND, red and gray, wet, soft, fine grained, subrounded, gradual color change to dark brown/black (47'-50'), moisture content decreases with depth, hard sand (48'-50')

Depth scale (ft): 0, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 52

PBW

Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446

Notes:
1. This log should not be used separately from the report to which it is attached.

Well Materials
(0-35) Casing, 2" Sch 40 FJT PVC
(35-40) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-31') Grout
(31'-33') Bentonite pellets
(33'-40') 20/40 sand

Luminant

Log of Boring: H-27

Martin Lake Steam Electric Station Tatum, TX	Completion Date:	9/15/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	50
PBW Project No. 5164B	Driller's License:	5814M	TOC Elevation (ft. AMSL):	
	Logged By:	Ryan Francis	Northing:	
	Sampling Method:	4"x10' Core barrel	Easting:	

Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0 - 20	10.0/10.0 (0-10); 10.0/10.0 (10-20)	CH	(0 - 20) CLAY, orange and brown mottling, minor black sreaking, blocky, moist, soft to hard, low to high plasticity, dry and variable sand content (5'-7'), wet at 20'
20 - 21	10.0/10.0 (20-30)	SP	(20 - 21) SAND, gray, moist, soft, subrounded, sharp contact
21 - 28		CL	(21 - 28) CLAY, gray and orange, blocky, moist, firm to hard, moderate cementation, low plasticity
28 - 40	10.0/10.0 (30-40)	SP	(28 - 40) SAND, light gray to tan/orange, moist to wet, soft, none to low plasticity, minor clay content decreasing with depth
40 - 44	10.0/10.0 (40-50)	CL	(40 - 44) Sandy CLAY, orange and gray, moist, firm, low to medium plasticity, flat, sharp contact, very hard and little to no sand at 43'
44 - 50		SP	(44 - 50) Clayey SAND, orange and gray, wet, soft, low plasticity, fine grained, decreasing clay content with depth, sharp contact, color change to brown at 48'

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Notes:
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Well Materials
(0-45) Casing, 2" Sch 40 FJT PVC
(45-50) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-41') Grout
(41'-43') Bentonite pellets
(43'-50') 20/40 sand

Luminant

Log of Boring: H-28

Martin Lake Steam Electric Station
Tatum, TX

PBW Project No. 5164B

Completion Date:	9/15/2015	Drilling Method:	Sonic
Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
Driller:	Timmy Beach	Total Depth (ft):	40
Driller's License:	5814M	TOC Elevation (ft. AMSL):	
Logged By:	Ryan Francis	Northing:	
Sampling Method:	4"x10' Core barrel	Easting:	

Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0 - 6	10.0/10.0	SP	(0 - 6) Soil with SAND, tan, dry, firm, moderate cementation, hard packed
6 - 21	10.0/10.0	SC	(6 - 21) Clayey SAND, moist, soft to firm, weak cementation, none to low plasticity, flat, 6" gray fine to very fine sand lense at 10', gray and orange mottling (11'-21'), fine grained
21 - 30	10.0/10.0	SP/SC	(21 - 30) Clayey SAND, tan and orange, wet, soft to firm, low plasticity, none to weak cementation, variation in clay content with depth, highest clay content at 21', more orange and less clay (29'-30')
30 - 33	10.0/10.0	SP	(30 - 33) SAND, orange and gray, fine grained, wet, soft, low plasticity, minor clay content, color change from tna to brown to dark gray
33 - 40		CL	(33 - 40) Silty CLAY, dark gray, moderate sand, dry, hard, weak cementation, flat

PBW

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Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446

Notes:
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Well Materials
(0-27) Casing, 2" Sch 40 FJT PVC
(27-32) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-23') Grout
(23'-25') Bentonite pellets
(25'-32') 20/40 sand

Luminant

Log of Boring: H-29

Martin Lake Steam Electric Station Tatum, TX	Completion Date: 9/23/2015	Drilling Method:	Sonic
	Drilling Company: Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller: Timmy Beach	Total Depth (ft):	60
	Driller's License: 5814M	TOC Elevation (ft. AMSL):	
PBW Project No. 5164B	Logged By: Ryan Francis	Northing:	
	Sampling Method: 4"x10' Core barrel	Easting:	

Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0 - 2	10.0/10.0	FILL	(0 - 2) Hard rock road bed, dry
2 - 18	10.0/10.0	SC	(2 - 18) Clayey SAND, orange and gray mottling, very fine grained, dry to moist, firm, weak cementation, low to medium plasticity, increasing clay content with depth
18 - 30	10.0/10.0	CL	(18 - 30) CLAY, orange, moist, firm, low to medium plasticity, very little sand or silt, black striping at 22', increasing sand content with depth (28'-30')
30 - 36	10.0/10.0	CH	(30 - 36) CLAY, orange, moist, soft, friable, high plasticity, minor silt
36 - 45	10.0/10.0	CL/SC	(36 - 45) Sandy CLAY/Clayey SAND, orange/gray/red mottling, friable, wet, soft to firm, low to medium plasticity, increasing clay content with depth
45 - 48		CH	(45 - 48) CLAY with sand, orange and gray mottling, wet, soft, high plasticity
48 - 57	10.0/10.0	SP	(48 - 57) SAND, gray, wet, soft, one to low plasticity, some black roots/ organics, interspersed clay lenses
57 - 60		CL	(57 - 60) Silty CLAY, gray/brown, dry, hard, weak cementation, sharp contact

PBW

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2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446

Notes:
1. This log should not be used separately from the report to which it is attached.

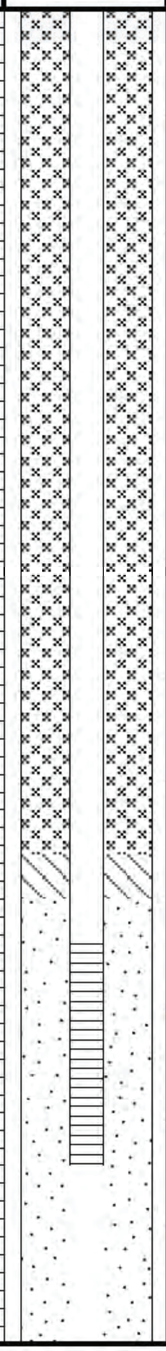
Well Materials
(0-52) Casing, 2" Sch 40 FJT PVC
(52-57) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-48') Grout
(48'-50') Bentonite pellets
(50'-57') 20/40 sand

Luminant

Log of Boring: H-31

Martin Lake Steam Electric Station Tatum, TX				
PBW Project No. 5164B	Completion Date:	9/24/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	60
	Driller's License:	5814M	TOC Elevation (ft. AMSL):	
	Logged By:	Ryan Francis	Northing:	
	Sampling Method:	4"x10' Core barrel	Easting:	



Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0 – 1	10.0/10.0	FILL	(0 - 1) Hard, packed gravel road bed, dry
1 – 12		SC	(1 - 12) Clayey SAND, orange, dry to moist, soft to firm, low plasticity, fine grained, increasing clay content with depth, gray clay ribbons at 10'
12 – 20	5.0/10.0	SP	(12 - 20) SAND, orange with red and gray mottling, dry to moist, soft, none to low plasticity, weak cementation, fine grained, very little clay
20 – 30	10.0/10.0	SC/CL	(20 - 30) Sandy CLAY, orange, dry to moist, firm, crumbly, color variation with depth, low plasticity, some gray sand lenses, very fine grained, color change to gray at 29'
30 – 41	10.0/10.0	CL/SC	(30 - 41) Sandy CLAY,/ Clayey SAND, gray and tan, moist, soft, fine grained, low plasticity, variations in clay content and firmness with depth, moisture content changes to wet at 35'
41 – 57	10.0/10.0 10.0/10.0	SP	(41 - 57) SAND, orange/tan, wet, very soft, fine grained, subrounded, increasing red color with depth starting at 52', hard iron concretion layer with some black staining at 55'
57 – 60		CL	(57 - 60) Sandy CLAY, gray, dry to moist, hard, fine grained, weak cementation, low plasticity, flat

PBW

Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
Tel (512) [illegible] (512) 671-3446

Notes:
1. This log should not be used separately from the report to which it is attached.

Well Materials
(0-42) Casing, 2" Sch 40 FJT PVC
(42-52) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-38') Grout
(38'-40') Bentonite pellets
(40'-52') 20/40 sand

Luminant

Log of Boring: H-32

Martin Lake Steam Electric Station Tatum, TX	Completion Date:	9/24/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	60
PBW Project No. 5164B	Driller's License:	5814M	TOC Elevation (ft. AMSL):	
	Logged By:	Ryan Francis	Northing:	
	Sampling Method:	4"x10' Core barrel	Easting:	

Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0 - 1	10.0/10.0	FILL	(0 - 1) Hard, packed gravel road bed, dry
1 - 10		SC/CL	(1 - 10) Sandy CLAY/Clayey SAND, orange/tan, dry, firm, fine grained, low plasticity, weak cementation
10 - 21	10.0/10.0	CH	(10 - 21) CLAY with minor silt/sand, orange with some black streaks, moist, firm, high plasticity, gradual contact
21 - 23.5	10.0/10.0	SP	(21 - 23.5) SAND, gray, dry, soft to firm, friable, fine grained
23.5 - 38	10.0/10.0	CH	(23.5 - 38) CLAY, orange/tan/gray, moist, soft to firm, unconsolidated, high plasticity, minor sand at 30', tan and gray with orange stripes (30'-38'), sharp contact
38 - 57	10.0/10.0 10.0/10.0	SP	(38 - 57) SAND, orange/tan, moist to wet, very soft to soft, fine grained, subrounded, minor clay, low plasticity, no clay content at 42', gradual coarsening of sand grains (48'-55'), some gray streakings at 49', color change to reddish brown at 52'
57 - 60		CL	(57 - 60) Sandy CLAY, dark red and brown, wet, soft, low plasticity, layer of dark red concretions at 57', weak cementation, flat

PBW

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Round Rock, TX 78664
Tel (512) 671-3434

Notes:
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Well Materials
(0-42) Casing, 2" Sch 40 FJT PVC
(42-52) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-38') Grout
(38'-40') Bentonite pellets
(40'-52') 20/40 sand

Luminant

Log of Boring: H-33

Martin Lake Steam Electric Station Tatum, TX	Completion Date:	9/14/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	60
PBW Project No. 5164B	Driller's License:	5814M	TOC Elevation (ft. AMSL):	
	Logged By:	Ryan Francis	Northing:	
	Sampling Method:	4"x10' Core barrel	Easting:	

Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0 - 4	10.0/10.0	ML	(0 - 4) Silty CLAY, minor sand, red and orange with gray ribbons, dry, soft to firm, low to medium plasticity, flat
4 - 12		CH	(4 - 12) CLAY, red with gray concretions, moist, soft to firm, high plasticity, gradual contact
12 - 24	10.0/10.0	ML	(12 - 24) Sandy SILT, gray and red, dry, soft, weak cementation, sharp contact, red and gray clay lense at 19'
24 - 28	10.0/10.0	CL	(24 - 28) Clay, red, moist to wet, soft to firm, high plasticity, pebbles present
28 - 34		SP	(28 - 34) SAND, gray, wet, soft to firm, minor clay, low to medium plasticity, subrounded, increasing clay content with depth, sharp contact
34 - 39	10.0/10.0	CL	(34 - 39) CLAY, orange and gray mottling, dry, very hard, moderate cementation, low plasticity
39 - 46	10.0/10.0	CL	(39 - 46) Sandy CLAY, orange and gray, moist to wet, firm, medium plasticity, weak cementation, increasing sand content with depth
46 - 60	10.0/10.0	ML	(46 - 60) Sandy SILT, dark gray, dry, hard, flat

PBW
Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
Tel (512

Notes:
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Well Materials
(0-41) Casing, 2" Sch 40 FJT PVC
(41-46) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-37') Grout
(37'-39') Bentonite pellets
(39'-46') 20/40 sand

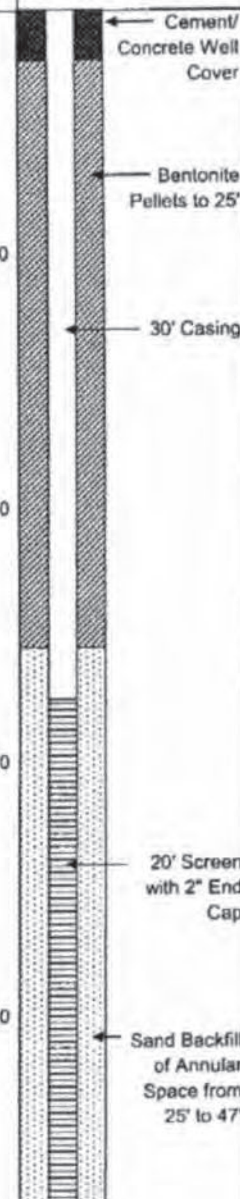
GREEN STAR ENVIRONMENTAL

BORING/WELL CONSTRUCTION LOG

Project Number:	08-1388	Boring/Well Number:	MW-17A
Project Name:	Martin Lake SES	Date Drilled:	October 1, 2008
Location:	8850 FM 2658 Tatum, TX	Casing Type/Diameter:	PVC/2" ID
Drilling Method:	HSA	Screen Type/Diameter:	PVC/0.01"
Sampling Method:	CT	Gravel Pack Type:	8/16 Grade Silica Sand
Ground Elevation:	384.63' msl	Grout Type:	Bentonite Pellets
Top of Casing Elevation:	387.53' msl	Depth to Water/Date:	26.62' BTOC/10-09-2008
Logged by:	T. Ripley	Ground Water Elevation/Date:	360.91' msl/10-09-2008
Remarks:		Drilling Co./Driller:	SCI / M. Bridges

PID (ppm)	Blow Counts	Recovery (%)	Sampling Method	Sample	Depth (ft. BGL)	U.S.C.S	Graphic Log	Lithologic Description	Contact Depth
NA	NA	NA	CT	NA				See MW-17B boring log for Lithologic Description	
					10				10.0
					20			∇	20.0
					30				30.0
					40				40.0
					50			The boring was terminated and the well was set at 47' bgs. The well was completed with a protective stickup which requires approximately 3 feet of additional casing above grade.	50.0

Well Diagram



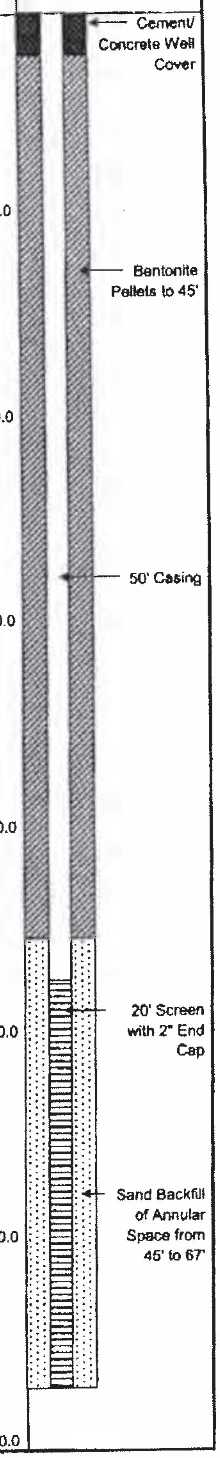
GREEN STAR ENVIRONMENTAL

BORING/WELL CONSTRUCTION LOG

Project Number:	08-1388	Boring/Well Number:	MW-18A
Project Name:	Martin Lake SES	Date Drilled:	October 2, 2008
Location:	8850 FM 2658 Tatum, TX	Casing Type/Diameter:	PVC/2" ID
Drilling Method:	HSA	Screen Type/Diameter:	PVC/0.01"
Sampling Method:	CT	Gravel Pack Type:	8/16 Grade Silica Sand
Ground Elevation:	410.83' msl	Grout Type:	Bentonite Pellets
Top of Casing Elevation:	414.43' msl	Depth to Water/Date:	43.17' BTOC/10-09-2008
Logged by:	T. Ripley	Ground Water Elevation/Date:	371.26' msl/10-09-2008
Remarks:		Drilling Co./Driller:	SCI / M. Bridges

PID (ppm)	Blow Counts	Recovery (%)	Sampling Method	Sample	Depth (ft. BGL)	U.S.C.S	Graphic Log	Lithologic Description	Contact Depth
NA	NA	NA	CT	NA				See MW-18B boring log for Lithologic Description	
					10				10.0
					20				20.0
					30				30.0
					40			∇	40.0
					50				50.0
					60				60.0
					70			The boring was terminated and the well was set at 67' bgs. The well was completed with a protective stickup which requires approximately 3 feet of additional casing above grade.	70.0

Well Diagram



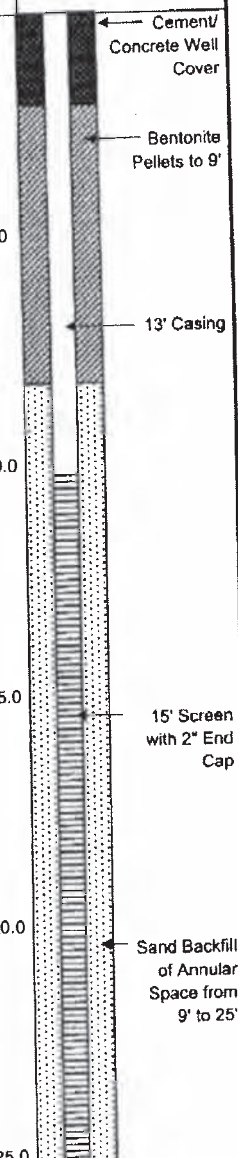
GREEN STAR ENVIRONMENTAL

BORING/WELL CONSTRUCTION LOG

Project Number:	08-1388	Boring/Well Number:	MW-19
Project Name:	Martin Lake SES	Date Drilled:	September 30, 2008
Location:	8850 FM 2658 Tatum, TX	Casing Type/Diameter:	PVC/2" ID
Drilling Method:	HSA	Screen Type/Diameter:	PVC/0.01"
Sampling Method:	CT	Gravel Pack Type:	20/40 Grade Silica Sand
Ground Elevation:	367.84' msl	Grout Type:	Bentonite Pellets
Top of Casing Elevation:	371.23' msl	Depth to Water/Date:	13.89' BTOC/10-09-2008
Logged by:	T. Ripley	Ground Water Elevation/Date:	357.34' msl/10-09-2008
Remarks:		Drilling Co./Driller:	SCI / M. Bridges

PID (ppm)	Blow Counts	Recovery (%)	Sampling Method	Sample	Depth (ft. BGL)	U.S.C.S	Graphic Log	Lithologic Description	Contact Depth
NA	NA	90	CT	NA		SC		Moist, medium dense, reddish-brown, CLAYEY SAND (fine-grained SAND)	
						CL		Moist, soft, reddish-brown, SANDY CLAY	
					5	SP		Moist, loose, reddish-brown, fine-grained SAND -gray	5.0
		60							
					10	CL		Moist to wet, soft, brown, SANDY CLAY (fine-grained SAND) -stiff -light gray ∇	10.0
						CL		Moist, very stiff, light gray, SILTY CLAY	
		100				SC		Moist, dense, gray and reddish-brown, CLAYEY SAND (fine-grained SAND ∇	
					15	SP		Wet, loose, light gray and reddish-brown, fine-grained SAND -medium dense	15.0
		70							
					20	SC		Wet, medium dense, light gray and reddish-brown, CLAYEY SAND (fine-grained SAND) -stringer of dense -stringer of dense	20.0
		100				ML		Moist, very stiff, gray CLAYEY SILT with some iron staining	
					25			The boring was terminated and the well was set at 25' bgs. The well was completed with a protective stickup which requires approximately 3 feet of additional casing above grade.	25.0

Well Diagram



GREEN STAR ENVIRONMENTAL

BORING/WELL CONSTRUCTION LOG

Project Number:	08-1388	Boring/Well Number:	MW-20A
Project Name:	Martin Lake SES	Date Drilled:	September 30, 2008
Location:	8850 FM 2658 Tatum, TX	Casing Type/Diameter:	PVC/2" ID
Drilling Method:	HSA	Screen Type/Diameter:	PVC/0.01"
Sampling Method:	CT	Gravel Pack Type:	20/40 Grade Silica Sand
Ground Elevation:	395.95' msl	Grout Type:	Bentonite Pellets
Top of Casing Elevation:	398.34' msl	Depth to Water/Date:	29.19' BTOC/10-09-2008
Logged by:	T. Ripley	Ground Water Elevation/Date:	369.65' msl/10-09-2008
Remarks:		Drilling Co./Driller:	SCI / M. Bridges

PID (ppm)	Blow Counts	Recovery (%)	Sampling Method	Sample	Depth (ft. BGL)	U.S.C.S	Graphic Log	Lithologic Description	Contact Depth	Well Diagram
NA	NA	NA	CT	NA				See MW-20B boring log for Lithologic Description		Cement/ Concrete Well Cover; Bentonite Pellets to 19'
					10				10.0	24' Casing
					20				20.0	20' Screen with 2" End Cap
					30				30.0	Sand Backfill of Annular Space from 19' to 41'
					40				40.0	
								The boring was terminated and the well was set at 41' bgs. The well was completed with a protective stickup which requires approximately 3 feet of additional casing above grade.		

Luminant

Log of Boring: PDP-22

Martin Lake Steam Electric Station Tatum, TX	Completion Date:	9/9/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	60
PBW Project No. 5164B	Driller's License:	5814M	TOC Elevation (ft. AMSL):	
	Logged By:	Ryan Francis	Northing:	
	Sampling Method:	4"x10' Core barrel	Easting:	

Depth (ft)	Well Materials	Recovery (ft/ft)	USCS	Lithologic Description
0–3		8.0/10.0	SP	(0 - 3) Fine SAND, tan, dry, very soft, small iron concretions, grass roots
3–10			CL	(3 - 10) Sandy CLAY, red/orange mottled, dry, firm, moderate cementation, flat to subrounded, sharp contact
10–20		10.0/10.0	CH	(10 - 20) Silty CLAY with minor sand, dry, firm, moderate cementation, flat to subrounded, medium to high plasticity, micro laminated structure, increasing sand content with depth, transition from red/gray at 10' to tan at 20'
20–28		10.0/10.0	SM	(20 - 28) Sandy SILT, gray and tan, dry, firm, moderate cementation, flat to subrounded, grass lense (fill), transition to gray at 26'
28–30				(28 - 30) Silty SAND, iron-rich, dry, soft, weak cementation, subrounded, sharp contact
30–53		10.0/10.0 10.0/10.0	SC	(30 - 53) SAND, gray with small streaks and iron at 32', moist to wet, soft, moderate plasticity at 30', transition to low plasticity at 40', minor clay content
53–60		10.0/10.0	CL	(53 - 60) Silty CLAY, gray, dry, firm, moderate cementation, dry, flat, transition to very hard gray/dark gray clay at 56'

PBW

Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446

Notes:
1. This log should not be used separately from the report to which it is attached.

Well Materials
(0-35) Casing, 2" Sch 40 FJT PVC
(35-60) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-31') Grout
(31'-33') Bentonite pellets
(33'-60') 20/40 sand

Luminant

Log of Boring: PDP-23

Martin Lake Steam Electric Station Tatum, TX	Completion Date:	9/10/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	50
PBW Project No. 5164B	Driller's License:	5814M	TOC Elevation (ft. AMSL):	
	Logged By:	Ryan Francis	Northing:	
	Sampling Method:	4"x10' Core barrel	Easting:	

Depth (ft)	Well Materials	Recovery (ft/ft)	USCS	Lithologic Description
0–10		10.0/10.0	CL	(0 - 30) Sandy CLAY, brown to red to tan, dry, soft to firm, weak cementation, iron rich at 5', none to moderate plasticity, black mottling and some organics present at 10', iron banding and iron nodules with increasing sand cotent at 16', microlaminated iron rich banded gray, tan, and red sandy clay (21' - 30')
10–20		10.0/10.0	CL	
20–30		10.0/10.0	CL	
30–40		10.0/10.0	CL	(30 - 39) CLAY, gray, micro laminated, minor sand content, dry, firm to hard, weak to moderate cementation, low plasticity
			CL	(39 - 41) Sandy CLAY, light gray, dry, firm, weak cementation, medium plasticity
40–50		10.0/10.0	SC	(41 - 44) Clayey SAND, wet, soft, weak cementation, subrounded, medium to high plasticity
			CL	(44 - 50) Sandy CLAY, dark gray, dry, hard, moderate cementation

PBW

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Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446

Notes:
1. This log should not be used separately from the report to which it is attached.

Well Materials
(0-35) Casing, 2" Sch 40 FJT PVC
(35-45) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-31') Grout
(31'-33') Bentonite pellets
(33'-45') 20/40 sand

Luminant

Log of Boring: PDP-24

Martin Lake Steam Electric Station Tatum, TX	Completion Date:	9/11/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	50
	Driller's License:	5814M	TOC Elevation (ft. AMSL):	
PBW Project No. 5164B	Logged By:	Ryan Francis	Northing:	
	Sampling Method:	4"x10' Core barrel	Easting:	

Depth (ft)	Well Materials	Recovery (ft/ft)	USCS	Lithologic Description
0–10		8.0/10.0	CL	(0 - 30) Sandy CLAY, red and tan mottling, fine sand, dry to moist, firm, weak cementation, low to medium plasticity, occasional black inclusions, minor very fine sand content in gray and orange clay and high plasticity (20'-30')
10–20		7.0/10.0		
20–30		10.0/10.0		
30–40		10.0/10.0	CL/SC	(30 - 45) Sandy CLAY/Clayey SAND, gray, moist to wet, very fine grained, firm, weak cementation, medium plasticity, softens and increasing wetness with depth (35'-39'), brown with increased iron content (39'-42'), dark gray, dry, and none to low plasticity (39'-45')
40–50		10.0/10.0	SP	(45 - 47) Clayey SAND, wet, soft, weak cementation, medium to high plasticity
			CL	(47 - 50) Sandy CLAY, dark gray, fine grained, dry, firm to hard, weak cementation

Depth scale (ft): 0, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 52

PBW

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Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446

Notes:
1. This log should not be used separately from the report to which it is attached.

Well Materials
(0-30) Casing, 2" Sch 40 FJT PVC
(30-40) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-26') Grout
(26'-28') Bentonite pellets
(28'-40') 20/40 sand

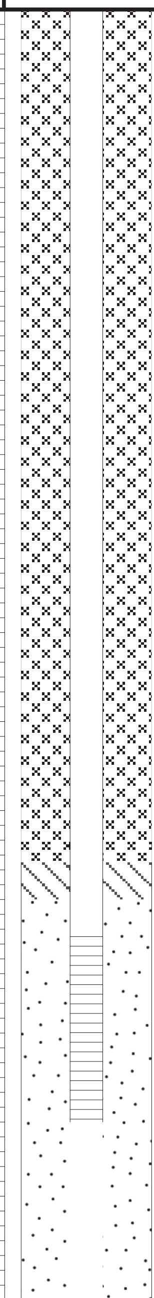
Luminant

Log of Boring: PDP-25

Martin Lake Steam Electric Station
Tatum, TX

PBW Project No. 5164B

Completion Date:	9/11/2015	Drilling Method:	Sonic
Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
Driller:	Timmy Beach	Total Depth (ft):	70
Driller's License:	5814M	TOC Elevation (ft. AMSL):	
Logged By:	Ryan Francis	Northing:	
Sampling Method:	4"x10' Core barrel	Easting:	



Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0 - 44	10.0/10.0 (0-10); 10.0/10.0 (10-20); 10.0/10.0 (20-30); 10.0/10.0 (30-40); 10.0/10.0 (40-50)	CL	(0 - 44) Sandy CLAY, red to gray and tan, very fine grained, dry to moist, firm, low to medium plasticity, weak to moderate cementation, micro laminated, minor organics, variable sand content with depth, high plasticity and very low sand content (22'-23'), higher sand content and high iron content with occasional subrounded pebbles (27'-30'), red, orange, tan, and gray mottling (30'-44')
44 - 68	10.0/10.0 (50-60); 10.0/10.0 (60-70)	SP	(44 - 68) Clayey SAND, gray, moist, soft to firm, minor orange streaking, low plasticity, weak cementation, subrounded, minor wet and soft clay zone (62'-64')
68 - 70		CL	(68 - 70) CLAY, black, minor silt, dry, very hard, moderate cementation, smooth shiny surface when fractured

PBW

Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446

Notes:
1. This log should not be used separately from the report to which it is attached.

Well Materials
(0-50) Casing, 2" Sch 40 FJT PVC
(50-60) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-46') Grout
(46'-48') Bentonite pellets
(48'-60') 20/40 sand

Luminant

Log of Boring: PDP-26

Martin Lake Steam Electric Station
Tatum, TX

PBW Project No. 5164B

Completion Date:	9/9/2015	Drilling Method:	Sonic
Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
Driller:	Timmy Beach	Total Depth (ft):	50
Driller's License:	5814M	TOC Elevation (ft. AMSL):	
Logged By:	Ryan Francis	Northing:	
Sampling Method:	4"x10' Core barrel	Easting:	

Depth (ft)	Well Materials	Recovery (ft/ft)	USCS	Lithologic Description
0		10.0/10.0	SP	(0 - 3) SAND, tan, dry, very soft, weak cementation
4			SC	(3 - 6) Clayey SAND, dry, firm, black lignite present
8			CL	(6 - 9) CLAY with minor sand, red, moist, firm, medium plasticity, smear zone black lignite
12		10.0/10.0	SC	(9 - 16) Clayey SAND, tan, moist, soft, low plasticity, more clay content with depth
16–40		10.0/10.0; 10.0/10.0	CL	(16 - 40) CLAY, tan, micro laminated orange and gray, moist, soft, medium plasticity, dry and silty clay (19'-27'), micro laminated gray and dark gray (27'-36'), increasing sand content (30'-36'), organics layer (36.5'-37'), high iron content (39'-40')
44		10.0/10.0	SP	(40 - 48) SAND, tan, medium, moist to wet, soft, subrounded
48			CL	(48 - 50) CLAY, gray, micro laminated, dry, firm, moderate cementation
52				

PBW
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Notes:
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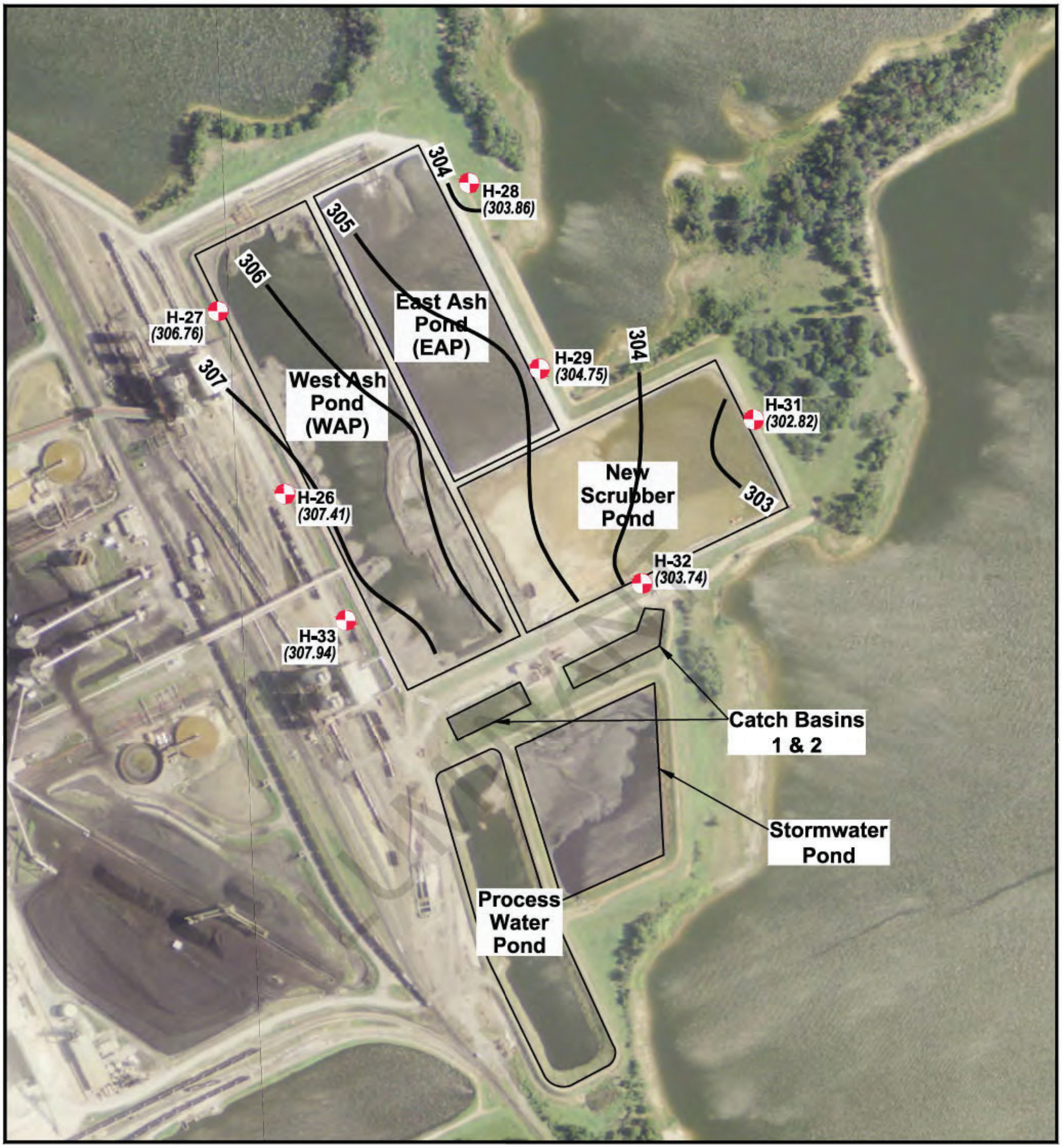
Well Materials
(0-39) Casing, 2" Sch 40 FJT PVC
(39-49) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-35') Grout
(35'-37') Bentonite pellets
(37'-49') 20/40 sand

APPENDIX F3 - MAPS OF THE DIRECTION OF GROUNDWATER FLOW



EXPLANATION

CCR Monitoring Well Location

(308.70) Groundwater Potentiometric Surface (ft. MSL)

— 308 — Groundwater Potentiometric Surface Contour (C.I. = 1 ft.)

N

Scale in Feet

0 250 500

SOURCE: Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

MARTIN LAKE STEAM ELECTRIC STATION

TATUM, TEXAS

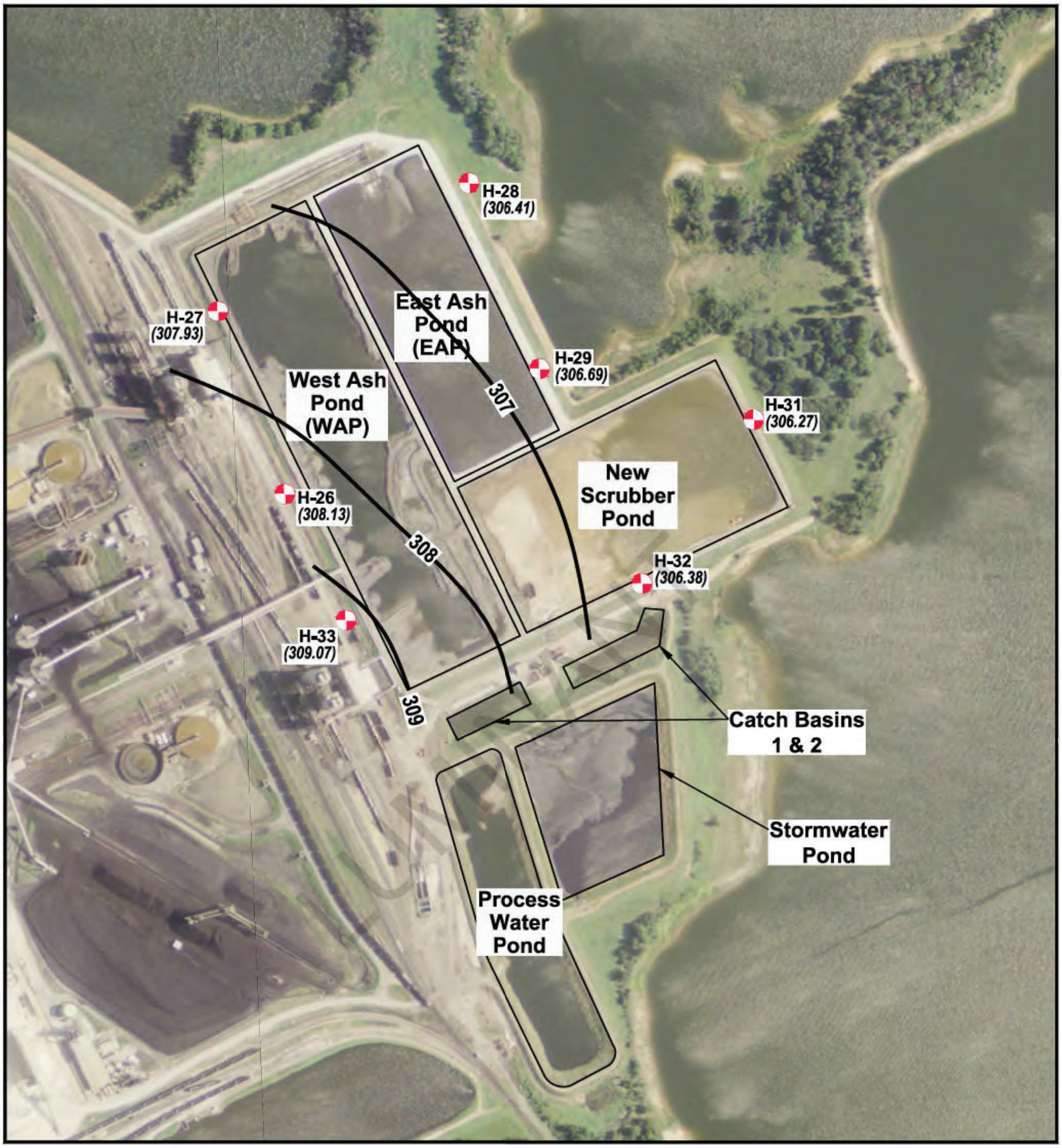
Figure 1

ASH POND AREA - GROUNDWATER ZONE B POTENTIOMETRIC SURFACE MAP - OCTOBER 21-22, 2015

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC

CONSULTING ENGINEERS AND SCIENTISTS



EXPLANATION

CCR Monitoring Well Location

(308.70) Groundwater Potentiometric Surface (ft. MSL)

— 308 — Groundwater Potentiometric Surface Contour (C.I. = 1 ft.)

N

Scale in Feet

0 250 500

SOURCE: Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

MARTIN LAKE STEAM ELECTRIC STATION

TATUM, TEXAS

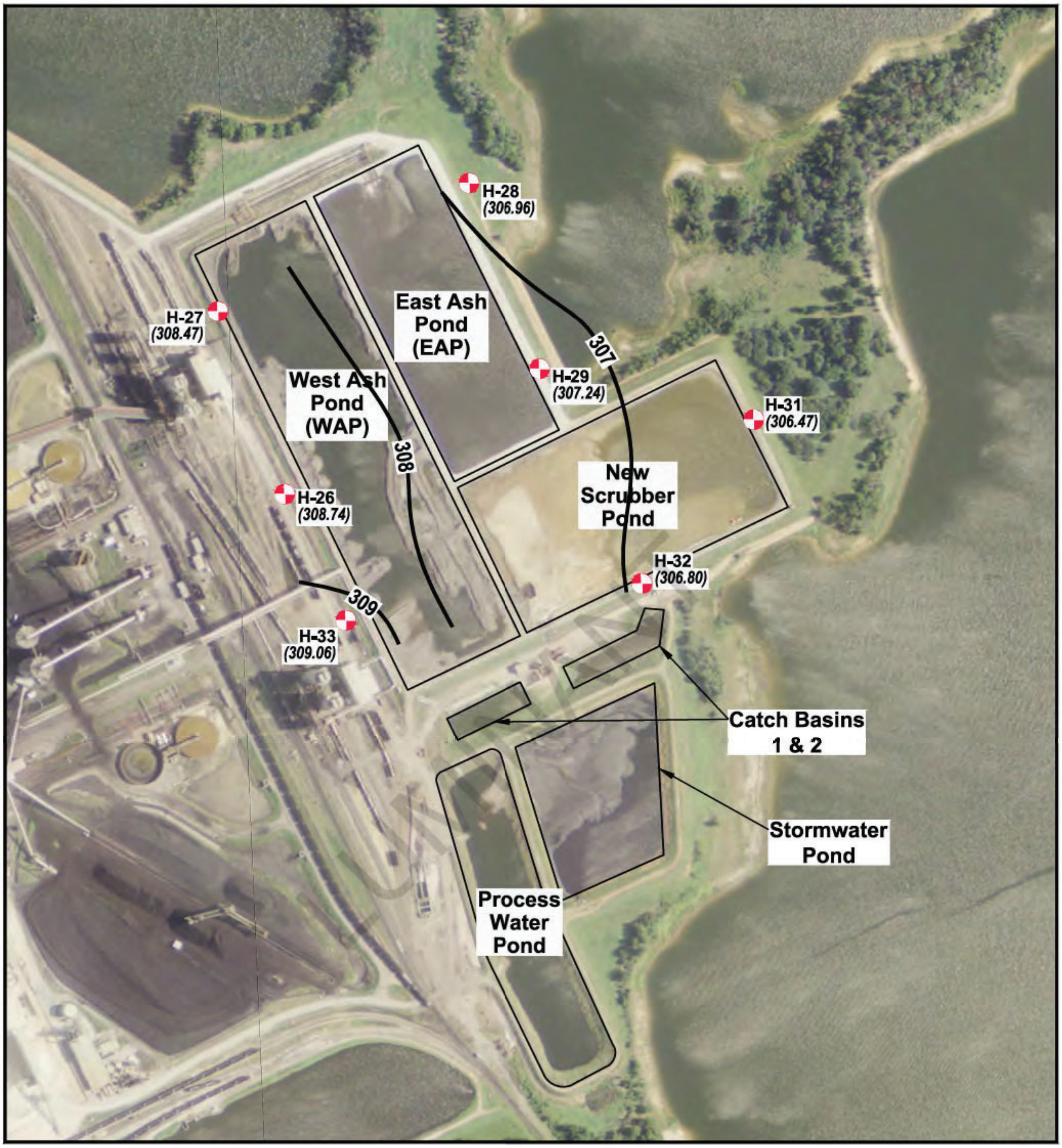
Figure 2

ASH POND AREA - GROUNDWATER ZONE B POTENTIOMETRIC SURFACE MAP - DECEMBER 14, 2015

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC

CONSULTING ENGINEERS AND SCIENTISTS



EXPLANATION

CCR Monitoring Well Location

(308.70) Groundwater Potentiometric Surface (ft. MSL)

— 308 — Groundwater Potentiometric Surface Contour (C.I. = 1 ft.)

N

Scale in Feet

0 250 500

SOURCE: Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

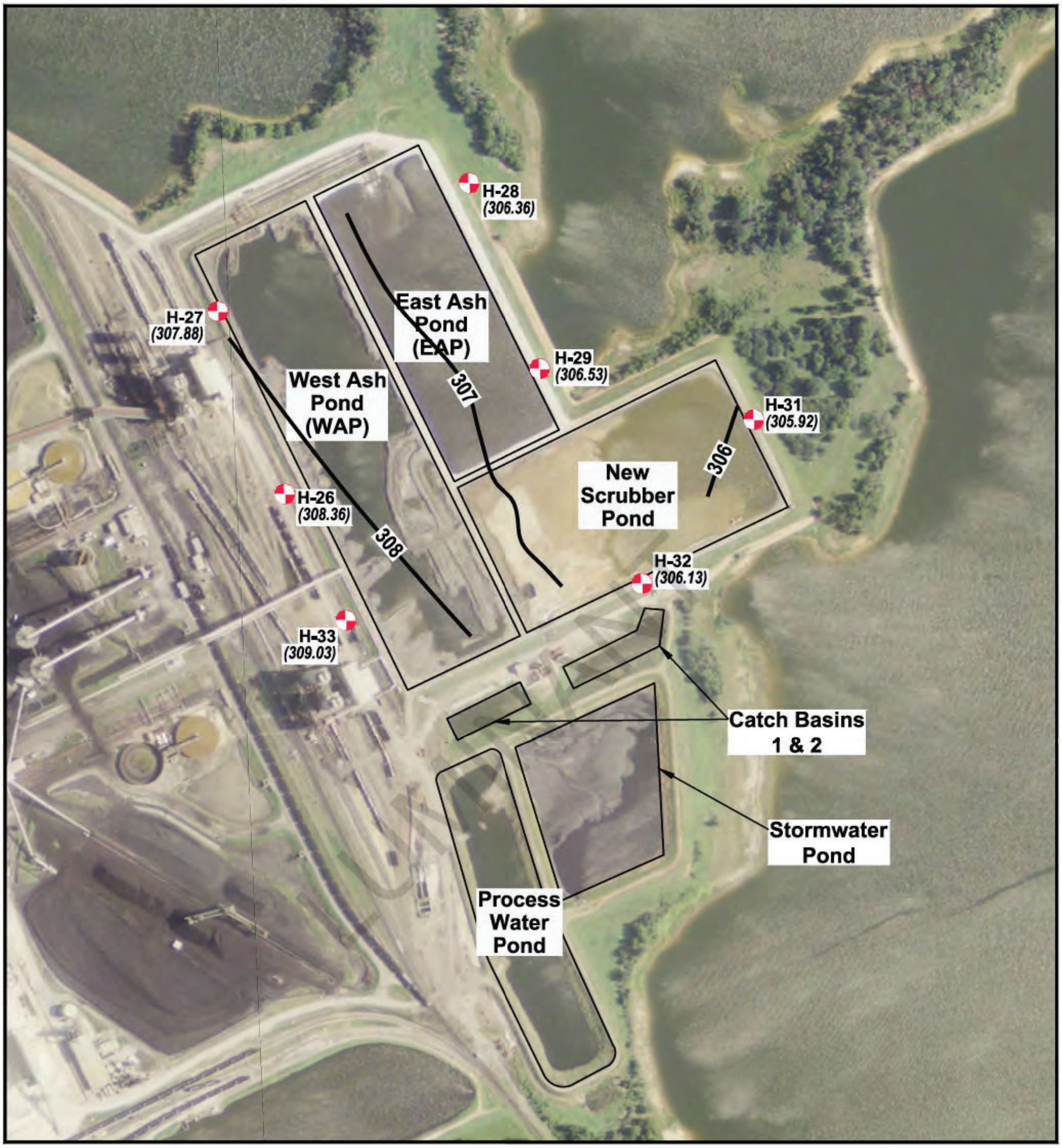
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

Figure 3

ASH POND AREA - GROUNDWATER ZONE B POTENTIOMETRIC SURFACE MAP - FEBRUARY 25, 2016

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS



EXPLANATION

CCR Monitoring Well Location

(308.70) Groundwater Potentiometric Surface (ft. MSL)

— 308 — Groundwater Potentiometric Surface Contour (C.I. = 1 ft.)

N

Scale in Feet

0 250 500

SOURCE: Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

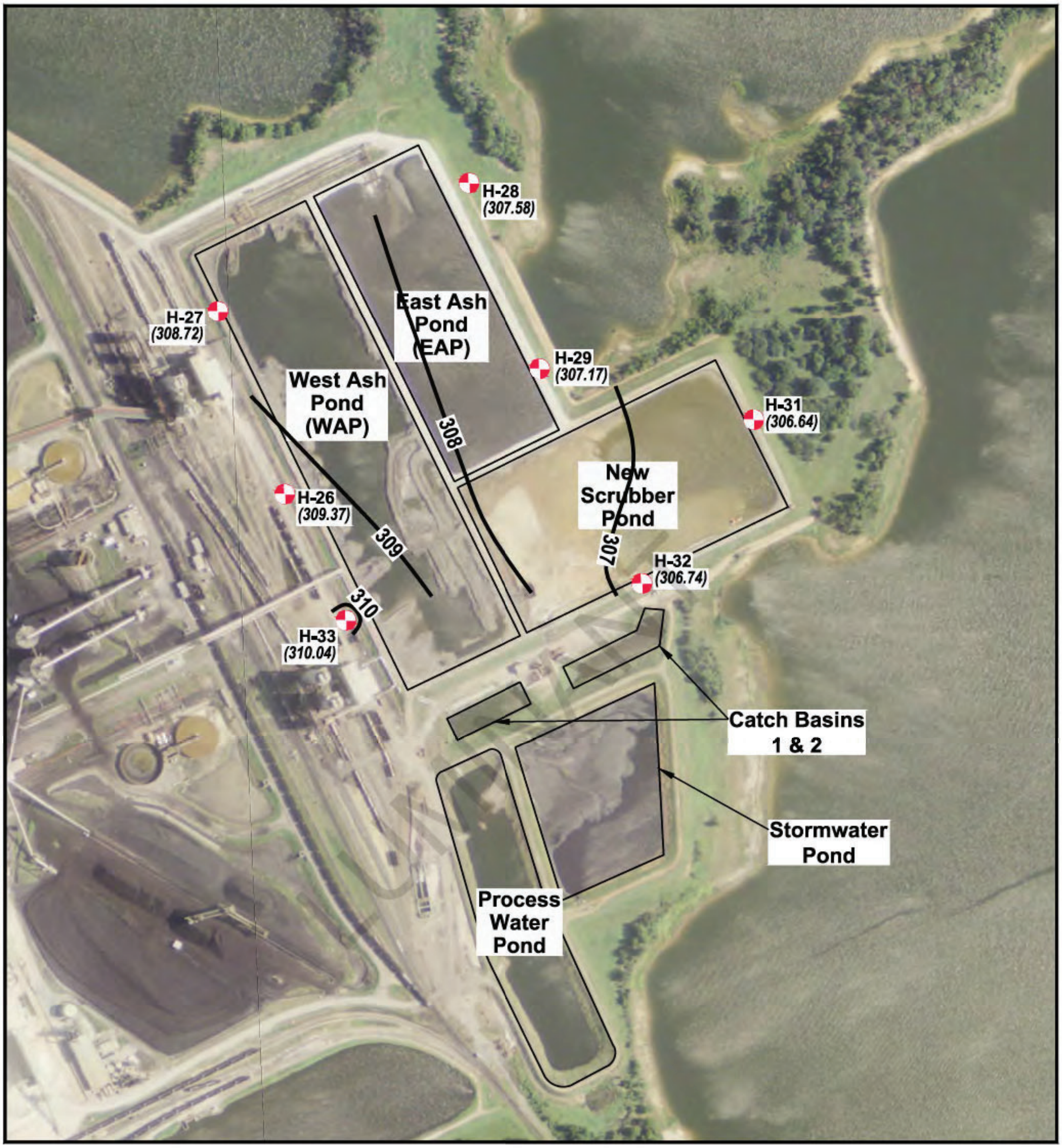
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

Figure 4

ASH POND AREA - GROUNDWATER ZONE B POTENTIOMETRIC SURFACE MAP - APRIL 5, 2016

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS



EXPLANATION

CCR Monitoring Well Location

(308.70) Groundwater Potentiometric Surface (ft. MSL)

— 308 — Groundwater Potentiometric Surface Contour (C.I. = 1 ft.)

N

Scale in Feet

0 250 500

SOURCE: Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

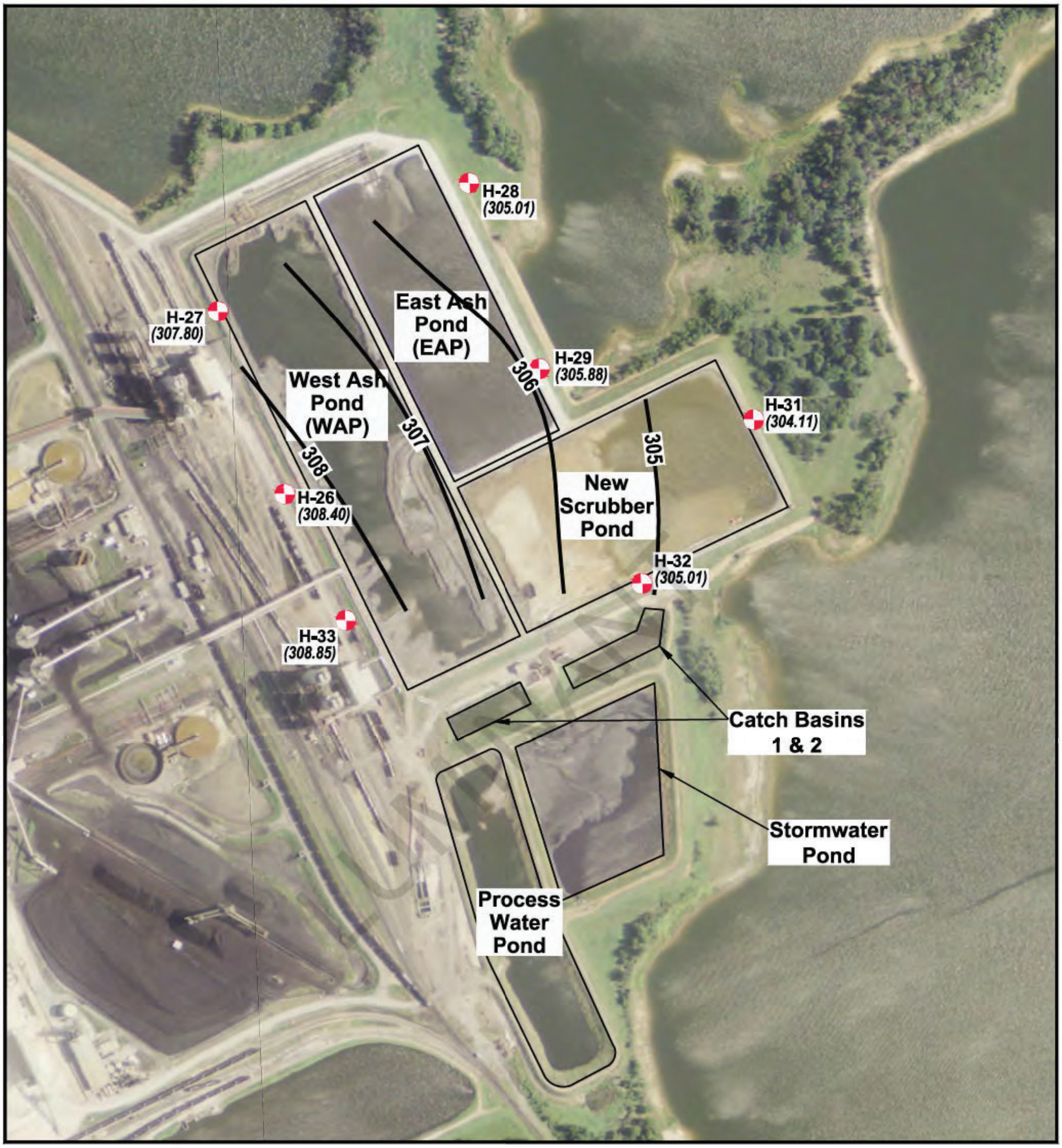
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

Figure 5

ASH POND AREA - GROUNDWATER ZONE B POTENTIOMETRIC SURFACE MAP - JUNE 6, 2016

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS



EXPLANATION

CCR Monitoring Well Location

(308.70) Groundwater Potentiometric Surface (ft. MSL)

— 308 — Groundwater Potentiometric Surface Contour (C.I. = 1 ft.)

N

Scale in Feet

0 250 500

SOURCE: Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

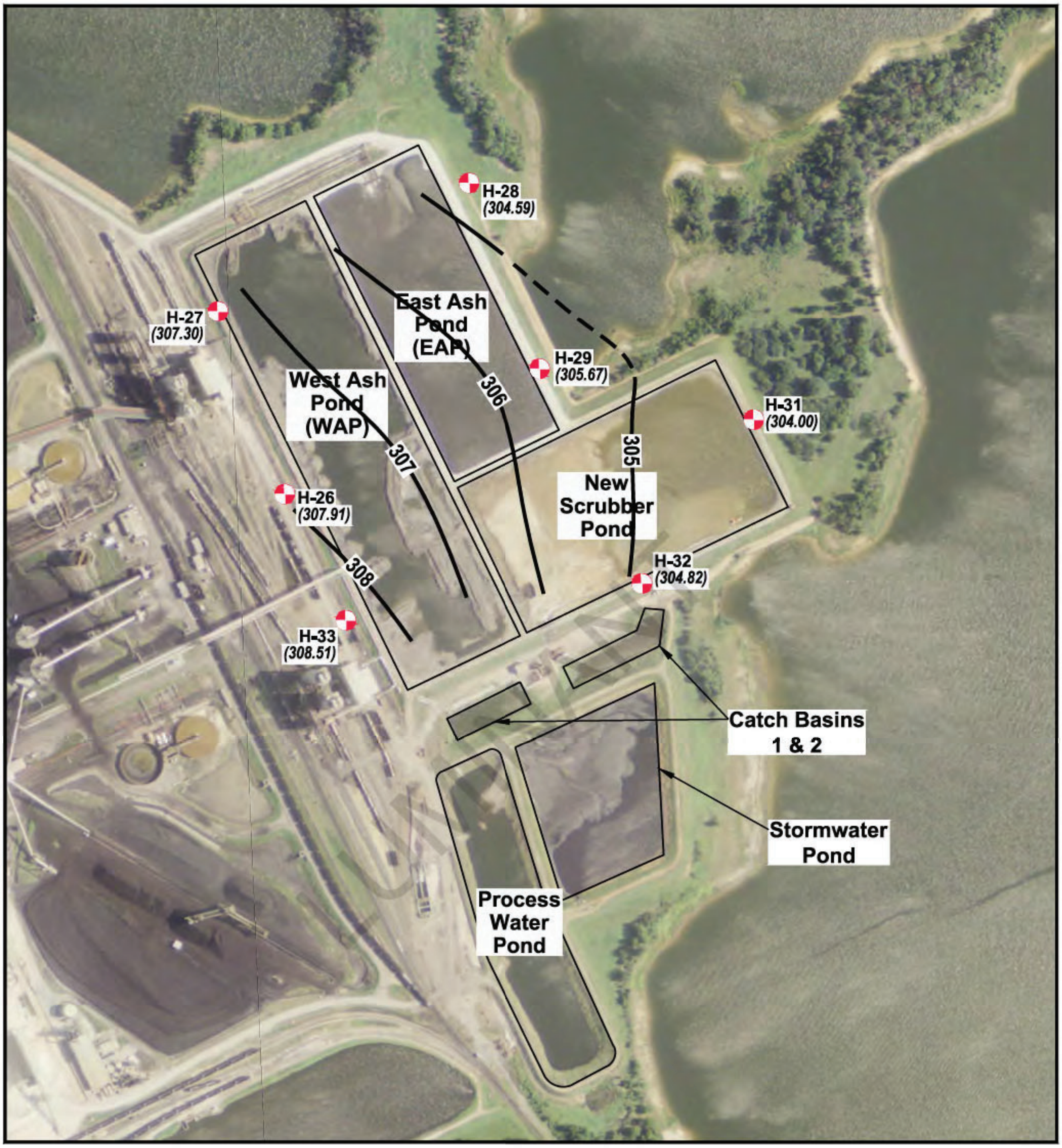
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

Figure 6

ASH POND AREA - GROUNDWATER ZONE B POTENTIOMETRIC SURFACE MAP - AUGUST 9, 2016

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS



EXPLANATION

CCR Monitoring Well Location

(308.70) Groundwater Potentiometric Surface (ft. MSL)

— 308 — Groundwater Potentiometric Surface Contour (C.I. = 1 ft.)

N

Scale in Feet

0 250 500

SOURCE: Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

MARTIN LAKE STEAM ELECTRIC STATION

TATUM, TEXAS

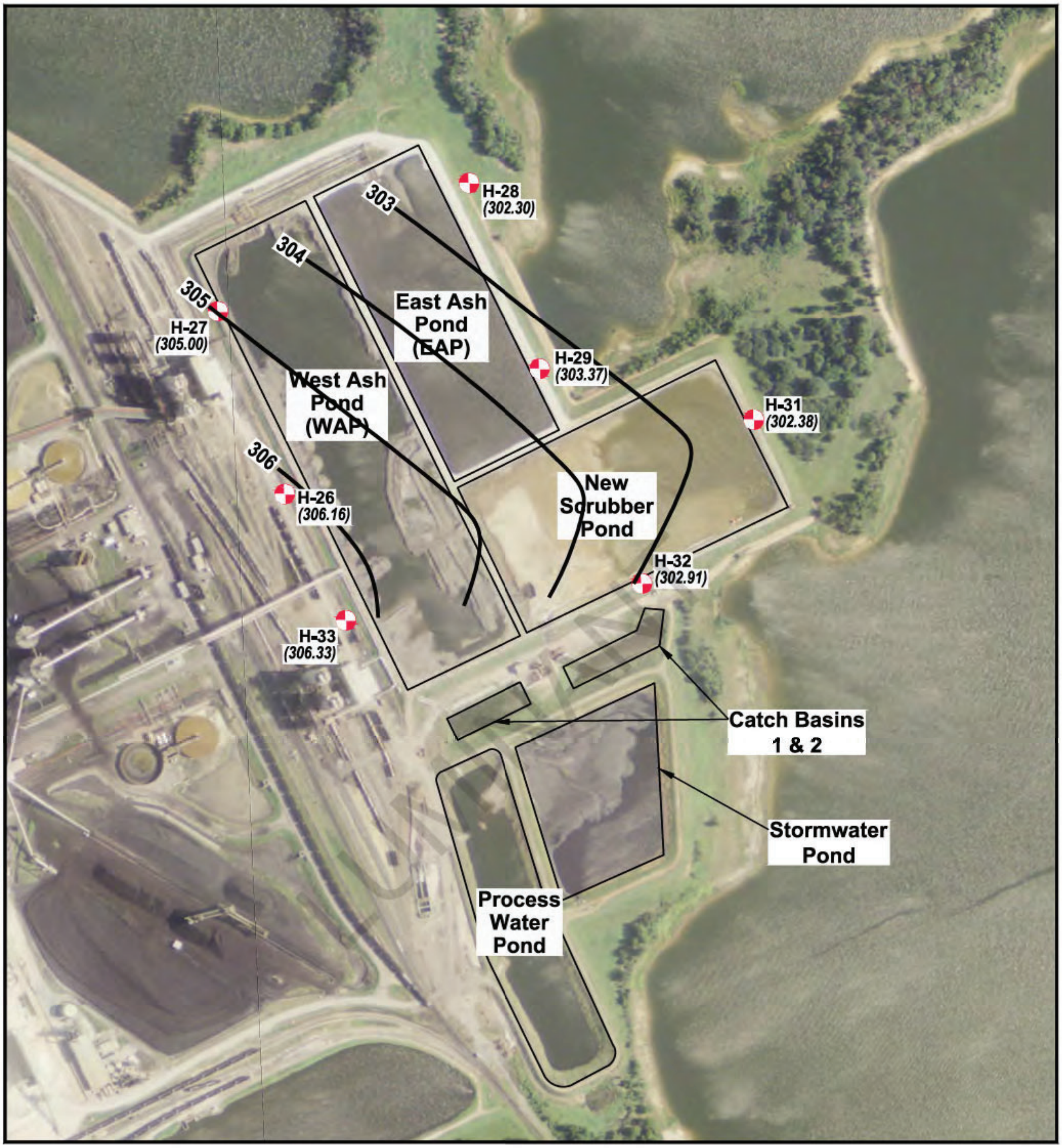
Figure 7

ASH POND AREA - GROUNDWATER ZONE B POTENTIOMETRIC SURFACE MAP - OCTOBER 17, 2016

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC

CONSULTING ENGINEERS AND SCIENTISTS



EXPLANATION

CCR Monitoring Well Location

(308.70) Groundwater Potentiometric Surface (ft. MSL)

— 308 — Groundwater Potentiometric Surface Contour (C.I. = 1 ft.)

N

Scale in Feet

0 250 500

SOURCE: Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

Figure 8

ASH POND AREA - GROUNDWATER ZONE B POTENTIOMETRIC SURFACE MAP - DECEMBER 11, 2016

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS

LEGEND

- DOWNGRADIENT CCR MONITORING WELL
- UPGRADIENT CCR MONITORING WELL
- *(308.70)* GROUNDWATER POTENTIOMETRIC SURFACE (FT MSL)
- 308 GROUNDWATER POTENTIOMETRIC SURFACE CONTOUR (C.I. = 1 FT)

CLIENT
LUMINANT

PROJECT
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

TITLE
ASH POND AREA
POTENTIOMETRIC SURFACE MAP
MAY 14, 2019

CONSULTANT

GOLDER

YYYY-MM-DD	2019-06-24
DESIGNED	AJD
PREPARED	AJD
REVIEWED	WFV
APPROVED	WFV

PROJECT NO. 19122449 REV. 0 FIGURE 6

REFERENCE(S)
BASE MAP TAKEN FROM GOOGLE EARTH, IMAGERY DATED

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

EXPLANATION

CCR Monitoring Well Location

Non-CCR Monitoring Well Used to Further Evaluate Groundwater Flow Direction

(374.34) Groundwater Potentiometric Surface (ft. MSL)

— 360 — Groundwater Potentiometric Surface Contour (C.I. = 5 ft.)

N

Scale in Feet

0 275 550

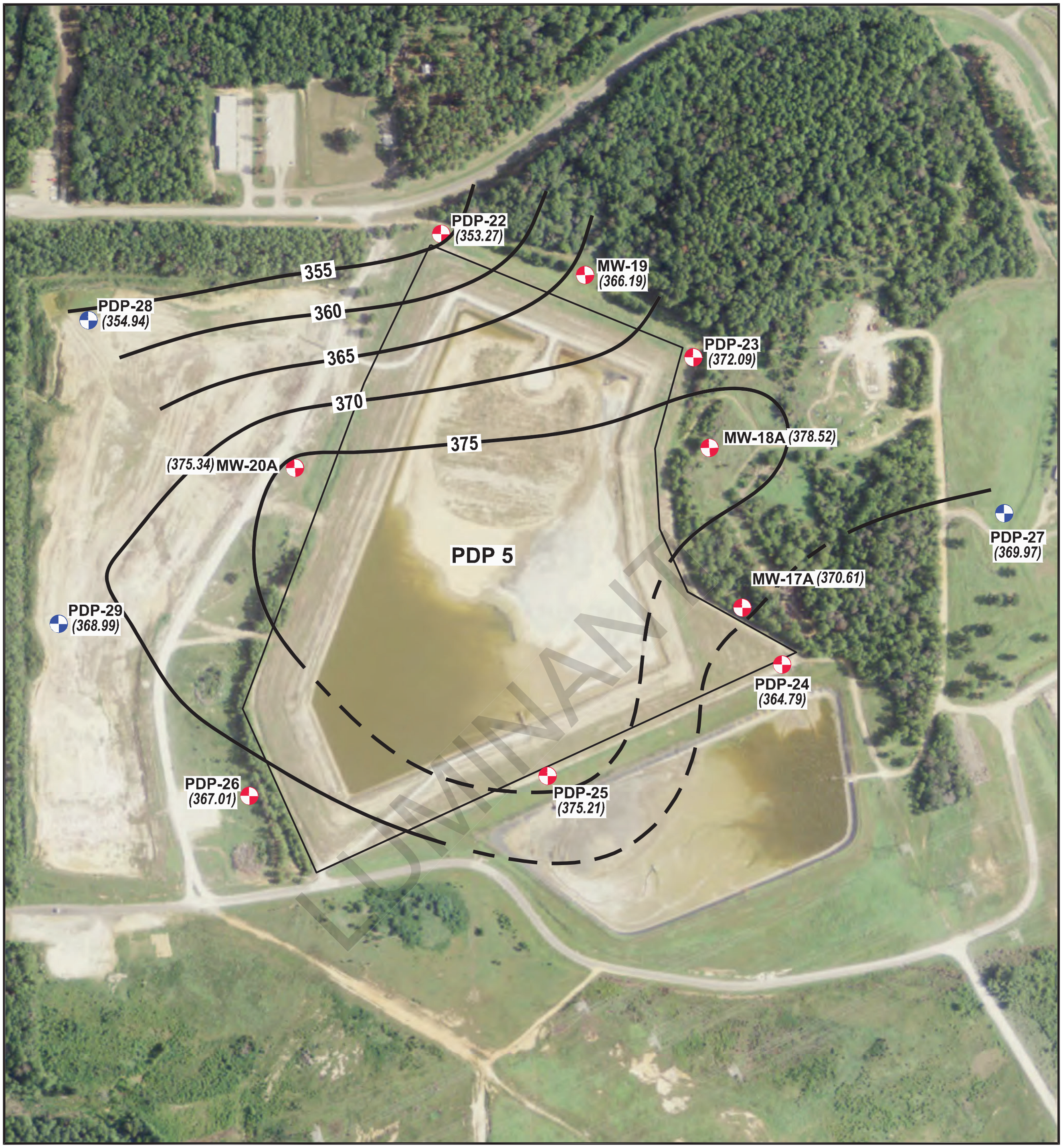
SOURCE:
Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

PDP 5 - GROUNDWATER ZONE A POTENTIOMETRIC SURFACE MAP OCTOBER 20, 2015

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS



EXPLANATION

CCR Monitoring Well Location

Non-CCR Monitoring Well Used to Further Evaluate Groundwater Flow Direction

(374.34) Groundwater Potentiometric Surface (ft. MSL)

— 360 — Groundwater Potentiometric Surface Contour (C.I. = 5 ft.)

N

Scale in Feet

0 275 550

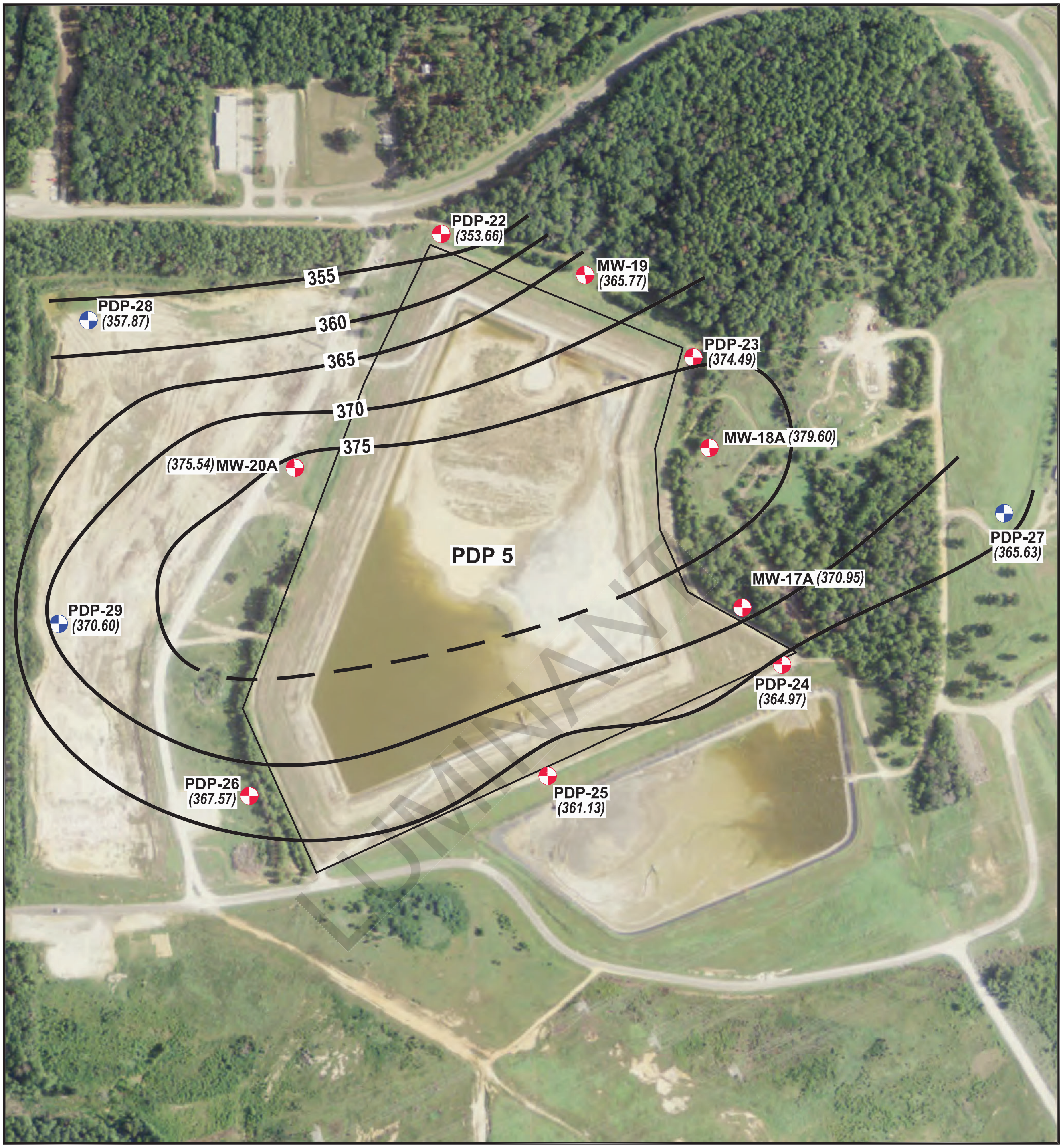
SOURCE:
Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

PDP 5 - GROUNDWATER ZONE A POTENTIOMETRIC SURFACE MAP - DEC. 14, 2015

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS



EXPLANATION

CCR Monitoring Well Location

Non-CCR Monitoring Well Used to Further Evaluate Groundwater Flow Direction

(374.34) Groundwater Potentiometric Surface (ft. MSL)

— 360 — Groundwater Potentiometric Surface Contour (C.I. = 5 ft.)

N

Scale in Feet

0 275 550

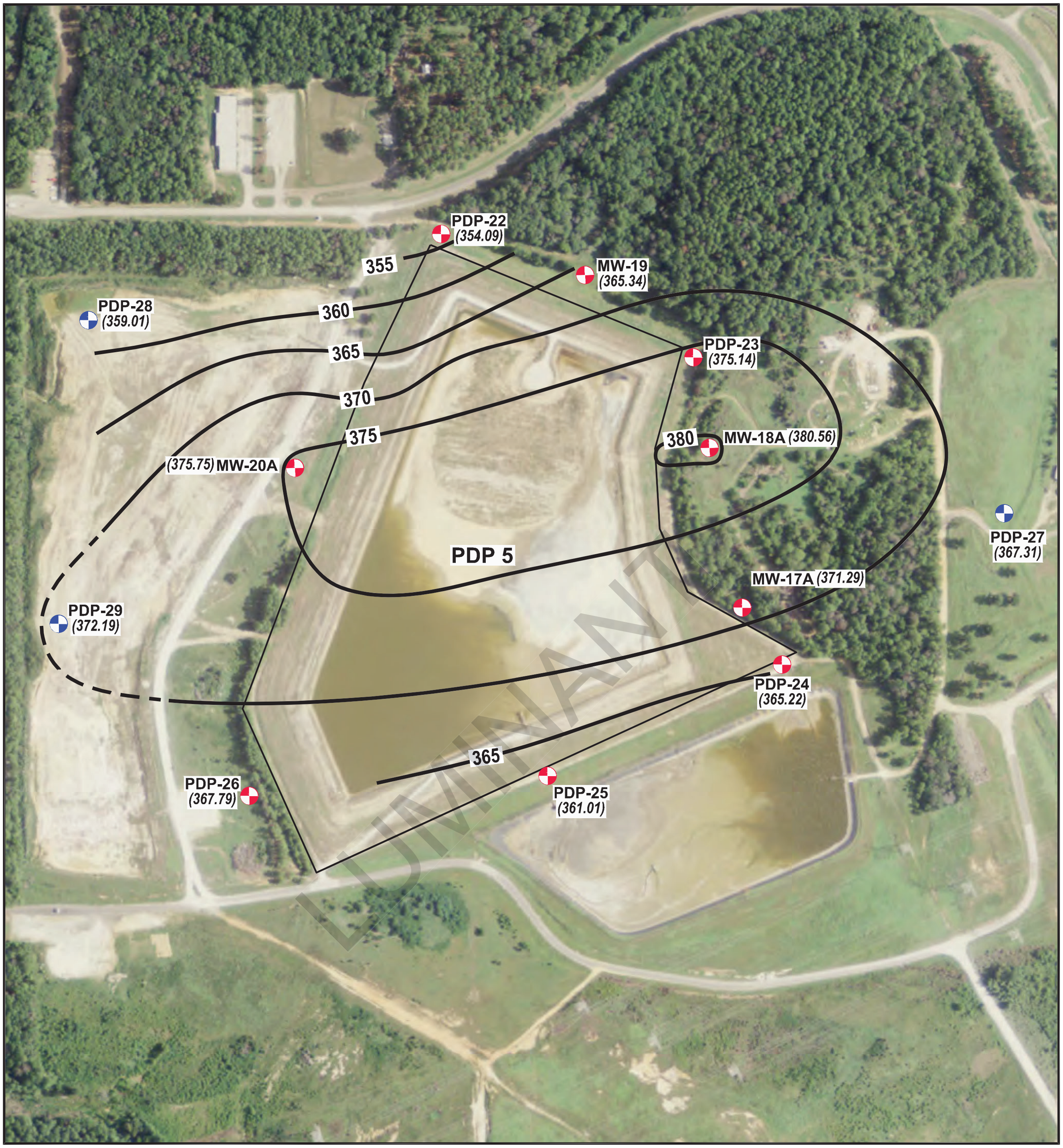
SOURCE:
Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

PDP 5 - GROUNDWATER ZONE A POTENTIOMETRIC SURFACE MAP - FEB. 24, 2016

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS



EXPLANATION

CCR Monitoring Well Location

Non-CCR Monitoring Well Used to Further Evaluate Groundwater Flow Direction

(374.34) Groundwater Potentiometric Surface (ft. MSL)

— 360 — Groundwater Potentiometric Surface Contour (C.I. = 5 ft.)

N

Scale in Feet

0 275 550

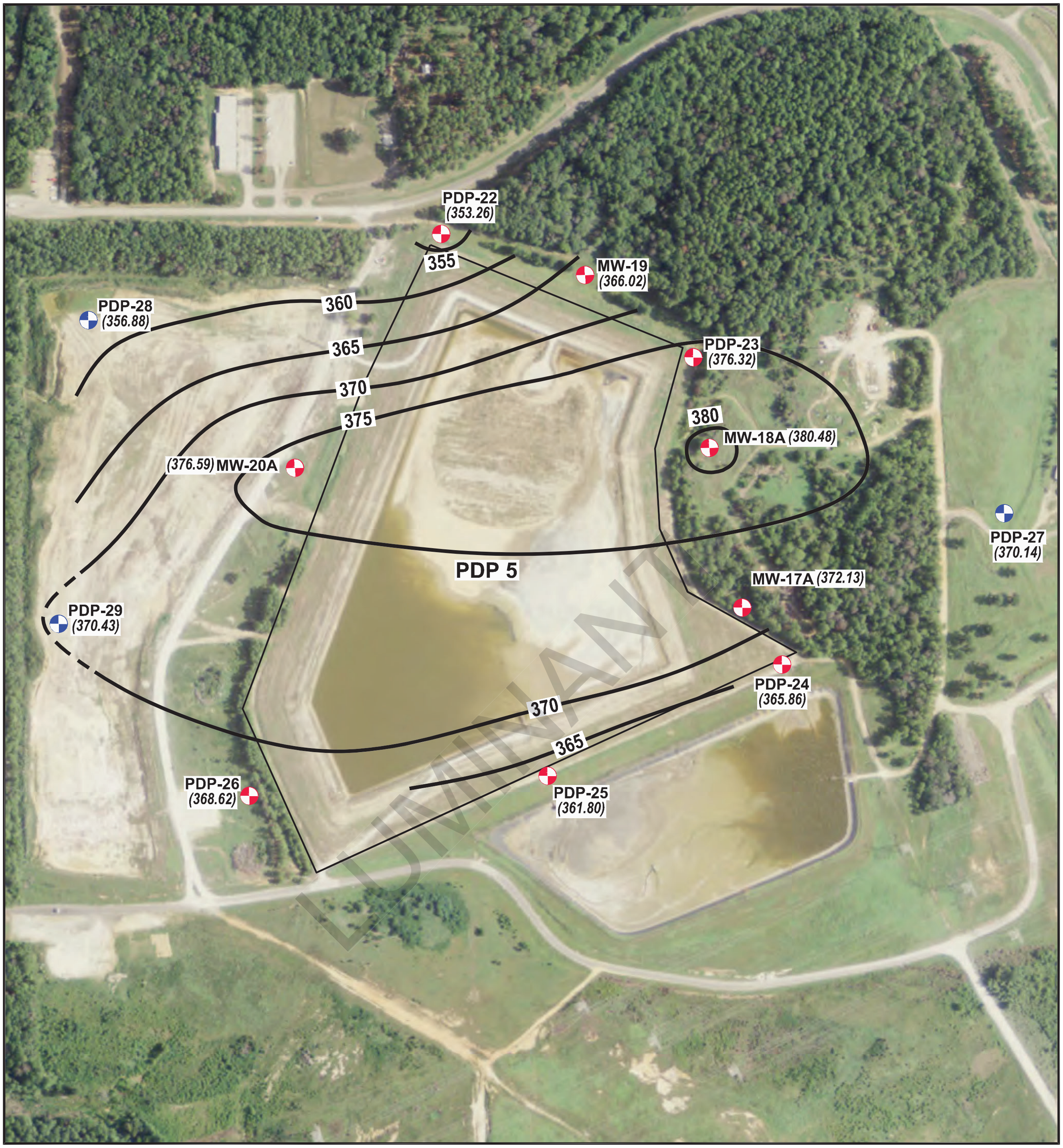
SOURCE:
Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

PDP 5 - GROUNDWATER ZONE A POTENTIOMETRIC SURFACE MAP - APRIL 5, 2016

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS



EXPLANATION

CCR Monitoring Well Location

Non-CCR Monitoring Well Used to Further Evaluate Groundwater Flow Direction

(374.34) Groundwater Potentiometric Surface (ft. MSL)

— 360 — Groundwater Potentiometric Surface Contour (C.I. = 5 ft.)

N

Scale in Feet

0 275 550

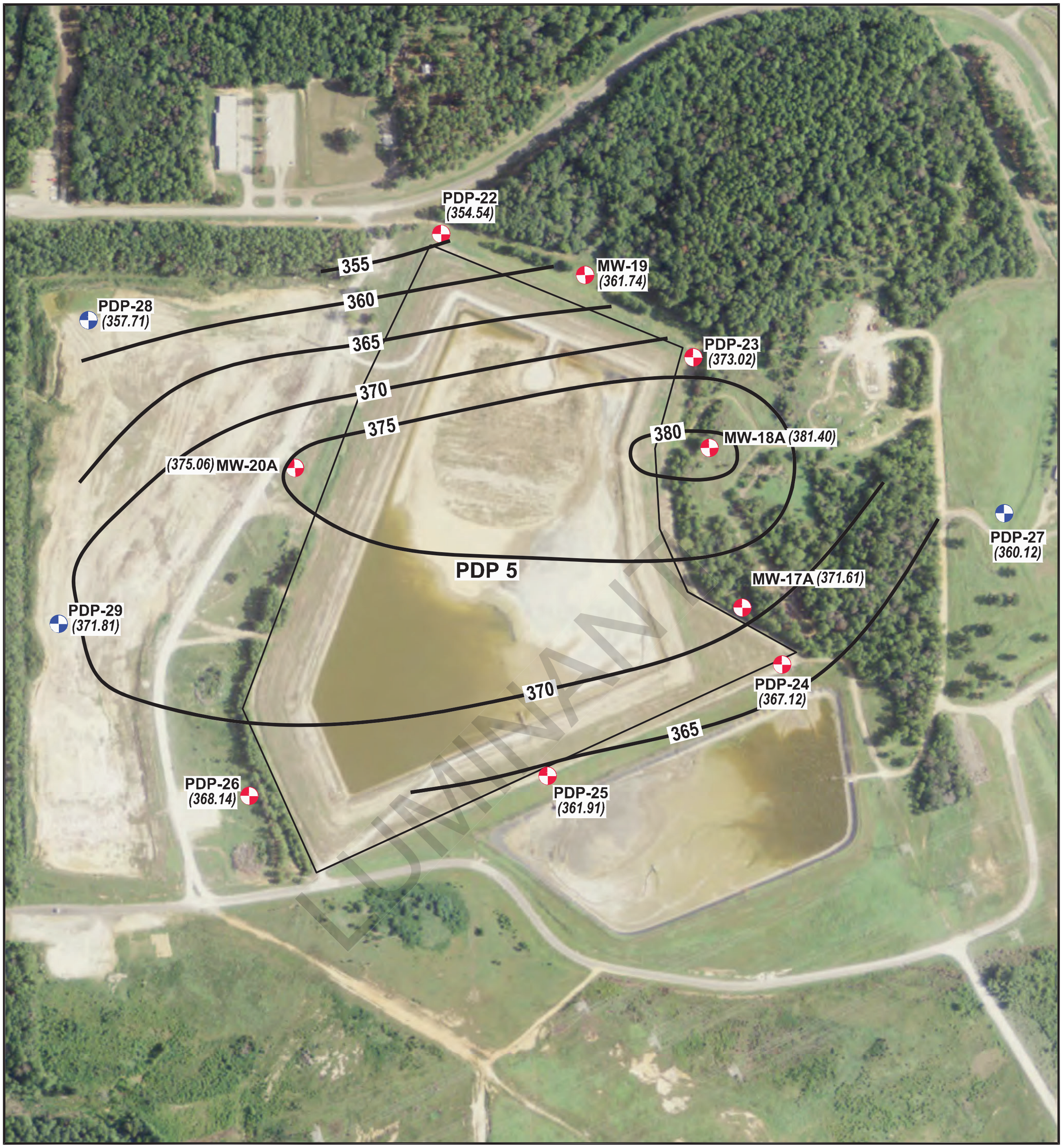
SOURCE:
Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

PDP 5 - GROUNDWATER ZONE A POTENTIOMETRIC SURFACE MAP - JUNE 6, 2016

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS



EXPLANATION

CCR Monitoring Well Location

Non-CCR Monitoring Well Used to Further Evaluate Groundwater Flow Direction

(374.34) Groundwater Potentiometric Surface (ft. MSL)

— 360 — Groundwater Potentiometric Surface Contour (C.I. = 5 ft.)

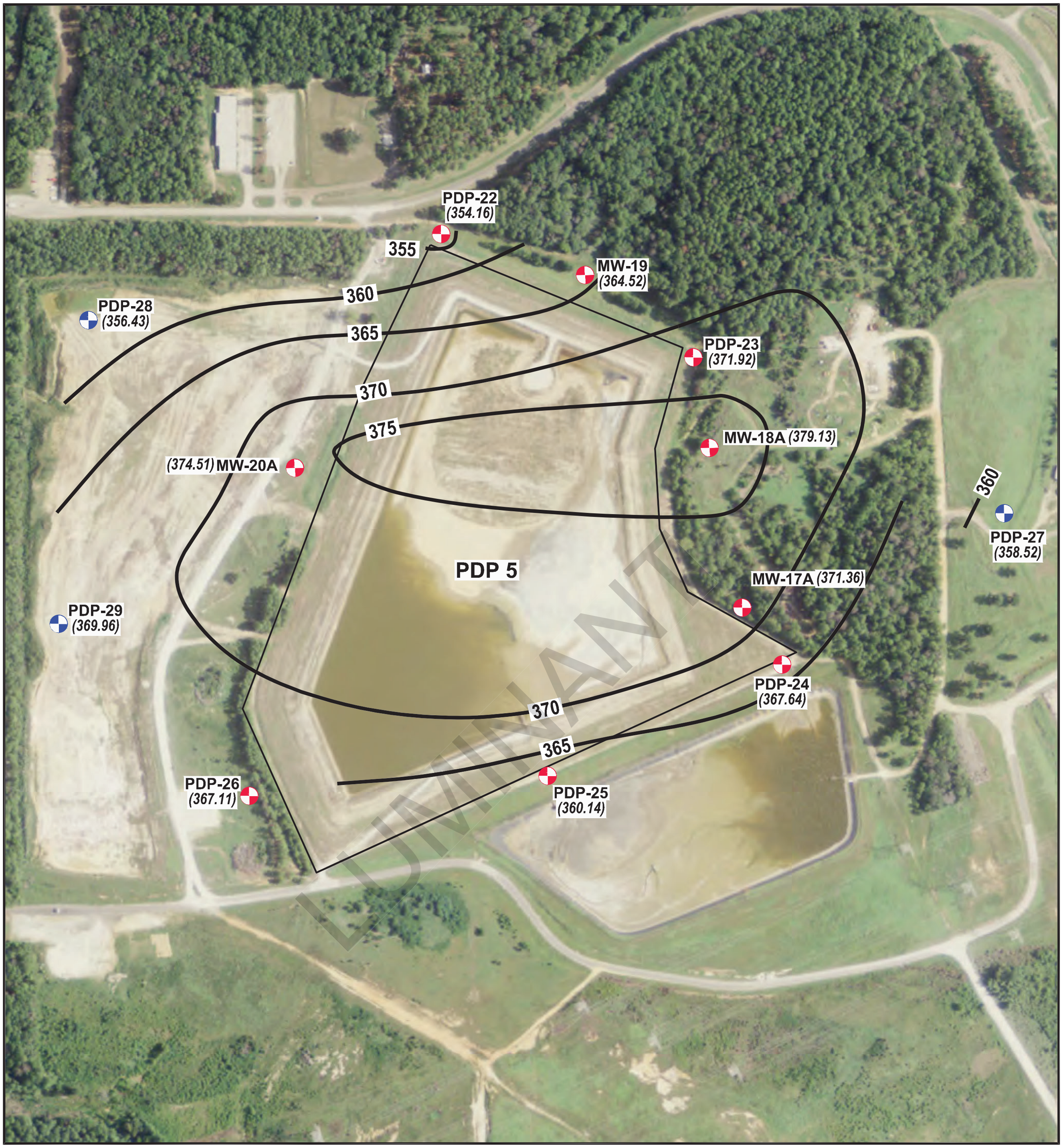
N

Scale in Feet

0 275 550

SOURCE:
Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

MARTIN LAKE STEAM ELECTRIC STATION TATUM, TEXAS		
PDP 5 - GROUNDWATER ZONE A POTENTIOMETRIC SURFACE MAP - AUGUST 9, 2016		
PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	
PASTOR, BEHLING & WHEELER, LLC CONSULTING ENGINEERS AND SCIENTISTS		



EXPLANATION

CCR Monitoring Well Location

Non-CCR Monitoring Well Used to Further Evaluate Groundwater Flow Direction

(374.34) Groundwater Potentiometric Surface (ft. MSL)

— 360 — Groundwater Potentiometric Surface Contour (C.I. = 5 ft.)

N

Scale in Feet

0 275 550

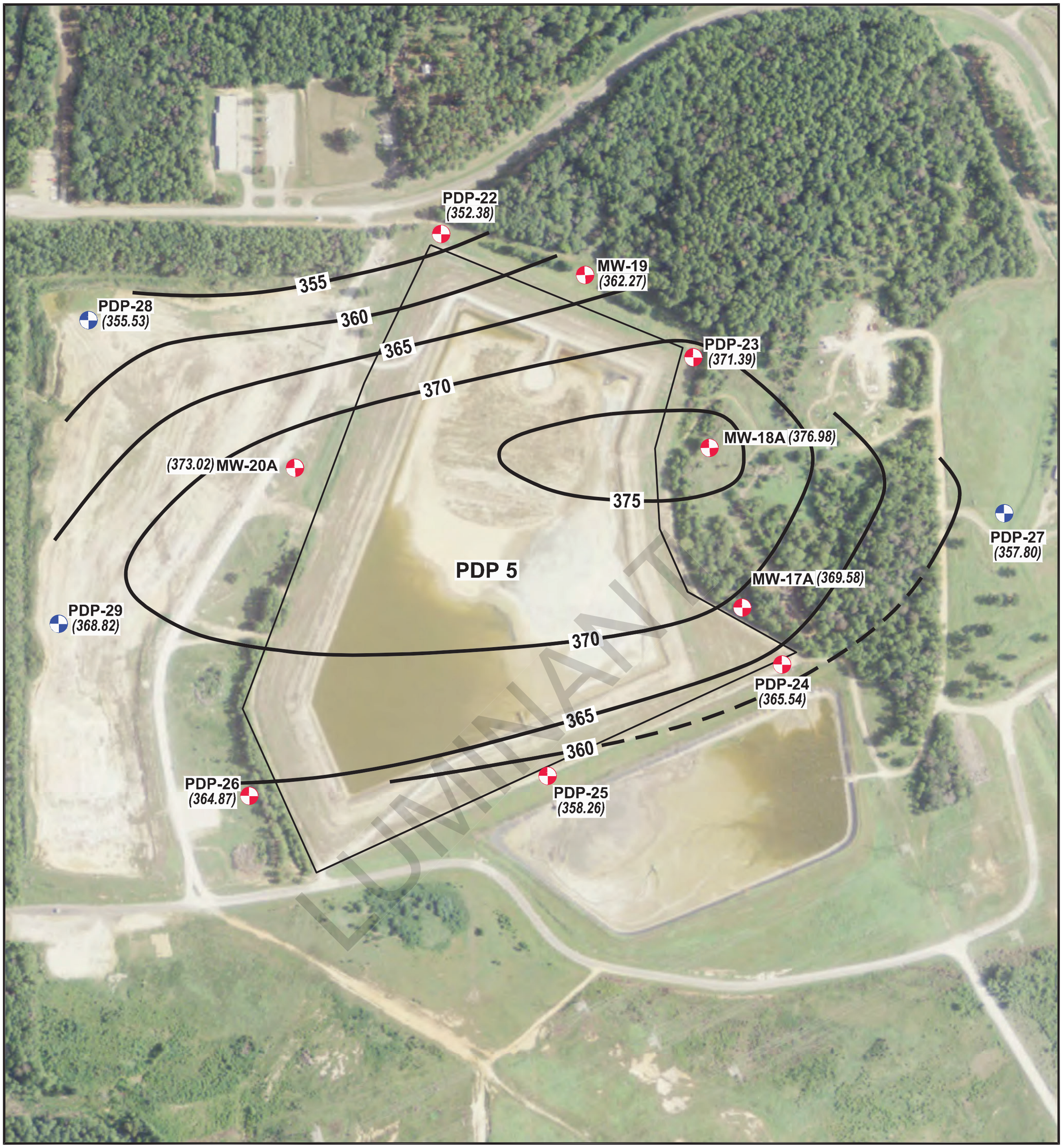
SOURCE:
Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

PDP 5 - GROUNDWATER ZONE A POTENTIOMETRIC SURFACE MAP - OCTOBER 17, 2016

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS



EXPLANATION

CCR Monitoring Well Location

Non-CCR Monitoring Well Used to Further Evaluate Groundwater Flow Direction

(374.34) Groundwater Potentiometric Surface (ft. MSL)

— 360 — Groundwater Potentiometric Surface Contour (C.I. = 5 ft.)

N

Scale in Feet

0 275 550

SOURCE:
Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

PDP 5 - GROUNDWATER ZONE A POTENTIOMETRIC SURFACE MAP - DECEMBER 11, 2016

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS

APPENDIX F4 - TABLES SUMMARIZING CONSTITUENT CONCENTRATIONS AT EACH MONITORING WELL

TABLE 1
APPENDIX III GROUNDWATER ANALYTICAL DATA
MARTIN LAKE STEAM ELECTRIC STATION
ASH POND AREA

Sample Location	Date Sampled	B (mg/L)	Ca (mg/L)	Cl (mg/L)	Fl (mg/L)	pH (s.u.)	SO_4 (mg/L)	TDS (mg/L)
Prediction Limit		0.602	57.2	153	0.4	4.63 7.6	365	1110
Upgradient Wells								
H-26	10/21/15	0.602	24.2	69.2	<0.1	5.82	154	466
	12/14/15	0.0679	9.88	40.3	<0.1	5.91	75.8	280
	02/23/16	0.206	11.7	17.1	0.151 J	6.84	54	219
	04/05/16	0.289	11.8	27.8	0.199 J	5.89	56.8	213
	06/07/16	0.441	11.7	48.6	<0.1	5.98	72.2	278
	08/09/16	0.569	14	70	<0.1	4.63	90.9	354
	10/18/16	0.439	13.6	49.1	0.127 J	6.63	69.7	263
	12/11/16	0.537	11.9	57.6	0.161 J	6.73	68.8	236
	09/21/17	0.579	13.1	67.8	<0.100	6.88	69.6	288
	06/13/18	0.512	17	66.1	<0.100	6.74	67	313
	09/07/18	0.606	11.3	65.1	<0.100	6.85	60.7	265
	05/14/19	0.0507	85.2	61.7	0.140 J	6.83	88.2	453
	09/10/19	0.505	12	72.1	<0.1	6.75	69.4	265
	05/13/20	0.644	30.4	71	<0.100		58.4	280
H-27	10/21/15	0.58	55.3	117	<0.1	6.24	328	800
	12/14/15	0.474	57.2	112	0.156 J	6.32	317	857
	02/23/16	0.523	53.8	113	0.101 J	5.82	344	811
	04/05/16	0.48	52.7	115	0.124 J	6.04	360	819
	06/07/16	0.319	10.6	40.5	<0.1	6.32	55	207
	08/09/16	0.462	54.3	124	<0.1	4.35	365	854
	10/18/16	0.477	56.5	114	0.144 J	6.87	336	868
	12/11/16	0.427	52.8	119	0.161 J	6.78	355	805
	09/21/17	0.48	61.1	122	<0.100	6.87	378	852
	06/13/18	0.404	57	110	0.208 J	6.52	372	850
	09/07/18	0.347	6.96	58.3	0.14 J	6.72	188	716
	05/14/19	0.35	61.8	132	0.159 J	6.78	406	897
	09/10/19	0.368	57.7	117	<0.1	6.77	365	841
	05/13/20	0.583	53.1	93	<0.100		274	786
H-33	10/20/15	0.0462	17.9	60.5	<0.1	5.78	120	415
	12/14/15	0.0596	10.7	59.6	0.136 J	5.73	110	403
	02/23/16	0.0656	11.2	56.1	0.125 J	6.92	111	625
	04/05/16	0.0659	14.9	58.3	0.14 J	6.31	113	589
	06/07/16	0.0571	20.1	67.5	<0.1	6.04	121	515
	08/09/16	0.0431	11.2	64.9	<0.1	5.13	120	442
	10/18/16	0.0539	11.1	59.2	<0.1	6.86	114	398
	12/11/16	0.0594	12.1	63.2	0.132 J	6.85	112	395
	09/21/17	0.0452	13.7	67.9	<0.100	7.02	107	412
	06/13/18	0.114	24	65.5	0.105 J	6.72	93.8	447
	09/07/18	0.112	22.4	66.2	0.135 J	6.73	96.8	489
	05/14/19	0.0592	68.6	80.4	0.166 J	6.81	104	559
	09/10/19	0.0631	44.1	86.1	<0.1	6.75	119	495
	05/13/20	0.103	24	84.3	<0.100		113	439
Downgradient Wells								
H-28	10/21/15	9.25	113	109	<0.1	5.92	1,010	1,830
	12/14/15	1.02	17.3	15.5	<0.1	6.02	113	299
	02/23/16	10.2	123	97.4	<0.1	4.45	1,070	1,910
	04/05/16	10.3	120	94.4	<0.1	5.97	1,080	1,890
	06/07/16	3.66	45.4	62.2	<0.1	6.16	465	817
	08/09/16	9.29	116	98.4	<0.1	3.83	1,080	2,100
	10/18/16	4.96	67.3	91.4	0.165 J	6.82	643	1,460
	12/11/16	3.94	45.7	56.7	0.114 J	6.64	445	766
	09/21/17	6.06	74.1	88.5	<0.100	6.77	702	1,220
	06/13/18	6.97	92.1	96.5	0.126 J	6.59	826	1,490

TABLE 1
APPENDIX III GROUNDWATER ANALYTICAL DATA
MARTIN LAKE STEAM ELECTRIC STATION
ASH POND AREA

Sample Location	Date Sampled	B (mg/L)	Ca (mg/L)	Cl (mg/L)	Fl (mg/L)	pH (s.u.)	SO_4 (mg/L)	TDS (mg/L)
Prediction Limit		0.602	57.2	153	0.4	4.63 7.6	365	1110
	09/07/18	4.54	60.5	93.4	<0.100	6.84	679	1,330
	05/14/19	8.51	99.7	98.9	<0.100	6.32	935	1,680
	09/10/19	5.69	68.9	95.9	<0.100	6.89	716	1,390
	05/13/20	7.03	88.9	86.7	<0.100		676	1,220
H-29	10/21/15	0.0788	16	65.2	<0.1	5.78	171	441
	12/14/15	0.29	165	8.68	0.56	5.92	178	990
	02/23/16	0.268	59.4	14.6	0.239 J	11.20	156	334
	04/05/16	0.361	80.8	14.2	0.363 J	6.04	181	489
	06/07/16	0.311	29.8	19.3	0.27 J	6.13	166	308
	08/09/16	0.172	64.6	53.1	<0.1	5.97	124	575
	10/18/16	0.953	150	4.33	1.15	6.63	346	607
	12/11/16	1.02	130	4.65	1.4	6.59	365	651
	09/21/17	1.4	147	42	0.304	6.78	170	782
	06/13/18	5.89	81.1	84.1	0.123 J	6.75	713	1,240
	09/07/18	3.21	46.7	78.6	<0.100	6.77	544	1,030
	05/14/19	8.12	95.9	81.8	0.104 J	6.52	780	1,400
	09/10/19	8.05	97.1	90.5	<0.1	6.62	930	1,600
	05/13/20	6.98	84.9	70.7	<0.100		769	1,340
H-31	10/20/15	17.2	194	179	0.889	6.57	1,930	3,270
	12/14/15	20.4	236	147	0.692	6.60	1,740	2,250
	02/23/16	22.3	252	199	0.921	5.33	2,510	4,180
	04/05/16	21.1	250	186	1.36	6.46	2,450	3,920
	06/07/16	22.2	244	241	0.783	6.42	2,720	4,570
	08/09/16	24.1	251	217	0.216 J	4.38	2,730	4,440
	10/18/16	20	236	187	0.298 J	6.82	1,960	3,690
	12/11/16	22.3	246	201	0.892	6.82	2,640	4,170
	09/21/17	23.8	260	227	0.308 J	6.87	2,870	4,570
	06/12/18	16.6	246	205	0.646	6.61	2,390	4,100
	09/07/18	0.838	12.2	17.7	<0.275	6.77	136	457
	05/14/19	20	234	225	0.96	6.42	2,470	4,230
	09/10/18	19.7	234	232	2.1	6.78	2,640	4,220
	05/13/20	22.9	235	223	0.231 J		2,340	4,150
H-32	10/20/15	1.22	42.2	120	0.374 J	6.18	309	797
	12/14/15	1.39	37.4	122	0.619	6.29	325	860
	02/23/16	1.48	45.3	123	0.701	4.82	323	842
	04/05/16	1.65	44.3	125	1.05	6.17	337	831
	06/07/16	1.82	45.6	137	0.858	6.05	350	829
	08/09/16	1.69	45.4	132	0.68	3.64	342	839
	10/18/16	1.72	50.5	121	0.904	6.75	319	888
	12/11/16	2.5 J	44.3	120	1.00	6.83	341	759
	09/21/17	2.07 J	52.8	129	0.519	6.82	337	807
	06/12/18	1.82 J	52.6	126	1.02	6.75	339	793
	09/07/18	0.292 J	10.9	17.8	0.551	6.79	53.8	283
	05/14/19	2.08	45.2	135	1.15	6.02	320	910
	09/10/19	1.87	45.9	127	0.923	6.68	365	810
	05/13/20	2.15	43.3	124	0.641		343	791

Notes:
1. Abbreviations: mg/L - milligrams per liter; TDS - total dissolved solids; s.u. - standard units.
2. J - concentration is below method quantitation limit; result is an estimate.

TABLE 2
APPENDIX IV GROUNDWATER ANALYTICAL DATA
MARTIN LAKE STEAM ELECTRIC STATION
ASH POND AREA

Sample Location	Date Sampled	Sb (mg/L)	As (mg/L)	Ba (mg/L)	Be (mg/L)	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	F (mg/L)	Pb (mg/L)	Li (mg/L)	Hg (mg/L)	Mo (mg/L)	Se (mg/L)	Tl (mg/L)	Ra 226 (pCi/L)	Ra 228 (pCi/L)	Ra 226/228 Comb.^ (pCi/L)
GWPS:		0.006	0.01	2	0.004	0.005	0.1	0.0564	4	0.015	0.177	0.002	0.1	0.05	0.002	--	--	5
Upgradient Wells																		
H-26	10/21/15	<0.0008	0.0036 J	0.0785	0.000349 J	<0.0003	<0.002	0.0385	<0.1	<0.0003	0.0139	<0.00008	<0.002	<0.002	<0.0005	0.919	<1.64	2.56
	12/14/15	<0.0008	<0.002	0.0401	0.000458 J	<0.0003	<0.002	0.0244	<0.1	<0.0003	0.0769	<0.00008	<0.002	<0.002	<0.0005	0.619	<1.95	2.57
	02/23/16	<0.0008	<0.002	0.0423	<0.0003	<0.0003	0.0077	0.00813	0.151 J	0.000315 J	0.0124	<0.00008	0.00248 J	0.0022 J	<0.0005	0.37	<2.06	2.43
	04/05/16	<0.0008	<0.002	0.0408	<0.0003	<0.0003	0.00798	0.0125	0.199 J	<0.0003	0.0121	<0.00008	<0.002	<0.002	<0.0005	<0.243	<1.06	<1.303
	06/07/16	<0.0008	<0.002	0.0467	0.000721 J	<0.0003	<0.002	0.0217	<0.1	<0.0003	0.0132	<0.00008	<0.002	<0.002	<0.0005	0.245	1.67	1.92
	08/09/16	<0.0008	0.0029 J	0.0431	0.00136	<0.0003	<0.002	0.0352	<0.1	<0.0003	0.0155	<0.00008	<0.002	<0.002	<0.0005	<0.2	<0.932	<1.132
	10/18/16	<0.0008	<0.002	0.0497	0.000709 J	<0.0003	<0.002	0.0214	0.127 J	<0.0003	0.0136	<0.00008	<0.002	0.0027 J	<0.0005	0.243	<0.622	0.87
	12/11/16	<0.0008	<0.002	0.0468	0.00146	<0.0003	0.0031 J	0.0275	0.161 J	0.000358 J	0.014	<0.00008	<0.002	<0.002	<0.0005	0.248	1.82	2.07
	06/13/18	<0.0008	<0.002	0.0659	0.0016	<0.0003	0.00213 J	0.0261	<0.100	<0.0003	0.032	<0.00008	<0.002	<0.002	<0.0005	<0.297	3.72	4.017
	09/07/18	NA	<0.002	0.0470	0.00155	<0.0003	0.00319 J	0.0247	<0.100	<0.0003	0.0489	NA	NA	<0.002	NA	<0.473	<0.665	<1.138
	05/14/19	<0.0008	0.0041 J	0.1900	0.00147	<0.0003	0.0406	0.0795	0.140 J	0.000972 J	0.147	<0.00008	<0.002	0.0022 J	<0.0005	1.43	0.598	2.028
	9/10/2019	NA	<0.002	0.046	0.00165	<0.0003	<0.002	0.0237	<0.1	0.000313 J	0.0141	NA	NA	0.0109	NA	0.115	2.74	2.85
	5/13/2020	<0.0008	<0.002	0.129	0.00166	<0.0003	0.00314 J	0.0241	<0.100	0.000798	0.0218 J	<0.00008	<0.002	0.0147	<0.0005	0.295	0.585	0.88
H-27	10/21/15	<0.0008	<0.002	0.0378	<0.0003	<0.0003	<0.002	0.0043 J	<0.1	<0.0003	0.0607	<0.00008	<0.002	<0.002	<0.0005	<0.553	<1.67	<2.223
	12/14/15	<0.0008	0.0021 J	0.039	<0.0003	<0.0003	<0.002	0.00326 J	0.156 J	0.000339 J	0.0624	<0.00008	<0.002	<0.002	<0.0005	0.468	<1.68	2.15
	02/23/16	<0.0008	<0.002	0.0266	<0.0003	<0.0003	<0.002	<0.003	0.101 J	<0.0003	0.0601	<0.00008	<0.002	<0.002	<0.0005	0.921	<1.62	2.54
	04/05/16	<0.0008	<0.002	0.0245	<0.0003	<0.0003	<0.002	<0.003	0.124 J	<0.0003	0.0573	<0.00008	<0.002	<0.002	<0.0005	0.269	<2.05	2.32
	06/07/16	<0.0008	<0.002	0.0342	0.000609 J	<0.0003	<0.002	0.016	<0.1	<0.0003	0.0107	<0.00008	<0.002	<0.002	<0.0005	0.269	<0.658	0.927
	08/09/16	<0.0008	<0.002	0.0241	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0616	<0.00008	<0.002	<0.002	<0.0005	0.408	<0.632	1.04
	10/18/16	<0.0008	<0.002	0.0248	<0.0003	<0.0003	<0.002	<0.003	0.144J	<0.0003	0.0576	<0.00008	<0.002	<0.002	<0.0005	<0.178	1.07	1.25
	12/11/16	<0.0008	<0.002	0.0236	<0.0003	<0.0003	<0.002	<0.003	0.161 J	<0.0003	0.0606	<0.00008	<0.002	<0.002	<0.0005	0.143	1.54	1.68
	06/13/18	<0.0008	<0.002	0.0237	<0.0003	<0.0003	0.00964	<0.003	0.208 J	<0.0003	0.108	<0.00008	<0.002	<0.002	<0.0005	0.267	<1.4	1.667
	09/07/18	NA	<0.002	0.0196	<0.0003	<0.0003	0.0453	<0.003	0.140 J	<0.0003	0.306	NA	NA	0.00773	NA	<0.285	1.43	1.715
	05/14/19	<0.0008	<0.002	0.0208	<0.0003	<0.0003	<0.002	<0.003	0.159 J	<0.0003	0.0678	<0.00008	<0.002	<0.002	<0.0005	1.10	0.928	2.028
	9/10/2019	NA	<0.002	0.384	<0.0003	<0.0003	0.00668	<0.003	<0.1	<0.0003	0.103	NA	NA	0.0027 J	NA	0.185	3.57	3.76
	5/13/2020	<0.0008	<0.002	0.0668	<0.0003	<0.0003	0.0133	<0.003	<0.100	<0.0003	0.170	<0.00008	<0.002	0.00671	<0.0005	0.166	-0.0371	0.166
H-33	10/20/15	<0.0008	0.0021 J	0.0586	0.000351 J	<0.0003	<0.002	0.0274	<0.1	<0.0003	0.0814	<0.00008	<0.002	<0.002	<0.0005	1.76	1.64	3.40
	12/14/15	<0.0008	0.00205 J	0.0473	0.000382 J	<0.0003	<0.002	0.0293	0.136 J	<0.0003	0.0903	<0.00008	<0.002	<0.002	<0.0005	1.94	<1.79	3.73
	02/23/16	<0.0008	<0.002	0.0529	0.000311 J	<0.0003	0.0194	0.0163	0.125 J	<0.0003	0.182	<0.00008	<0.002	<0.002	<0.0005	0.906	<2.32	3.23
	04/05/16	<0.0008	<0.002	0.0576	0.000302 J	<0.0003	0.0171	0.016	0.14 J	<0.0003	0.16	<0.00008	<0.002	<0.002	<0.0005	0.328	1.08	1.41
	06/07/16	<0.0008	<0.002	0.0774	0.000604 J	<0.0003	0.0153	0.0196	<0.1	<0.0003	0.163	<0.00008	<0.002	<0.002	<0.0005	0.276	0.897	1.17
	08/09/16	<0.0008	<0.002	0.0424	0.000519 J	<0.0003	0.0029 J	0.0284	<0.1	<0.0003	0.102	<0.00008	<0.002	<0.002	<0.0005	<0.149	0.649	0.80
	10/18/16	<0.0008	0.0035 J	0.0464	0.000617 J	<0.0003	0.0309	0.0644	<0.1	0.000329 J	0.118	<0.00008	<0.002	<0.002	<0.0005	0.096	<0.517	0.61
	12/11/16	<0.0008	0.0022 J	0.0537	0.000865 J	<0.0003	0.0368	0.0408	0.132 J	0.000495 J	0.115	<0.00008	<0.002	<0.002	<0.0005	0.159	1.29	1.45
	06/13/18	<0.0008	0.00283 J	0.0741	0.0004 J	<0.0003	0.0182	0.0266	0.105 J	0.0009 J	0.183	<0.00008	<0.002	<0.002	<0.0005	0.795	<0.712	1.507
	09/07/18	NA	0.00239 J	0.0757	0.0003 J	<0.0003	0.0105	0.0288	0.135 J	<0.0003	0.160	NA	NA	<0.002	NA	0.334	<0.645	0.979
	05/14/19	<0.0008	0.00355 J	0.158	0.00114	<0.0003	0.0342	0.0648	0.166 J	0.000772 J	0.161	<0.00008	<0.002	<0.002	<0.0005	0.850	1.35	2.200
	9/10/2019	NA	<0.002	0.111	0.000518 J	<0.0003	0.00637	0.0347	0.01	<0.0003	0.142	NA	NA	<0.002	NA	0.6	2.97	3.57
	5/13/2020	<0.0008	<0.002	0.0784	0.00053 J	<0.0003	0.00755	0.0312	<0.100	0.00191	0.173	<0.00008	<0.002	0.00243 J	<0.0005	0.395	1.9	2.29
Downgradient Wells																		
H-28	10/21/15	<0.0008	0.0028 J	0.0396	0.00148	0.00121	<0.002	0.188	<0.1	0.000491 J	0.154	<0.00008	<0.002	0.00682	<0.0005	<0.558	<1.65	<2.208
	12/14/15	<0.0008	<0.002	0.0224	<0.0003	0.000572 J	<0.002	0.0225	<0.1	<0.0003	0.021	<0.00008	<0.002	<0.002	<0.0005	0.707	<1.18	1.89
	02/23/16	<0.0008	0.00225 J	0.0202	0.00133	0.00151	<0.002	0.201	<0.1	0.00053 J	0.159	<0.00008	<0.002	0.00222 J	<0.0005	<0.396	2.24	2.64
	04/05/16	<0.0008	<0.002	0.0173	0.0011	0.00252	<0.002	0.199	<0.1	0.00087 J	0.15	<0.00008	<0.002	0.00237 J	<0.0005	<0.231	1.76	1.99
	06/07/16	<0.0008	<0.002	0.0468	0.000934 J	0.000664 J	<0.002	0.0944	<0.1	<0.0003	0.0959	<0.00008	<0.002	<0.002	<0.0005	0.310	1.48	1.79
	08/09/16	<0.0008	<0.002	0.0155	0.00275	0.0016	<0.002	0.195	<0.1	0.000774 J	0.155	<0.00008	<0.002	0.0029 J	<0.0005	<0.451	1.41	1.86
	10/18/16	<0.0008	0.00284J	0.0174	0.00685	0.000744 J	<0.002	0.169	0.165J	0.00108	0.155	<0.00008	<0.002	0.0027 J	<0.0005	<0.228	0.645	0.87
	12/11/16	<0.0008	<0.002	0.0471	0.000698 J	0.000668 J	<0.002	0.0924	0.114 J	<0.0003	0.0869	<0.00008	<0.002	<0.002	<0.0005	<0.149	1.13	1.28
	06/13/18	<0.0008	<0.002	0.0186	0.00393	0.0038	<0.002	0.169	0.126 J	0.000448 J	0.18	<0.00008	<0.002	<0.002	<0.0005	0.327	<1.56	1.887
	09/07/18	NA	<0.002	0.0192	0.00704	0.00115	<0.002	0.162	<0.100	0.00118 J	0.203	NA	NA	0.00281 J	NA	<0.243	0.845	1.088
	05/14/19	<0.0008	<0.002	0.0141	0.00281	0.00212	<0.002	0.187	<0.100	0.000595 J	0.172	<0.00008	<0.002	0.00619	<0.0005	0.444	0.615	1.059
	9/10/2019	NA	<0.002	0.145	0.0058	0.000951	<0.002	0.146	<0.1	0.00132	0.169	NA	NA	0.00461	NA	0.205	4.26	4.47
	5/13/2020	<0.0008	<0.002	0.0149	0.00252	0.00126	<0.002	0.159	<0.100	0.00751 J	0.171	<0.00008	<0.002	0.0032 J	<0.0005	0.151	0.984	1.13
H-29	10/21/15	<0.0008	<0.002	0.159	0.000359 J	<0.0003	<0.002	0.0301	<0.1	<0.0003	0.0156	<0.00008	<0.002	<0.002	<0.0005	0.464	1.82	2.28
	12/14/15	<0.0008	<0.002	0.277	<0.0003	<0.0003	0.062	<0.003	0.56	0.000542 J	0.0202	<0.00008	0.00819	0.0282	<0.0005	<0.53	<1.25	<1.78
	02/23/16	<0.0008	0.00203 J	0.151	<0.0003	<0.0003	0.019	<0.003	0.239 J	<0.0003	0.0135	<0.00008	0.00603	0.0148	<0.0005	<0.374	<2.22	<2.594
	04/05/16	<0.0008	<0.002	0.167	<0.0003	<0.0003	0.042	<0.003	0.363 J	<0.0003	0.0175	<0.00008	0.00697	0.0232	<0.0005	<0.228	<0.897	<1.125
	06/07/16	<0.0008	<0.002	0.136	<0.0003	<0.0003	0.0274	<0.003	0.27 J	<0.0003	0.0188	<0.00008	0.00551	0.0152	<0.0005	0.173	<0.834	1.01
	08/09/16	<0.0008	0.00995	0.315	<0.0003	<0.0003	0.003 J	0.0047 J	<0.1	<0.0003	0.0143	<0.00008	<0.002	<0.002	<0.0005	0.261	<0.578	0.84
	10/18/16	<0.0008	<0.002	0.118	<0.0003	<0.0003	0.0041 J	<0.003	1.15	0.000427J	0.0056 J	<0.00008	0.0031 J	0.0681	<0.0005	0.155	<0.439	0.59
	12/11/16	<0.0008	<0.002	0.0779	<0.0003	<0.0003	<0.002	<0.003	1.4	<0.0003	<0.005	<0.00008	0.0031 J	0.0642	<0.0005	<0.113	<0.599	<0.712
	06/13/18	<0.0008	<0.002	0.0157	0.00345	0.00318	<0.002	0.153	0.123 J	0.000779 J	0.153	<0.00008	<0.002	<0.002	<0.0005	<0.274	<1.62	<1.894
	09/07/18	NA	<0.002	0.0374	0.00513	0.000938	<0.002	0.119	<0.100	0.00172	0.145	NA	NA	0.00374 J	NA	<0.371	<0.71	<1.081
	5/14/2019	<0.0008	<0.002	0.0138	0.00341	0.00219	<0.002	0.183	0.104 J	0.000543 J	0.173	<0.00008	<0.002	0.00616	<0.0005	<0.339	<0.707	<1.046
	9/10/2019	NA	<0.002	0.0135	0.00233	0.00127	<0.002	0.164	<0.1	0.000916 J	0.157	NA	NA	0.004 J	NA	0.364	4.99	5.35
	5/13/2020	<0.0008	<0.002	0.0117	0.0013	0.00129	<0.002	0.142	<0.100	0.000684 J	0.134	<0.00008	<0.002	0.00281 J	<0.0005	0.246	0.545	0.791

TABLE 2
APPENDIX IV GROUNDWATER ANALYTICAL DATA
MARTIN LAKE STEAM ELECTRIC STATION
ASH POND AREA

Sample Location	Date Sampled	Sb (mg/L)	As (mg/L)	Ba (mg/L)	Be (mg/L)	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	F (mg/L)	Pb (mg/L)	Li (mg/L)	Hg (mg/L)	Mo (mg/L)	Se (mg/L)	Tl (mg/L)	Ra 226 (pCi/L)	Ra 228 (pCi/L)	Ra 226/228 Comb.^ (pCi/L)
GWPS:		0.006	0.01	2	0.004	0.005	0.1	0.0564	4	0.015	0.177	0.002	0.1	0.05	0.002	--	--	5
H-31	10/20/15	<0.0008	0.0168	0.0732	0.0126	0.0032	0.00687	0.434	0.889	<0.0003	0.137	<0.00008	<0.002	0.116	<0.0005	0.943	<1.88	2.82
	12/14/15	<0.0008	0.00513	0.0388	0.00702	<0.0003	0.00456 J	0.0651	0.692	<0.0003	0.149	<0.00008	<0.002	0.0231	<0.0005	1.61	<1.29	2.90
	02/23/16	<0.0008	0.00436 J	0.0243	0.0101	<0.0003	<0.002	0.0594	0.921	<0.0003	0.146	<0.00008	<0.002	0.0209	<0.0005	<0.419	<1.64	<2.059
	04/05/16	<0.0008	0.00514	0.0241	0.00925	<0.0003	0.00435 J	0.0685	1.36	<0.0003	0.146	<0.00008	<0.002	0.0226	<0.0005	<0.334	<0.897	<1.231
	06/07/16	<0.0008	0.0038 J	0.0242	0.00789	<0.0003	<0.002	0.0406	0.783	<0.0003	0.157	<0.00008	<0.002	0.0307	<0.0005	0.257	<0.555	0.81
	08/09/16	<0.0008	0.00886	0.0191	0.00734	<0.0003	<0.002	0.286	0.216 J	<0.0003	0.17	<0.00008	<0.002	0.0202	<0.0005	1.31	0.900	2.21
	10/18/16	<0.0008	0.0035 J	0.0215	0.00167 J	<0.0003	<0.002	0.0304 J	0.298 J	<0.0003	0.165	<0.00008	<0.002	0.0057 J	<0.0005	0.169	1.18	1.35
	12/11/16	<0.0008	0.0088 J	0.0189	0.0197	<0.0003	0.0039 J	0.23 J	0.892	<0.0003	0.198	<0.00008	<0.002	0.0365	<0.0005	0.195	<0.754	0.95
	06/12/18	<0.0008	0.00532	0.0194	0.00545	<0.0003	0.003 J	0.236	0.646	<0.0003	0.214	<0.00008	<0.002	0.00475 J	<0.0005	<0.26	<0.597	<0.857
	09/07/18	NA	<0.002	0.0287	<0.0003	<0.0003	<0.002	0.00353 J	0.275 J	<0.0003	0.0187	NA	NA	0.00424 J	NA	<0.261	<0.567	<0.828
	05/14/19	<0.0008	0.00675	0.0163	0.00928	<0.0003	0.0032 J	0.389	0.96	<0.0003	0.219	<0.0004	<0.002	0.0261	<0.0005	2.62	<0.789	3.409
	9/10/2019	NA	0.00845	0.0158	0.0312	<0.0003	0.0031 J	0.41	2.1	<0.0003	0.225	NA	NA	0.0642	NA	0.247	2.92	3.17
	5/13/2020	<0.0008	0.011	0.0159	0.0331	<0.0003	0.00367 J	0.449	0.231 J	<0.0003	0.249	<0.00008	<0.002	0.0792	<0.0005	0.0808	1.7	1.78
H-32	10/20/15	<0.0008	0.0028 J	0.16	0.00266	<0.0003	<0.002	0.163	0.374 J	<0.0003	0.0788	<0.00008	<0.002	0.003 J	<0.0005	1.05	<1.90	2.95
	12/14/15	<0.0008	0.0123	0.0384	0.00313	<0.0003	<0.002	0.155	0.619	<0.0003	0.0733	<0.00008	<0.002	<0.002	<0.0005	0.712	<2.21	2.92
	02/23/16	<0.0008	0.00712	0.0277	0.00452	<0.0003	<0.002	0.188	0.701	0.000326 J	0.0821	<0.00008	<0.002	<0.002	<0.0005	1.12	1.60	2.72
	04/05/16	<0.0008	0.00648	0.0237	0.00527	0.00128	<0.002	0.208	1.05	0.00182	0.0818	<0.00008	<0.002	<0.002	<0.0005	<0.364	<1.15	<1.514
	06/07/16	<0.0008	0.0045 J	0.0238	0.00583	0.000997 J	<0.002	0.207	0.858	0.00168	0.087	<0.00008	<0.002	0.003 J	<0.0005	<0.165	0.613	0.778
	08/09/16	<0.0008	0.0034 J	0.0234	0.00548	0.000713 J	<0.002	0.19	0.68	0.00115	0.0774	<0.00008	<0.002	0.0028 J	<0.0005	2.56	<0.446	3.01
	10/18/16	<0.0008	0.0029 J	0.02	0.00567	0.00254	<0.002	0.204	0.904	0.00332	0.0834	<0.00008	<0.002	0.0027 J	<0.0005	<0.139	0.683	0.82
	12/11/16	<0.0008	0.0025 J	0.0205	0.00609	0.00108	<0.002	0.208	1	0.00137	0.0838	<0.00008	<0.002	0.0024 J	<0.0005	<0.163	<0.753	<0.916
	06/12/18	<0.0008	<0.002	0.0175	0.00681	0.000586 J	<0.002	0.215	1.02	0.000701 J	0.0957	<0.00008	<0.002	<0.002	<0.0005	<0.275	0.917	1.192
	09/07/18	NA	<0.002	0.0404	<0.0003	<0.0003	<0.002	0.00347 J	0.551	<0.0003	0.0195	NA	NA	0.0157	NA	0.343	1.25	1.593
	05/14/19	<0.0008	0.002 J	0.0162	0.00713	0.000366 J	<0.002	0.202	1.15	0.000574 J	0.0978	<0.00008	<0.002	0.00675	<0.0005	0.303	<0.546	<0.849
	9/10/2019	NA	<0.002	0.016	0.00678	0.000467 J	<0.002	0.185	0.923	0.00056 J	0.0935	NA	NA	0.0049 J	NA	0.0404	4.74	4.78
	5/13/2020	<0.0008	0.00214 J	0.0166	0.00725	0.000389 J	<0.00200	0.195	0.641	0.000743 J	0.0978	<0.00008	<0.002	0.00401 J	<0.0005	-0.0142	1.15	1.15

Notes:
1. Abbreviations: mg/L - milligrams per liter; pCi/L - picocuries per liter.
2. ^ - Sum of Ra 226 and Ra 228 concentrations. Non-detect isotope results were assigned a value equal to the minimum detectable concentration.
3. J - concentration is below method quantitation limit; result is an estimate.
4. NA = Not analyzed.

Table 3
Appendix III Groundwater Analytical Data Summary
Matin Lake Steam Electric Station
PDP 5

Sample Location	Date Sampled	B Prediction Limit	B Sample Data	Ca Prediction Limit	Ca Sample Data	Cl Prediction Limit	Cl Sample Data	Fl Prediction Limit	Fl Sample Data	field pH Prediction Limit	field pH Sample Data	SO_4 Prediction Limit	SO_4 Sample Data	TDS Prediction Limit	TDS Sample Data
MW-17A	09/22/17	0.538	0.402	6.73	3.1	10.4	8.3	0.4	<0.1	2.5 9.19	6.78	51.9	31.2	170	111
	06/14/18		0.485		6.48		9.16		<0.1		6.87		45.9		129
	09/11/18		0.523		5.06		8.82		0.179 J		5.03		43.1		137
	05/13/19		0.497		4.88		9.18		<0.1		6.79		44.7		145
	11/7/2019		0.52		5.05		8.81		<0.100		6.44		43.9		127
	5/19/2020		0.521		5.09		8.74		<0.100				46.8		140
MW-18A	09/21/17	0.20	0.0654	3.1	1.04	10.4	5.27	0.4	<0.1	4.88 7.92	6.94	9.1	3.23	157	45
	06/14/18		0.102		2		6.56		<0.1		6.92		3.48		71
	09/12/18		**0.211**		**3.23**		9.06		<0.1		5.69		4.82		150
	11/07/18		0.128		--		--		--		--		--		--
	05/13/19		0.117		1.01		6.17		0.138 J		6.64		3.23		73
	11/7/2019		0.127		11.5		6.34		<0.100		6.23		3.67		68
	5/19/2020		**0.225**		1.54		7.09		<0.100				5.97		86
MW-19	09/22/17	0.782	0.0677	237	2.74	57.7	5.36	0.512	<0.1	4.6 8.08	6.94	672	1.46 J	1,380	98
	06/14/18		0.577		133		24.4		0.216 J		6.78		328		758
	09/11/18		0.243		38		**65.1**		0.228 J		6.04		166		597
	11/07/18		--		--		5.22		--		--		--		--
	05/13/19		0.429		122		26.8		0.229 J		6.72		349		813
	11/8/2019		0.529		77.8		49.3		0.189 J		6.87		310		844
	5/19/2020		0.0724		1.49		5.84		<0.100				1.02 J		85
MW-20A	09/22/17	0.213	0.0807	25.7	17.4	12.3	12.6	0.954	0.175 J	3.06 8.76	6.71	148	74.2	381	237
	02/21/18 re-sample		--		--		10.7		--		--		--		--
	06/13/18		0.171		24		10.9		0.672		6.72		132		250
	09/11/18		0.141		7.16		11		0.235 J		4.70		39.1		154
	05/13/19		**0.239**		**37.4**		10.2		0.731		6.81		**178**		328
	11/8/2019		0.132		9.9		10.2		0.465		6.51		88		205
	5/19/2020		0.22		24		10.4		0.413				133		270
PDP-22	09/22/17	0.411	0.221	306	92.5	32.7	12.3	1.07	0.321 J	4.08 8.63	6.98	216	178	1,780	558
	06/14/18		0.115		7.78		11.8		0.239		6.63		186		491
	09/12/18		0.164		61.1		10.9		0.216 J		5.88		143		476
	05/13/19		0.158		98.2		10.1		0.303 J		6.86		184		615
	11/12/2019		0.226		34.3		12.6		0.218 J		6.93		215		482
	5/19/2020		0.0646		54.9		1.06		<0.100				5.21		205
PDP-23	09/22/17	0.0678	0.0463	2	2.34	7.52	4.48	0.4	0.147 J	3.38 8.45	6.77	3.27	1.47 J	143	111
	02/21/18 re-sample		--		2.37		--		--		--		--		--
	06/13/18		0.0357		2.29		6.21		<0.1		6.82		1.26 J		98
	09/11/18		**0.0760**		1.96		6.38		<0.1		5.32		1.52 J		98
	11/07/18		**0.0683**		--		--		--		--		--		--
	05/13/19		0.0628		1.89		6.98		<0.1		6.68		1.28 J		103
	11/12/2019		0.0675		**2.14**		4.98		<0.100		6.72		1.41 J		93
	5/19/2020		0.0709		**2.03**		6.86		<0.100				1.19 J		104
PDP-24	09/22/17	4.92	3.01	45.9	25.8	22.6	17.5	1.03	0.898	1.33 9.97	6.95	533	231	894	440
	06/14/18		2.71		23.9		21.1		0.629		6.82		284		481
	09/11/18		4.08		41.6		19.4		0.832		4.20		460		760
	05/13/19		3.23		23		21		0.871		6.95		300		537
	11/12/2019		3		21.9		20.6		0.751		6.87		295		520
	11/12/2019		2.97		22.2		20.5		0.744		6.87		300		504
	5/19/2020		3.17		21.4		21		0.61				286		512
PDP-25	09/22/17	0.136	0.133	41.3	36.8	197	130	0.4	0.157 J	4.65 7.93	6.81	118	89.1	705	481
	06/14/18		0.119		40.4		111		<0.1		6.78		73.4		439
	09/11/18		**0.167**		36.2		135		0.115 J		5.87		90.3		469
	11/07/18		**0.142**		--		--		--		--		--		--
	05/13/19		**0.144**		**44.4**		108		0.121 J		6.84		69		469
	11/12/2019		**0.184**		38.6		117		<0.100		6.82		71.4		454
	5/19/2020		**0.202**		**53.7**		105		<0.100				62.2		442
PDP-26	09/22/17	0.111	0.0343	4.74	2.32	14.6	5.24	0.577	0.157 J	5.35 7.57	6.84	64.6	5.88	438	107
	06/14/18		0.0225 J		2.93		4.8		<0.1		6.89		4.27		100
	09/12/18		0.0371		2.37		4.88		<0.1		6.07		2.66 J		107
	05/13/19		0.0528		1.9		4.59		0.217 J		6.86		2.7 J		106
	11/12/2019		0.0622		2.25		4.64		0.122 J		6.77		2.1 J		102
	5/19/2020		0.0538		2.09		4.52		<0.100				2.1 J		108

Notes:
1. All concentrations in mg/L. pH in standard units.
2. J - concentration is below sample quantitation limit; result is an estimate.
3. Highlighted sample results exceed the prediction limit.

COAL COMBUSTION RESIDUAL RULE
ALTERNATIVE SOURCE DEMONSTRATION REPORT

MARTIN LAKE STEAM ELECTRIC STATION
PERMANENT DISPOSAL POND 5 (PDP 5)
RUSK COUNTY, TEXAS

APRIL 15, 2018

Prepared For:

Luminant Generation Company LLC
6555 Sierra Drive
Irving, TX 75039

Prepared By:

Pastor, Behling & Wheeler, LLC
2201 Double Creek Drive, Suite 4004
Round Rock, Texas 78664
Texas Engineering Firm No. 4760

PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by Pastor, Behling & Wheeler, LLC under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I hereby certify that the alternative source demonstration at the referenced facility meets the requirements of Section 257.94(e)(2) of the CCR Rule.

Patrick J. Behling, P.E.
Principal Engineer
PASTOR, BEHLING & WHEELER, LLC

STATE OF TEXAS
PATRICK J. BEHLING
79872
LICENSED
PROFESSIONAL ENGINEER

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1.0 INTRODUCTION

Luminant Generation Company LLC (Luminant) operates the Martin Lake Steam Electric Station (MLSES) located approximately 5 miles southeast of Tatum in Rusk County, Texas (Figure 1). Three CCR Units that are subject to the CCR Rule have been identified within the MLSES operations: Ash Pond Area (the West Ash Pond (WAP) East Ash Pond (EAP), and the New Scrubber Pond), Permanent Disposal Pond 5 (PDP 5), and A1 Area Landfill.

The purpose of this report is to document that a source other than PDP 5 (hereafter, the “Site”) caused the statistically significant increase (SSI) over background levels for the Appendix III samples collected during the initial detection monitoring event in 2017 as required in 40 CFR 257.94(e)(2).

1.1 CCR Unit Groundwater Monitoring Applicability

Pastor, Behling & Wheeler, LLC (PBW) was retained by Luminant to evaluate the CCR groundwater monitoring system and develop and implement a CCR groundwater sampling and analysis program at the Site. To document these activities, PBW prepared the following reports, which have been placed in the facility’s operating record to comply with Section 257.105(h) of the CCR Rule:

- CCR Groundwater Monitoring System Certification (PBW, 2017a);
- CCR Monitoring Well Design, Installation, Development, and Decommissioning Report (PBW, 2017b);
- CCR Statistical Analysis Plan (PBW, 2017c); and
- 2017 Annual Groundwater Monitoring Report (PBW, 2018).

2.0 GROUNDWATER MONITORING SYSTEM

The CCR groundwater monitoring well system at PDP 5 consists of nine monitoring wells (MW-17A, MW-18A, MW-19, MW-20A, PDP-22, PDP-23, PDP-24, PDP-25, PDP-26) that are screened in the uppermost aquifer at the Site. Based on groundwater elevation data evaluated in the 2017 Annual Groundwater Monitoring Report (PBW, 2018), groundwater flows radially outward from the hilltop where PDP 5 is located. As such, all of the PDP 5 CCR monitoring wells are downgradient of the unit. Locations of the PDP 5 CCR monitoring wells are shown on Figure 2. Well construction information and survey data for the CCR wells are summarized in Table 1.

3.0 GROUNDWATER MONITORING PROGRAM

3.1 Background Monitoring Program

Statistical analysis of groundwater monitoring data is required under Section 257.93 of the CCR Rule. Section 257.93 of the CCR Rule provides several options for statistically evaluating the groundwater data. In accordance with paragraph (f)(1) through (5) of Section 257.93, the following statistical evaluation approache was selected to demonstrate groundwater compliance for PDP 5 under the CCR Rule (PBW, 2017c):

- Use of intrawell data evaluations, which compare new sample data to historical data at each groundwater monitoring well independently; and
- Use of prediction limits for data comparisons. This approach is a common statistical method used to evaluate groundwater compliance for Subtitle D landfill facilities and is one of the approved options for groundwater quality data statistical evaluation under the CCR Rule.

Eight background groundwater monitoring events were performed using the PDP 5 CCR monitoring well system from October 2015 to December 2016. Groundwater samples collected during the background monitoring events were evaluated for each Appendix III and Appendix IV parameter at each well to establish prediction limits in accordance with procedures outlined in the CCR Statistical Analysis Plan (PBW, 2017c). Development of the prediction limits and documentation on the collection and analysis of the background sample data were detailed in the 2017 Annual Groundwater Monitoring Report (PBW, 2018).

3.2 Detection Monitoring Program

Section 257.94 of the CCR Rule requires that detection monitoring of groundwater be performed at all CCR units. The following constituents are evaluated as part of the detection monitoring program (from Appendix III to the CCR Rule):

- Boron
- Calcium
- Chloride
- Fluoride
- pH
- Sulfate
- Total Dissolved Solids (TDS)

If an SSI over background is determined for one or more of the constituents listed above at any monitoring well at the CCR unit waste boundary, within 90 days the owner or operator must:

- Establish an assessment monitoring program as described in Section 257.95 of the Rule; or
- Demonstrate that a source other than the CCR unit caused the SSI over background levels for a constituent or that the SSI resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. If a successful demonstration is completed within the 90-day period, the owner or operator of the CCR unit may continue with the detection monitoring program.

3.2.1 PDP 5 Detection Monitoring Results

PBW began evaluating the groundwater monitoring data collected during the first detection monitoring event from the PDP 5 CCR monitoring wells for SSIs over background levels by October 17, 2017. The statistical evaluation was completed in early January 2018. The detection monitoring data are presented, along with the applicable prediction limits, in Table 2. Laboratory analytical reports for the detection monitoring data are included in Appendix A.

All detection monitoring constituent concentrations in all PDP 5 CCR monitoring wells from the September 2017 monitoring event were below applicable prediction limits, with the exception of chloride in well MW-20A and calcium in well PDP-23. In accordance with the Statistical Analysis Plan (PBW, 2017c), re-samples were collected from each of these wells in February 2018. The re-samples were analyzed for the constituents that exceeded prediction limits during the initial detection monitoring event.

3.2.2 PDP 5 Chloride Re-Sample Results

The chloride concentration in the MW-20A re-sample (10.7 mg/L) was below the chloride prediction limit of 12.3 mg/L for that well; therefore, a SSI over background is not indicated in that well.

3.2.3 PDP 5 Calcium Re-Sample Results

The calcium concentration in the PDP-23 re-sample (2.37 mg/L) was similar to the calcium concentration observed in the initial detection monitoring event sample (2.34 mg/L). Both results exceeded the calcium prediction limit of 2.0 mg/L for that well; however, based on the extremely low concentrations of calcium in PDP-23, and the high variability in calcium concentrations observed in the Site-wide PDP 5 detection monitoring samples, the prediction limit exceedances observed in PDP-23 are attributed to natural variation in groundwater quality at the unit.

As shown on Table 2, calcium sample concentrations observed in the PDP 5 CCR monitoring wells during the initial detection monitoring event ranged from 1.04 mg/L (in well MW-18A) to 92.5 mg/L (in well PDP-22). PDP-23 had the third lowest calcium concentration and lowest prediction limit of the nine wells in the CCR groundwater monitoring network. The prediction limits for calcium, which are based on sample concentrations observed during the background period, ranged from 2.0 mg/L (in well PDP-23) to 306 mg/L (in well PDP-22).

The wells nearest to PDP-23 (MW-18A and MW-19) had calcium sample concentrations similar to those of PDP-23 during the detection monitoring event, but also had higher calcium prediction limits than PDP-23. Well MW-18A, which is located approximately 300 feet south of PDP-23, had a calcium sample concentration of 1.04 mg/L and a prediction limit of 3.1 mg/L. Well MW-19, which is located approximately 480 feet west of PDP-23, had a calcium sample concentration of 2.74 mg/L and a prediction limit of 237 mg/L. The relatively high prediction limit for MW-19 is a result of the high variability in MW-19 calcium concentrations during the background period, which, as indicated in the 2017 Annual Groundwater Monitoring Report, ranged from 8.62 mg/L to 155 mg/L (PBW, 2018).

4.0 CONCLUSION

One constituent (calcium) exceeded the prediction limit in one well (PDP-23) during the initial detection monitoring event and subsequent re-sample event at PDP 5. Based on the extremely low concentrations of calcium in PDP-23 relative to the calcium concentrations observed in other CCR Site wells, and the generally high variability in calcium concentrations observed in the PDP 5 detection monitoring samples, the prediction limit exceedances observed at PDP-23 are attributed to natural variation in groundwater quality within the monitoring system and are not considered evidence of a release from the unit. In accordance with Section 257.94(e)(2), Luminant will continue the detection monitoring program at the unit. Initiation of an assessment monitoring program is not required at this time.

5.0 REFERENCES

Burns & McDonnell Engineering Company, Inc (BM), 2015. CCR Study for Martin Lake Steam Electric Station – Final Draft. June 2015.

Pastor, Behling & Wheeler, LLC (PBW), 2017a. Coal Combustion Residual Rule Groundwater Monitoring System Certification, Martin Lake Steam Electric Station, PDP 5, Rusk County, Texas. October 16, 2017.

Pastor, Behling & Wheeler, LLC (PBW), 2017b. Coal Combustion Residual Rule Monitoring Well Design, Installation, Development, and Decommissioning Report, Martin Lake Steam Electric Station, PDP 5, Rusk County, Texas. October 13, 2017.

Pastor, Behling & Wheeler, LLC (PBW), 2017c. Coal Combustion Residual Rule Statistical Analysis Plan, Martin Lake Steam Electric Station, PDP 5, Rusk County, Texas. October 11, 2017.

Pastor, Behling & Wheeler, LLC (PBW), 2018. Coal Combustion Residual Rule 2017 Annual Groundwater Monitoring Report, Martin Lake Steam Electric Station, PDP 5, Rusk County, Texas. January 31, 2018.

ALTERNATE SOURCE DEMONSTRATION SUMMARY

MARTIN LAKE STEAM ELECTRIC STATION – PDP 5

Introduction

This Alternative Source Demonstration Summary was prepared to document that a source other than the Permanent Disposal Pond 5 (PDP 5) (the Site) caused the statistically significant increases (SSIs) over background levels observed during the 2018 Detection Monitoring Program sampling events as required by 40 CFR 257.94(e)(2). A detailed Site plan of the Coal Combustion Residual (CCR) groundwater monitoring network is shown on Figure 1. The Detection Monitoring Program groundwater data are summarized in Table 1.

2018 Semi-Annual Detection Monitoring Results and Discussion

Detection Monitoring Program groundwater samples were collected on a semi-annual basis from the Site CCR monitoring well network in 2018 in accordance with 40 CFR 257.94. Golder collected the initial 2018 Detection Monitoring Program groundwater samples in June 2018 and the second semi-annual Detection Monitoring Program groundwater samples in September 2018. In accordance with procedures described in the Statistical Analysis Plan (PBW, 2017), several verification re-samples were collected in November 2018 to verify the September 2018 sample results. Based on the semi-annual and re-sample results, SSIs were identified for boron in wells PDP-23 and PDP-25 during the second semi-annual and November 2018 re-sampling events. Additional potential SSIs were identified for other wells and Appendix III constituents (boron, calcium and chloride) during the second 2018 semi-annual sampling event; however, all verification sample results for these wells and constituents were below prediction limits. Therefore, in accordance with procedures outlined in the Statistical Analysis Plan, SSIs are not indicated for these wells and constituents.

The boron concentrations in wells PDP-23 and PDP-25 (maximum sample concentrations of 0.076 and 0.167 mg/L, respectively) are significantly lower than the boron concentrations observed at other Site wells where SSIs were not observed. For example, six of the seven other CCR monitoring wells (MW-17A, MW-18A, MW-19, MW-20A, PDP-22, and PDP-24) have had Detection Monitoring Program boron sample concentrations that were higher than those observed in the PDP-23 and PDP-25 SSI samples. As such, the boron sample concentrations observed at PDP-23 and PDP-25 are similar or less than those observed in other Site wells, and could be attributed to variability caused by the heterogeneity of the uppermost aquifer at the Site.

PDP 5 is built on top of three closed and capped landfills (PDP 1, PDP 2, and PDP 3). PDP 4, which is located adjacent to PDP 5 to the south, is also a closed and capped landfill. PDP 1 through PDP 4 are not considered regulated units under the CCR Rule. In addition to the natural variability caused by the heterogeneity of the groundwater system at the Site, sample concentrations identified as SSIs may also be attributed to potential historical effects to groundwater caused by the closed landfills in the vicinity of PDP 5.

Conclusion

SSIs were identified for boron during the 2018 Detection Monitoring Program sampling events at PDP 5. All observed SSIs are attributed to natural variation in groundwater quality due to the heterogeneity of the groundwater system and to potential effects from the closed landfills in the vicinity of PDP 5 (PDP 1 through PDP 4), and are not considered evidence of a release from the CCR unit. In accordance with Section 257.94(e)(2), Luminant should continue the Detection Monitoring Program. Initiation of an Assessment Monitoring Program is not required at this time.

References

Pastor, Behling & Wheeler, LLC (PBW), 2017. Coal Combustion Residual Rule, Statistical Analysis Plan, PDP 5, Rusk County, Texas. October 11, 2017.

PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by Golder Associates Inc. under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I hereby certify that the alternative source demonstration at the referenced facility meets the requirements of Section 257.94(e)(2) of the CCR Rule.

STATE OF TEXAS
PATRICK J. BEHLING
79872
LICENSED
PROFESSIONAL ENGINEER
04/10/19

Patrick J. Behling, P.E.

Principal Engineer

GOLDER ASSOCIATES INC.

ALTERNATE SOURCE DEMONSTRATION SUMMARY

MARTIN LAKE STEAM ELECTRIC STATION – PDP 5

Introduction

This Alternative Source Demonstration Summary was prepared to document that a source other than the Permanent Disposal Pond 5 (PDP 5) (the Site) caused the statistically significant increases (SSIs) over background levels observed during the 2019 Detection Monitoring Program sampling events as required by 40 CFR 257.94(e)(2). A detailed Site plan of the Coal Combustion Residual (CCR) groundwater monitoring network is shown on Figure 1. The Detection Monitoring Program groundwater data are summarized in Table 1.

2019 Semi-Annual Detection Monitoring Results and Discussion

Detection Monitoring Program groundwater samples were collected on a semi-annual basis from the Site CCR monitoring well network in 2019 in accordance with 40 CFR 257.94. Golder collected the initial 2019 Detection Monitoring Program groundwater samples in May 2019 and the second semi-annual Detection Monitoring Program groundwater samples in November 2019. Based on the semi-annual analytical results, SSIs were identified for boron in well PDP-25 and calcium in well PDP-23. Prediction limits for boron, calcium, and sulfate in well MW-20A and calcium in well PDP-25 were exceeded during the first semi-annual 2019 sampling event; however, since the prediction limits were not exceeded during the second semi-annual 2019 event, SSIs were not indicated for these constituents/wells in accordance with the procedures outlined in the Statistical Analysis Plan (PBW, 2017).

The boron concentrations in the 2019 groundwater samples from well PDP-25 (maximum sample concentration of 0.184 mg/L) exceeded the boron prediction limit of 0.136 mg/L for that well; however, the PDP-25 boron results are significantly lower than the boron concentrations observed at other Site wells where SSIs were not indicated. For example, five of the eight other CCR monitoring wells (MW-17A, MW-19, MW-20A, PDP-22, and PDP-24) had boron sample concentrations in 2019 that were higher than those observed in the PDP-25 samples, but SSIs were not indicated in these other wells. As such, the boron sample concentrations observed at PDP-25 are similar or less than those observed in other Site wells and are attributed to variability caused by the heterogeneity of the uppermost aquifer at the Site.

The calcium concentrations in the November 2019 groundwater sample from well PDP-23 (maximum sample concentration of 2.14 mg/L) exceeded the calcium prediction limit of 2.0 mg/L for that well; however, based on the extremely low concentrations of calcium in PDP-23, and the high variability in calcium concentrations observed in the site-wide PDP 5 detection monitoring samples (average calcium concentration for all wells in November 2019 was 22.6 mg/L), the prediction limit exceedance observed in PDP-23 is attributed to variability caused by the heterogeneity of the uppermost aquifer at the Site.

PDP 5 is built on top of three closed and capped landfills (PDP 1, PDP 2, and PDP 3). PDP 4, which is located adjacent to PDP 5 to the south, is also a closed and capped landfill. PDP 1 through PDP 4 are not considered regulated units under the CCR Rule. In addition to the natural variability caused by the heterogeneity of the groundwater system at the Site, sample concentrations identified as SSIs may also be influenced by potential historical effects caused by the closed landfills in the vicinity of PDP 5.

Conclusion

SSIs were identified for boron and calcium during the 2019 Detection Monitoring Program sampling events at PDP 5. All observed SSIs are attributed to natural variation in groundwater quality due to the heterogeneity of the groundwater system and to potential effects from the closed landfills in the vicinity of PDP 5 (PDP 1 through PDP 4), and are not considered evidence of a release from the CCR unit. In accordance with Section 257.94(e)(2), Luminant should continue the Detection Monitoring Program. Initiation of an Assessment Monitoring Program is not required at this time.

References

Pastor, Behling & Wheeler, LLC (PBW), 2017. Coal Combustion Residual Rule, Statistical Analysis Plan, PDP 5, Rusk County, Texas. October 11, 2017.

PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by Golder Associates Inc. under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I hereby certify that the alternative source demonstration at the referenced facility meets the requirements of Section 257.94(e)(2) of the CCR Rule.

STATE OF TEXAS
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04-07-20

Patrick J. Behling, P.E.

Principal Engineer

GOLDER ASSOCIATES INC.

Table 1
CCR Groundwater Detection Monitoring Data Summary
Martin Lake Steam Electric Station - PDP 5

Sample Location	Date Sampled	B Prediction Limit	B Sample Data	Ca Prediction Limit	Ca Sample Data	Cl Prediction Limit	Cl Sample Data	Fl Prediction Limit	Fl Sample Data	field pH Prediction Limit	field pH Sample Data	SO_4 Prediction Limit	SO_4 Sample Data	TDS Prediction Limit	TDS Sample Data
MW-17A	09/22/17	0.538	0.402	6.73	3.1	10.4	8.3	0.4	<0.1	2.5 9.19	6.78	51.9	31.2	170	111
	06/14/18		0.485		6.48		9.16		<0.1		6.87		45.9		129
	09/11/18		0.523		5.06		8.82		0.179 J		5.03		43.1		137
	05/13/19		0.497		4.88		9.18		<0.1		6.79		44.7		145
	11/07/19		0.52		5.05		8.81		<0.100		6.44		43.9		127
MW-18A	09/21/17	0.20	0.0654	3.1	1.04	10.4	5.27	0.4	<0.1	4.88 7.92	6.94	9.1	3.23	157	45
	06/14/18		0.102		2		6.56		<0.1		6.92		3.48		71
	09/12/18		0.211		3.23		9.06		<0.1		5.69		4.82		150
	11/07/18		0.128		--		--		--		--		--		--
	05/13/19		0.117		1.01		6.17		0.138 J		6.64		3.23		73
	11/07/19		0.127		11.5		6.34		<0.100		6.23		3.67		68
MW-19	09/22/17	0.782	0.0677	237	2.74	57.7	5.36	0.512	<0.1	4.6 8.08	6.94	672	1.46 J	1,380	98
	06/14/18		0.577		133		24.4		0.216 J		6.78		328		758
	09/11/18		0.243		38		65.1		0.228 J		6.04		166		597
	11/07/18		--		--		5.22		--		--		--		--
	05/13/19		0.429		122		26.8		0.229 J		6.72		349		813
	11/08/19		0.529		77.8		49.3		0.189 J		6.87		310		844
MW-20A	09/22/17	0.213	0.0807	25.7	17.4	12.3	12.6	0.954	0.175 J	3.06 8.76	6.71	148	74.2	381	237
	02/21/18 re-sample		--		--		10.7		--		--		--		--
	06/13/18		0.171		24		10.9		0.672		6.72		132		250
	09/11/18		0.141		7.16		11		0.235 J		4.70		39.1		154
	05/13/19		0.239		37.4		10.2		0.731		6.81		178		328
	11/08/19		0.132		9.9		10.2		0.465		6.51		88		205

Table 1
CCR Groundwater Detection Monitoring Data Summary
Martin Lake Steam Electric Station - PDP 5

Sample Location	Date Sampled	B Prediction Limit	B Sample Data	Ca Predictio n Limit	Ca Sample Data	Cl Prediction Limit	Cl Sample Data	Fl Prediction Limit	Fl Sample Data	field pH Predictio n Limit	field pH Sample Data	SO_4 Prediction Limit	SO_4 Sample Data	TDS Predictio n Limit	TDS Sample Data
PDP-22	09/22/17	0.411	0.221	306	92.5	32.7	12.3	1.07	0.321 J	4.08 8.63	6.98	216	178	1,780	558
	06/14/18		0.115		7.78		11.8		0.239		6.63		186		491
	09/12/18		0.164		61.1		10.9		0.216 J		5.88		143		476
	05/13/19		0.158		98.2		10.1		0.303 J		6.86		184		615
	11/12/19		0.226		34.3		12.6		0.218 J		6.93		215		482
PDP-23	09/22/17	0.0678	0.0463	2	2.34	7.52	4.48	0.4	0.147 J	3.38 8.45	6.77	3.27	1.47 J	143	111
	02/21/18 re-sample		--		2.37		--		--		--		--		--
	06/13/18		0.0357		2.29		6.21		<0.1		6.82		1.26 J		98
	09/11/18		0.0760		1.96		6.38		<0.1		5.32		1.52 J		98
	11/07/18		0.0683		--		--		--		--		--		--
	05/13/19		0.0628		1.89		6.98		<0.1		6.68		1.28 J		103
	11/12/19		0.0675		2.14		4.98		<0.100		6.72		1.41 J		93
PDP-24	09/22/17	4.92	3.01	45.9	25.8	22.6	17.5	1.03	0.898	1.33 9.97	6.95	533	231	894	440
	06/14/18		2.71		23.9		21.1		0.629		6.82		284		481
	09/11/18		4.08		41.6		19.4		0.832		4.20		460		760
	05/13/19		3.23		23		21		0.871		6.95		300		537
	11/12/19		3		21.9		20.6		0.751		6.87		295		520
	11/12/19		2.97		22.2		20.5		0.744		6.87		300		504
PDP-25	09/22/17	0.136	0.133	41.3	36.8	197	130	0.4	0.157 J	4.65 7.93	6.81	118	89.1	705	481
	06/14/18		0.119		40.4		111		<0.1		6.78		73.4		439
	09/11/18		0.167		36.2		135		0.115 J		5.87		90.3		469
	11/07/18		0.142		--		--		--		--		--		--
	05/13/19		0.144		44.4		108		0.121 J		6.84		69		469
	11/12/19		0.184		38.6		117		<0.100		6.82		71.4		454

Table 1
CCR Groundwater Detection Monitoring Data Summary
Martin Lake Steam Electric Station - PDP 5

Sample Location	Date Sampled	B		Ca		Cl		Fl		field pH		SO_4		TDS	
		Prediction Limit	Sample Data	Predictio n Limit	Sample Data	Prediction Limit	Sample Data	Prediction Limit	Sample Data	Predictio n Limit	Sample Data	Prediction Limit	Sample Data	Predictio n Limit	Sample Data
PDP-26	09/22/17	0.111	0.0343	4.74	2.32	14.6	5.24	0.577	0.157 J	5.35 7.57	6.84	64.6	5.88	438	107
	06/14/18		0.0225 J		2.93		4.8		<0.1		6.89		4.27		100
	09/12/18		0.0371		2.37		4.88		<0.1		6.07		2.66 J		107
	05/13/19		0.0528		1.9		4.59		0.217 J		6.86		2.7 J		106
	11/12/19		0.0622		2.25		4.64		0.122 J		6.77		2.1 J		102

Notes:
1. All concentrations in mg/L. pH in standard units.
2. J - concentration is below sample quantitation limit; result is an estimate.

EXPLANATION

CCR Monitoring Well

N

Scale in Feet

0 275 550

SOURCE:
Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

Figure 1

PDP 5 AREA
DETAILED SITE PLAN

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

APPENDIX F5 - SITE HYDROGEOLOGY AND STRATIGRAPHIC CROSS-SECTIONS OF THE SITE

CONCEPTUAL SITE MODEL AND DESCRIPTION OF SITE HYDROGEOLOGY (ASH POND AREA)

The Martin Lake Steam Electric Station (Martin Lake) conceptual site model (CSM) and Description of Site Hydrogeology for the Ash Pond Area (APA), which includes the East Bottom Ash Pond (EAP), West Bottom Ash Pond (WAP), and New Scrubber Pond (NSP) located near Tatum, Texas are described in the following sections.

REGIONAL SETTING

The APA is located in the Martin Creek area on the west flank of the Sabine Uplift within the Sabine River Valley (Golder, 2016). Formations in the Martin Creek area mainly include continental and marine sedimentary deposits of Eocene-aged Wilcox Group (Barnes, 1965; Golder, 2016), which are overlain by sands of the Carrizo Formation at higher elevations (not present at the APA) (Golder, 2019). The Wilcox formation is approximately 650 to 700 feet thick in the Martin Creek area, and includes sandy clays, silty sands, clays, and variable amounts of lignite (Golder, 2016). The Wilcox Group was described as mostly unconsolidated to moderately consolidated clay and silt with variable degrees of interbedded sand and lignite in the area of the Site (Golder, 2019), and derived from a depositional environment associated with fluvial-deltaic processes, which may include inter-channel crevasses splays, overbank deposits, and localized channel fills (Golder, 2019). In the Martin Creek area, the Wilcox Group is underlain by the approximately 900-foot thick silty clay and clay deposits of the Paleocene Midway Group, which overlies approximately 7000 feet of Cretaceous rock (Golder, 2016).

Potable water supply wells are completed in Wilcox Group sands of the Martin Creek area, including two Martin Lake locations upgradient of the APA (screened at depths of at least 300 feet below ground surface) (Golder, 2019). In addition, to these Martin Lake potable water supply wells, other groundwater wells completed in the Wilcox Group sands include well used for domestic, oil and gas, or stock watering purposes (Golder, 2019).

Groundwater occurring within the upper 100 feet below ground surface in the Martin Creek area is typically under unconfined or semi-confined conditions, where the potentiometric surface of these shallow flow systems typically mirror that of the topographic surface (Golder, 2019). Groundwater flow is generally from the potentiometric highs that mimic the topographic highs (coincident with groundwater recharge areas, groundwater divides and surface water divides) toward potentiometric lows and valleys (coincident with groundwater discharge zones) (Golder, 2019).

SITE GEOLOGY

The APA is located in the outcrop area of the Wilcox Group described above (PBW, 2017). Surficial soils in the vicinity of the APA include the following (described in order from shallow to deep) based on soil borings (Golder, 2019):

- Upper Zone - low to medium plasticity lean clay to clayey sand, occurring at thicknesses ranging from approximately 30 to 40 feet.
- Intermediate Zone (Uppermost Aquifer) - poorly-graded fine sand and silty sand, occurring at thicknesses ranging from approximately 5 to 20 feet.
- Lower Confining Unit - laterally-continuous silty to sandy clay.

Cross-sections showing the subsurface materials encountered at the APA are included as an attachment to this demonstration. Drilling logs used to develop the cross-sections are also included as an attachment to this demonstration.

SITE HYDROGEOLOGY

Seven monitoring wells are included in the CCR groundwater monitoring system, which includes three upgradient monitoring wells (H-26, H-27, and H-33) and four downgradient monitoring wells (H-28, H-29, H-31, and H-32) (PBW, 2017) (see Monitoring Well Location Map, and Well Construction Diagrams and Drilling Logs attached to this demonstration). All wells included in the CCR monitoring system are screened in the intermediate zone (i.e., uppermost aquifer) at the APA (PBW, 2017).

Hydraulic Conductivity

Hydraulic conductivity results from field testing (i.e., slug tests) in the upper zone (clayey sand) and intermediate zone (sand and silty sand) ranged from 3.5 x 10^{-6} to 3.8 x 10^{-4} centimeters per second (cm/s) and 1.2 x 10^{-4} to 7.5 x 10^{-3} cm/s, respectively as reported by PBW (2017).

Groundwater Elevations, Flow Direction and Velocity

Groundwater elevations adjacent to the APA for the eight CCR background monitoring events from October 2015 through December 2016 ranged from approximately 302.30 feet above mean sea level (amsl) to 310.04 feet amsl, corresponding to groundwater depths from 9.24 to 26.94 feet below ground surface (PBW, 2017). In general, groundwater elevations were highest in the west, with inferred groundwater flow direction to the east toward Martin Lake during the eight background monitoring events (PBW, 2017). These groundwater elevations and flow directions are consistent with the groundwater potentiometric map for May 2019 included as an attachment to this demonstration (Golder, 2019). Golder (2019) estimated the lateral groundwater flow velocity in the intermediate zone (i.e., uppermost aquifer) to be 27 feet per year.

REFERENCES

Barnes, Virgil E., 1965. Geologic Atlas of Texas, Tyler Sheet, Texas Bureau of Economic Geology.

Golder Associates Inc. (Golder). 2016. Safety Factor Assessment Report, Martin Lake Steam Electric Station.

Golder Associates Inc. (Golder). 2019. CCR Assessment of Corrective Measures, Martin Lake Steam Electric Station – Ash Pond Area, Rusk County, Texas.

Pastor, Behling & Wheeler (PBW). 2017. Coal Combustion Residual Rule Groundwater Monitoring System Certification, Martin Lake Steam Electric Station, Ash Pond Area, Rusk County, Texas. October 16.

LEGEND

- DOWNGRADIENT CCR MONITORING WELL
- UPGRADIENT CCR MONITORING WELL
- LAKE WATER/GROUNDWATER MIXING ZONE SAMPLE
- MNA SOIL SAMPLE
- A ——— A' CROSS SECTION LOCATION

REFERENCE(S)

BASE MAP TAKEN FROM GOOGLE EARTH, IMAGERY DATED 4/2017.

APPENDIX G Revision 1 December 15, 2022

CLIENT
LUMINANT

PROJECT
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

TITLE
DETAILED SITE PLAN - ASH POND AREA

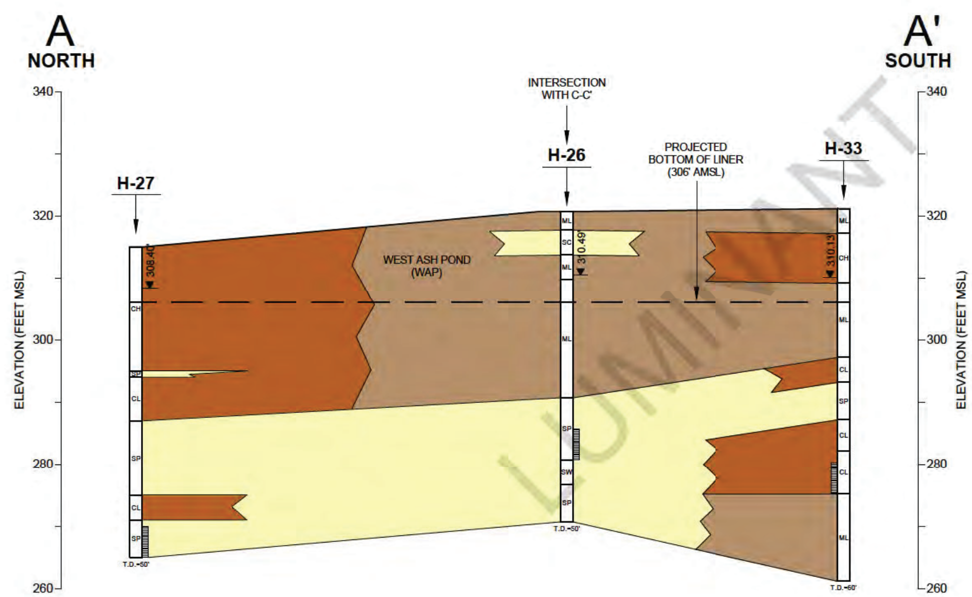
CONSULTANT

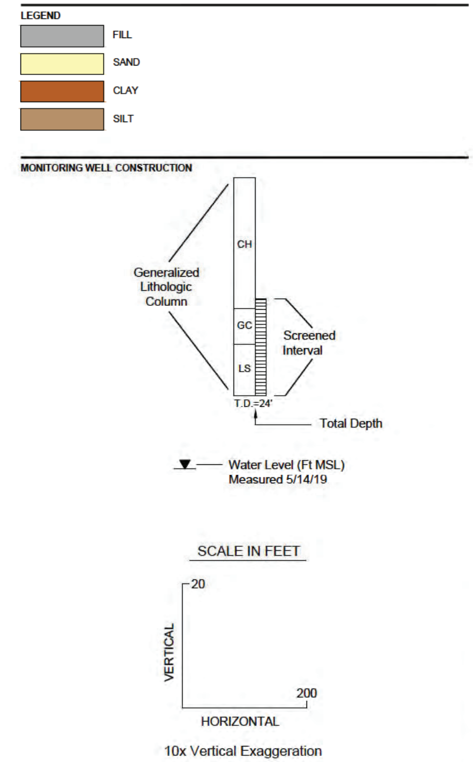
GOLDER

YYYY-MM-DD	2019-08-28
DESIGNED	AJD
PREPARED	AJD
REVIEWED	WFV
APPROVED	WFV

PROJECT NO.	REV.	FIGURE
19121403	0	2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A





CLIENT
LUMINANT

PROJECT
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

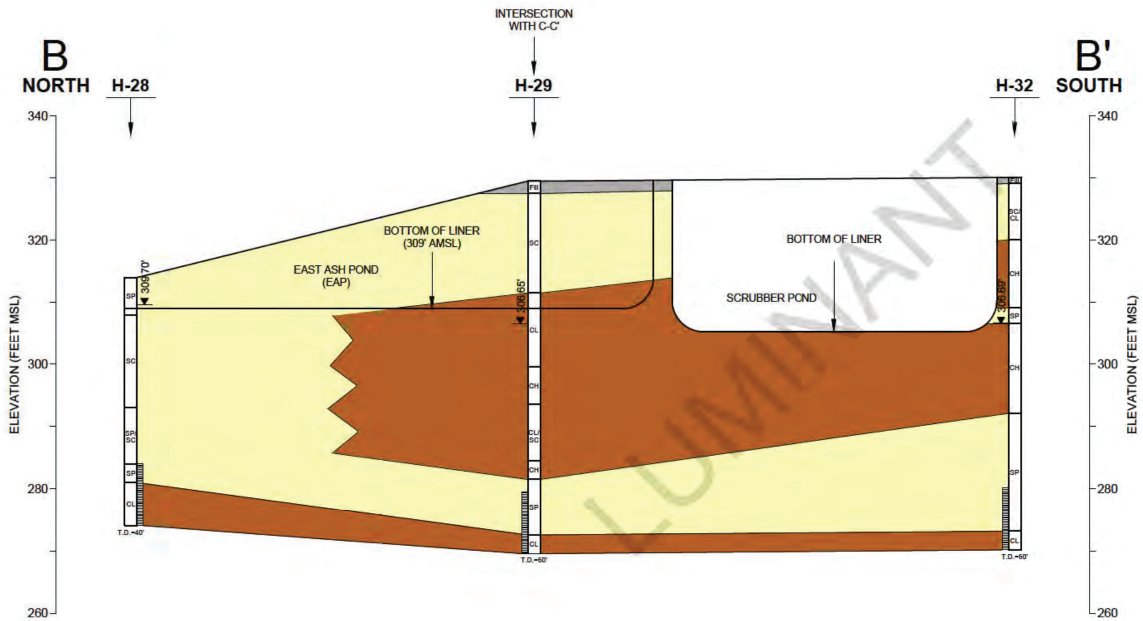
TITLE
ASH POND AREA - GEOLOGIC CROSS SECTION A-A'
WEST SIDE OF WEST ASH POND
THROUGH PROCESS WATER POND

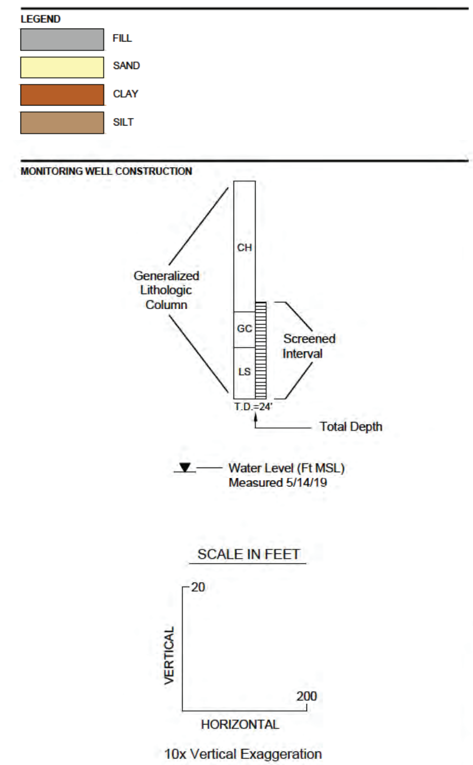
CONSULTANT

GOLDER

YYYY-MM-DD	2019-08-28
DESIGNED	AJD
PREPARED	AJD
REVIEWED	WFV
APPROVED	WFV

PROJECT NO. 19121403 REV. 0 FIGURE 3





CLIENT
LUMINANT

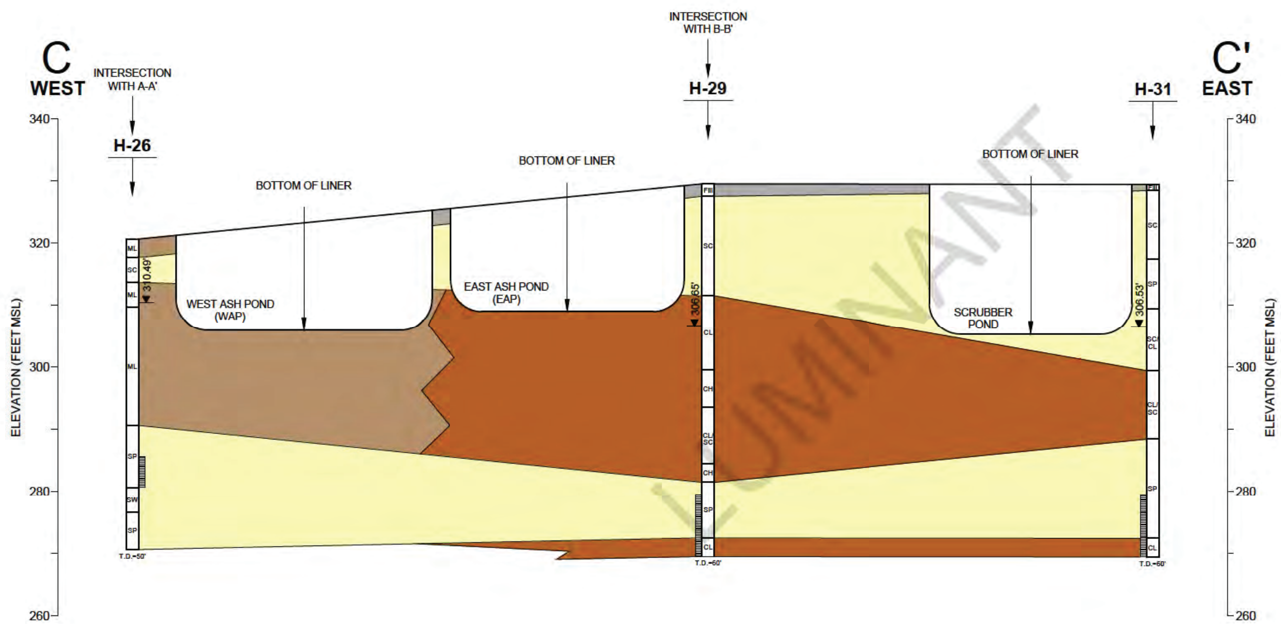
PROJECT
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

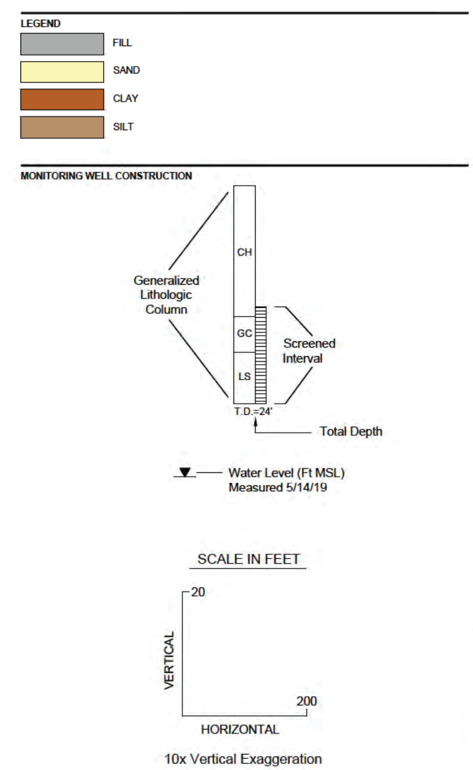
TITLE
ASH POND AREA - GEOLOGIC CROSS SECTION B-B'
EAST SIDE OF ASH POND THROUGH SCRUBBER POND

CONSULTANT
GOLDER

YYYY-MM-DD	2019-08-28
DESIGNED	AJD
PREPARED	AJD
REVIEWED	WFV
APPROVED	WFV

PROJECT NO. 19121403 REV. 0 FIGURE 4





CLIENT
LUMINANT

PROJECT
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

TITLE
ASH POND AREA - GEOLOGIC CROSS SECTION C-C' THROUGH WEST ASH POND AND EAST ASH POND

CONSULTANT
GOLDER

YYYY-MM-DD	2019-08-28
DESIGNED	AJD
PREPARED	AJD
REVIEWED	WFV
APPROVED	WFV

PROJECT NO. 19121403 REV. 0 FIGURE 5

CONCEPTUAL SITE MODEL AND DESCRIPTION OF SITE HYDROGEOLOGY (PERMANENT DISPOSAL POND 5)

The Martin Lake Steam Electric Station (Martin Lake) conceptual site model (CSM) and Description of Site Hydrogeology for the Permanent Disposal Pond-5 (PDP5), located near Tatum, Texas are described in the following sections.

REGIONAL SETTING

The PDP5 is located in the Martin Creek area on the west flank of the Sabine Uplift within the Sabine River Valley (Golder, 2016). Formations in the Martin Creek area mainly include continental and marine sedimentary deposits of Eocene-aged Wilcox Group (Barnes, 1965; Golder, 2016), which are overlain by sands of the Carrizo Formation at higher elevations (Golder, 2019). The Wilcox formation is approximately 650 to 700 feet thick in the Martin Creek area, and includes sandy clays, silty sands, clays, and variable amounts of lignite (Golder, 2016). The Wilcox Group was described as mostly unconsolidated to moderately consolidated clay and silt with variable degrees of interbedded sand and lignite in the area of the Site (Golder, 2019), and derived from a depositional environment associated with fluvial-deltaic processes, which may include inter-channel crevasses splays, overbank deposits, and localized channel fills (Golder, 2019). In the Martin Creek area, the Wilcox Group is underlain by the approximately 900-foot thick silty clay and clay deposits of the Paleocene Midway Group, which overlies approximately 7000 feet of Cretaceous rock (Golder, 2016).

Potable water supply wells are completed in Wilcox Group sands of the Martin Creek area, including two Martin Lake locations (screened at depths of at least 300 feet below ground surface) (Golder, 2019). In addition, to these Martin Lake potable water supply wells, other groundwater wells completed in the Wilcox Group sands include well used for domestic, oil and gas, or stock watering purposes (Golder, 2019).

Groundwater occurring within the upper 100 feet below ground surface in the Martin Creek area is typically under unconfined or semi-confined conditions, where the potentiometric surface of these shallow flow systems typically mirror that of the topographic surface (Golder, 2019). Groundwater flow is generally from the potentiometric highs that mimic the topographic highs (coincident with groundwater recharge areas, groundwater divides and surface water divides) toward potentiometric lows and valleys (coincident with groundwater discharge zones) (Golder, 2019).

SITE GEOLOGY

The PDP5 is located in the outcrop area of the Wilcox Group described above (PBW, 2017). Surficial soils in the vicinity of PDP5 include the following (described in order from shallow to deep) based on soil borings (PBW, 2017):

- Upper Sand Unit – an upper sand unit is observed on hilltops and other topographically high areas.
- Intermediate Continuous Clay Unit – a continuous clay unit that contains discontinuous packages of relatively thick layers of interbedded sand.
- Lower Silt and Sand Unit (Uppermost Aquifer) – a silt and sand unit that contains discontinuous packages of relatively thick layers of clay.

A cross-section showing the subsurface materials encountered in the vicinity of PDP5 is included as an attachment to this demonstration. Drilling logs used to develop the cross-section are also included as an attachment to this demonstration.

SITE HYDROGEOLOGY

Nine monitoring wells (MW-17A, MW-18A, MW-19, MW-20A, PDP-22, PDP-23, PDP-24, PDP-25, and PDP-26), positioned radially around PDP5, are included in the CCR groundwater monitoring system. Groundwater flow directions around PDP5 indicate there are no upgradient areas in the vicinity of the CCR unit and all nine CCR groundwater monitoring wells are downgradient of PDP5 (PBW, 2017) (see Monitoring Well Location Map, and Well Construction Diagrams and Drilling Logs attached to this demonstration). All wells included in the CCR monitoring system are screened in the lower silt and sand unit (i.e., uppermost aquifer) at the PDP5 (PBW, 2017).

Hydraulic Conductivity

Hydraulic conductivity results from field testing (i.e., slug tests) at monitoring wells PDP-22, PDP-25, and PDP-26 in the lower sand and silt unit (uppermost aquifer) ranged from approximately 2.48×10^{-5} to 1.37×10^{-4} centimeters per second (cm/s), with a geometric mean of approximately 4.40×10^{-5} cm/s (PBW, 2017).

Groundwater Elevations and Flow Direction

Groundwater elevations adjacent to the PDP5 for the eight CCR background monitoring events from October 2015 through December 2016 ranged from approximately 352.38 feet above mean sea level (amsl) to 381.40 feet amsl, corresponding to groundwater depths from 5.14 to 37.46 feet below ground surface (PBW, 2017). In general, mounding was observed within PDP5 with an inferred radial groundwater flow outward from PDP5 (PBW, 2017). These groundwater elevations and flow directions are consistent with the groundwater potentiometric map for December 2016 included as an attachment to this demonstration (PBW, 2017).

REFERENCES

Barnes, Virgil E., 1965. Geologic Atlas of Texas, Tyler Sheet, Texas Bureau of Economic Geology.

Golder Associates Inc. (Golder). 2016. Safety Factor Assessment Report, Martin Lake Steam Electric Station.

Golder Associates Inc. (Golder). 2019. CCR Assessment of Corrective Measures, Martin Lake Steam Electric Station – Ash Pond Area, Rusk County, Texas.

Pastor, Behling & Wheeler (PBW). 2017. Coal Combustion Residual Rule Groundwater Monitoring System Certification, Martin Lake Steam Electric Station, Permanent Disposal Pond 5, Rusk County, Texas. October 16.

EXPLANATION

MW-12A — A Zone Monitoring Well

MW-12B — B Zone Monitoring Well

N

Scale in Feet

0 200 400

SOURCE:
Base map from http://www.tnris.state.tx.us, Tatum SW DOQQ, Texas, 2010.

LUMINANT - MARTIN LAKE SES

PDP 1, 2 AND 3 CLOSURE REPORT

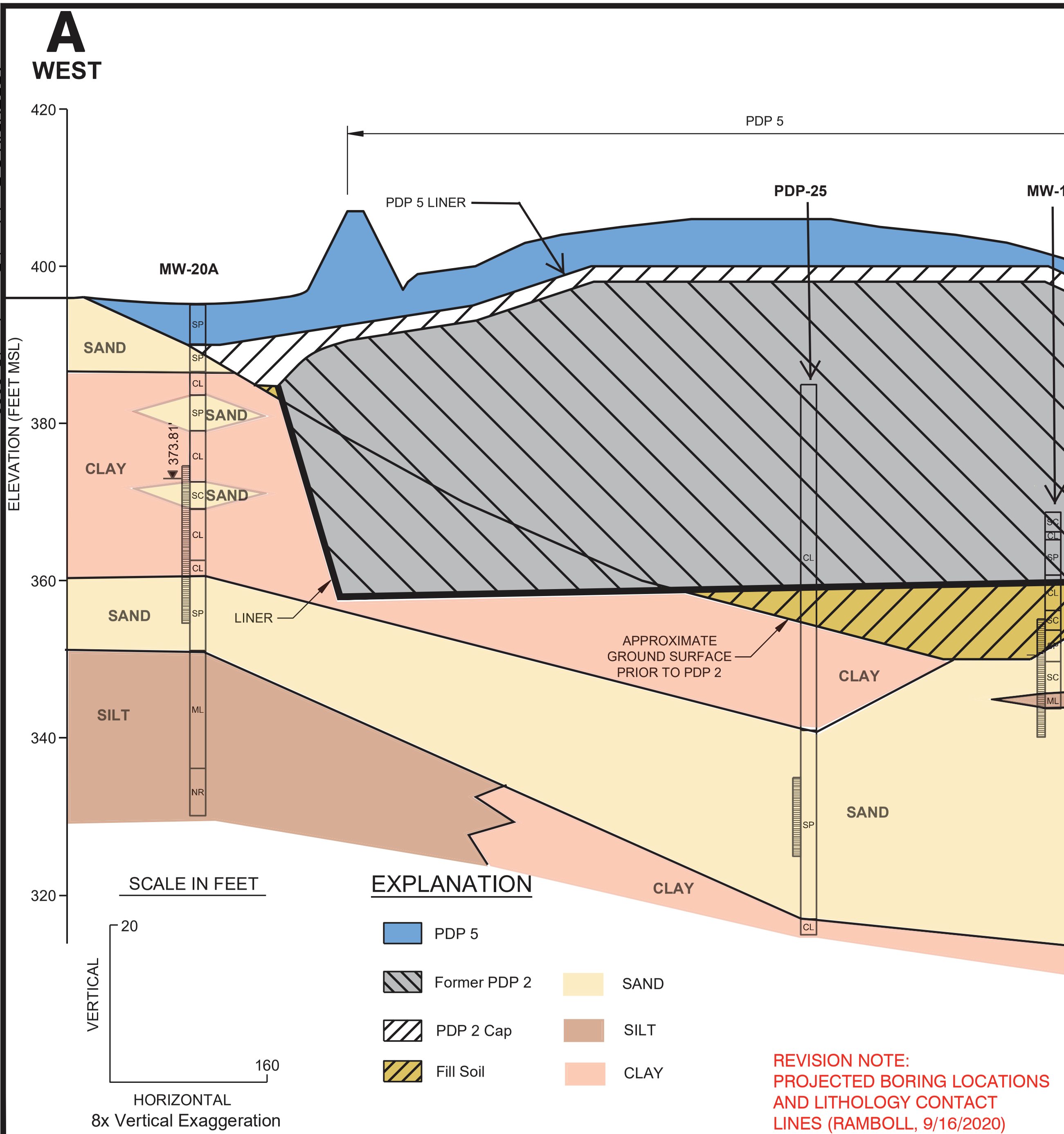
Figure 3

PDP 1, 2 AND 3 POST CLOSURE SITE PLAN

PROJECT: 5058	BY: AJD	REVISIONS
DATE: NOV., 2014	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC

CONSULTING ENGINEERS AND SCIENTISTS



LUMINANT - MARTIN LAKE SES
PDP 1, 2 AND 3 CLOSURE REPORT

Figure 4

CROSS SECTION A-A'

PROJECT: 5058	BY: AJD	REVISIONS
DATE: NOV., 2014	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS

APPENDIX F6 - CORRECTIVE MEASURES ASSESSMENT (ASH POND AREA)

REPORT

CCR ASSESSMENT OF CORRECTIVE MEASURES

Martin Lake Steam Electric Station - Ash Pond Area
Rusk County, Texas

Submitted to:

Luminant Generation Company LLC

Submitted by:

Golder Associates Inc.
2201 Double Creek Dr, Suite 4004, Round Rock, Texas, USA 78664

+1 512 671-3434

19121403

September 2019

Table of Contents

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Golder Associates Inc. (Golder) has prepared this assessment of corrective measures (ACM) report on behalf of Luminant Generation Company LLC (Luminant) for the West Ash Pond (WAP), East Ash Pond (EAP), and New Scrubber Pond (NSP) (collectively referred to as the "Ash Pond Area") located at the Martin Lake Steam Electric Station (MLSES) in Rusk County, Texas (hereafter, the "Site"). The ACM was prepared in accordance with §257.96 of the Coal Combustion Residual (CCR) Rule and was required due to the presence of concentrations of selected Appendix IV constituents at statistically significant levels (SSLs) above the groundwater protection standards (GWPS) established for the constituents at the Site. This ACM Report will be placed in the MLSES operating record in accordance with §257.105(h)(10).

This report also incorporates the results of a site investigation conducted at the Site in May and June 2019. The objectives of the site investigation were:

- delineate the nature and extent of the selected Appendix IV constituents to their respective GWPS;
- update the statistical evaluations of the Appendix IV constituents to include data collected during 2019 to confirm that SSL exceedances continue to occur at the Site;
- collect data to evaluate potential future alternate source demonstrations (ASDs) for the Appendix IV constituents; and
- assess the potential for monitored natural attenuation (MNA) to be successful at the Site for the Appendix IV constituents.

The MLSES is located approximately 5 miles southeast of Tatum, Rusk County, Texas (Figure 1). The MLSES is expected to remain in operation for the foreseeable future, depending on future power demands.

The Ash Pond Area is located immediately east of the MLSES power units (Figure 2). The WAP is constructed with a composite liner consisting of an 18-inch thick compacted clay liner, overlain by two 60-mil HDPE geomembrane liners with a geonet drainage layer between the geomembranes. The EAP is constructed with a composite liner consisting of an 18-inch thick compacted clay liner, overlain by a geotextile, overlain by two 60-mil HDPE geomembrane liners with a geonet drainage layer between the geomembranes. A 4-inch thick concrete revetment mat is installed on top of the upper geomembrane liner in both the WAP and EAP. The WAP and EAP are considered unlined surface impoundments under §257.71(a)(1)(ii) of the CCR Rule (BM 2016).

The NSP is constructed with liner system consisting of two 60-mil HDPE geomembrane liners with a geonet drainage layer between the geomembranes, overlain by a 4-inch thick concrete revetment mat. The NSP is considered an unlined surface impoundment under §257.71(a)(1)(ii) of the CCR Rule (BM 2016).

2.0 REGIONAL AND SITE SETTING

2.1 Regional Geology

MLSES is located in the outcrop area of the Eocene-aged Wilcox Group (Barnes, 1965). The Wilcox Group in the vicinity of the Site consists mostly of unconsolidated to moderately consolidated clay and silt, with various amounts of interbedded sand and lignite. The depositional environment is associated with fluvial-deltaic processes such as inter-channel crevasse splays, overbank deposits, and localized channel fills. The Wilcox Group is overlain by sands of the Carrizo Formation, which is present only at higher elevations in the area. The Carrizo Formation is not present at the Site.

2.2 Regional Hydrogeology

Groundwater wells completed in the Wilcox Group sands in the area are typically used for domestic, oil and gas supply, or stock watering purposes. Some potable water supply wells in the region are also completed in the Wilcox Group, including two wells at the MLSES that are both located upgradient of the Ash Pond Area and are screened at depths of 300 feet bgs or greater. Groundwater within the upper 100 feet below ground surface (bgs) in the region typically flows under unconfined to semi-confined conditions. The direction and rate of groundwater movement in the Wilcox Group are affected by a number of physical features, including topography, surface drainage, and geology. The natural groundwater potentiometric surface in these shallow flow systems is generally a subdued replica of topography. In general, groundwater flow occurs from high potentiometric areas (recharge zones) toward valleys (discharge zones). Groundwater divides generally coincide with surface drainage divides.

2.3 Site Hydrogeology and CCR Monitoring Well Network

The CCR groundwater monitoring well network at the Ash Pond Area was established in 2015 using newly installed monitoring wells H-26, H-27, H-28, H-29, H-31, H-32, AND H-33 (Figure 2). Based on soil borings completed at the Site, the geology near the CCR units generally consists of an upper zone composed of an approximately 30- to 40-foot thick low- to medium-plasticity, lean clay to clayey sand unit. The upper zone is underlain by an intermediate zone composed of poorly-graded fine sand and silty sand unit that is generally about 5 to 20 feet thick. The intermediate zone is underlain by a laterally-continuous, silty to sandy confining clay unit. The uppermost aquifer occurs in the intermediate sand and silty sand unit at the Site (PBW 2017a). The CCR monitoring wells are completed in the intermediate zone. Geologic cross sections of the Ash Pond Area are presented on Figures 3, 4, and 5.

Groundwater elevations are generally highest near the western side of the Ash Pond Area with an inferred groundwater flow direction to the east toward Martin Lake. A groundwater potentiometric map constructed using groundwater elevation data collected in May 2019 from the CCR monitoring network is presented on Figure 6. Based on the inferred groundwater flow direction, the location of each CCR monitoring well relative to the Ash Pond Area is as follows:

Upgradient/Background Wells	Downgradient Wells
H-27 H-26 H-33	H-28 H-29 H-31 H-32

Rising- and falling-head aquifer tests (i.e., slug tests) were conducted at the Site as part of a 2011 assessment for the Texas Commission on Environmental Quality (TCEQ) Texas Risk Reduction Program (TRRP) (PBW 2011). Based on the test results, the intermediate zone had an estimated hydraulic conductivity of 1.0E-03 cm/sec and an estimated lateral groundwater flow velocity of 27 feet per year.

Golder performed a survey of water supply wells located in the vicinity of the Ash Pond Area in May 2019 as part of a Texas Commission on Environmental Quality (TCEQ) Texas Risk Reduction Program (TRRP) assessment of the Site. A Drinking Water Survey Report (Golder, 2019) documenting the water well survey activities and findings was approved by the TCEQ in a letter dated August 15, 2019. No imminent threats to water wells or potentially affected drinking water wells were identified.

3.0 NATURE AND EXTENT EVALUATION

3.1 Groundwater Monitoring Summary

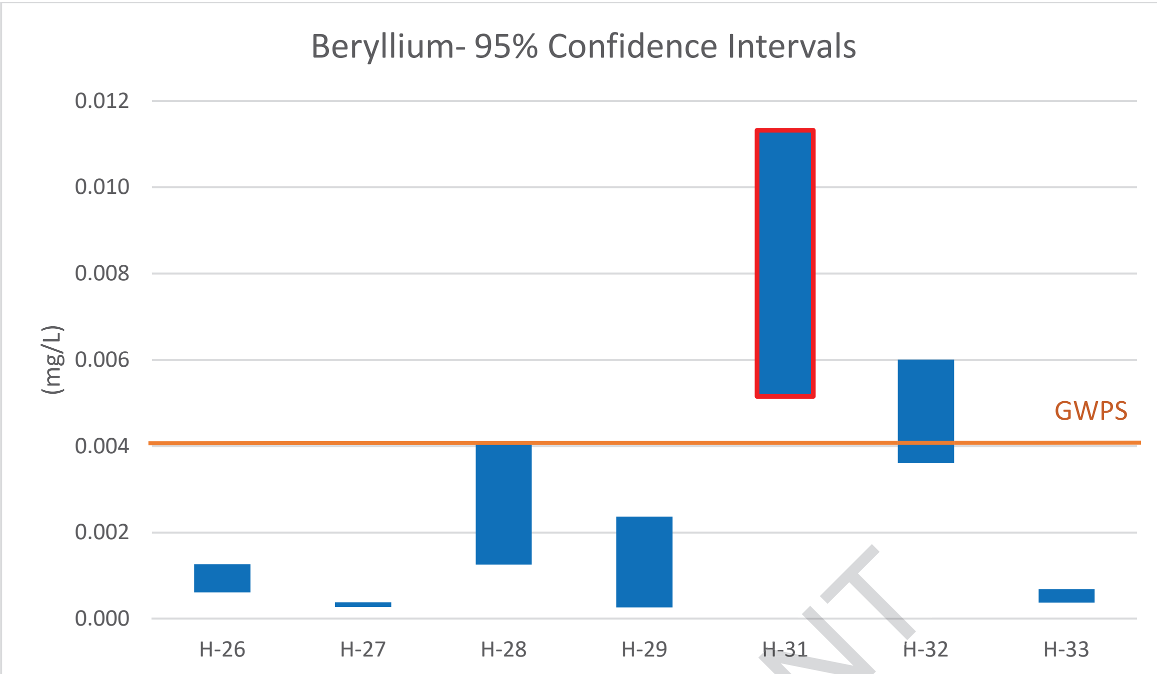
Background monitoring of groundwater in the vicinity of the Ash Pond Area began in October 2015 and was completed in December 2016. Samples collected during this period were analyzed for Appendix III and Appendix IV constituents to establish background concentrations pursuant to §257.94(b).

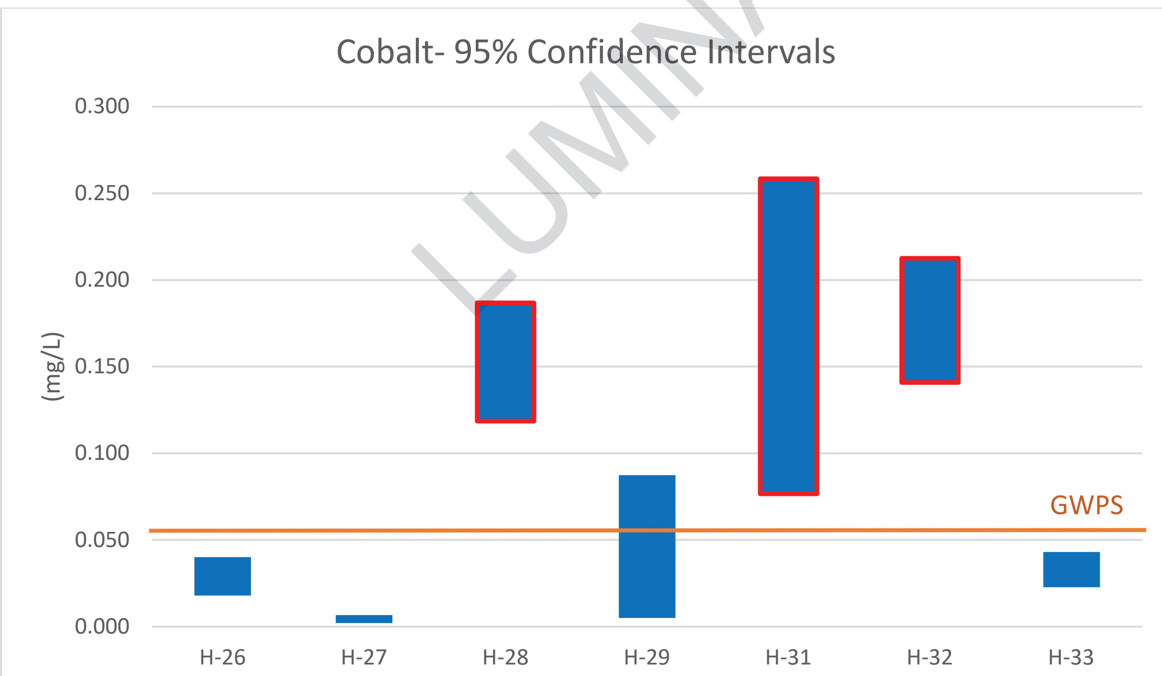
A detection monitoring program in accordance §257.94 was initiated in September 2017. The evaluation of those data was completed in 2018 using procedures described in the Statistical Analysis Plan (PBW 2017b) to identify statistically significant increases (SSIs) of Appendix III parameters above background concentrations. Based on the identification of SSIs for one or more Appendix III parameters, an assessment monitoring program was established pursuant to §257.94(e)(1).

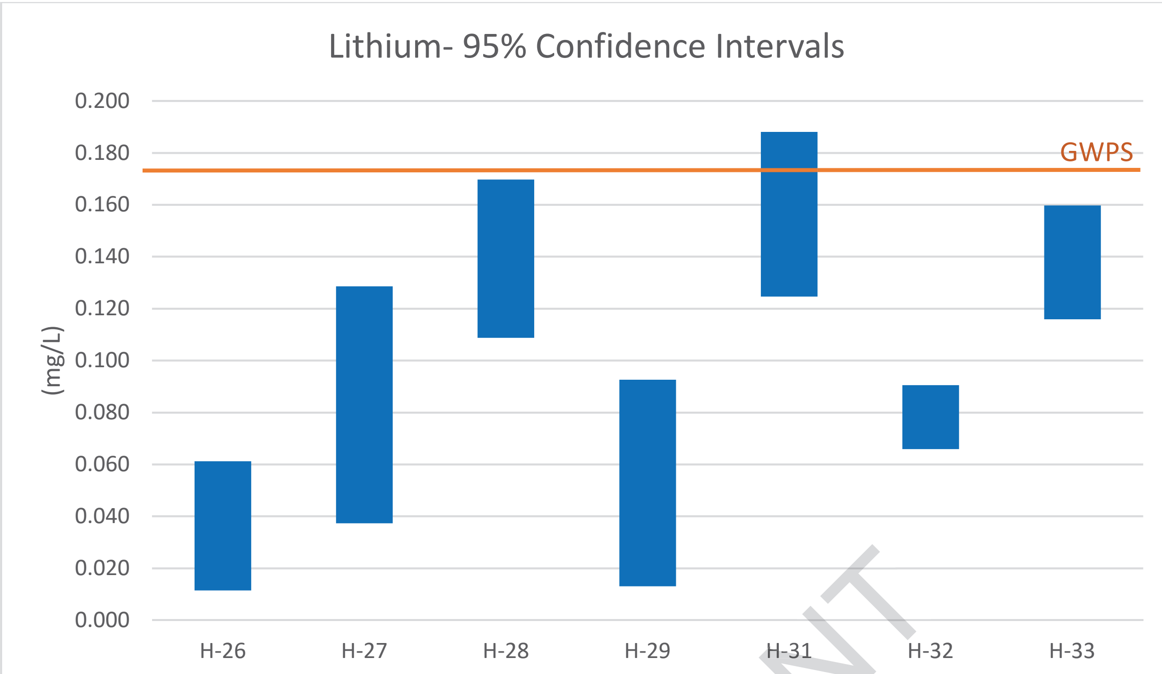
The initial assessment monitoring event was performed in June 2018 and a subsequent semi-annual assessment monitoring event was conducted in September 2018 in accordance with §257.95(a) and §257.95(d). Using the Appendix IV data collected during the assessment monitoring period through September 2018, SSLs above GWPSs were initially identified in downgradient wells in January 2019 for beryllium (H-28, and H-29), cobalt (H-28 and H-29), and lithium (H-28); therefore, an ACM was initiated on April 8, 2019 pursuant to §257.95(g). A justification letter for a 60-day extension due to site-specific circumstances that delayed work on the ACM was certified on July 3, 2019 in accordance with §257.96(a). Based on the extension, the deadline for completing the ACM is September 5, 2019.

3.2 Assessment Monitoring SSL Evaluation

An additional assessment monitoring event was performed in May 2019. Groundwater sampling analytical results for all Appendix IV parameters from 2015 through 2019 are presented in Table 1. An updated statistical analysis of the Appendix IV results from downgradient CCR monitoring wells was conducted including the May 2019 data to evaluate if constituent concentrations detected in the samples remained at SSLs relative to the GWPSs. The updated statistical analysis was performed in accordance with the Statistical Analysis Plan for CCR Groundwater Monitoring (PBW 2017b) and the USEPA Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities-Unified Guidance (USEPA 2009). Confidence intervals were calculated for any Appendix IV parameter that historically has had more than one occurrence in excess of the GWPS in any well within the monitoring network. Plots of the confidence intervals for each of those Appendix IV parameters are presented below (SSLs are highlighted in red around the bars):


Beryllium- 95% Confidence Intervals
0.012
0.010
0.008
0.006
0.004
0.002
0.000
(mg/L)
GWPS
H-26
H-27
H-28
H-29
H-31
H-32
H-33


Cobalt- 95% Confidence Intervals
0.300
0.250
0.200
0.150
0.100
0.050
0.000
(mg/L)
GWPS
H-26
H-27
H-28
H-29
H-31
H-32
H-33



The previous statistical analysis using data collected during the assessment monitoring period through September 2018 indicated SSLs for beryllium (H-28 and H-29), cobalt (H-28 and H-29), and lithium (H-28) as identified in the February 2019 SSL notification; however, the updated statistical analysis only identified beryllium (H-31) and cobalt (H-28, H-31, and H-32) as having SSLs above GWPSs. The monitoring wells will continue to be monitored to confirm that lithium concentrations remain below SSLs in the future in accordance with the CCR Rule. For the purposes of this ACM evaluation, concentrations are conservatively assumed to be present at SSLs above their respective GWPSs for the following constituents in the wells indicated based on the initial and updated statistical evaluations:

- Beryllium (H-28, H-29, and H-31);
- Cobalt (H-28, H-29, H-31, and H-32); and
- Lithium (H-28).

Figure 7 shows the extent of Appendix IV constituents detected at SSLs above GWPSs based on the initial and updated statistical analysis.

3.3 Field Investigation

3.3.1 General

Field investigation activities conducted as part of the ACM included collection of soil samples for a mineralogical assessment and chemical analysis, a lake sample from Martin Lake, groundwater-level measurements, and groundwater sampling and analysis. Figure 2 presents the locations of soil borings and monitoring wells installed and sampled as part of the field investigation.

3.3.2 Soil Sample Collection

Soil borings were completed in June 2019 at soil boring locations AP-2019-1, AP-2019-2, and AP-2019-3. Soil samples were collected within the target GWBU in each of the soil borings. Soil samples were submitted under chain-of-custody for laboratory analysis of the following parameters:

- Mineralogical composition: The purpose of the mineralogical analysis was to identify and quantify the crystalline mineral phases in each sample. This information is required for geochemical modeling as the release or attenuation of constituents of interest is influenced by the mineral phase(s) present in the aquifer (Hem 1985). The mineralogical testing laboratory (SGS Minerals Services) performed the analysis using quantitative (Rietveld) X-ray diffraction (XRD) (ME-LR-MIN-MET-MN-DO5) and a Bruker AXS D8 Advance Diffractometer.
- Total metals: Analysis of total metals was conducted to quantify the chemical composition of soil materials. The total mass of metals, in combination with the results of sequential extraction testing, can be used to determine the provenance of metals and verify sequential extraction results.
- Sequential extraction (SEP): This test consists of a seven-step metals extraction from solids as per Tessier et al. (1979) to identify the provenance of constituents of interest (i.e. the operationally-defined fraction that contains the metal) and determine their potential environmental mobility. For instance, metals bound in the carbonate fraction, or that are exchangeable, are much more likely to become mobile due to changes in groundwater conditions than metals bound within a sulfide or silicate fraction. The total concentration of a metal measured from all seven steps can be compared to the concentration determined from the total metal analysis for compositional accountability.

3.3.3 Groundwater and Surface Water Sampling

Groundwater samples were collected from the CCR monitoring network and one surface water sample was collected from Martin Lake downgradient of the Ash Pond Area in May 2019. Laboratory analytical reports are provided in Appendix B and sampling records, which include field-measured parameters, are presented in Appendix C.

Chemical/geochemical analysis of groundwater samples included field parameters and radionuclides, nutrients, and major cations and anions. The rationale and methods used are as follows:

- Field Parameters: Parameters measured in the field included pH, dissolved oxygen, oxidation reduction potential (ORP), conductivity, and temperature. These parameters were used to evaluate general geochemical conditions in the groundwater and support geochemical modeling.
- Metals and Regulated COIs: Analysis of Appendix III and IV metals and uranium to better understand the geochemical composition of groundwater. Metals analysis allows for the delineation of a potential plume, evaluation of mineral saturation indices, and evaluation of background contributions from natural sources or anthropogenic sources.
- Major Cations, Anions, and Nutrients: Geochemical modeling of mineral solubility, metals attenuation and background contributions requires analysis of major cations and anions because they affect and participate in sorption and mineral dissolution or precipitation reactions.

3.4 Evaluation of Groundwater Water

3.4.1 Geochemical Modeling Approach

Geochemical modeling was conducted to evaluate general groundwater quality, determine the potential for precipitation of sorbent media, evaluate the potential for mineral precipitation or adsorption in the aquifer, and determine the speciation of metals of interest. The geochemical computer code developed by the United States Geological Survey (USGS), PHREEQC, was used for these simulations (Parkhurst and Appelo 2013). PHREEQC version 3.4 is a general-purpose geochemical modeling code used to simulate reactions in water and between water and solid mineral phases (e.g., rocks and sediments). Reactions include aqueous equilibria, mineral dissolution and precipitation, ion exchange, surface complexation, solid solutions, gas-water equilibrium, and kinetic biogeochemical reactions. The widely-accepted thermodynamic database Minteq.v4, 2017 edition, was used as a basis for the thermodynamic constants required for modeling.

The Geochemist's Workbench Version 12 (Bethke 2015) was used to generate graphical representations of geochemical modeling outputs in the form of predominance, or Pourbaix diagrams (also known as Eh-pH diagrams) for the species of interest (i.e. beryllium and cobalt) and trilinear plots (also known as Piper plots) displaying the relative abundance of major ions. The Minteq.v4 database was used as the basis for the Pourbaix diagrams.

3.4.2 Summary of Groundwater and Surface Water Data

Groundwater quality data from background wells H-26, H-27, and H-33; downgradient monitoring wells H-28, H-29, H-31, and H-32; and the surface water sample collected from Martin Lake were used for this evaluation. The water quality monitoring data are presented in Appendices B and C and can be summarized as follows:

General Chemistry Parameters

- pH: The pH of groundwater samples collected from CCR monitoring well network ranged from 6.01 to 6.83 in May 2019. Historically, the pH in the CCR monitoring well network has ranged from 5.8 to 7.0. Isolated values as low as 3.64 and as high as 11.20 have been recorded in some wells; however, these conditions do not persist but pH returns to circumneutral values by the next sampling round. The pH of Martin Lake was 6.79 in May 2019.
- ORP (Redox): Field-measured redox values, corrected to Eh (+200mV), ranged from +113 to +174 mV in the groundwater samples in the CCR monitoring well network.
- Total Dissolved Solids (TDS): Groundwater TDS concentrations were variable in May 2019 in the CCR monitoring well network. The lowest TDS concentration (453 mg/L) occurred in groundwater at CCR monitoring well H-26 (upgradient) and the highest TDS value (4,230 mg/L) was observed at CCR monitoring well H-31 (downgradient). The TDS concentration measured in Martin Lake water was 119 mg/L.
- Major ion chemistry: A Piper plot was generated for groundwater and Martin Lake samples to facilitate the identification of water types and source contributions (Figure 8a). Two distinct groupings of wells are apparent based on their relative major ion proportions. Upgradient wells H-26 and H-33 show close similarity with the water sample from Martin Lake, indicating potential influences of Martin Lake on the groundwater in these locations. Groundwater composition in upgradient well H-27, in contrast, is more closely related to that of the downgradient wells. Based on the molar ratios of calcium, sodium, and sulfate (Figure 8b), all groundwater samples and the Martin Lake water sample generally plot as one group.

- Iron: Oxidized iron (ferric iron - Fe^{+3}) concentrations were variable, ranging from non-detect (<0.05 mg/L) to 8.81 mg/L in May 2019 (Appendix B). Reduced iron (ferrous iron - Fe^{+2}) concentrations were non-detect (<0.05 mg/L) in the groundwater at all CCR monitoring wells except H-31 and H-32. The highest concentration of ferrous iron in groundwater was 49.5 mg/L observed in monitoring well H-31, over 40 times higher than any other monitoring well. This value corresponded to the highest measured beryllium, cobalt, and lithium concentrations in groundwater at the Ash Pond area. Ferric iron in water from Martin Lake was measured at 0.365 mg/L while ferrous iron was non-detect (<0.05 mg/L).

- Nutrients: Nitrate (nitrate as N) was present in groundwater at variable levels, ranging from non-detect (< 0.1 mg/L as N) to 272 mg/L as N at H-32 in May 2019 (Appendix B). Nitrate in CCR monitoring well H-32 at 272 mg/L as N, was orders of magnitude higher than in other monitoring wells, in which nitrate ranged from non-detect (<0.1 mg/L as N) to 0.658 mg/L as N. Nitrate was not detected in Martin Lake water. Phosphate concentrations in groundwater ranged from near non-detect (0.03 mg/L as P) to 0.126 mg/L as P in CCR monitoring wells. Phosphate was not detected in the water of Martin Lake in May 2019. No spatial trend was apparent in the nitrate or phosphate distribution in groundwater.

Constituents Identified in February 2019 SSL Notification

- Beryllium: Beryllium concentrations in groundwater samples historically have exceeded the GWPS (0.004 mg/L) in CCR monitoring wells H-28, H-29, H-31, and H-32 on at least one occasion since October 2015 (Figure 9a). However, due to the variability of beryllium concentrations in groundwater at these wells, only H-31 currently has beryllium at an SSL. As of May 2019, beryllium concentrations in H-31 and H-32 were above the GWPS, at 0.00713 mg/L and 0.00928 mg/L, respectively. The highest beryllium concentration in groundwater was measured in H-31 in December 2016. Beryllium was not detected in the Martin Lake water sample (<0.0003 mg/L). Beryllium is likely present in groundwater as the divalent cation Be^{+2} based on the pH and Eh of groundwater (Figure 10a).

- Cobalt: Cobalt concentrations in groundwater samples historically have exceeded the GWPS (0.0564 mg/L) in all CCR monitoring wells except H-27 on at least one occasion since October 2015 (Figure 9b). All CCR network monitoring wells have also reported groundwater cobalt concentrations below the GWPS on at least one occasion since October 2015, indicating variability in cobalt In May 2019, all wells except H-27 had cobalt concentrations in groundwater above the GWPS. Cobalt was not detected in water from Martin Lake in May 2019 (<0.003 mg/L). Cobalt is likely present in groundwater as the divalent cation Co^{+2} based on the pH and Eh of groundwater (Figure 10b).

- Lithium: Lithium concentrations in groundwater have exceeded the GWPS (0.040 mg/L) since October 2015 in four wells: H-27 (upgradient), H-28, H-31, and H-33 (Figure 9c). In May 2019, only the sample from CCR monitoring well H-31 exceeded the GWPS for lithium. Based on an evaluation of the 95% confidence intervals, the GWPS exceedances for lithium at H-27. H-28. H-31, and H-33 are not at an SSL above the GWPS. Water from Martin Lake did not contain lithium above its detection limit (<0.005 mg/L) in May 2019.

The groundwater analytical results indicate that the Ash Pond Area may be the potential source for the cobalt and/or beryllium concentrations observed at SSLs in monitoring wells H-28, H-31 and H-32. However, the data also indicates that lithium concentrations are not present at SSLs in any of the monitoring wells at the Site.

3.5 Evaluation of Soil

3.5.1 Mineralogical Composition

Quantitative X-ray diffraction (XRD) with Rietveld refinement was used to identify and quantify minerals in three overburden samples collected during the drilling activities - one sample from each of the soil borings completed in June 2019 (AP-2019-1, AP-2019-2, and AP-2019-3). These samples were obtained to better understand the mineralogical composition of the aquifer system and identify any minerals that would potentially influence attenuation of constituents of interest. In contrast, the presence of certain minerals could also indicate a potential for naturally-occurring release of metals into groundwater, for instance due to oxidation of sulfide minerals.

The mineralogical analysis of soil from borehole samples at the Ash Pond Area identified quartz as the predominant mineral, with varying amounts of albite in all three boreholes. Soil samples from boreholes AP-2019-1 and AP-2019-2 (ranging 30' below ground surface (bgs) to 31' bgs and 35' bgs to 36' bgs) also contained small or trace amounts of the silicate minerals K-felspar, chlorite, muscovite, kaolinite, vermiculite, illite, and montmorillonite. Analytical reports for the XRD samples are provided in Appendix B. These minerals were not identified in the shallower borehole samples of AP-2019-1 (18' bgs to 19' bgs), indicating potentially a greater abundance of clay minerals (kaolinite, vermiculite, illite, montmorillonite) in deeper samples.

3.5.2 Chemical Composition and Sequential Extraction

Chemical analysis and sequential extractions were used to determine the chemical composition of the soil and the distribution of constituents of interest over various operationally-defined fractions comprising the soil. Testing was completed as described in Section 3.3.2 on soil samples obtained from three borehole locations (Figure 2) and the analytical reports for the soil analyses are provided in Appendix B.

Soil sample locations were chosen to gain a better understanding of the underlying geological conditions of the area surrounding the Ash Pond Area, mostly adjacent to or downgradient of a CCR monitoring well. In addition, this information allows for a better understanding of naturally-occurring metal contributions to groundwater or the potential for sequestration of constituents from groundwater.

A description of the individual fractions determined by sequential extraction is presented in Section 3.3.2. Metals extracted in steps 1 through 5 are considered environmentally available, whereas metals extracted in steps 6 and 7 are present in refractory fractions and are not expected to be released under conditions typically encountered in aquifers (Tessier et al. 1979). Total metal quantities from the sequential extraction are expressed as "SEP Total" in Appendix B. The sum of the sequential extraction steps is also presented for comparison but does not represent an analytically-determined value.

The results from the chemical analysis and sequential extraction presented in Appendix B are summarized as follows:

General Chemistry Parameters

- <u>Aluminum</u>: Aluminum is not a constituent of interest (COI) at the site but it has been well studied as a sorbing medium in soils (e.g., Karamalidis and Dzombak 2011). Total aluminum in soils ranged from 14,244 to 33,160 mg/kg, and the environmentally-available fraction ranged from 1,044 (AP-2019-3) to 1,989 mg/kg (AP-2019-2). Aluminum in the soil at the site is, therefore, largely (~84% to 87%) present in the residual, or silicate-bound fraction. This fraction is likely at least partially represented by hydrous aluminum phyllosilicate minerals or clays intermixed in the silica sand matrix. Clays can represent an important sorptive reservoir for numerous trace metals and metalloids (Uddin 2017).

- Iron: While not a COI, iron and its minerals commonly represent one of most abundant reservoirs for metal/metalloid attenuation in soils (Dzombak and Morel 1990; Smith 1999). Iron was present in all three core samples analyzed, varying from 5,192 (AP-2019-3) to 13,933 mg/kg (AP-2019-2). In all samples, the non-environmentally available (sulfide and residual) fractions accounted for the largest proportion of total iron (54% to 64%) and, as such, most of the iron is not environmentally available. The remainder of the iron in the samples is present across the exchangeable (except AP-2019-1), carbonate (only in AP-2019-2), amorphous metal, and metal hydroxide phases. These phases, part of the labile fraction in steps 1 through 5, can generally be considered representative of the amount of iron in soil that may be available as a sorbing medium and can, therefore, be important for potential attenuation of beryllium and cobalt.

Constituents Identified in February 2019 SSL Notification

- Beryllium: Total beryllium in soil ranged from 0.23 to 0.68 mg/kg, of which 16% to 75% of the beryllium was present in the environmentally-available fraction. The non-environmentally available fraction of beryllium (25% to 84% of total) is also indicative of naturally occurring beryllium in soil at the Ash Pond Area. All of the environmentally-available beryllium resorted in the amorphous metal and metal hydroxide fractions, indicating potential attenuation of beryllium from groundwater (Smith 1999).
- Cobalt: Total cobalt in soil ranged from 1.68 to 6.29 mg/kg while the environmentally-available fraction ranged from 1.4 mg/kg in AP-2019-3 to 4.39 mg/kg in AP-2019-2, representing from 58% to 83% of total cobalt. The majority of the environmentally-available cobalt was present in the metal hydroxide fractions in soils samples AP-2019-1 and AP-2019-2, while the exchangeable fraction hosted the largest proportion of cobalt in soils sample AP-2019-3. Soil sample AP-2019-2 contained cobalt in every fraction of the sequential extraction test, indicating potential attenuation of cobalt from groundwater, and the potential presence of naturally occurring cobalt in soil.
- Lithium: Total lithium in soil ranged from 7.15 to 17.3 mg/kg, of which between only 7% (AP-2019-3) and 24% (AP-2019-2) resorted in the environmentally-available fraction. Lithium that was environmentally available (0.53 to 4.2 mg/kg) was all contained in the metal hydroxide fraction. This indicates the likelihood of the presence of naturally-occurring lithium at the site that is contained within non-environmentally available fractions while attenuation of lithium by metal hydroxide minerals also appears to be occurring.

The results of the soil analysis indicate the following:

- A naturally-occurring source of beryllium, cobalt, and lithium is present in the vicinity of the Ash Pond Area at the MLSES.
- Attenuation of beryllium, cobalt, and lithium in groundwater is likely occurring in the vicinity of the Ash Pond Area.

3.6 Summary of Site Characterization

Based on the above site characterization and nature and extent investigation, the following is concluded with respect to beryllium, cobalt, and lithium:

- Beryllium: Beryllium concentrations statistically exceeded the GWPS in groundwater from only one CCR monitoring well (H-31). Beryllium concentrations in groundwater monitoring well H-31 were the highest in December 2016, followed by a stable or decreasing trend since that occurrence. Beryllium was not detected in water from Martin Lake. Sequential extraction results indicate the potential for attenuation of beryllium by amorphous metals and metal hydroxides (Smith 1999). Beryllium should, therefore, be considered for further evaluation as part of an ACM as a viable candidate for monitored natural attenuation based on the results of this initial assessment (USEPA 2007a, b).

- Cobalt: Historical data from CCR monitoring wells in which cobalt concentrations in groundwater exceeded the GWPS indicate a stable or decreasing concentrations since the highest measured cobalt in groundwater of 0.434 mg/L in October 2015. Cobalt concentrations in groundwater currently statistically exceed the GWPS in three CCR monitoring wells (H-28, H-31 and H-32). Cobalt was not detected in water from Martin Lake. Cobalt was present in nearly every fraction of soil as determined from sequential extraction, indicating the strong potential for cobalt attenuation by soils (Smith 1999). Cobalt should, therefore, be considered for further evaluation as part of an ACM as a viable candidate for monitored natural attenuation based on the results of this initial assessment (USEPA 2007a, b).

- Lithium: Recent data indicates that lithium concentrations in groundwater statistically no longer exceed the GWPS at any monitoring well location. Lithium was not detected in water from Martin Lake. Based on the data collected to date, lithium concentrations in groundwater are no longer considered to be present at an SSL above the GWPS; however, lithium concentrations in groundwater will continue to be monitored to confirm that lithium levels remain below the GWPS in the future. For the purposes of this ACM evaluation, lithium concentrations are conservatively assumed to be present at an SSL above the GWPS in well H-31 based on the February 2019 SSL notification.

4.0 ASSESSMENT OF CORRECTIVE MEASURES

In accordance with §257.96 and §257.97, an ACM was conducted for the Ash Ponds to address concentrations of the following Appendix IV constituents conservatively assumed to occur at SSLs above their respective GWPS based on the February 2019 SSL notification:

- cobalt concentrations in monitoring wells H-28, H-31 and H-32;
- beryllium concentrations in monitoring well H-31; and
- lithium concentrations in monitoring well H-31.

Potential response technologies were identified for Source Control (to reduce the potential for releases of constituents to groundwater) and Groundwater Response Actions (to reduce constituent concentrations below GWPS). The potential response technologies were then screened to identify options that are appropriate for further consideration in developing potential corrective measures alternatives for the Site. The results of the ACM are presented in this section.

4.1 Corrective Measures Objectives and Evaluation Criteria

As described in §257.96(a), the corrective measures must prevent further releases, remediate any releases and restore the affected area to original conditions. Potential corrective measures must meet the requirements specified in §257.97(b):

1) Be protective of human health and the environment;
2) Attain the groundwater protection standard as specified pursuant to § 257.95(h);
3) Control the source(s) of releases to reduce or eliminate, to the maximum extent feasible, further releases of constituents in appendix IV to this part into the environment;
4) Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, considering factors such as avoiding inappropriate disturbance of sensitive ecosystems;
5) Comply with standards for management of wastes as specified in § 257.98(d).

In accordance with §257.96(c), the assessment of potential corrective measures alternatives must include an evaluation of the following:

1) The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination
2) The time required to begin and complete the remedy
3) Institutional requirements, such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy(s).

4.2 Potential Source Control Response Technologies

One of the listed objectives in §257.97(b) for the corrective measures is to control the source of releases of Appendix IV constituents to the environment from the CCR Unit. The MLSES Ash Ponds are an integral part of the CCR management system at the plant. As a result, any potential source control technology must keep the WAP, EAP and NSP in operation.

The WAP, EAP and NSP are considered unlined surface impoundments under the CCR Rule. As a result, the WAP, EAP and NSP will be retrofitted with new composite liner systems that comply with the requirements of §257.71(a)(1)(ii) of the CCR Rule to improve the level of source control in the ponds. The new liner systems will be installed in general accordance with the following procedures:

- The ponds will be retrofitted one at a time;
- Water will be removed from the pond being retrofitted and transferred to the other Ash Ponds;
- Solids in the ponds will be dewatered, removed and transported to the MLSES A1 Area Landfill for disposal.
- A minimum of 2 feet of compacted clay liner will be placed at the base of each pond;
- A 60-mil HDPE geomembrane liner will be installed over the 2 feet of compacted clay liner;
- A protective layer of soil, ash or other material will be placed over the geomembrane liner.

Retrofitting the WAP, EAP and NSP with new composite liner systems is assumed to serve as the source control component of the potential corrective measures for the Ash Ponds. The estimated time to retrofit the WAP, EAP and NSP is estimated to be approximately 1 to 2 years per pond, including design and construction.

4.3 Potential Groundwater Response Technologies

For the purposes of this ACM, cobalt, beryllium and lithium are conservatively assumed to be present in groundwater at the Site at SSLs above their respective GWPS based on the February 2019 SSL notification. In this section, potential groundwater response technologies to address these constituents are identified and screened for further consideration in developing potential corrective measures alternatives for the Ash Ponds.

4.3.1 Monitored Natural Attenuation

Monitored natural attenuation (MNA) refers to the reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific groundwater remediation objectives within a time frame that is reasonable compared to that offered by more active remediation methods (USEPA 2007a). MNA relies on a range of natural processes, including dispersion, dilution, sorption, (co)precipitation, radioactive decay, and abiotic degradation/transformation to achieve remediation objectives (ITRC 2010). Routine groundwater monitoring would be required to verify MNA is occurring at the Site.

Where necessary, MNA processes can be enhanced through the use of low-energy, in-situ techniques to stimulate or increase the attenuation of contaminants or reduce contaminant loading (ITRC 2010). Enhancement options include increasing the attenuation capacity of the aquifer, decreasing the mobility of contaminants, and/or increasing the stability of immobilized contaminants by increasing the ability of aquifer solids to remove contaminants from groundwater and/or manipulating the geochemistry to reduce remobilization of contaminants by desorption or dissolution of precipitates (ITRC 2010).

MNA has been demonstrated effective in reducing cobalt and beryllium concentrations in groundwater (ITRC 2010; USEPA 2007b). Cobalt is removed through adsorption to iron hydroxides and/or amorphous metals and the level of effectiveness is dependent on iron hydroxide availability as well as pH, alkalinity, and calcium levels (ITRC 2010). Beryllium is removed through adsorption or coprecipitation (DOD 2014). The removal mechanisms for lithium are not identified in the professional literature. As described in Section 3.6 of this report, the Site is a good candidate for MNA, since natural attenuation of cobalt, lithium and beryllium is ongoing at the Site.

MNA would be effective in remediating groundwater beneath t and downgradient of the Ash Ponds. The estimated time to implement MNA is estimated to be approximately 2 to 3 years, including characterization, design, and construction. The estimated time to achieve GWPS for the target Appendix IV constituents is dependent on site-specific conditions and groundwater modelling is needed to evaluate remedial timeframes.

4.3.2 Groundwater Extraction and Treatment

Groundwater extraction and treatment is one of the most widely implemented groundwater remediation technologies and is used to provide 1) hydraulic containment and 2) treatment (USEPA 1996). A groundwater extraction and treatment system consists of the following major components:

- A series of extraction wells or trenches strategically located to modify/interrupt the natural flow of groundwater;
- Extraction pumps installed in each well/trench to pump groundwater from the subsurface;
- A treatment system to remove constituents of concern from the extracted groundwater; and
- A point of discharge for the treated groundwater (surface water, re-injection to groundwater, etc.).

For the Ash Ponds, a system of extraction wells would be installed along the downgradient edge of the ponds to provide hydraulic control of the Appendix IV constituent groundwater plumes. The extracted groundwater would be treated in an on-site treatment system and treated water would be discharged to Martin Lake or re-injected into the aquifer.

Potential groundwater treatment methods for the target Appendix IV constituents include the following:

- Cobalt - ion exchange, adsorptive media, activated carbon, and chemical treatment with membrane filtration (USEPA 2019a).
- Lithium - reverse osmosis, precipitation/co-precipitation, and ion exchange. (USACE, 2010).
- Beryllium - activated alumina, ion exchange, lime softening, coagulation/filtration, and reverse osmosis (USEPA 2003)

Treatment methods for these constituents would need to be bench/pilot tested to evaluate their effectiveness prior to designing a full-scale system. Treatment will generate residual material (sludge, regenerate brine, etc.) containing concentrated levels of the target Appendix IV constituents that must managed.

Groundwater extraction and treatment would be effective in reducing contaminant concentrations in groundwater downgradient of the Ash Ponds through hydraulic containment, but would have little effect on groundwater conditions beneath the ponds. The estimated time to implement groundwater extraction and treatment is estimated to be approximately 3 to 4 years, including testing, design, and construction. The estimated time to achieve GWPS for the target Appendix IV constituents is dependent on site-specific conditions and groundwater modeling is needed to better evaluate remedial timeframes.

4.3.3 Vertical Hydraulic Barrier

A vertical, low permeability hydraulic barrier can be installed to provide a physical barrier to groundwater flow to contain the migration of contaminated groundwater. Vertical hydraulic barriers that have been demonstrated effective at controlling groundwater flow include the following (USEPA 1998):

- Slurry Wall. Slurry walls consist of a narrow, excavated trench that is filled with a soil-bentonite slurry mixture. The slurry shores and supports the trench walls and forms a low-permeability barrier in the trench. Key design considerations include wall depth, key depth, and material compatibility. Slurry trenches can be excavated to depths of 50 feet using standard excavators and over 80 feet using long-reach excavators or a crane mounted drag line/clamshell bucket. Geosynthetic materials can be placed in the trench in conjunction with the slurry wall to improve the hydraulic performance (decrease permeability) and chemical resistance.
- Soil-Mixed Wall. Soil-mixed walls form a hydraulic barrier through in-situ mixing of soil with amendments, such as bentonite and/or cement. Soil-mixed barrier walls can be installed to depths of over 100 feet. The walls are installed by sections or panels that overlap to achieve a continuous barrier.
- Grout Curtain. Grout curtain barriers are constructed by injecting grout into the subsurface in an overlapping injection pattern to form a continuous barrier. Grouted barriers can be installed using permeation grouting, jet grouting, or vibrating beam technologies. Grouted barriers must be designed and constructed to ensure hydrofracturing does not occur and the completed wall is effective at restricting groundwater flow.
- Sheet-pile Wall. Sheet-pile walls consist of steel, vinyl, or other materials driven into the subsurface using a hydraulic percussion hammer or vibratory hammer. Sheet-pile walls are common in civil engineering applications; however, their use in environmental applications has been more limited. One of the major concerns with sheet-walls in environmental applications is leakage through the vertical joints between piles; however, improvements in pile interlock designs have been made to improve joint sealing.

For a vertical hydraulic barrier to be effective, the bottom of the barrier must be “keyed” into a low-permeability confining layer. A detailed engineering analysis and design, likely including a bench/pilot test to identify most appropriate barrier materials, would be required for the construction of a vertical hydraulic barrier.

For the Ash Ponds, the vertical hydraulic barrier would be constructed along the downgradient edge of the ponds to provide hydraulic control of the target Appendix IV constituent groundwater plumes. A vertical hydraulic barrier physically interrupts the natural flow of groundwater; consequently, groundwater elevations upgradient of the barrier will rise, potentially to the point that groundwater could begin to flow around the edges of the barrier. To address this concern, a groundwater extraction and treatment system would be required upgradient of the barrier to control the groundwater levels. The groundwater extraction and treatment system used in conjunction with the vertical hydraulic barrier would be similar to the system described in Section 4.3.2; however, the required capacity of the system would be less since the rate of groundwater extraction would be limited to that required to control upgradient groundwater levels.

Construction of a vertical hydraulic barrier is expected to require significant effort and time. Prior to implementation of the barrier, pre-design field work, including site investigations and bench/pilot-scale barrier material testing would be required, followed by full-scale design and construction. The estimated time to implement a vertical hydraulic barrier with groundwater extraction and treatment is estimated to be approximately 5 to 8 years, including testing, design, and construction. The estimated time to achieve GWPS for the target Appendix IV constituents is dependent on site-specific conditions and groundwater modeling is needed to better evaluate remedial timeframes.

4.3.4 Permeable Reactive Barrier

A permeable reactive barrier (PRB) is an in-situ, permeable treatment zone that contains reactive media designed to intercept impacted groundwater and either immobilize contaminants or transform the contaminants to a more desirable state (ITRC 2011). A PRB is a passive treatment system that acts as a barrier to groundwater contamination but not groundwater flow. The PRB must intercept the flow of impacted groundwater and must be designed and constructed such that impacted groundwater cannot bypass the reactive media by flowing over, under, or around the PRB. A PRB must include the appropriate reactive media and the residence time within the PRB needs to sufficient to allow for effective treatment. The effectiveness of the reactive media will be reduced over time and the media will likely have to be replaced periodically. Groundwater monitoring is used to evaluate the performance/effectiveness of a PRB system.

There are two primary PRB configurations: continuous and funnel-and-gate. A continuous PRB features permeable reactive media across the entire length of the barrier. A funnel-and -gate PRB uses sections of vertical hydraulic barriers to direct groundwater flow through permeable reactive media sections that allow the groundwater to pass through while treating contaminants. In both configurations, the permeability of the reactive media must be greater than the aquifer to ensure flow is not diverted around the PRB media. For the ash Ponds, a PRB system would be constructed along the downgradient edge of the ponds to provide control of the target Appendix IV groundwater plumes.

PRB systems are generally considered a proven technology, however, site conditions and the specific contaminants of interest affect the system performance. The potential applicability of a PRB system for the target Appendix IV constituents can be summarized as follows:

- Cobalt - potentially removed using sulfate-reducing media or combination of zero-valent iron (ZVI) and organic material (Ludwig 2002; ITRC 2011);
- Lithium – potentially precipitated as phosphate using appetite media, (Arnseth 2018).
- Beryllium – potentially removed through in-situ biomass sorption (Goldemund and Robb 2018)

Removal of the target Appendix IV constituents using a PRB system has not been consistently demonstrated under full-scale conditions and bench/pilot-scale testing would be required to confirm the effectiveness of a PRB system at the Site. A groundwater model would be needed to evaluate the remedial timeframes.

Similar to a vertical hydraulic barrier, construction of a PRB system is expected to require significant effort and time. Prior to implementation of the PRB, pre-design field work, including site investigations, groundwater modeling, and bench-scale soil mix testing would be required, followed by full-scale design and construction. The estimated time to implement a PRB system is estimated to be approximately 5 to 8 years, including testing, design, and construction. The estimated time to achieve GWPS for the target Appendix IV constituents is dependent on site-specific conditions and groundwater modeling is needed to better evaluate remedial timeframes.

4.3.5 In-situ Chemical Treatment

In-situ Chemical Treatment (ICT) involves the injection of a chemical reagent or other material into the groundwater aquifer to adjust the geochemistry to enhance the direct precipitation, co-precipitation, or related adsorption/precipitation of the target contaminants (USEPA 2019c). Direct precipitation occurs when a constituent exceeds its solubility in water and precipitates out of solution. Co-precipitation refers to the removal of a constituent through adsorption onto the precipitate of another chemical reaction.

Cobalt has the potential to be removed through adsorption and/or coprecipitation under reducing groundwater conditions and beryllium can potentially be removed through in-situ biomass sorption (Goldemund and Robb 2018). Lithium has the potential to be precipitated as a phosphate under appropriate geochemical conditions (Arnseth 2018).

Injection wells would be installed into the aquifer along the downgradient edge of Ash Ponds and the chemical reagents would be injected to provide control of the target Appendix IV constituent groundwater plumes.

ICT is considered an emerging remediation technology for the target Appendix IV constituents and the effectiveness of the technology on most of the constituents is uncertain. Bench/pilot-scale testing would be required to confirm the effectiveness of an ICT system at the Site. The estimated time to implement an ICT system is estimated to be approximately 5 to 8 years, including testing, design, and construction. The estimated time to achieve GWPS for the target Appendix IV constituents is dependent on site-specific conditions and groundwater modeling is needed to better evaluate remedial timeframes.

4.3.6 Phytoremediation

Phytoremediation refers to the use of plants to partially or substantially remediate selected contaminants in contaminated soil, sludge, sediment, ground water, surface water, and wastewater (USEPA 2001). The process utilizes a variety of plant biological processes and plant physical characteristics to aid in remediation; however, the primary plant process potentially applicable to the target Appendix IV constituents at the Site is phytoextraction, which is the uptake and accumulation of contaminants within aboveground portions of a plant. The contaminants are removed from the Site when the plants are harvested and managed off-site.

Phytoextraction occurs in the root zone of plants, which is typically relatively shallow, with the bulk of roots at shallower rather than deeper depths. This would limit the effectiveness of phytoextraction at the Site due to the depth of groundwater. Phytoremediation for cobalt removal from groundwater has not been demonstrated under full-scale conditions and no information concerning the effectiveness of phytoremediation for lithium and beryllium removal was identified (USEPA 2001).

Implementation of a phytoremediation process at the Site would involve planting appropriate vegetation at intervals along the downgradient edge of the Ash Ponds and across the affected groundwater plume area. A comprehensive bench/pilot testing program would be required to select the most appropriate plants for removal of the target Appendix IV constituents from groundwater at the Site. Since the target Appendix IV constituents would likely accumulate in the plants, management of harvested plants in accordance with RCRA may be required. The estimated time to implement an ICT system is estimated to be approximately 15 to 20 years, based on the success and rate of vegetation growth. The estimated time to achieve GWPS for the target Appendix IV constituents is dependent on site-specific conditions and groundwater modeling is needed to better evaluate remedial timeframes.

4.3.7 Screening of Potential Groundwater Response Technologies

Following identification of potential groundwater response technologies, Golder screened the potential options for further consideration in developing potential corrective measures alternatives for the Ash Ponds. The screening results for each potential source technology are summarized in Table 3. Based on the initial screening, the following potential groundwater response technologies were retained for future evaluation as part of the corrective measures alternatives for the Ash Ponds:

- Monitored Natural Attenuation
- Groundwater Extraction and Treatment
- Vertical Hydraulic Barrier

4.4 Potential Corrective Measures Alternatives

Based on the response technology screening discussed above, Golder assembled the following potential corrective measures alternatives that could be both effective and implementable at the Site:

- Retrofit Liners in WAP, EAP and NSP with Monitored Natural Attenuation
- Retrofit Liners in WAP, EAP and NSP with Groundwater Extraction and Treatment
- Retrofit Liners in WAP, EAP and NSP with Vertical Hydraulic Barrier

A summary of the corrective measure alternatives, including an assessment of each alternative against the evaluation criteria presented in §257.96(c) is provided in Table 4.

4.5 Remedy Selection

The corrective measure alternative proposed as the remedy for the Ash Ponds will be selected in accordance with §257.97 a minimum of 30 days after the public meeting required under §257.96(e) has been completed.

It should also be noted that, for the purposes of this ACM, cobalt, beryllium and lithium concentrations were conservatively assumed to be present at SSLs above their respective GWPSs based on the February 2019 SSL notification. However, as discussed in Sections 3.4-3.6, lithium concentrations are no longer considered to be present at SSLs above the GWPS based on recent data and naturally occurring sources of cobalt, beryllium and lithium exist in the vicinity of the Ash Ponds. Cobalt, beryllium and lithium concentrations in groundwater will continue to be monitored in accordance with the CCR rule to confirm that the concentrations of these constituents remain below the GWPSs in the future. These monitoring results, along with updated statistical analysis and alternate source demonstrations (if applicable), will be considered as part of the remedy selection process.

5.0 REFERENCES

Arnseth, Richard W., 2018. Remedial Technologies to Address CCR Constituents in Groundwater, Tennessee Department of Environmental Conservation - Environmental Show of the South, May.

Barnes, Virgil E., 1965. Geologic Atlas of Texas, Tyler Sheet. Texas Bureau of Economic Geology.

Bethke, C., 2015. Geochemist's Workbench: Release 12.0 - Aqueous Solutions, LLC.

Burns & McDonnell Engineering Company, Inc (BM), 20166. Summary of Liner Construction – Martin Lake Impoundments, Martin Lake Steam Electric Station. September.

Code of Federal Regulations, 2015 April. Chapter 40, Part 257, Subpart D.

Dzombak, D.A. and Morel, F., 1990. Surface complexation modeling: hydrous ferric oxide. John Wiley & Sons.

Goldemund, H and Robb, C, 2018. Current Overview of Groundwater Remediation Options for CCR Units, Proceedings of 2018 World of Coal Ash Conference.

Golder, 2019. Drinking Water Survey Report – Revision No. 1, Martin Lake Steam Electric Station – Ash Pond Area and PDP 5, Rusk County, Texas. July 25.

Hem, J.D., 1985. Study and interpretation of the chemical characteristics of natural water (Vol. 2254). US Geological Survey.

ITRC. 2010. A Decision Framework for Applying Monitored Natural Attenuation Processes to Metals and Radionuclides in Groundwater. Technical/Regulatory Guidance, December 2010.

ITRC. 2011. Permeable Reactive Barrier: Technology Update. PRB-5. June 2011.

Karamalidis, A. and Dzombak, D., 2011. Surface complexation modeling: gibbsite. John Wiley & Sons.

Ludwig, R, et. al., 2002. A Permeable Reactive Barrier for Treatment of Heavy Metals in Ground Water 40(1):59-66, January 2002.

Parkhurst, D. and Appelo, C., 2013. Description of input and examples for PHREEQC version 3: a computer program for speciation, batch-reaction, one-dimensional transport, and inverse geochemical calculations (No. 6-A43). US Geological Survey.

Pastor, Behling & Wheeler, LLC (PBW), 2011. Revised Affected Property Assessment Report, Martin Lake Steam Electric Station – Ash Pond Area (TCEQ SWR No. 31277). May 3.

PBW, 2017a. Coal Combustion Residual Rule Groundwater Monitoring System Certification, Martin Lake Steam Electric Station, Ash Pond Area, Rusk County, Texas. October 16

PBW 2017b. Coal Combustion Residual Rule Statistical Analysis Plan, Martin Lake Steam Electric Station, Ash Pond Area, Freestone County, Texas.

Smith, K., 1999. Metal sorption on mineral surfaces: an overview with examples relating to mineral deposits. The Environmental Geochemistry of Mineral Deposits. Part B: Case Studies and Research Topics, 6, pp.161-182.

Tessier, A., Campbell, P.G. and Bisson, M., 1979. Sequential extraction procedure for the speciation of particulate trace metals. Analytical chemistry, 51(7), pp.844-851.

Uddin, M., 2017. A review on the adsorption of heavy metals by clay minerals, with special focus on the past decade. Chemical Engineering Journal, 308, pp.438-462.

US Department of Defense (DOD), 2014. Frequently Asked Questions about Monitored Natural Attenuation in Groundwater, February.

USEPA, 1996. Pump-and-Treat Ground-Water Remediation: A Guide for Decision Makers and Practitioners. EPA/625/R-95/005. July 1996.

USEPA. 1998. Evaluation of Subsurface Engineered Barriers at Waste Sites, EPA-542-R-98-005, July 1998.

USEPA. 2001. Phytoremediation of Contaminated Soil and Ground Water at Hazardous Waste Sites, EPA/540-S-01/500. February 2001.

USEPA. 2003. Water Treatment Technology Feasibility Support Document for Chemical Contaminants, EPA 815-R-03-004, June.

USEPA, 2007a. Monitored Natural Attenuation of Inorganic Contaminants in Ground Water. Volume 1. Technical Basis for Assessment. EPA/600/R-07/139.

USEPA, 2007b. Monitored Natural Attenuation of Inorganic Contaminants in Ground Water. Volume 2. Assessment for Non-Radionuclides Including Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Nitrate, Perchlorate, and Beryllium. EPA/600/R-07/140.

USEPA, 2009. Unified Guidance Document: Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, EPA 530-R-09-007, March 2009.

USEPA, 2014. Reference Guide to Treatment Technologies for Mining-Influenced Water. March 2014.

USEPA, 2015. 40 CFR Parts 257 and 261; Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule. April 17, 2015.

USEPA, 2015. Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites. U.S. Environmental Protection Agency Office of Solid Waste and Emergency Response Directive 9283.1-36. August 2015.

USEPA, 2019a. Drinking Water Treatability Database – Cobalt and Beryllium. Retrieved from https://oaspub.epa.gov/tdb/pages/general/home.do

USEPA, 2019b. Permeable Reactive Barriers. CLU-IN. Retrieved from https://clu-in.org/techfocus/default.focus/sec/Permeable_Reactive_Barriers%2C_Permeable_Treatment_Zones%2C_and_Application_of_Zero-Valent_Iron/cat/Overview/

USEPA, 2019c. In Situ Chemical Reduction. CLU-IN. Retrieved from https://clu-in.org/techfocus/default.focus/sec/In_Situ_Chemical_Reduction/cat/Overview/

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TABLES

TABLE 1
APPENDIX IV GROUNDWATER ANALYTICAL DATA SUMMARY
MARTIN LAKE STEAM ELECTRIC STATION
ASH POND AREA

Sample Location	Date Sampled	Sb (mg/L)	As (mg/L)	Ba (mg/L)	Be (mg/L)	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	Fl (mg/L)	Pb (mg/L)	Li (mg/L)	Hg (mg/L)	Mo (mg/L)	Se (mg/L)	Tl (mg/L)	Ra 226 (pCi/L)	Ra 228 (pCi/L)	Ra 226/228 Comb.^ (pCi/L)
GWPS:		0.006	0.01	2	0.004	0.005	0.1	0.0564	4	0.015	0.177	0.002	0.1	0.05	0.002	--	--	5
Upgradient Wells																		
H-26	10/21/15	<0.0008	0.00364 J	0.0785	0.000349 J	<0.0003	<0.002	0.0385	<0.1	<0.0003	0.0139	<0.00008	<0.002	<0.002	<0.0005	0.919	<1.64	2.56
	12/14/15	<0.0008	<0.002	0.0401	0.000458 J	<0.0003	<0.002	0.0244	<0.1	<0.0003	0.0769	<0.00008	<0.002	<0.002	<0.0005	0.619	<1.95	2.57
	02/23/16	<0.0008	<0.002	0.0423	<0.0003	<0.0003	0.0077	0.00813	0.151 J	0.000315 J	0.0124	<0.00008	0.00248 J	0.0022 J	<0.0005	0.37	<2.06	2.43
	04/05/16	<0.0008	<0.002	0.0408	<0.0003	<0.0003	0.00798	0.0125	0.199 J	<0.0003	0.0121	<0.00008	<0.002	<0.002	<0.0005	<0.243	<1.06	<1.303
	06/07/16	<0.0008	<0.002	0.0467	0.000721 J	<0.0003	<0.002	0.0217	<0.1	<0.0003	0.0132	<0.00008	<0.002	<0.002	<0.0005	0.245	1.67	1.92
	08/09/16	<0.0008	0.0029 J	0.0431	0.00136	<0.0003	<0.002	0.0352	<0.1	<0.0003	0.0155	<0.00008	<0.002	<0.002	<0.0005	<0.2	<0.932	<1.132
	10/18/16	<0.0008	<0.002	0.0497	0.000709 J	<0.0003	<0.002	0.0214	0.127 J	<0.0003	0.0136	<0.00008	<0.002	0.00265 J	<0.0005	0.243	<0.622	0.87
	12/11/16	<0.0008	<0.002	0.0468	0.00146	<0.0003	0.00311 J	0.0275	0.161 J	0.000358 J	0.014	<0.00008	<0.002	<0.002	<0.0005	0.248	1.82	2.07
	06/13/18	<0.0008	<0.002	0.0659	0.0016	<0.0003	0.00213 J	0.0261	<0.100	<0.0003	0.032	<0.00008	<0.002	<0.002	<0.0005	<0.297	3.72	4.017
	09/07/18	NA	<0.002	0.0470	0.00155	<0.0003	0.00319 J	0.0247	<0.100	<0.0003	0.0489	NA	NA	<0.002	NA	<0.473	<0.665	<1.138
	05/14/19	<0.0008	0.0041 J	0.1900	0.00147	<0.0003	0.0406	0.0795	0.140 J	0.000972 J	0.147	<0.00008	<0.002	0.00222 J	<0.0005	1.43	0.598	2.028
H-27	10/21/15	<0.0008	<0.002	0.0378	<0.0003	<0.0003	<0.002	0.00432 J	<0.1	<0.0003	0.0607	<0.00008	<0.002	<0.002	<0.0005	<0.553	<1.67	<2.223
	12/14/15	<0.0008	0.0021 J	0.039	<0.0003	<0.0003	<0.002	0.00326 J	0.156 J	0.000339 J	0.0624	<0.00008	<0.002	<0.002	<0.0005	0.468	<1.68	2.15
	02/23/16	<0.0008	<0.002	0.0266	<0.0003	<0.0003	<0.002	<0.003	0.101 J	<0.0003	0.0601	<0.00008	<0.002	<0.002	<0.0005	0.921	<1.62	2.54
	04/05/16	<0.0008	<0.002	0.0245	<0.0003	<0.0003	<0.002	<0.003	0.124 J	<0.0003	0.0573	<0.00008	<0.002	<0.002	<0.0005	0.269	<2.05	2.32
	06/07/16	<0.0008	<0.002	0.0342	0.000609 J	<0.0003	<0.002	0.016	<0.1	<0.0003	0.0107	<0.00008	<0.002	<0.002	<0.0005	0.269	<0.658	0.927
	08/09/16	<0.0008	<0.002	0.0241	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0616	<0.00008	<0.002	<0.002	<0.0005	0.408	<0.632	1.04
	10/18/16	<0.0008	<0.002	0.0248	<0.0003	<0.0003	<0.002	<0.003	0.144J	<0.0003	0.0576	<0.00008	<0.002	<0.002	<0.0005	<0.178	1.07	1.25
	12/11/16	<0.0008	<0.002	0.0236	<0.0003	<0.0003	<0.002	<0.003	0.161 J	<0.0003	0.0606	<0.00008	<0.002	<0.002	<0.0005	0.143	1.54	1.68
	06/13/18	<0.0008	<0.002	0.0237	<0.0003	<0.0003	0.00964	<0.003	0.208 J	<0.0003	0.108	<0.00008	<0.002	<0.002	<0.0005	0.267	<1.4	1.667
	09/07/18	NA	<0.002	0.0196	<0.0003	<0.0003	0.0453	<0.003	0.140 J	<0.0003	0.306	NA	NA	0.00773	NA	<0.285	1.43	1.715
	05/14/19	<0.0008	<0.002	0.0208	<0.0003	<0.0003	<0.002	<0.003	0.159 J	<0.0003	0.0678	<0.00008	<0.002	<0.002	<0.0005	1.10	0.928	2.028
H-33	10/20/15	<0.0008	0.00208 J	0.0586	0.000351 J	<0.0003	<0.002	0.0274	<0.1	<0.0003	0.0814	<0.00008	<0.002	<0.002	<0.0005	1.76	1.64	3.40
	12/14/15	<0.0008	0.00205 J	0.0473	0.000382 J	<0.0003	<0.002	0.0293	0.136 J	<0.0003	0.0903	<0.00008	<0.002	<0.002	<0.0005	1.94	<1.79	3.73
	02/23/16	<0.0008	<0.002	0.0529	0.000311 J	<0.0003	0.0194	0.0163	0.125 J	<0.0003	0.182	<0.00008	<0.002	<0.002	<0.0005	0.906	<2.32	3.23
	04/05/16	<0.0008	<0.002	0.0576	0.000302 J	<0.0003	0.0171	0.016	0.14 J	<0.0003	0.16	<0.00008	<0.002	<0.002	<0.0005	0.328	1.08	1.41
	06/07/16	<0.0008	<0.002	0.0774	0.000604 J	<0.0003	0.0153	0.0196	<0.1	<0.0003	0.163	<0.00008	<0.002	<0.002	<0.0005	0.276	0.897	1.17
	08/09/16	<0.0008	<0.002	0.0424	0.000519 J	<0.0003	0.00291 J	0.0284	<0.1	<0.0003	0.102	<0.00008	<0.002	<0.002	<0.0005	<0.149	0.649	0.80
	10/18/16	<0.0008	0.00347 J	0.0464	0.000617 J	<0.0003	0.0309	0.0644	<0.1	0.000329 J	0.118	<0.00008	<0.002	<0.002	<0.0005	0.096	<0.517	0.61
	12/11/16	<0.0008	0.00218 J	0.0537	0.000865 J	<0.0003	0.0368	0.0408	0.132 J	0.000495 J	0.115	<0.00008	<0.002	<0.002	<0.0005	0.159	1.29	1.45
	06/13/18	<0.0008	0.00283 J	0.0741	0.0004 J	<0.0003	0.0182	0.0266	0.105 J	0.0009 J	0.183	<0.00008	<0.002	<0.002	<0.0005	0.795	<0.712	1.507
	09/07/18	NA	0.00239 J	0.0757	0.0003 J	<0.0003	0.0105	0.0288	0.135 J	<0.0003	0.160	NA	NA	<0.002	NA	0.334	<0.645	0.979
	05/14/19	<0.0008	0.00355 J	0.158	0.00114	<0.0003	0.0342	0.0648	0.166 J	0.000772 J	0.161	<0.00008	<0.002	<0.002	<0.0005	0.850	1.35	2.200
Downgradient Wells																		
H-28	10/21/15	<0.0008	0.00278 J	0.0396	0.00148	0.00121	<0.002	0.188	<0.1	0.000491 J	0.154	<0.00008	<0.002	0.00682	<0.0005	<0.558	<1.65	<2.208
	12/14/15	<0.0008	<0.002	0.0224	<0.0003	0.000572 J	<0.002	0.0225	<0.1	<0.0003	0.021	<0.00008	<0.002	<0.002	<0.0005	0.707	<1.18	1.89
	02/23/16	<0.0008	0.00225 J	0.0202	0.00133	0.00151	<0.002	0.201	<0.1	0.00053 J	0.159	<0.00008	<0.002	0.00222 J	<0.0005	<0.396	2.24	2.64
	04/05/16	<0.0008	<0.002	0.0173	0.0011	0.00252	<0.002	0.199	<0.1	0.00087 J	0.15	<0.00008	<0.002	0.00237 J	<0.0005	<0.231	1.76	1.99
	06/07/16	<0.0008	<0.002	0.0468	0.000934 J	0.000664 J	<0.002	0.0944	<0.1	<0.0003	0.0959	<0.00008	<0.002	<0.002	<0.0005	0.310	1.48	1.79
	08/09/16	<0.0008	<0.002	0.0155	0.00275	0.0016	<0.002	0.195	<0.1	0.000774 J	0.155	<0.00008	<0.002	0.00286 J	<0.0005	<0.451	1.41	1.86
	10/18/16	<0.0008	0.00284J	0.0174	0.00685	0.000744 J	<0.002	0.169	0.165J	0.00108	0.155	<0.00008	<0.002	0.00273 J	<0.0005	<0.228	0.645	0.87
	12/11/16	<0.0008	<0.002	0.0471	0.000698 J	0.000668 J	<0.002	0.0924	0.114 J	<0.0003	0.0869	<0.00008	<0.002	<0.002	<0.0005	<0.149	1.13	1.28
	06/13/18	<0.0008	<0.002	0.0186	0.00393	0.0038	<0.002	0.169	0.126 J	0.000448 J	0.18	<0.00008	<0.002	<0.002	<0.0005	0.327	<1.56	1.887
	09/07/18	NA	<0.002	0.0192	0.00704	0.00115	<0.002	0.162	<0.100	0.00118 J	0.203	NA	NA	0.00281 J	NA	<0.243	0.845	1.088
	05/14/19	<0.0008	<0.002	0.0141	0.00281	0.00212	<0.002	0.187	<0.100	0.000595 J	0.172	<0.00008	<0.002	0.00619	<0.0005	0.444	0.615	1.059
H-29	10/21/15	<0.0008	<0.002	0.159	0.000359 J	<0.0003	<0.002	0.0301	<0.1	<0.0003	0.0156	<0.00008	<0.002	<0.002	<0.0005	0.464	1.82	2.28
	12/14/15	<0.0008	<0.002	0.277	<0.0003	<0.0003	0.062	<0.003	0.56	0.000542 J	0.0202	<0.00008	0.00819	0.0282	<0.0005	<0.53	<1.25	<1.78
	02/23/16	<0.0008	0.00203 J	0.151	<0.0003	<0.0003	0.019	<0.003	0.239 J	<0.0003	0.0135	<0.00008	0.00603	0.0148	<0.0005	<0.374	<2.22	<2.594
	04/05/16	<0.0008	<0.002	0.167	<0.0003	<0.0003	0.042	<0.003	0.363 J	<0.0003	0.0175	<0.00008	0.00697	0.0232	<0.0005	<0.228	<0.897	<1.125
	06/07/16	<0.0008	<0.002	0.136	<0.0003	<0.0003	0.0274	<0.003	0.27 J	<0.0003	0.0188	<0.00008	0.00551	0.0152	<0.0005	0.173	<0.834	1.01
	08/09/16	<0.0008	0.00995	0.315	<0.0003	<0.0003	0.00297 J	0.00473 J	<0.1	<0.0003	0.0143	<0.00008	<0.002	<0.002	<0.0005	0.261	<0.578	0.84
	10/18/16	<0.0008	<0.002	0.118	<0.0003	<0.0003	0.00412 J	<0.003	1.15	0.000427J	0.0056 J	<0.00008	0.00305 J	0.0681	<0.0005	0.155	<0.439	0.59
	12/11/16	<0.0008	<0.002	0.0779	<0.0003	<0.0003	<0.002	<0.003	1.4	<0.0003	<0.005	<0.00008	0.00307 J	0.0642	<0.0005	<0.113	<0.599	<0.712
	06/13/18	<0.0008	<0.002	0.0157	0.00345	0.00318	<0.002	0.153	0.123 J	0.000779 J	0.153	<0.00008	<0.002	<0.002	<0.0005	<0.274	<1.62	<1.894
	09/07/18	NA	<0.002	0.0374	0.00513	0.000938	<0.002	0.119	<0.100	0.00172	0.145	NA	NA	0.00374 J	NA	<0.371	<0.71	<1.081
	5/14/2019	<0.0008	<0.002	0.0138	0.00341	0.00219	<0.002	0.183	0.104 J	0.000543 J	0.173	<0.00008	<0.002	0.00616	<0.0005	<0.339	<0.707	<1.046

TABLE 1
APPENDIX IV GROUNDWATER ANALYTICAL DATA SUMMARY
MARTIN LAKE STEAM ELECTRIC STATION
ASH POND AREA

Sample Location	Date Sampled	Sb (mg/L)	As (mg/L)	Ba (mg/L)	Be (mg/L)	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	Fl (mg/L)	Pb (mg/L)	Li (mg/L)	Hg (mg/L)	Mo (mg/L)	Se (mg/L)	Tl (mg/L)	Ra 226 (pCi/L)	Ra 228 (pCi/L)	Ra 226/228 Comb.^ (pCi/L)
GWPS:		0.006	0.01	2	0.004	0.005	0.1	0.0564	4	0.015	0.177	0.002	0.1	0.05	0.002	--	--	5
H-31	10/20/15	<0.0008	0.0168	0.0732	0.0126	0.0032	0.00687	0.434	0.889	<0.0003	0.137	<0.00008	<0.002	0.116	<0.0005	0.943	<1.88	2.82
	12/14/15	<0.0008	0.00513	0.0388	0.00702	<0.0003	0.00456 J	0.0651	0.692	<0.0003	0.149	<0.00008	<0.002	0.0231	<0.0005	1.61	<1.29	2.90
	02/23/16	<0.0008	0.00436 J	0.0243	0.0101	<0.0003	<0.002	0.0594	0.921	<0.0003	0.146	<0.00008	<0.002	0.0209	<0.0005	<0.419	<1.64	<2.059
	04/05/16	<0.0008	0.00514	0.0241	0.00925	<0.0003	0.00435 J	0.0685	1.36	<0.0003	0.146	<0.00008	<0.002	0.0226	<0.0005	<0.334	<0.897	<1.231
	06/07/16	<0.0008	0.0038 J	0.0242	0.00789	<0.0003	<0.002	0.0406	0.783	<0.0003	0.157	<0.00008	<0.002	0.0307	<0.0005	0.257	<0.555	0.81
	08/09/16	<0.0008	0.00886	0.0191	0.00734	<0.0003	<0.002	0.286	0.216 J	<0.0003	0.17	<0.00008	<0.002	0.0202	<0.0005	1.31	0.900	2.21
	10/18/16	<0.0008	0.00351 J	0.0215	0.00167 J	<0.0003	<0.002	0.0304 J	0.298 J	<0.0003	0.165	<0.00008	<0.002	0.00567 J	<0.0005	0.169	1.18	1.35
	12/11/16	<0.0008	0.00875 J	0.0189	0.0197	<0.0003	0.00386 J	0.23 J	0.892	<0.0003	0.198	<0.00008	<0.002	0.0365	<0.0005	0.195	<0.754	0.95
	06/12/18	<0.0008	0.00532	0.0194	0.00545	<0.0003	0.003 J	0.236	0.646	<0.0003	0.214	<0.00008	<0.002	0.00475 J	<0.0005	<0.26	<0.597	<0.857
	09/07/18	NA	<0.002	0.0287	<0.0003	<0.0003	<0.002	0.00353 J	0.275 J	<0.0003	0.0187	NA	NA	0.00424 J	NA	<0.261	<0.567	<0.828
	05/14/19	<0.0008	0.00675	0.0163	0.00928	<0.0003	0.00315 J	0.389	0.96	<0.0003	0.219	<0.0004	<0.002	0.0261	<0.0005	2.62	<0.789	3.409
H-32	10/20/15	<0.0008	0.0028 J	0.16	0.00266	<0.0003	<0.002	0.163	0.374 J	<0.0003	0.0788	<0.00008	<0.002	0.00303 J	<0.0005	1.05	<1.90	2.95
	12/14/15	<0.0008	0.0123	0.0384	0.00313	<0.0003	<0.002	0.155	0.619	<0.0003	0.0733	<0.00008	<0.002	<0.002	<0.0005	0.712	<2.21	2.92
	02/23/16	<0.0008	0.00712	0.0277	0.00452	<0.0003	<0.002	0.188	0.701	0.000326 J	0.0821	<0.00008	<0.002	<0.002	<0.0005	1.12	1.60	2.72
	04/05/16	<0.0008	0.00648	0.0237	0.00527	0.00128	<0.002	0.208	1.05	0.00182	0.0818	<0.00008	<0.002	<0.002	<0.0005	<0.364	<1.15	<1.514
	06/07/16	<0.0008	0.00446 J	0.0238	0.00583	0.000997 J	<0.002	0.207	0.858	0.00168	0.087	<0.00008	<0.002	0.00298 J	<0.0005	<0.165	0.613	0.778
	08/09/16	<0.0008	0.00344 J	0.0234	0.00548	0.000713 J	<0.002	0.19	0.68	0.00115	0.0774	<0.00008	<0.002	0.00281 J	<0.0005	2.56	<0.446	3.01
	10/18/16	<0.0008	0.00289 J	0.02	0.00567	0.00254	<0.002	0.204	0.904	0.00332	0.0834	<0.00008	<0.002	0.00267 J	<0.0005	<0.139	0.683	0.82
	12/11/16	<0.0008	0.00246 J	0.0205	0.00609	0.00108	<0.002	0.208	1	0.00137	0.0838	<0.00008	<0.002	0.00237 J	<0.0005	<0.163	<0.753	<0.916
	06/12/18	<0.0008	<0.002	0.0175	0.00681	0.000586 J	<0.002	0.215	1.02	0.000701 J	0.0957	<0.00008	<0.002	<0.002	<0.0005	<0.275	0.917	1.192
	09/07/18	NA	<0.002	0.0404	<0.0003	<0.0003	<0.002	0.00347 J	0.551	<0.0003	0.0195	NA	NA	0.0157	NA	0.343	1.25	1.593
	05/14/19	<0.0008	0.002 J	0.0162	0.00713	0.000366 J	<0.002	0.202	1.15	0.000574 J	0.0978	<0.00008	<0.002	0.00675	<0.0005	0.303	<0.546	<0.849

Notes:
1. Abbreviations: GWPS - groundwater protection standard; mg/L - milligrams per liter; pCi/L - picocuries per liter.
2. ^ - Sum of Ra 226 and Ra 228 concentrations. Non-detect isotope results were assigned a value equal to the minimum detectable concentration.
3. J - concentration is below method quantitation limit; result is an estimate.
4. NA = Not analyzed.

Table 2

Screening of Potential Groundwater Response Technologies
Martin Lake Steam Electric Station
Ash Ponds

Groundwater Response Technology	Description	Protective of Human Health and Environment	Attain Groundwater Protection Standard	Control Source of Release	Remove Contaminated Material From Environment	RCRA Compliance	Screening Comments	Retained for Further Evaluation
Monitored Natural Attenuation	Natural processes (dispersion, dilution, sorption, coprecipitation, degradation/transformation, etc.) remove CCR constituents from groundwater in-situ. Groundwater monitoring to verify MNA effectiveness.	Migration of CCR constituents in groundwater controlled and CCR concentrations in groundwater reduced.	CCR constituents removed through adsorption, precipitation or coprecipitation. CCR constituents removed from groundwater and retained in aquifer soil matrix to achieve GWPS below and downgradient of CCR Unit.	CCR constituents removed from groundwater below and downgradient of CCR Unit.	CCR constituents removed from groundwater and retained in aquifer soil matrix.	Purge water from groundwater monitoring requires management in accordance with applicable RCRA requirements.	Site is good MNA candidate for CCR constituents based on field MNA evaluation. Long-term groundwater monitoring required. Easy to implement. Groundwater modelling required to assess remediation timeframe.	Yes
Groundwater Extraction and Treatment	System of extraction wells along downgradient edge of ponds to provide hydraulic control of CCR constituent groundwater plumes. Extracted groundwater treated in an on-site treatment system and discharged to Martin Lake or re-injected into aquifer. Groundwater monitoring to verify system effectiveness.	Migration of CCR constituents in groundwater controlled.	GWPS attained downgradient of CCR Unit, but limited effect on concentrations beneath unit.	CCR groundwater constituents contained at edge of ponds.	CCR constituents removed from extracted groundwater by treatment system. Treatment residuals (sludge, regenerate brine, etc.) require management.	Treatment residuals (sludge, regenerate brine, etc.) require management in accordance with applicable RCRA requirements.	Regulatory authorization for treated water discharge required. Bench/pilot testing of treatment system required. Groundwater modelling required to assess remediation timeframe.	Yes
Vertical Hydraulic Barrier	Vertical, low permeability hydraulic barrier along downgradient edge of ponds to provide hydraulic control of CCR constituent groundwater plumes. Groundwater extraction and treatment required upgradient of barrier to control groundwater elevations. Groundwater monitoring to verify system effectiveness.	Migration of CCR constituents in groundwater controlled.	GWPS attained downgradient of CCR Unit, but limited effect on concentrations beneath unit.	CCR groundwater constituents contained at edge of ponds.	CCR constituents removed from extracted groundwater by treatment system. Treatment residuals (sludge, regenerate brine, etc.) require management.	Excavated soil generated from barrier installation requires testing and management as necessary. Treatment residuals (sludge, regenerate brine, etc.) require management in accordance with applicable RCRA requirements.	Bench/pilot test of barrier materials likely required. Regulatory authorization for treated water discharge required. Bench/pilot testing of treatment system required. Groundwater modelling required to assess remediation timeframe.	Yes

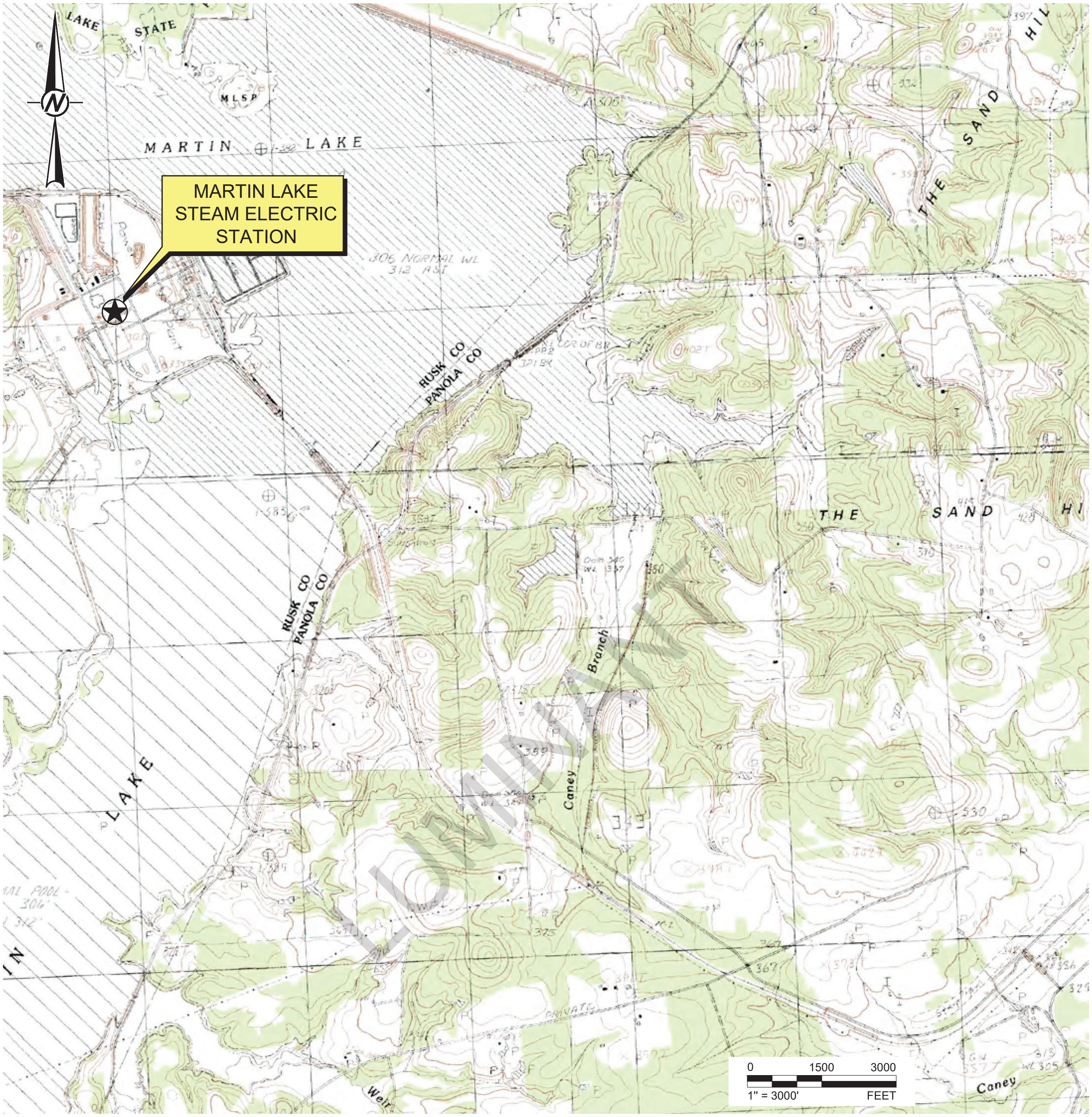
Groundwater Response Technology	Description	Protective of Human Health and Environment	Attain Groundwater Protection Standard	Control Source of Release	Remove Contaminated Material From Environment	RCRA Compliance	Screening Comments	Retained for Further Evaluation
Permeable Reactive Barrier	In-situ, passive, permeable treatment zone containing reactive media designed to intercept impacted groundwater and adjust geochemistry to immobilize CCR contaminants. CCR constituents removed from groundwater through adsorption and/or coprecipitation under reducing groundwater conditions. PRB acts as a barrier to groundwater contamination but not groundwater flow. Groundwater monitoring to verify system effectiveness.	Migration of CCR constituents in groundwater controlled.	GWPS attained downgradient of CCR Unit, but limited effect on concentrations beneath unit.	CCR groundwater constituents removed from groundwater downgradient of CCR Unit.	CCR constituents removed from groundwater and retained on reactive media or aquifer soil matrix.	Excavated soil generated from PRB installation requires testing and management as necessary.	CCR constituent removal using PRB possible but full-scale performance uncertain. Reactive media effectiveness reduced over time and media likely replaced periodically. Bench/pilot testing of PRB media/system required. Groundwater modelling required to assess remediation timeframe.	No
In-Situ Chemical Treatment	Injection of chemical/material into aquifer to adjust geochemistry and enhance precipitation, co-precipitation, or indirect adsorption of CCR constituents. CCR constituents potentially removed through adsorption, precipitation and/or coprecipitation. Groundwater monitoring to verify system effectiveness.	Migration of CCR constituents in groundwater controlled.	GWPS attained downgradient of CCR Unit, but limited effect on concentrations beneath unit.	CCR groundwater constituents removed from groundwater downgradient of CCR Unit.	CCR constituents removed from groundwater and retained on aquifer soil matrix.	No significant RCRA compliance issues anticipated.	ICT considered emerging remediation technology for CCR constituents - not demonstrated under full-scale conditions. Bench/pilot-scale testing of ICT system required. Groundwater modelling required to assess remediation timeframe.	No
Phytoremediation	Use of plants to remove CCR constituents through uptake and accumulation within above ground portions of the plant. Primary plant process for CCR constituent removal is phytoextraction (uptake/accumulation of contaminants within aboveground portions of a plant). Groundwater monitoring to verify system effectiveness.	Migration of CCR constituents in groundwater controlled.	GWPS attained downgradient of CCR Unit, but limited effect on concentrations beneath unit.	CCR groundwater constituents removed from groundwater downgradient of CCR Unit.	CCR constituents removed from groundwater and accumulates in plants.	Management of harvested plants in accordance with RCRA may be required if accumulated CCR constituent concentrations are high.	Phytoextraction occurs in shallow root zone of plants, which limits the effectiveness for the groundwater depths at the Site. Phytoremediation for CCR constituent removal from groundwater has not been demonstrated under full-scale conditions Bench/pilot-scale testing of phytoremediation system required. Groundwater modelling required to assess remediation timeframe.	No

Table 3

Evaluation of Corrective Measures Alternatives
Martin Lake Steam Electric Station
Ash Ponds

Corrective Measures Alternative	Description	Performance	Reliability	Ease of Implementation	Potential Impacts	Time Requirements	Institutional Requirements
Retrofit Liners in WAP, EAP and NSP with Monitored Natural Attenuation	New Liners in WAP, EAP and NSP. MNA to remove CCR constituents from groundwater and control migration. Groundwater monitoring to verify MNA effectiveness.	New Liners in WAP, EAP and NSP isolate CCR material in pond and mitigate on-going source of CCR constituents to groundwater. Site is good MNA candidate for CCR constituents based on MNA field evaluation.	Liner construction is a common and effective source control technology. On-going attenuation of CCR constituents in groundwater demonstrated during MNA field evaluation. Groundwater monitoring used to verify long-term MNA effectiveness.	Readily implementable with common construction techniques.	Source controlled through pond liner systems. CCR constituents removed from groundwater beneath and downgradient of ponds.	Retrofit Implementation: 1-2 years per pond. MNA Implementation: 2-3 years. Groundwater modelling required to assess remediation timeframe.	Minimal regulatory requirements.
Retrofit Liners in WAP, EAP and NSP with Groundwater Extraction and Treatment	New Liners in WAP, EAP and NSP. System of extraction wells along downgradient edge of ponds to provide hydraulic control of CCR constituent groundwater plumes. Extracted groundwater treated in an on-site treatment system and discharged to Martin Lake or re-injected into aquifer. Groundwater monitoring to verify system effectiveness.	New Liners in WAP, EAP and NSP isolate CCR material in pond and mitigate on-going source of CCR constituents to groundwater. Migration of CCR constituents in groundwater controlled at pond boundaries by extraction wells.	Liner construction is a common and effective source control technology. Groundwater extraction and treatment is a common and effective hydraulic control technology. Treatment system operational reliability is key component of overall reliability.	Readily implementable with common construction techniques. Bench/pilot testing of treatment system required. Regulatory authorization for treated water discharge could be difficult to obtain.	Source controlled through pond liner systems. Control of CCR constituent migration downgradient of ponds by extraction wells. Extraction system does not address groundwater beneath ponds.	Retrofit Implementation: 1-2 years per pond. GW Ext/Treatment Implementation: 3-4 years. Groundwater modelling required to assess remediation timeframe.	Regulatory authorization for treated water discharge required. Treatment system residuals (sludge, regenerate brine, etc.) require management.
Retrofit Liners in WAP, EAP and NSP with Vertical Hydraulic Barrier and Groundwater Extraction and Treatment	New Liners in WAP, EAP and NSP. Vertical, low permeability hydraulic barrier along downgradient edge of ponds to provide hydraulic control of CCR constituent groundwater plumes. Groundwater extraction and treatment required upgradient of barrier to control groundwater elevations. Groundwater monitoring to verify system effectiveness.	New Liners in WAP, EAP and NSP isolate CCR material in pond and mitigate on-going source of CCR constituents to groundwater. Migration of CCR constituents in groundwater controlled at pond boundaries by vertical barrier. Groundwater elevations upgradient of barrier controlled by groundwater extraction.	Liner construction is a common and effective source control technology. Vertical hydraulic barrier must be keyed into lower impermeable layer. Groundwater extraction and treatment is a common and effective hydraulic control technology. Treatment system operational reliability is key component of overall reliability.	Readily implementable with common construction techniques. Bench/pilot testing of treatment system required. Regulatory authorization for treated water discharge could be difficult to obtain.	Source controlled through pond liner systems. Control of CCR constituent migration downgradient of pond by vertical barrier. Vertical barrier does not address groundwater beneath pond.	Retrofit Implementation: 1-2 years per pond. Barrier and GW Ext/Treat Implementation: 5-8 years. Groundwater modelling required to assess remediation timeframe.	Regulatory authorization for treated water discharge required. Treatment system residuals (sludge, regenerate brine, etc.) require management.

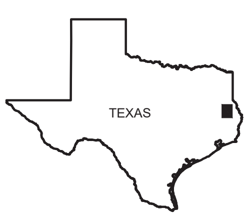
FIGURES



CLIENT
LUMINANT

PROJECT
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

TITLE
SITE LOCATION MAP



QUADRANGLE LOCATION

CONSULTANT

GOLDER

YYYY-MM-DD	2019-08-28
DESIGNED	AJD
PREPARED	AJD
REVIEWED	WFV
APPROVED	WFV

REFERENCE(S)
BASE MAP TAKEN FROM TNRIS.GOV, TATUM, TX 7.5 MIN. USGS QUADRANGLE DATED 1983.

APPENDIX G-Revision 1 December 15, 2022

PROJECT NO.	REV.	FIGURE
19121403	0	1

Last Edited By: adiamond Date: 2019-08-28 Time:12:07:47 PM | Printed By: adiamond Date: 2019-08-28 Time:12:09:57 PM
Path: \\texarkana\data\Projects - Round Rock\19121403 - Luminant\Martin Lake Ash Pond Area\ | File Name: FIG 1 - Site Location Map.dwg

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
0 1 in

LEGEND

DOWNGRADIENT CCR MONITORING WELL

UPGRADIENT CCR MONITORING WELL

LAKE WATER/GROUNDWATER MIXING ZONE SAMPLE

MNA SOIL SAMPLE

A —— A' CROSS SECTION LOCATION

REFERENCE(S)

BASE MAP TAKEN FROM GOOGLE EARTH, IMAGERY DATED 4/6/17.

APPENDIX G Revision 1 December 15, 2022

CLIENT

LUMINANT

PROJECT

MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

TITLE

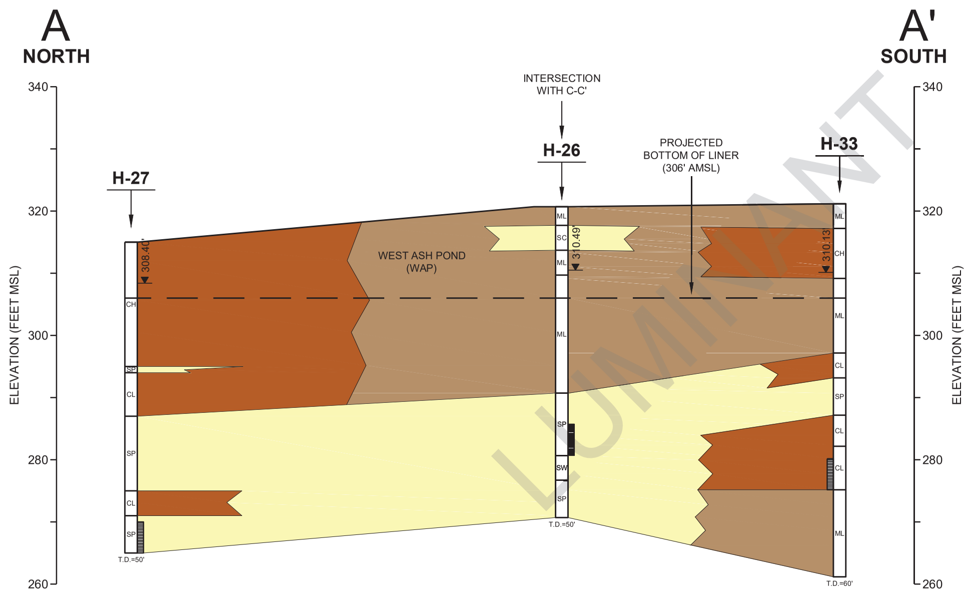
DETAILED SITE PLAN - ASH POND AREA

CONSULTANT

GOLDER

YYYY-MM-DD	2019-08-28
DESIGNED	AJD
PREPARED	AJD
REVIEWED	WFV
APPROVED	WFV

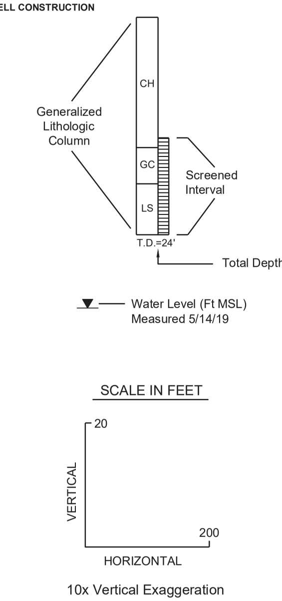
PROJECT NO. 19121403 REV. 0 FIGURE 2



LEGEND

FILL
SAND
CLAY
SILT

MONITORING WELL CONSTRUCTION



CLIENT
LUMINANT

PROJECT
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

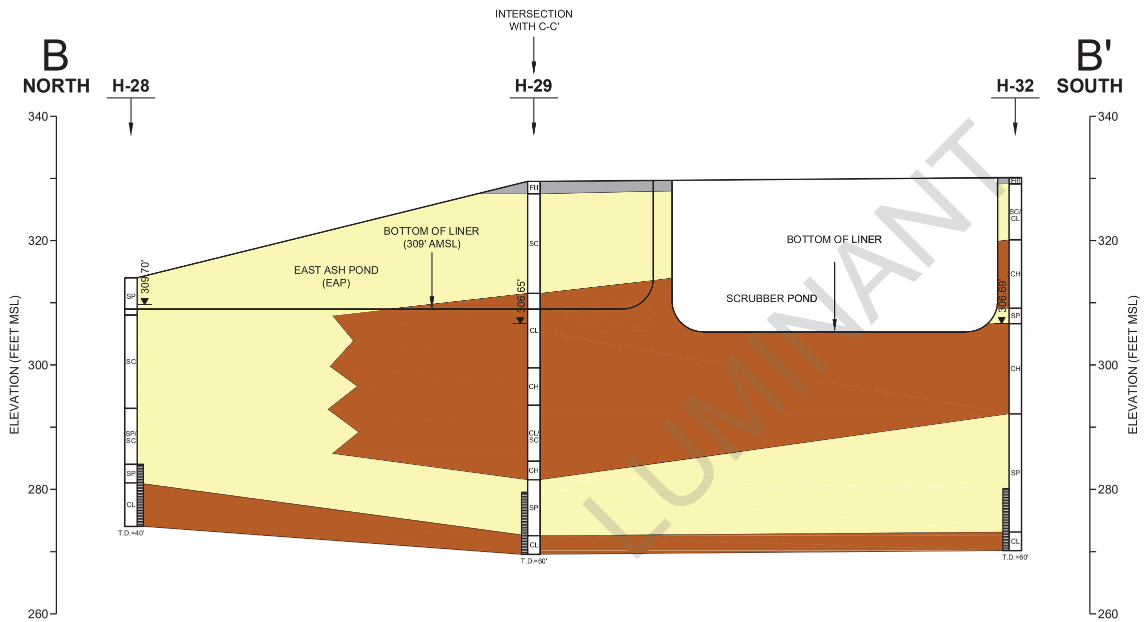
TITLE
ASH POND AREA - GEOLOGIC CROSS SECTION A-A'
WEST SIDE OF WEST ASH POND
THROUGH PROCESS WATER POND

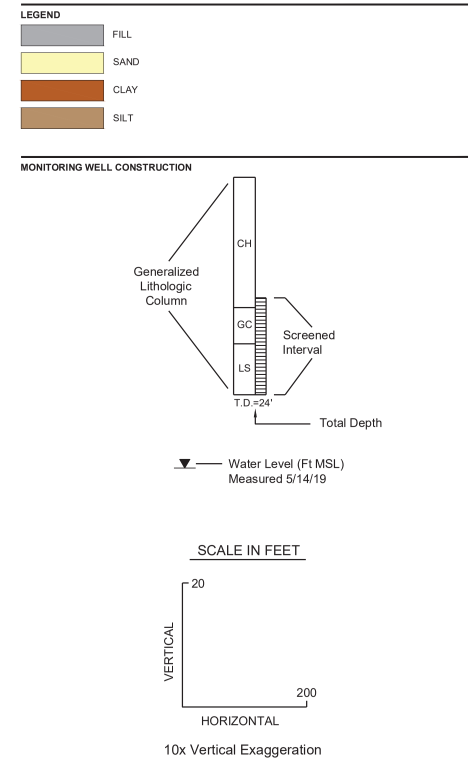
CONSULTANT

GOLDER

YYYY-MM-DD	2019-08-28
DESIGNED	AJD
PREPARED	AJD
REVIEWED	WFV
APPROVED	WFV

PROJECT NO. 19121403 | REV. 0 | FIGURE 3





CLIENT
LUMINANT

PROJECT
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

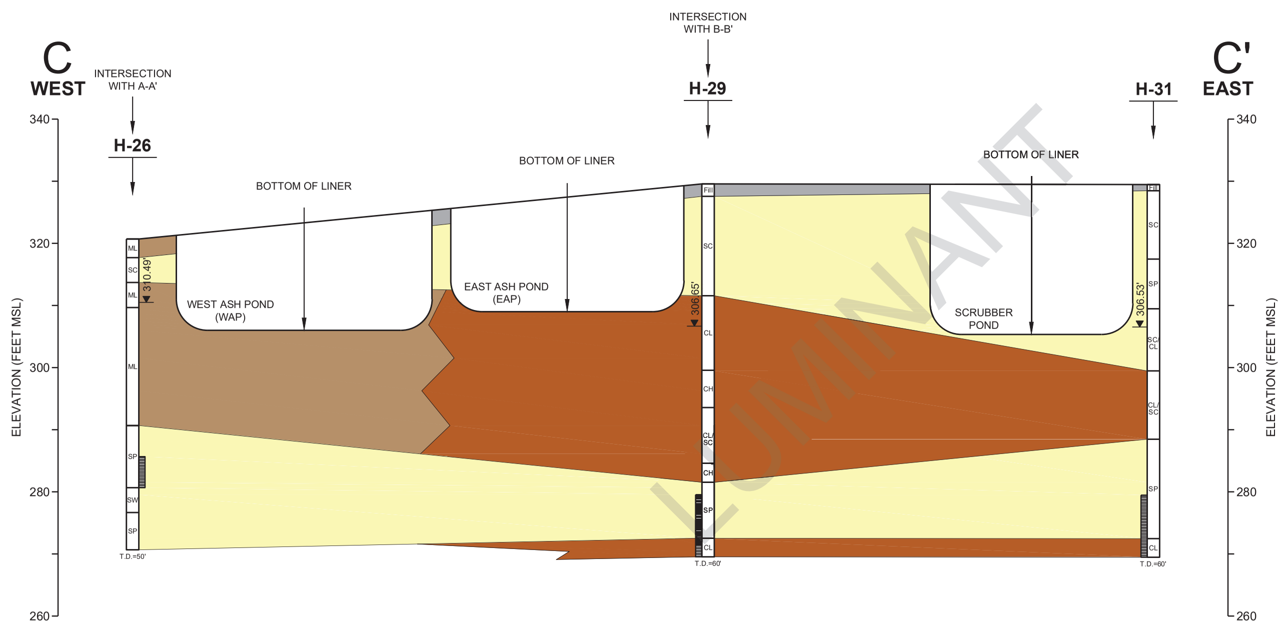
TITLE
ASH POND AREA - GEOLOGIC CROSS SECTION B-B'
EAST SIDE OF ASH POND THROUGH SCRUBBER POND

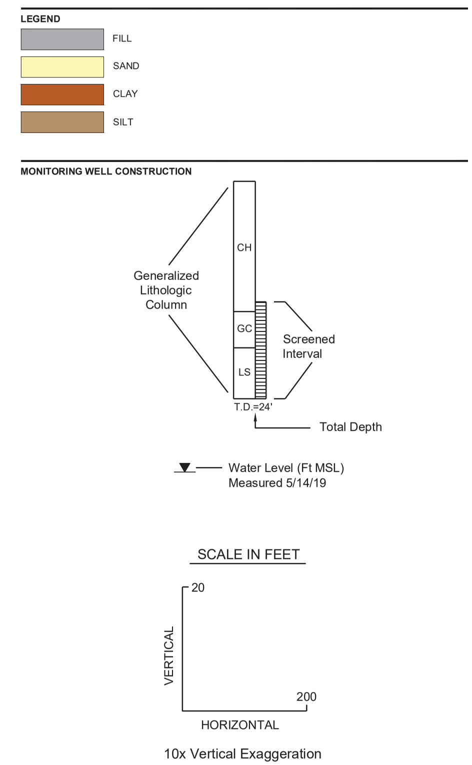
CONSULTANT

GOLDER

YYYY-MM-DD	2019-08-28
DESIGNED	AJD
PREPARED	AJD
REVIEWED	WFV
APPROVED	WFV

PROJECT NO. 19121403 REV. 0 FIGURE 4





CLIENT
LUMINANT

PROJECT
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

TITLE
ASH POND AREA - GEOLOGIC CROSS SECTION C-C' THROUGH WEST ASH POND AND EAST ASH POND

CONSULTANT

GOLDER

YYYY-MM-DD	2019-08-28
DESIGNED	AJD
PREPARED	AJD
REVIEWED	WFV
APPROVED	WFV

PROJECT NO. 19121403 REV. 0 FIGURE 5

LEGEND

DOWNGRADIENT CCR MONITORING WELL

UPGRADIENT CCR MONITORING WELL

(308.70) GROUNDWATER POTENTIOMETRIC SURFACE (FT MSL)

308 GROUNDWATER POTENTIOMETRIC SURFACE CONTOUR (C.I. = 1 FT)

REFERENCE(S)

BASE MAP TAKEN FROM GOOGLE EARTH, IMAGERY DATED 4/8/17.

APPENDIX G Revision 1 December 15, 2022

CLIENT
LUMINANT

PROJECT
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

TITLE
ASH POND AREA
POTENTIOMETRIC SURFACE MAP
MAY 14, 2019

CONSULTANT

GOLDER

YYYY-MM-DD	2019-06-24
DESIGNED	AJD
PREPARED	AJD
REVIEWED	WFV
APPROVED	WFV

PROJECT NO. 19122449 REV. 0 FIGURE 6

Last Edited By: pmcbride Date: 2019-06-26 Time:12:45:32 PM | Printed By: PMcBride Date: 2019-07-15 Time:11:20:29 AM
Path: \\texarkana.golder.gds\data\Projects - Round Rock\19122449 - Luminant\Martin Lake\ | File Name: FIG 3 - POT Surface Map-Ash Pond Area (May 2019).dwg

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
0 1 in

LEGEND

- DOWNGRADIENT CCR MONITORING WELL
- UPGRADIENT CCR MONITORING WELL
- LAKE WATER/GROUNDWATER MIXING ZONE SAMPLE
- MNA SOIL SAMPLE
- SSLs FOR ONE OR MORE APPENDIX IV CONSTITUENTS IN DOWNGRADIENT WELLS BASED ON INITIAL STATISTICAL EVALUATION
- SSLs FOR ONE OR MORE APPENDIX IV CONSTITUENTS IN DOWNGRADIENT WELLS BASED ON UPDATED STATISTICAL EVALUATION

CLIENT
LUMINANT

PROJECT
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

TITLE
ASH POND AREA
EXTENT OF APPENDIX IV CONSTITUENTS DETECTED AT SSLs ABOVE GWPSs

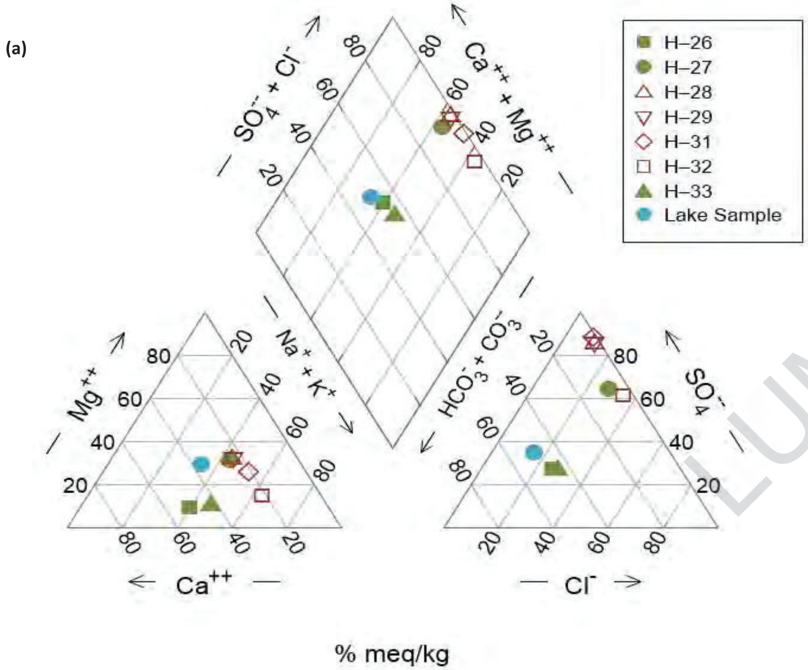
CONSULTANT
GOLDER

YYYY-MM-DD	2019-08-29
DESIGNED	AJD
PREPARED	AJD
REVIEWED	WFV
APPROVED	WFV

PROJECT NO. 19121403 REV. 0 FIGURE 7

REFERENCE(S)
BASE MAP TAKEN FROM GOOGLE EARTH, IMAGERY DATED 4/9/17.

(a)



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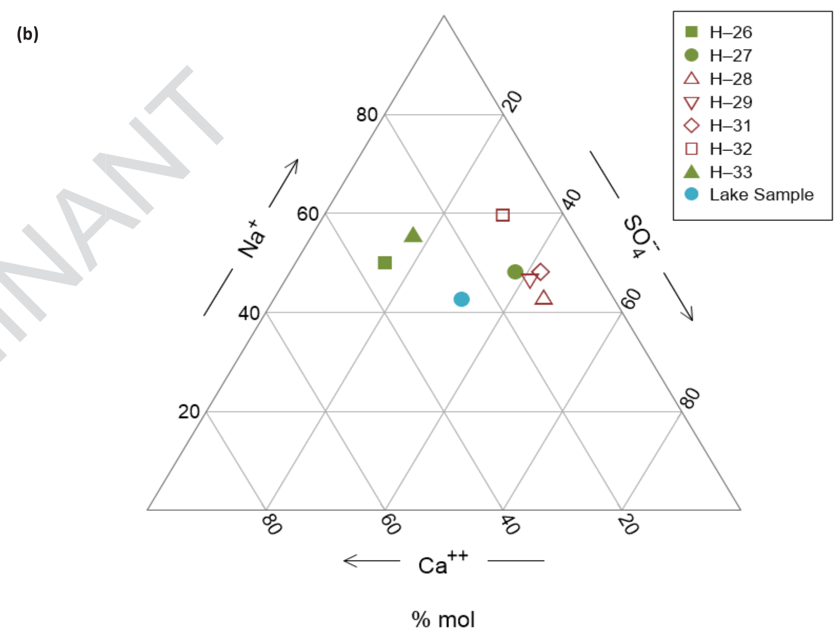


CLIENT
LUMINANT
MARTIN LAKE SES
ASH POND AREA

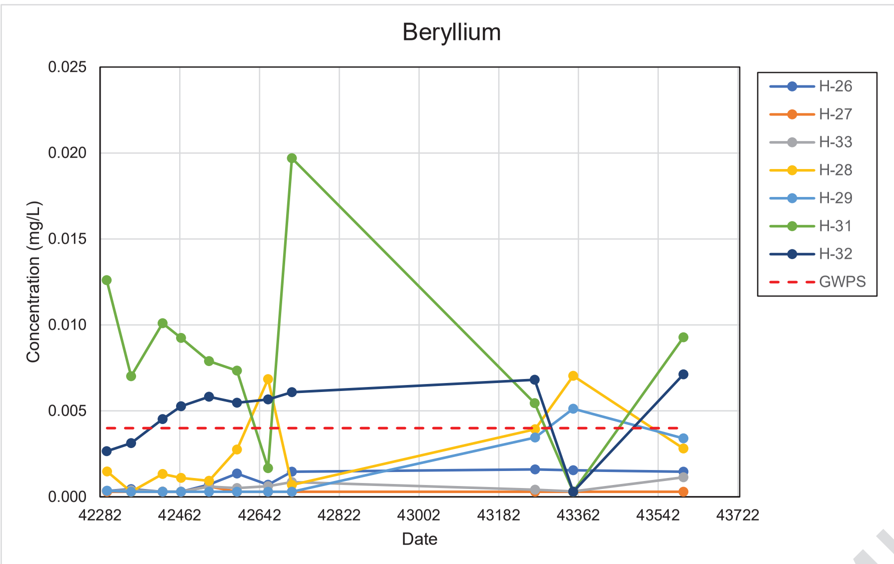
CONSULTANT
GOLDER

PROJECT
ASSESSMENT OF CORRECTIVE MEASURES
GEOCHEMICAL ASSESSMENT

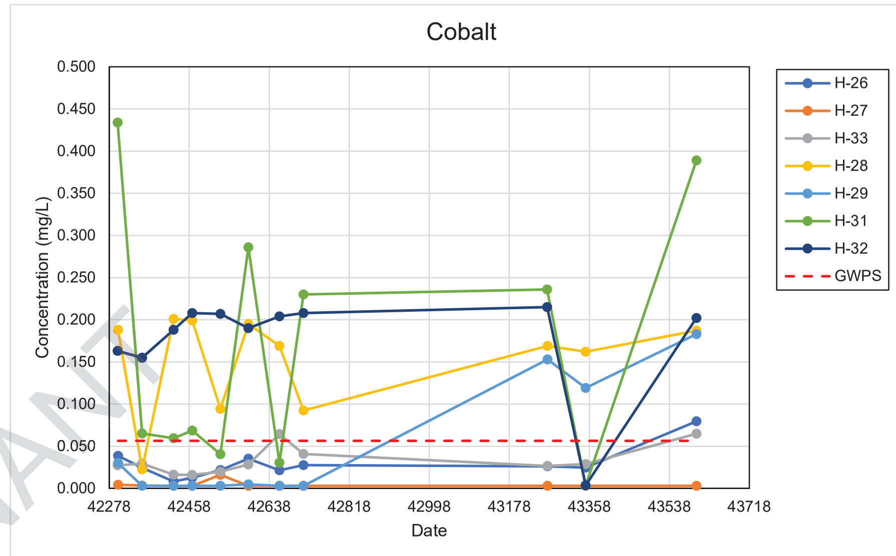
TITLE
MAJOR GROUNDWATER CEHMISTRY (A) AND SELECT RELATIVE ION ABUNDANCE (B) IN GROUNDWATER AT MONITORING WELLS

PROJECT NO.	PHASE	REV.	FIGURE
19122434	01	A	8a-b

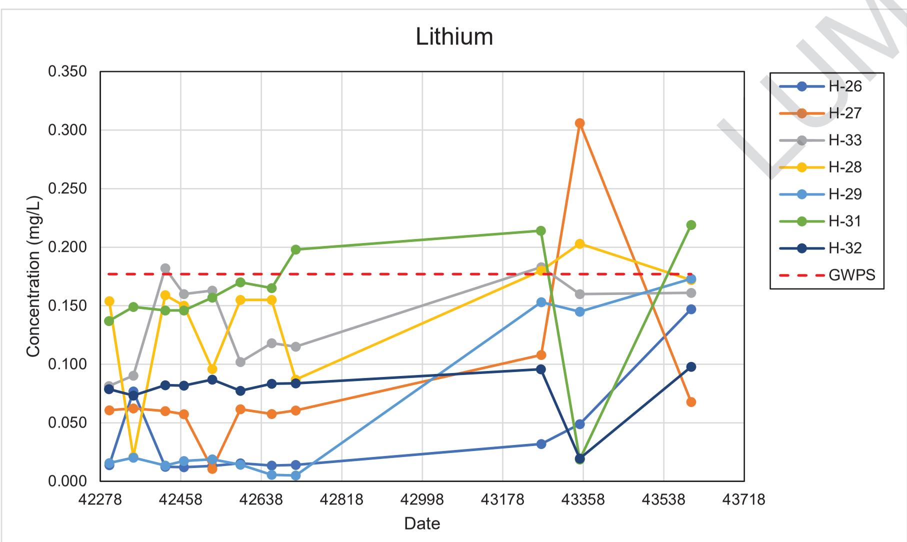
(a)



(b)



(c)



CLIENT
LUMINANT
MARTIN LAKE SES
ASH POND AREA

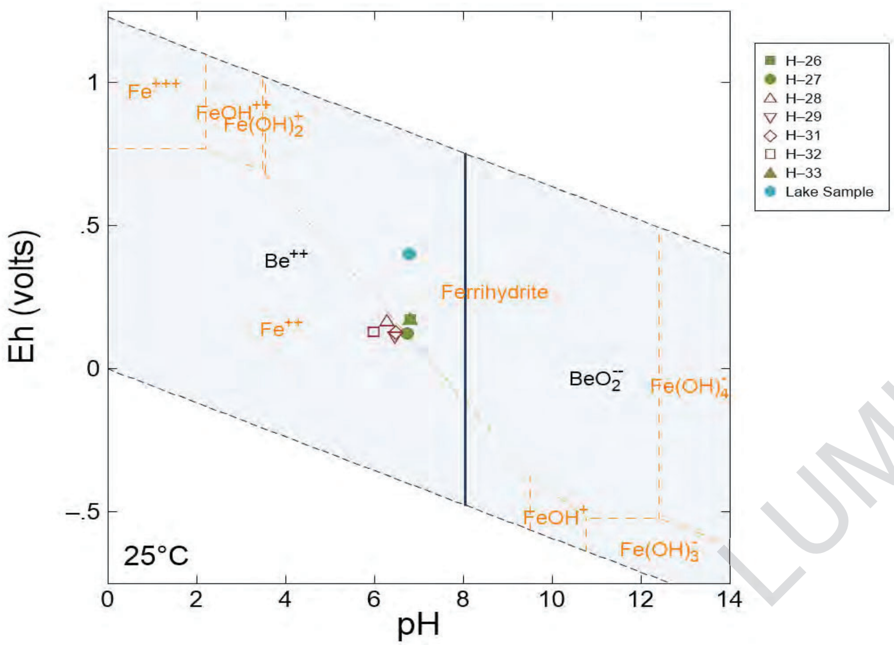
CONSULTANT
GOLDER

PROJECT
ASSESSMENT OF CORRECTIVE MEASURES
GEOCHEMICAL ASSESSMENT

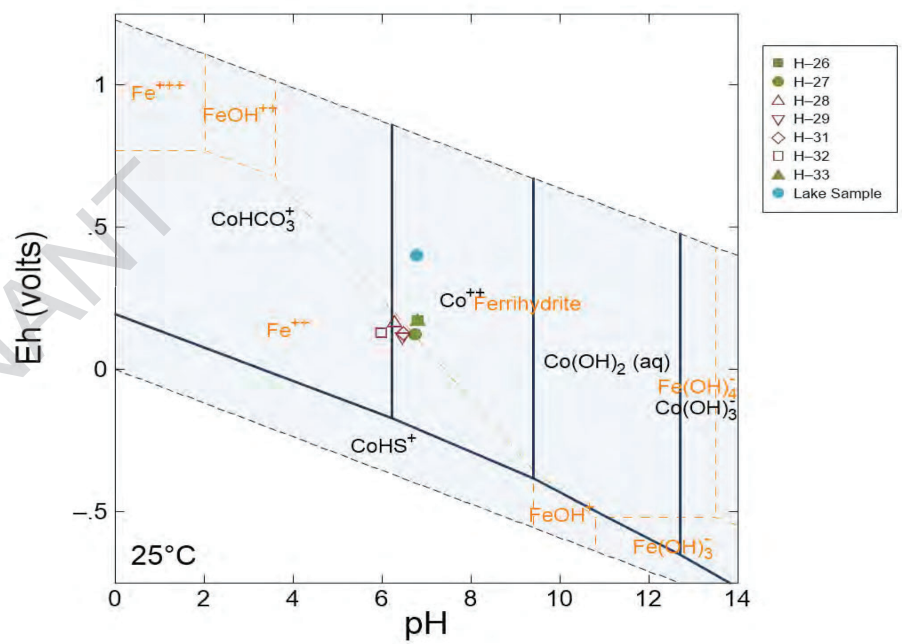
TITLE
HISTORICAL TRENDS OF BERYLLIUM (A), COBALT (B), AND LITHIUM (C), IN GROUNDWATER AT MONITORING WELLS

PROJECT NO.	PHASE	REV.	FIGURE
19122434	01	A	9a-c

(a)



(b)



CLIENT
LUMINANT
MARTIN LAKE SES
ASH POND AREA

CONSULTANT
GOLDER

PROJECT
ASSESSMENT OF CORRECTIVE MEASURES
GEOCHEMICAL ASSESSMENT

TITLE
SPECIATION OF BERYLLIUM (A), AND
COBALT (B), IN GROUNDWATER

PROJECT NO.	PHASE	REV.	FIGURE
164817101	01	A	10a-b

APPENDIX A

BORING LOGS

Luminant

Log of Boring: H-26

Martin Lake Steam Electric Station Tatum, TX	Completion Date:	9/14/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	50
	Driller's License:	5814M	TOC Elevation (ft. AMSL):	323.701
PBW Project No. 5164B	Logged By:	Ryan Francis	Northing:	1042229019.685
	Sampling Method:	4"x10' Core barrel	Easting:	2907068.36

Depth (ft)	Well Materials	Recovery (ft/ft)	USCS	Lithologic Description
0		10.0/10.0	CL	(0 - 3) Silty CLAY, dark brown, dry, soft to firm, weak cementation, low plasticity
4				(3 - 7) Sandy CLAY, red/orange with gray clay ribbons, dry, soft to firm, weak cementation, medium plasticity, minor rounded pebbles
8			SM	(7 - 11) Silty SAND, gray, dry, soft, weak cementation, subrounded, sharp contact
12		10.0/10.0		
16				
20		10.0/10.0	SC	(11 - 30) Clayey silty SAND, tan with red and gray ribbons, moist to wet, soft, weak cementation, medium plasticity
24				
28				
32		10.0/10.0	SP	(30 - 40) SAND, tan and orange, fine grained, higher clay content (31'-34'), wet, very soft to soft, low to medium plasticity
36				
40		10.0/10.0	SW	(40 - 44) SAND, red, wet, soft to firm, moderate cementation, heavy iron content, iron concretions ("rocky" texture)
44			SP	(44 - 50) SAND, red and gray, wet, soft, fine grained, subrounded, gradual color change to dark brown/black (47'-50'), moisture content decreases with depth, hard sand (48'-50')
48				
52				

PBW

Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446

Notes:
1. This log should not be used separately from the report to which it is attached.

Well Materials
(0-35) Casing, 2" Sch 40 FJT PVC
(35-40) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-31') Grout
(31'-33') Bentonite pellets
(33'-40') 20/40 sand

Luminant

Log of Boring: H-27

Martin Lake Steam Electric Station Tatum, TX	Completion Date:	9/15/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	50
PBW Project No. 5164B	Driller's License:	5814M	TOC Elevation (ft. AMSL):	330.423
	Logged By:	Ryan Francis	Northing:	1038229615.42
	Sampling Method:	4"x10' Core barrel	Easting:	2906850.991

Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0 - 20	10.0/10.0 (0-10); 10.0/10.0 (10-20)	CL	(0 - 20) CLAY, orange and brown mottling, minor black streaking, blocky, moist, soft to hard, low to high plasticity, dry and variable sand content (5'-7'), wet at 20'
20 - 21	10.0/10.0	SP	(20 - 21) SAND, gray, moist, soft, subrounded, sharp contact
21 - 28		CL	(21 - 28) CLAY, gray and orange, blocky, moist, firm to hard, moderate cementation, low plasticity
28 - 40	10.0/10.0	SP	(28 - 40) SAND, light gray to tan/orange, moist to wet, soft, none to low plasticity, minor clay content decreasing with depth
40 - 44	10.0/10.0	CL	(40 - 44) Sandy CLAY, orange and gray, moist, firm, low to medium plasticity, sharp contact, very hard and little to no sand at 43'
44 - 50		SC	(44 - 50) Clayey SAND, orange and gray, wet, soft, low plasticity, fine grained, decreasing clay content with depth, sharp contact, color change to brown at 48'

Depth scale (ft): 0, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 52

PBW

Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446

Notes:
1. This log should not be used separately from the report to which it is attached.

Well Materials
(0-45) Casing, 2" Sch 40 FJT PVC
(45-50) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-41') Grout
(41'-43') Bentonite pellets
(43'-50') 20/40 sand

Luminant

Log of Boring: H-28

Martin Lake Steam Electric Station Tatum, TX	Completion Date:	9/15/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	40
	Driller's License:	5814M	TOC Elevation (ft. AMSL):	316.821
PBW Project No. 5164B	Logged By:	Ryan Francis	Northing:	1030230033.689
	Sampling Method:	4"x10' Core barrel	Easting:	2907668.815

Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0 - 6	10.0/10.0		(0 - 6) Soil with SAND, tan, dry, firm, moderate cementation, hard packed, abundant organics
6 - 21	10.0/10.0	SC	(6 - 21) Clayey SAND, moist, soft to firm, weak cementation, none to low plasticity, 6" gray fine to very fine sand lense at 10', gray and orange mottling (11'-21'), fine grained
21 - 30	10.0/10.0		(21 - 30) Clayey SAND, tan and orange, wet, soft to firm, low plasticity, none to weak cementation, variation in clay content with depth, highest clay content at 21', more orange and less clay (29'-30')
30 - 33		SP	(30 - 33) SAND, orange and gray, fine grained, wet, soft, low plasticity, minor clay content, color change from tan to brown to dark gray
33 - 40	10.0/10.0	CL	(33 - 40) Silty CLAY, dark gray, moderate sand, dry, hard, weak cementation

PBW

Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446

Notes:
1. This log should not be used separately from the report to which it is attached.

Well Materials
(0-27) Casing, 2" Sch 40 FJT PVC
(27-32) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-23') Grout
(23'-25') Bentonite pellets
(25'-32') 20/40 sand

Luminant

Log of Boring: H-29

Martin Lake Steam Electric Station Tatum, TX	Completion Date:	9/23/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	60
	Driller's License:	5814M	TOC Elevation (ft. AMSL):	329.255
PBW Project No. 5164B	Logged By:	Ryan Francis	Northing:	1026229427.784
	Sampling Method:	4"x10' Core barrel	Easting:	2907899.511

Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0 - 2	10.0/10.0	FILL	(0 - 2) Hard rock road bed, dry
2 - 18	10.0/10.0	SC	(2 - 18) Clayey SAND, orange and gray mottling, very fine grained, dry to moist, firm, weak cementation, low to medium plasticity, increasing clay content with depth
18 - 30	10.0/10.0	CL	(18 - 30) CLAY, orange, moist, firm, low to medium plasticity, very little sand or silt, black striping at 22', increasing sand content with depth (28'-30')
30 - 36	10.0/10.0	CH	(30 - 36) CLAY, orange, moist, soft, friable, high plasticity, minor silt
36 - 45	10.0/10.0	CL/SC	(36 - 45) Sandy CLAY/Clayey SAND, orange/gray/red mottling, friable, wet, soft to firm, low to medium plasticity, increasing clay content with depth
45 - 48		CH	(45 - 48) CLAY with sand, orange and gray mottling, wet, soft, high plasticity
48 - 57	10.0/10.0	SP	(48 - 57) SAND, gray, wet, soft, no to low plasticity, some black roots/ organics, interspersed clay lenses
57 - 60		CL	(57 - 60) Silty CLAY, gray/brown, dry, hard, weak cementation, sharp contact

Depth scale: 0, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 52, 56, 60

PBW

Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446

Notes:
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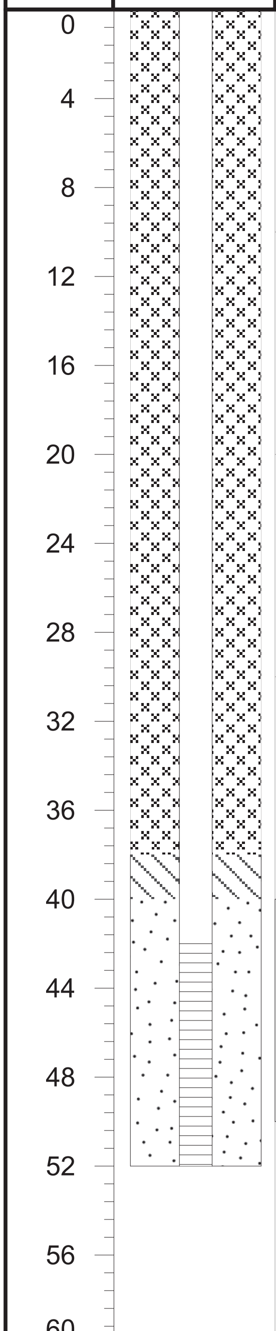
Well Materials
(0-52) Casing, 2" Sch 40 FJT PVC
(52-57) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-48') Grout
(48'-50') Bentonite pellets
(50'-57') 20/40 sand

Luminant

Log of Boring: H-31

Martin Lake Steam Electric Station Tatum, TX	Completion Date:	9/24/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	60
	Driller's License:	5814M	TOC Elevation (ft. AMSL):	329.258
PBW Project No. 5164B	Logged By:	Ryan Francis	Northing:	1035229262.289
	Sampling Method:	4"x10' Core barrel	Easting:	2908596.681



Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0 - 1	10.0/10.0	FILL	(0 - 1) Hard, packed gravel road bed, dry
1 - 12		SC	(1 - 12) Clayey SAND, orange, dry to moist, soft to firm, low plasticity, fine grained, increasing clay content with depth, gray clay ribbons at 10'
12 - 20	5.0/10.0	SP	(12 - 20) SAND, orange with red and gray mottling, dry to moist, soft, none to low plasticity, weak cementation, fine grained, very little clay
20 - 30	10.0/10.0	CL	(20 - 30) Sandy CLAY, orange, dry to moist, firm, crumbly, color variation with depth, low plasticity, some gray sand lenses, very fine grained, color change to gray at 29'
30 - 41	10.0/10.0	CL/SC	(30 - 41) Sandy CLAY/ Clayey SAND, gray and tan, moist, soft, fine grained, low plasticity, variations in clay content and firmness with depth, moisture content changes to wet at 35'
41 - 57	10.0/10.0 10.0/10.0	SP	(41 - 57) SAND, orange/tan, wet, very soft, fine grained, subrounded, increasing red color with depth starting at 52', hard iron concretion layer with some black staining at 55'
57 - 60		CL	(57 - 60) Sandy CLAY, gray, dry to moist, hard, fine grained, weak cementation, low plasticity

PBW

Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446

Notes:
1. This log should not be used separately from the report to which it is attached.

Well Materials
(0-42) Casing, 2" Sch 40 FJT PVC
(42-52) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-38') Grout
(38'-40') Bentonite pellets
(40'-52') 20/40 sand

Luminant

Log of Boring: H-32

Martin Lake Steam Electric Station Tatum, TX	Completion Date:	9/24/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	60
PBW Project No. 5164B	Driller's License:	5814M	TOC Elevation (ft. AMSL):	329.854
	Logged By:	Ryan Francis	Northing:	1034228728.295
	Sampling Method:	4"x10' Core barrel	Easting:	2908232.588

Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0 - 1		FILL	(0 - 1) Hard, packed gravel road bed, dry
1 - 10	10.0/10.0	SC/CL	(1 - 10) Sandy CLAY/Clayey SAND, orange/tan, dry, firm, fine grained, low plasticity, weak cementation
10 - 21	10.0/10.0	CH	(10 - 21) CLAY with minor silt/sand, orange with some black streaks, moist, firm, high plasticity, gradual contact
21 - 23.5		SP	(21 - 23.5) SAND, gray, dry, soft to firm, friable, fine grained
23.5 - 38	10.0/10.0 10.0/10.0	CH	(23.5 - 38) CLAY, orange/tan/gray, moist, soft to firm, high plasticity, minor sand at 30', tan and gray with orange stripes (30'-38'), sharp contact
38 - 57	10.0/10.0 10.0/10.0	SP	(38 - 57) SAND, orange/tan, moist to wet, very soft to soft, fine grained, subrounded, minor clay, low plasticity, no clay content at 42', gradual coarsening of sand grains (48'-55'), some gray streakings at 49', color change to reddish brown at 52'
57 - 60		CL	(57 - 60) Sandy CLAY, dark red and brown, wet, soft, low plasticity, layer of dark red concretions at 57', weak cementation

Depth scale (ft): 0, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 52, 56, 60

PBW

Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446

Notes:
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Well Materials
(0-42) Casing, 2" Sch 40 FJT PVC
(42-52) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-38') Grout
(38'-40') Bentonite pellets
(40'-52') 20/40 sand

Luminant

Log of Boring: H-33

Martin Lake Steam Electric Station
Tatum, TX

PBW Project No. 5164B

Completion Date:	9/14/2015	Drilling Method:	Sonic
Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
Driller:	Timmy Beach	Total Depth (ft):	60
Driller's License:	5814M	TOC Elevation (ft. AMSL):	323.845
Logged By:	Ryan Francis	Northing:	1041228608.597
Sampling Method:	4"x10' Core barrel	Easting:	2907267.556

Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0 - 4	10.0/10.0	CL	(0 - 4) Silty CLAY, minor sand, red and orange with gray ribbons, dry, soft to firm, low to medium plasticity
4 - 12		CH	(4 - 12) CLAY, red with gray concretions, moist, soft to firm, high plasticity, gradual contact
12 - 24	10.0/10.0	ML	(12 - 24) Sandy SILT, gray and red, dry, soft, weak cementation, sharp contact, red and gray clay lens at 19'
24 - 28	10.0/10.0	CL	(24 - 28) CLAY, red, moist to wet, soft to firm, high plasticity, pebbles present
28 - 34		SP	(28 - 34) SAND, gray, wet, soft to firm, minor clay, low to medium plasticity, subrounded, increasing clay content with depth, sharp contact
34 - 39	10.0/10.0	CL	(34 - 39) CLAY, orange and gray mottling, dry, very hard, moderate cementation, low plasticity
39 - 46	10.0/10.0	CL	(39 - 46) Sandy CLAY, orange and gray, moist to wet, firm, medium plasticity, weak cementation, increasing sand content with depth
46 - 60	10.0/10.0	ML	(46 - 60) Sandy SILT, dark gray, dry, hard

PBW
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Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446

Notes:
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Well Materials
(0-41) Casing, 2" Sch 40 FJT PVC
(41-46) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-37') Grout
(37'-39') Bentonite pellets
(39'-46') 20/40 sand

Luminant

Log of Boring: AP-2019-1

Big Brown Steam Electric Station Franklin, TX	Completion Date:	6/3/2019	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6
	Driller:	Rodney Labrosse	Total Depth (ft):	40
Golder Project No. 19122434E	Driller's License:	60059	TOC Elevation (ft. AMSL):	
	Logged By:	Kelsey Worley	Northing:	3570888
	Sampling Method:	4"x10' Core barrel	Easting:	352661.3

Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0		CL	(0 - 1) Silty CLAY, brown, roots present, low plasticity, slightly moist
5	10.0/10.0	CL	(1 - 8) Silty CLAY, brown to orange, moist, moderate plasticity, soft to hard
10		SC	(8 - 12.5) Clayey SAND, orange and brown, moist, soft, clay content increases with depth, moderate plasticity
15	10.0/10.0	CH	(12.5 - 22) CLAY, gray to light brown, blocky, moist, firm to stiff, low plasticity
20			
25	10.0/10.0	SW	(22 - 34) SAND, light brown to gray and orange, moist, very fine to fine grained, subrounded, soft to firm, iron staining 22'-23.5', color change to light gray and light brown at 24', saturated at 30'
30			
35	10.0/10.0	SC	(34 - 40) Clayey SAND, gray and tan, becomes gray to dark gray at 35.5', stiff, moist, variations in clay content and firmness with depth
40			

GOLDER
2201 Double Creek Dr., Suite 4004
Round Rock, Texas 78664
O 512.671.3434 F 512.671.3446

Notes:
1. This log should not be used separately from the report to which it is attached.

Luminant

Log of Boring: AP-2019-2

Big Brown Steam Electric Station Franklin, TX	Completion Date:	6/3/2019	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6
	Driller:	Rodney Labrosse	Total Depth (ft):	40
	Driller's License:	60059	TOC Elevation (ft. AMSL):	
Golder Project No. 19122434E	Logged By:	Kelsey Worley	Northing:	3570800
	Sampling Method:	4"x10' Core barrel	Easting:	352739.4

Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0–10	10.0/10.0	CL	(0 - 6) Silty CLAY, brown to gray, soft to firm, damp, low plasticity
		CL	(6 - 11) Sandy CLAY, red and orange with gray, clay ribbons, damp, soft to firm, weak cementation, moderate plasticity
10–20	10.0/10.0	SC	(11 - 20) Clayey Silty SAND, tan with red and gray, clay ribbons, moist, firm, weak cementation, moderate plasticity
20–30	10.0/10.0	SW	(20 - 22) SAND, light brown, moist to wet, fine grained, subrounded, soft
		SC	(22 - 34) Clayey SAND, gray and tan, becomes gray to dark, gray at 26', stiff, moist, brown clay ribbons from 27'-29.5'
30–40	10.0/10.0	SW	(34 - 40) SAND, gray, very fine to fine grained, wet, subrounded, soft to firm, saturated 35'-38', black organics at 38.8'-40.0'

GOLDER
2201 Double Creek Dr., Suite 4004
Round Rock, Texas 78664
O 512.671.3434 F 512.671.3446

Notes:
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Luminant

Log of Boring: AP-2019-3

Big Brown Steam Electric Station Franklin, TX	Completion Date:	6/3/2019	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6
	Driller:	Rodney Labrosse	Total Depth (ft):	30
	Driller's License:	60059	TOC Elevation (ft. AMSL):	
Golder Project No. 19122434E	Logged By:	Kelsey Worley	Northing:	352739.4
	Sampling Method:	4"x10' Core barrel	Easting:	3570800

Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0–6	10.0/10.0	SM	(0 - 6) Silty SAND, light brown, firm, moderate cementation, roots present 0'-1.5'
6–11		SC	(6 - 11) Clayey SAND, orange to brown, moist, soft to firm, no plasticity, weak cementation, gray sand lense, fine grained, at 11', fine to very fine grained
11–18	10.0/10.0	SC	(11 - 18) Clayey SAND, wet, gray and tan to orange, soft to firm, sand content increases with depth
18–25	10.0/10.0	SP	(18 - 25) SAND, orange and gray, saturated, fine grained, soft, no cementation
25–30		CL	(25 - 30) Silty CLAY, dark gray, dry, hard, moderate sand content, weak cementation

GOLDER
2201 Double Creek Dr., Suite 4004
Round Rock, Texas 78664
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Notes:
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APPENDIX B

LABORATORY ANALYTICAL REPORTS

June 14, 2019

Will Vienne
Golder
2201 Double Creek Dr #4004
Round Rock, Texas 78664
TEL: (512) 671-3434
FAX (512) 671-3446

Order No.: 1905168

RE: Luminant-MLSES Ash Ponds

Dear Will Vienne:

DHL Analytical, Inc. received 7 sample(s) on 5/15/2019 for the analyses presented in the following report.

There were no problems with the analyses and all data met requirements of NELAP except where noted in the Case Narrative. All non-NELAP methods will be identified accordingly in the case narrative and all estimated uncertainties of test results are within method or EPA specifications.

If you have any questions regarding these tests results, please feel free to call. Thank you for using DHL Analytical.

Sincerely,

John DuPont
General Manager

This report was performed under the accreditation of the State of Texas Laboratory Certification Number: T104704211-19-24

Table of Contents

DHL ANALYTICAL
2300 Double Creek Dr. ■ Round Rock, TX 78664
Phone (512) 388-8222 ■ FAX (512) 388-8229
Web: www.dhlanalytical.com
E-Mail: login@dhlanalytical.com

№ 86479

CHAIN-OF-CUSTODY

CLIENT: GOLDER
ADDRESS: 2201 DOUBLE CREEK DR, ROUND ROCK, TX 78664
PHONE: 512-671-3434 FAX/E-MAIL: 512-671-3446
DATA REPORTED TO: WILL VIENNE
ADDITIONAL REPORT COPIES TO:

DATE: 5-14-19 PAGE 1 OF 1
PO #: DHL WORK ORDER #: 1905168
PROJECT LOCATION OR NAME: LUMINANT - MLSES ASH PONDS
CLENT PROJECT #: 19122262-C COLLECTOR: J. BRAYTON

Authorize 5% surcharge for TRRP Report? ☐ Yes ☐ No

S=SOIL W=WATER A=AIR L=LIQUID SE=SEDIMENT P=PAINT SL=SLUDGE O=OTHER SO=SOLID

ANALYSES: BTEX ☐ MTBE ☐ [METHOD 8021] TPH 1005 ☐ TPH 1006 ☐ HOLD 1006 ☐ GRO [METHOD 8015] ☐ DRO [METHOD 8015] ☐ VOC 8260 ☐ VOC 624 ☐ VOC 8260/5035 ☐ SVOC 8270 ☐ PAH 8270 ☐ HOLD PAH ☐ SVOC 625 ☐ 8270 PEST ☐ 625 PEST/PCB ☐ 608 PCB ☐ 8270 O-P PEST ☐ 8082 PCB ☐ 8270 PCB ☐ 8321 HERB ☐ T PHOS, AMMONIA ☐ METALS 6020 ☐ METALS 200.8 ☐ DISS. METALS ☐ RCRA ☐ TX11 ☐ PH ☐ HEX CHROM ☐ ALKALINITY ☐ COD ☐ CHLORIDE ☐ ANIONS ☐ TCLP-SVOC ☐ VOC ☐ PEST ☐ HERB ☐ TCLP-METALS ☐ RCRA 8 ☐ TX-11 ☐ Pb ☐ RCI ☐ FLASHPOINT ☐ DGAS ☐ TDS ☐ TSS ☐ % MOISTURE ☐ CYANIDE ☐ APPENDIX III & IV ALK, NO_3, PO_4, Mg, Mn, K FERROUS/FERRIC IRON

Field Sample I.D.	DHL Lab #	Date	Time	Matrix	Container Type	# of Containers	HCl	HNO_3	H_2SO_4 ☐ NaOH ☐	ICE	UNPRESERVED	APPENDIX III & IV	ALK, NO_3, PO_4, Mg, Mn, K	FERROUS/FERRIC IRON	FIELD NOTES
H-31	01	5-14-19	0740	W		7				X		X	X	X	
H-32	02	↓	0825	W		7				X		X	X	X	
H-27	03	↓	0940	W		7				X		X	X	X	
H-29	04	↓	1125	W		7				X		X	X	X	
H-28	05	↓	1230	W		7				X		X	X	X	
H-26	06	↓	1425	W		7				X		X	X	X	
H-33	07	↓	1530	W		7				X		X	X	X	

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)
[signature]	5-14-19	Fed Ex
Fed Ex	5/15/19 0943	[signature]

☐ DHL DISPOSAL @ $5.00 each ☐ Return

TURN AROUND TIME
RUSH ☐ CALL FIRST
1 DAY ☐ CALL FIRST
2 DAY ☐
NORMAL ☒
OTHER ☐ ____

LABORATORY USE ONLY:
RECEIVING TEMP: 4.5 / 3.0 °C THERM #: 78
CUSTODY SEALS: ☐ BROKEN ☐ INTACT ☒ NOT USED
CARRIER: ☐ LONE STAR ☒ FEDEX ☐ UPS ☐ OTHER
☐ COURIER DELIVERY
☐ HAND DELIVERED

DHL COC Rev 1 | FEB 2010

LUMINANT

Eric Lau

From: John DuPont
Sent: Tuesday, May 28, 2019 11:35 AM
To: Eric Lau
Subject: FW: CCR Analysis

Appendix III Parameters:
Metals (Ca and B)
Anions (Cl, F, and SO4)
TDS

Appendix IV Parameters:

Metals (As, Ba, Be, Cd, Co, Cr, Hg, Li, Mo, Pb, Sb, Se, and Tl)
Ra-226
Ra-228

From: Vienne, Will [mailto:William_Vienne@golder.com]
Sent: Tuesday, April 09, 2019 12:48 PM
To: John DuPont <dupont@dhlanalytical.com>
Subject: CCR Analysis

ORIGIN ID:GGGA (512) 671-3434
J . BRAYTON
GOLDER
2201 DOUBLE CREEK DR

ROUND ROCK, TX 78664
UNITED STATES US

SHIP DATE: 14MAY19
ACTWGT: 48.70 LB
CAD: 006994186/SSFE2002
DIMS: 23x13x13 IN

BILL THIRD PARTY

TO

DHL
2300 DOUBLE CREEK DR

ROUND ROCK TX 78664
(512) 388-8222
INV:
PO:
REF:
DEPT:

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Express
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J191019010701uv

4 of 4
MPS# 7872 5506 5879
0263
Mstr# 7872 5506 5846
0201

WED - 15 MAY 10:30A
PRIORITY OVERNIGHT

A8 BSMA

78664
TX-US AUS

ORIGIN ID:GGGA (512) 671-3434
J. BRAYTON
GOLDER
2201 DOUBLE CREEK DR

ROUND ROCK, TX 78664
UNITED STATES US

SHIP DATE: 14MAY19
ACTWGT: 50.90 LB
CAD: 006994166/SSFE2002
DIMS: 23x14x14 IN

BILL THIRD PARTY

TO
DHL
2300 DOUBLE CREEK DR

ROUND ROCK TX 78664
(512) 388-6222
INV:
PO:
REF:
DEPT:

FedEx
Express

E

J191019010701uv

2 of 4
MPS# 0263 7872 5506 5857
Mstr# 7872 5506 5846 0201

WED - 15 MAY 10:30A
PRIORITY OVERNIGHT

A8 BSMA

78664
TX-US AUS

DHL Analytical, Inc.

Sample Receipt Checklist

Client Name Golder

Date Received: 5/15/2019

Work Order Number 1905168

Received by EL

Checklist completed by: [signature] 5/15/2019
Signature Date

Reviewed by DL 5/15/2019
Initials Date

Carrier name FedEx 1day

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shippping container/cooler?	Yes ☐	No ☐	Not Present ☑
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐	4.5 °C
Water - VOA vials have zero headspace?	Yes ☑	No ☐	No VOA vials submitted ☐
Water - pH<2 acceptable upon receipt?	Yes ☑	No ☐	NA ☐ LOT # 11837
	Adjusted? no		Checked by EL
Water - ph>9 (S) or ph>10 (CN) acceptable upon receipt?	Yes ☐	No ☐	NA ☑ LOT #
	Adjusted?		Checked by

Any No response must be detailed in the comments section below.

Client contacted ______ Date contacted: ______ Person contacted ______

Contacted by: ______ Regarding: ______

Comments: ______

Corrective Action ______

DHL Analytical, Inc.

Date: *14-Jun-19*

CLIENT: Golder
Project: Luminant-MLSES Ash Ponds
Lab Order: 1905168

CASE NARRATIVE

Samples were analyzed using the methods outlined in the following references:

Method SW6020A - Metals Analysis
Method SW7470A - Mercury Analysis
Method E300 - Anions Analysis
Method M2320 B - Alkalinity Analysis
Method M3500-Fe D - Ferrous Iron Analysis (this parameter is not NELAP certified)
Method M3500-Fe D - Ferric Iron (calculation) (this calculation is not NELAP certified).
Method M4500-P E - Orthophosphate Analysis
Method M2540C - TDS Analysis
Sub-contract - Radium-228 and Radium-226 analyses by methods E904 and SM 7500 Ra B M. Analyzed at Pace Analytical.

LOG IN

The samples were received and log-in performed on 5/15/19. A total of 7 samples were received. The samples arrived in good condition and were properly packaged.

METALS ANALYSIS

For Metals analysis performed on 5/20/19 and 5/21/19 the matrix spike and matrix spike duplicate recoveries were out of control limits for a total of four analytes. These are flagged accordingly in the QC summary report. The sample selected for the matrix spike and matrix spike duplicate was not from this work order. The LCS was within control limits for these analytes. No further corrective actions were taken.

For Metals analysis peformed on 5/20/19 LCVL6-190520 was slightly above control limits for Sodium. This is flagged accordingly. The associated CCV6-190520 was within control limits for this analyte. No further corrective actions were taken.

ANIONS ANALYSIS

For Anions analysis performed on 5/15/19 (batch 90908) the matrix spike and matrix spike duplicate recoveries (1905167-02 MS/MSD) were out of control limits for Chloride and Sulfate. This was due to matrix effect. These are flagged accordingly in the QC summary report. The sample selected for the matrix spike and matrix spike duplicate was not from this work order. The LCS was within control limits for these analytes. No further corrective actions were taken.

FERRIC IRON (CALCULATION)

CLIENT:	Golder	
Project:	Luminant-MLSES Ash Ponds	**CASE NARRATIVE**
Lab Order:	1905168	

For Ferric Iron calculation the Ferrous Iron result was slightly higher than the total Iron result for sample H-31. This is within the acceptable variation limits. No further corrective actions were taken.

DHL Analytical, Inc.

Date: *14-Jun-19*

CLIENT: Golder
Project: Luminant-MLSES Ash Ponds
Lab Order: 1905168

Work Order Sample Summary

Lab Smp ID	Client Sample ID	Tag Number	Date Collected	Date Recved
1905168-01	H-31		05/14/19 07:40 AM	5/15/2019
1905168-02	H-32		05/14/19 08:25 AM	5/15/2019
1905168-03	H-27		05/14/19 09:40 AM	5/15/2019
1905168-04	H-29		05/14/19 11:25 AM	5/15/2019
1905168-05	H-28		05/14/19 12:30 PM	5/15/2019
1905168-06	H-26		05/14/19 02:25 PM	5/15/2019
1905168-07	H-33		05/14/19 03:30 PM	5/15/2019

Lab Order: 1905168
Client: Golder
Project: Luminant-MLSES Ash Ponds

PREP DATES REPORT

Sample ID	Client Sample ID	Collection Date	Matrix	Test Number	Test Name	Prep Date	Batch ID
1905168-01A	H-31	05/14/19 07:40 AM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002
	H-31	05/14/19 07:40 AM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002
1905168-01B	H-31	05/14/19 07:40 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/17/19 08:40 AM	90959
	H-31	05/14/19 07:40 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/17/19 08:40 AM	90959
	H-31	05/14/19 07:40 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/17/19 08:40 AM	90959
	H-31	05/14/19 07:40 AM	Aqueous	SW7470A	Mercury Aq Prep	05/21/19 09:56 AM	91017
	H-31	05/14/19 07:40 AM	Aqueous	SW7470A	Mercury Aq Prep	05/21/19 09:56 AM	91017
1905168-01C	H-31	05/14/19 07:40 AM	Aqueous	M2320 B	Alkalinity Preparation	05/16/19 10:12 AM	90940
	H-31	05/14/19 07:40 AM	Aqueous	E300	Anion Preparation	05/15/19 09:07 AM	90908
	H-31	05/14/19 07:40 AM	Aqueous	E300	Anion Preparation	05/15/19 09:07 AM	90908
	H-31	05/14/19 07:40 AM	Aqueous	E300	Anion Preparation	05/16/19 09:16 AM	90935
	H-31	05/14/19 07:40 AM	Aqueous	M4500-P E	Orthophosphate Prep	05/15/19 12:12 PM	90921
	H-31	05/14/19 07:40 AM	Aqueous	M2540C	TDS Preparation	05/16/19 03:23 PM	90953
1905168-02A	H-32	05/14/19 08:25 AM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002
	H-32	05/14/19 08:25 AM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002
1905168-02B	H-32	05/14/19 08:25 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/17/19 08:40 AM	90959
	H-32	05/14/19 08:25 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/17/19 08:40 AM	90959
	H-32	05/14/19 08:25 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/17/19 08:40 AM	90959
	H-32	05/14/19 08:25 AM	Aqueous	SW7470A	Mercury Aq Prep	05/21/19 09:56 AM	91017
1905168-02C	H-32	05/14/19 08:25 AM	Aqueous	M2320 B	Alkalinity Preparation	05/16/19 10:12 AM	90940
	H-32	05/14/19 08:25 AM	Aqueous	E300	Anion Preparation	05/15/19 09:07 AM	90908
	H-32	05/14/19 08:25 AM	Aqueous	E300	Anion Preparation	05/15/19 09:07 AM	90908
	H-32	05/14/19 08:25 AM	Aqueous	M4500-P E	Orthophosphate Prep	05/15/19 12:12 PM	90921
	H-32	05/14/19 08:25 AM	Aqueous	M2540C	TDS Preparation	05/16/19 03:23 PM	90953
1905168-03A	H-27	05/14/19 09:40 AM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002
1905168-03B	H-27	05/14/19 09:40 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/17/19 08:40 AM	90959
	H-27	05/14/19 09:40 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/17/19 08:40 AM	90959
	H-27	05/14/19 09:40 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/17/19 08:40 AM	90959

Lab Order: 1905168
Client: Golder
Project: Luminant-MLSES Ash Ponds

PREP DATES REPORT

Sample ID	Client Sample ID	Collection Date	Matrix	Test Number	Test Name	Prep Date	Batch ID
1905168-03B	H-27	05/14/19 09:40 AM	Aqueous	SW7470A	Mercury Aq Prep	05/21/19 09:56 AM	91017
1905168-03C	H-27	05/14/19 09:40 AM	Aqueous	M2320 B	Alkalinity Preparation	05/16/19 10:12 AM	90940
	H-27	05/14/19 09:40 AM	Aqueous	E300	Anion Preparation	05/15/19 09:07 AM	90908
	H-27	05/14/19 09:40 AM	Aqueous	E300	Anion Preparation	05/15/19 09:07 AM	90908
	H-27	05/14/19 09:40 AM	Aqueous	M4500-P E	Orthophosphate Prep	05/15/19 12:12 PM	90921
	H-27	05/14/19 09:40 AM	Aqueous	M2540C	TDS Preparation	05/16/19 03:23 PM	90953
1905168-04A	H-29	05/14/19 11:25 AM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002
1905168-04B	H-29	05/14/19 11:25 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/17/19 08:40 AM	90959
	H-29	05/14/19 11:25 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/17/19 08:40 AM	90959
	H-29	05/14/19 11:25 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/17/19 08:40 AM	90959
	H-29	05/14/19 11:25 AM	Aqueous	SW7470A	Mercury Aq Prep	05/21/19 09:56 AM	91017
1905168-04C	H-29	05/14/19 11:25 AM	Aqueous	M2320 B	Alkalinity Preparation	05/16/19 10:12 AM	90940
	H-29	05/14/19 11:25 AM	Aqueous	E300	Anion Preparation	05/15/19 09:07 AM	90908
	H-29	05/14/19 11:25 AM	Aqueous	E300	Anion Preparation	05/15/19 09:07 AM	90908
	H-29	05/14/19 11:25 AM	Aqueous	M4500-P E	Orthophosphate Prep	05/15/19 12:12 PM	90921
	H-29	05/14/19 11:25 AM	Aqueous	M2540C	TDS Preparation	05/16/19 03:23 PM	90953
1905168-05A	H-28	05/14/19 12:30 PM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002
1905168-05B	H-28	05/14/19 12:30 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/17/19 08:40 AM	90959
	H-28	05/14/19 12:30 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/17/19 08:40 AM	90959
	H-28	05/14/19 12:30 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/17/19 08:40 AM	90959
	H-28	05/14/19 12:30 PM	Aqueous	SW7470A	Mercury Aq Prep	05/21/19 09:56 AM	91017
1905168-05C	H-28	05/14/19 12:30 PM	Aqueous	M2320 B	Alkalinity Preparation	05/16/19 10:12 AM	90940
	H-28	05/14/19 12:30 PM	Aqueous	E300	Anion Preparation	05/15/19 09:07 AM	90908
	H-28	05/14/19 12:30 PM	Aqueous	E300	Anion Preparation	05/15/19 09:07 AM	90908
	H-28	05/14/19 12:30 PM	Aqueous	M4500-P E	Orthophosphate Prep	05/15/19 12:12 PM	90921
	H-28	05/14/19 12:30 PM	Aqueous	M2540C	TDS Preparation	05/16/19 03:23 PM	90953
1905168-06A	H-26	05/14/19 02:25 PM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002
1905168-06B	H-26	05/14/19 02:25 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/17/19 08:40 AM	90959

Lab Order: 1905168
Client: Golder
Project: Luminant-MLSES Ash Ponds

PREP DATES REPORT

Sample ID	Client Sample ID	Collection Date	Matrix	Test Number	Test Name	Prep Date	Batch ID
1905168-06B	H-26	05/14/19 02:25 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/17/19 08:40 AM	90959
	H-26	05/14/19 02:25 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/17/19 08:40 AM	90959
	H-26	05/14/19 02:25 PM	Aqueous	SW7470A	Mercury Aq Prep	05/21/19 09:56 AM	91017
1905168-06C	H-26	05/14/19 02:25 PM	Aqueous	M2320 B	Alkalinity Preparation	05/16/19 10:12 AM	90940
	H-26	05/14/19 02:25 PM	Aqueous	E300	Anion Preparation	05/15/19 09:07 AM	90908
	H-26	05/14/19 02:25 PM	Aqueous	E300	Anion Preparation	05/15/19 09:07 AM	90908
	H-26	05/14/19 02:25 PM	Aqueous	M4500-P E	Orthophosphate Prep	05/15/19 12:12 PM	90921
	H-26	05/14/19 02:25 PM	Aqueous	M2540C	TDS Preparation	05/16/19 03:23 PM	90953
1905168-07A	H-33	05/14/19 03:30 PM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002
1905168-07B	H-33	05/14/19 03:30 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/17/19 08:40 AM	90959
	H-33	05/14/19 03:30 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/17/19 08:40 AM	90959
	H-33	05/14/19 03:30 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/17/19 08:40 AM	90959
	H-33	05/14/19 03:30 PM	Aqueous	SW7470A	Mercury Aq Prep	05/21/19 09:56 AM	91017
1905168-07C	H-33	05/14/19 03:30 PM	Aqueous	M2320 B	Alkalinity Preparation	05/16/19 10:12 AM	90940
	H-33	05/14/19 03:30 PM	Aqueous	E300	Anion Preparation	05/15/19 09:07 AM	90908
	H-33	05/14/19 03:30 PM	Aqueous	E300	Anion Preparation	05/15/19 09:07 AM	90908
	H-33	05/14/19 03:30 PM	Aqueous	M4500-P E	Orthophosphate Prep	05/15/19 12:12 PM	90921
	H-33	05/14/19 03:30 PM	Aqueous	M2540C	TDS Preparation	05/16/19 03:23 PM	90953

Lab Order: 1905168
Client: Golder
Project: Luminant-MLSES Ash Ponds

ANALYTICAL DATES REPORT

Sample ID	Client Sample ID	Matrix	Test Number	Test Name	Batch ID	Dilution	Analysis Date	Run ID
1905168-01A	H-31	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91002	1	05/24/19	UV/VIS_2_190524A
	H-31	Aqueous	M3500-Fe D	Ferrous Iron	91002	1	05/20/19 03:55 PM	UV/VIS_2_190520A
	H-31	Aqueous	M3500-Fe D	Ferrous Iron	91002	100	05/20/19 04:11 PM	UV/VIS_2_190520A
1905168-01B	H-31	Aqueous	SW7470A	Mercury Total: Aqueous	91017	1	05/22/19 10:16 AM	CETAC2_HG_190522A
	H-31	Aqueous	SW7470A	Mercury Total: Aqueous	91017	5	05/22/19 11:21 AM	CETAC2_HG_190522A
	H-31	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90959	1	05/20/19 03:43 PM	ICP-MS4_190520B
	H-31	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90959	50	05/21/19 12:54 PM	ICP-MS5_190521A
	H-31	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90959	1	05/21/19 02:51 PM	ICP-MS5_190521A
1905168-01C	H-31	Aqueous	M2320 B	Alkalinity	90940	1	05/16/19 04:13 PM	TITRATOR_190516A
	H-31	Aqueous	E300	Anions by IC method - Water	90908	10	05/15/19 02:27 PM	IC2_190515A
	H-31	Aqueous	E300	Anions by IC method - Water	90908	1	05/15/19 05:55 PM	IC2_190515A
	H-31	Aqueous	E300	Anions by IC method - Water	90935	100	05/16/19 05:42 PM	IC4_190516A
	H-31	Aqueous	M4500-P E	Orthophosphate	90921	1	05/15/19 02:47 PM	UV/VIS_2_190515B
	H-31	Aqueous	M2540C	Total Dissolved Solids	90953	1	05/17/19 11:40 AM	WC_190517D
1905168-02A	H-32	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91002	1	05/24/19	UV/VIS_2_190524A
	H-32	Aqueous	M3500-Fe D	Ferrous Iron	91002	1	05/20/19 03:55 PM	UV/VIS_2_190520A
	H-32	Aqueous	M3500-Fe D	Ferrous Iron	91002	5	05/20/19 04:11 PM	UV/VIS_2_190520A
1905168-02B	H-32	Aqueous	SW7470A	Mercury Total: Aqueous	91017	1	05/22/19 10:27 AM	CETAC2_HG_190522A
	H-32	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90959	1	05/21/19 02:53 PM	ICP-MS5_190521A
	H-32	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90959	10	05/21/19 12:56 PM	ICP-MS5_190521A
	H-32	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90959	1	05/20/19 03:45 PM	ICP-MS4_190520B
1905168-02C	H-32	Aqueous	M2320 B	Alkalinity	90940	1	05/16/19 04:15 PM	TITRATOR_190516A
	H-32	Aqueous	E300	Anions by IC method - Water	90908	10	05/15/19 02:43 PM	IC2_190515A
	H-32	Aqueous	E300	Anions by IC method - Water	90908	1	05/15/19 06:11 PM	IC2_190515A
	H-32	Aqueous	M4500-P E	Orthophosphate	90921	1	05/15/19 12:49 PM	UV/VIS_2_190515B
	H-32	Aqueous	M2540C	Total Dissolved Solids	90953	1	05/17/19 11:40 AM	WC_190517D

Lab Order: 1905168
Client: Golder
Project: Luminant-MLSES Ash Ponds

ANALYTICAL DATES REPORT

Sample ID	Client Sample ID	Matrix	Test Number	Test Name	Batch ID	Dilution	Analysis Date	Run ID
1905168-03A	H-27	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91002	1	05/24/19	UV/VIS_2_190524A
	H-27	Aqueous	M3500-Fe D	Ferrous Iron	91002	1	05/20/19 03:56 PM	UV/VIS_2_190520A
1905168-03B	H-27	Aqueous	SW7470A	Mercury Total: Aqueous	91017	1	05/22/19 10:29 AM	CETAC2_HG_190522A
	H-27	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90959	1	05/20/19 03:47 PM	ICP-MS4_190520B
	H-27	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90959	10	05/21/19 12:59 PM	ICP-MS5_190521A
	H-27	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90959	1	05/21/19 02:14 PM	ICP-MS5_190521A
1905168-03C	H-27	Aqueous	M2320 B	Alkalinity	90940	1	05/16/19 04:20 PM	TITRATOR_190516A
	H-27	Aqueous	E300	Anions by IC method - Water	90908	10	05/15/19 02:59 PM	IC2_190515A
	H-27	Aqueous	E300	Anions by IC method - Water	90908	1	05/15/19 06:27 PM	IC2_190515A
	H-27	Aqueous	M4500-P E	Orthophosphate	90921	1	05/15/19 12:49 PM	UV/VIS_2_190515B
	H-27	Aqueous	M2540C	Total Dissolved Solids	90953	1	05/17/19 11:40 AM	WC_190517D
1905168-04A	H-29	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91002	1	05/24/19	UV/VIS_2_190524A
	H-29	Aqueous	M3500-Fe D	Ferrous Iron	91002	1	05/20/19 03:56 PM	UV/VIS_2_190520A
1905168-04B	H-29	Aqueous	SW7470A	Mercury Total: Aqueous	91017	1	05/22/19 10:31 AM	CETAC2_HG_190522A
	H-29	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90959	1	05/20/19 03:49 PM	ICP-MS4_190520B
	H-29	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90959	1	05/21/19 02:55 PM	ICP-MS5_190521A
	H-29	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90959	20	05/21/19 01:01 PM	ICP-MS5_190521A
1905168-04C	H-29	Aqueous	M2320 B	Alkalinity	90940	1	05/16/19 04:23 PM	TITRATOR_190516A
	H-29	Aqueous	E300	Anions by IC method - Water	90908	10	05/15/19 03:15 PM	IC2_190515A
	H-29	Aqueous	E300	Anions by IC method - Water	90908	1	05/15/19 06:43 PM	IC2_190515A
	H-29	Aqueous	M4500-P E	Orthophosphate	90921	1	05/15/19 12:49 PM	UV/VIS_2_190515B
	H-29	Aqueous	M2540C	Total Dissolved Solids	90953	1	05/17/19 11:40 AM	WC_190517D
1905168-05A	H-28	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91002	1	05/24/19	UV/VIS_2_190524A
	H-28	Aqueous	M3500-Fe D	Ferrous Iron	91002	1	05/20/19 03:57 PM	UV/VIS_2_190520A
1905168-05B	H-28	Aqueous	SW7470A	Mercury Total: Aqueous	91017	1	05/22/19 10:34 AM	CETAC2_HG_190522A
	H-28	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90959	20	05/21/19 01:03 PM	ICP-MS5_190521A

Lab Order: 1905168
Client: Golder
Project: Luminant-MLSES Ash Ponds

ANALYTICAL DATES REPORT

Sample ID	Client Sample ID	Matrix	Test Number	Test Name	Batch ID	Dilution	Analysis Date	Run ID
1905168-05B	H-28	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90959	1	05/21/19 02:57 PM	ICP-MS5_190521A
	H-28	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90959	1	05/20/19 03:51 PM	ICP-MS4_190520B
1905168-05C	H-28	Aqueous	M2320 B	Alkalinity	90940	1	05/16/19 04:27 PM	TITRATOR_190516A
	H-28	Aqueous	E300	Anions by IC method - Water	90908	10	05/15/19 03:31 PM	IC2_190515A
	H-28	Aqueous	E300	Anions by IC method - Water	90908	1	05/15/19 06:59 PM	IC2_190515A
	H-28	Aqueous	M4500-P E	Orthophosphate	90921	1	05/15/19 12:50 PM	UV/VIS_2_190515B
	H-28	Aqueous	M2540C	Total Dissolved Solids	90953	1	05/17/19 11:40 AM	WC_190517D
1905168-06A	H-26	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91002	1	05/24/19	UV/VIS_2_190524A
	H-26	Aqueous	M3500-Fe D	Ferrous Iron	91002	1	05/20/19 03:57 PM	UV/VIS_2_190520A
1905168-06B	H-26	Aqueous	SW7470A	Mercury Total: Aqueous	91017	1	05/22/19 10:36 AM	CETAC2_HG_190522A
	H-26	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90959	1	05/20/19 03:53 PM	ICP-MS4_190520B
	H-26	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90959	10	05/21/19 01:05 PM	ICP-MS5_190521A
	H-26	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90959	1	05/21/19 02:16 PM	ICP-MS5_190521A
1905168-06C	H-26	Aqueous	M2320 B	Alkalinity	90940	1	05/16/19 04:42 PM	TITRATOR_190516A
	H-26	Aqueous	E300	Anions by IC method - Water	90908	10	05/15/19 03:47 PM	IC2_190515A
	H-26	Aqueous	E300	Anions by IC method - Water	90908	1	05/15/19 07:15 PM	IC2_190515A
	H-26	Aqueous	M4500-P E	Orthophosphate	90921	1	05/15/19 12:50 PM	UV/VIS_2_190515B
	H-26	Aqueous	M2540C	Total Dissolved Solids	90953	1	05/17/19 11:40 AM	WC_190517D
1905168-07A	H-33	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91002	1	05/24/19	UV/VIS_2_190524A
	H-33	Aqueous	M3500-Fe D	Ferrous Iron	91002	1	05/20/19 03:58 PM	UV/VIS_2_190520A
1905168-07B	H-33	Aqueous	SW7470A	Mercury Total: Aqueous	91017	1	05/22/19 10:38 AM	CETAC2_HG_190522A
	H-33	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90959	1	05/20/19 03:54 PM	ICP-MS4_190520B
	H-33	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90959	10	05/21/19 01:08 PM	ICP-MS5_190521A
	H-33	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90959	1	05/21/19 02:19 PM	ICP-MS5_190521A
1905168-07C	H-33	Aqueous	M2320 B	Alkalinity	90940	1	05/16/19 04:49 PM	TITRATOR_190516A
	H-33	Aqueous	E300	Anions by IC method - Water	90908	10	05/15/19 04:03 PM	IC2_190515A
	H-33	Aqueous	E300	Anions by IC method - Water	90908	1	05/15/19 07:31 PM	IC2_190515A

Lab Order: 1905168
Client: Golder
Project: Luminant-MLSES Ash Ponds

ANALYTICAL DATES REPORT

Sample ID	Client Sample ID	Matrix	Test Number	Test Name	Batch ID	Dilution	Analysis Date	Run ID
1905168-07C	H-33	Aqueous	M4500-P E	Orthophosphate	90921	1	05/15/19 12:50 PM	UV/VIS_2_190515B
	H-33	Aqueous	M2540C	Total Dissolved Solids	90953	1	05/17/19 11:40 AM	WC_190517D

DHL Analytical, Inc.

Date: *14-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	H-31
Project:	Luminant-MLSES Ash Ponds	**Lab ID:**	1905168-01
Project No:	19122262-C	**Collection Date:**	05/14/19 07:40 AM
Lab Order:	1905168	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **RO**
Antimony	<0.000800	0.000800	0.00250		mg/L	1	05/20/19 03:43 PM
Arsenic	0.00675	0.00200	0.00500		mg/L	1	05/20/19 03:43 PM
Barium	0.0163	0.00300	0.0100		mg/L	1	05/20/19 03:43 PM
Beryllium	0.00928	0.000300	0.00100		mg/L	1	05/20/19 03:43 PM
Boron	20.0	0.500	1.50		mg/L	50	05/21/19 12:54 PM
Cadmium	<0.000300	0.000300	0.00100		mg/L	1	05/20/19 03:43 PM
Calcium	234	5.00	15.0		mg/L	50	05/21/19 12:54 PM
Chromium	0.00315	0.00200	0.00500	J	mg/L	1	05/20/19 03:43 PM
Cobalt	0.389	0.00300	0.00500		mg/L	1	05/20/19 03:43 PM
Iron	48.7	1.50	5.00		mg/L	50	05/21/19 12:54 PM
Lead	<0.000300	0.000300	0.00100		mg/L	1	05/20/19 03:43 PM
Lithium	0.219	0.00500	0.0100		mg/L	1	05/20/19 03:43 PM
Magnesium	170	5.00	15.0		mg/L	50	05/21/19 12:54 PM
Molybdenum	<0.00200	0.00200	0.00500		mg/L	1	05/21/19 02:51 PM
Potassium	6.18	0.100	0.300		mg/L	1	05/20/19 03:43 PM
Selenium	0.0261	0.00200	0.00500		mg/L	1	05/20/19 03:43 PM
Sodium	672	5.00	15.0		mg/L	50	05/21/19 12:54 PM
Thallium	<0.000500	0.000500	0.00150		mg/L	1	05/20/19 03:43 PM
MERCURY TOTAL: AQUEOUS		**SW7470A**					Analyst: **BM**
Mercury	<0.000400	0.000400	0.00100		mg/L	5	05/22/19 11:21 AM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	225	3.00	10.0		mg/L	10	05/15/19 02:27 PM
Fluoride	0.960	0.100	0.400		mg/L	1	05/15/19 05:55 PM
Nitrate-N	<0.100	0.100	0.500		mg/L	1	05/15/19 05:55 PM
Sulfate	2470	100	300		mg/L	100	05/16/19 05:42 PM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	33.9	10.0	20.0		mg/L @ pH 4.52	1	05/16/19 04:13 PM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.52	1	05/16/19 04:13 PM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.52	1	05/16/19 04:13 PM
Alkalinity, Total (As CaCO3)	33.9	20.0	20.0		mg/L @ pH 4.52	1	05/16/19 04:13 PM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	<0.0500	0.0500	0.100	N	mg/L	1	05/24/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	49.5	5.00	10.0	N	mg/L	100	05/20/19 04:11 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
S	Spike Recovery outside control limits	N	Parameter not NELAP certified

CLIENT:	Golder	**Client Sample ID:**	H-31
Project:	Luminant-MLSES Ash Ponds	**Lab ID:**	1905168-01
Project No:	19122262-C	**Collection Date:**	05/14/19 07:40 AM
Lab Order:	1905168	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **CC**
Phosphorus, Total Orthophosphate (As P)	0.0770	0.0300	0.100	J	mg/L	1	05/15/19 02:47 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	4230	50.0	50.0		mg/L	1	05/17/19 11:40 AM

Qualifiers:				
*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
S	Spike Recovery outside control limits	N	Parameter not NELAP certified

CLIENT:	Golder	**Client Sample ID:**	H-32
Project:	Luminant-MLSES Ash Ponds	**Lab ID:**	1905168-02
Project No:	19122262-C	**Collection Date:**	05/14/19 08:25 AM
Lab Order:	1905168	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **RO**
Antimony	<0.000800	0.000800	0.00250		mg/L	1	05/20/19 03:45 PM
Arsenic	0.00202	0.00200	0.00500	J	mg/L	1	05/20/19 03:45 PM
Barium	0.0162	0.00300	0.0100		mg/L	1	05/20/19 03:45 PM
Beryllium	0.00713	0.000300	0.00100		mg/L	1	05/20/19 03:45 PM
Boron	2.08	0.100	0.300		mg/L	10	05/21/19 12:56 PM
Cadmium	0.000366	0.000300	0.00100	J	mg/L	1	05/20/19 03:45 PM
Calcium	45.2	1.00	3.00		mg/L	10	05/21/19 12:56 PM
Chromium	<0.00200	0.00200	0.00500		mg/L	1	05/20/19 03:45 PM
Cobalt	0.202	0.00300	0.00500		mg/L	1	05/20/19 03:45 PM
Iron	1.81	0.0300	0.100		mg/L	1	05/20/19 03:45 PM
Lead	0.000574	0.000300	0.00100	J	mg/L	1	05/20/19 03:45 PM
Lithium	0.0978	0.00500	0.0100		mg/L	1	05/20/19 03:45 PM
Magnesium	18.5	0.100	0.300		mg/L	1	05/20/19 03:45 PM
Molybdenum	<0.00200	0.00200	0.00500		mg/L	1	05/21/19 02:53 PM
Potassium	2.57	0.100	0.300		mg/L	1	05/20/19 03:45 PM
Selenium	0.00675	0.00200	0.00500		mg/L	1	05/20/19 03:45 PM
Sodium	151	1.00	3.00		mg/L	10	05/21/19 12:56 PM
Thallium	<0.000500	0.000500	0.00150		mg/L	1	05/20/19 03:45 PM
MERCURY TOTAL: AQUEOUS		**SW7470A**					Analyst: **BM**
Mercury	<0.0000800	0.0000800	0.000200		mg/L	1	05/22/19 10:27 AM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	135	3.00	10.0		mg/L	10	05/15/19 02:43 PM
Fluoride	1.15	0.100	0.400		mg/L	1	05/15/19 06:11 PM
Nitrate-N	273	1.00	5.00		mg/L	10	05/15/19 02:43 PM
Sulfate	320	10.0	30.0		mg/L	10	05/15/19 02:43 PM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 1.76	1	05/16/19 04:15 PM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 1.76	1	05/16/19 04:15 PM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 1.76	1	05/16/19 04:15 PM
Alkalinity, Total (As CaCO3)	<20.0	20.0	20.0		mg/L @ pH 1.76	1	05/16/19 04:15 PM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	0.640	0.0500	0.100	N	mg/L	1	05/24/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	1.17	0.250	0.500	N	mg/L	5	05/20/19 04:11 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *14-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	H-32
Project:	Luminant-MLSES Ash Ponds	**Lab ID:**	1905168-02
Project No:	19122262-C	**Collection Date:**	05/14/19 08:25 AM
Lab Order:	1905168	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **CC**
Phosphorus, Total Orthophosphate (As P)	0.0600	0.0300	0.100	J	mg/L	1	05/15/19 12:49 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	910	50.0	50.0		mg/L	1	05/17/19 11:40 AM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *14-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	H-27
Project:	Luminant-MLSES Ash Ponds	**Lab ID:**	1905168-03
Project No:	19122262-C	**Collection Date:**	05/14/19 09:40 AM
Lab Order:	1905168	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **RO**
Antimony	<0.000800	0.000800	0.00250		mg/L	1	05/20/19 03:47 PM
Arsenic	<0.00200	0.00200	0.00500		mg/L	1	05/20/19 03:47 PM
Barium	0.0208	0.00300	0.0100		mg/L	1	05/20/19 03:47 PM
Beryllium	<0.000300	0.000300	0.00100		mg/L	1	05/20/19 03:47 PM
Boron	0.350	0.0100	0.0300		mg/L	1	05/21/19 02:14 PM
Cadmium	<0.000300	0.000300	0.00100		mg/L	1	05/20/19 03:47 PM
Calcium	61.8	1.00	3.00		mg/L	10	05/21/19 12:59 PM
Chromium	<0.00200	0.00200	0.00500		mg/L	1	05/20/19 03:47 PM
Cobalt	<0.00300	0.00300	0.00500		mg/L	1	05/20/19 03:47 PM
Iron	0.0711	0.0300	0.100	J	mg/L	1	05/20/19 03:47 PM
Lead	<0.000300	0.000300	0.00100		mg/L	1	05/20/19 03:47 PM
Lithium	0.0678	0.00500	0.0100		mg/L	1	05/20/19 03:47 PM
Magnesium	47.3	1.00	3.00		mg/L	10	05/21/19 12:59 PM
Molybdenum	<0.00200	0.00200	0.00500		mg/L	1	05/21/19 02:14 PM
Potassium	3.01	0.100	0.300		mg/L	1	05/20/19 03:47 PM
Selenium	<0.00200	0.00200	0.00500		mg/L	1	05/20/19 03:47 PM
Sodium	123	1.00	3.00		mg/L	10	05/21/19 12:59 PM
Thallium	<0.000500	0.000500	0.00150		mg/L	1	05/20/19 03:47 PM
MERCURY TOTAL: AQUEOUS		**SW7470A**					Analyst: **BM**
Mercury	<0.0000800	0.0000800	0.000200		mg/L	1	05/22/19 10:29 AM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	132	3.00	10.0		mg/L	10	05/15/19 02:59 PM
Fluoride	0.159	0.100	0.400	J	mg/L	1	05/15/19 06:27 PM
Nitrate-N	0.658	0.100	0.500		mg/L	1	05/15/19 06:27 PM
Sulfate	406	10.0	30.0		mg/L	10	05/15/19 02:59 PM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	49.0	10.0	20.0		mg/L @ pH 4.5	1	05/16/19 04:20 PM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.5	1	05/16/19 04:20 PM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.5	1	05/16/19 04:20 PM
Alkalinity, Total (As CaCO3)	49.0	20.0	20.0		mg/L @ pH 4.5	1	05/16/19 04:20 PM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	0.0711	0.0500	0.100	JN	mg/L	1	05/24/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	05/20/19 03:56 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *14-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	H-27
Project:	Luminant-MLSES Ash Ponds	**Lab ID:**	1905168-03
Project No:	19122262-C	**Collection Date:**	05/14/19 09:40 AM
Lab Order:	1905168	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **CC**
Phosphorus, Total Orthophosphate (As P)	0.126	0.0300	0.100		mg/L	1	05/15/19 12:49 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	897	10.0	10.0		mg/L	1	05/17/19 11:40 AM

Qualifiers:				
*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *14-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	H-29
Project:	Luminant-MLSES Ash Ponds	**Lab ID:**	1905168-04
Project No:	19122262-C	**Collection Date:**	05/14/19 11:25 AM
Lab Order:	1905168	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **RO**
Antimony	<0.000800	0.000800	0.00250		mg/L	1	05/20/19 03:49 PM
Arsenic	<0.00200	0.00200	0.00500		mg/L	1	05/20/19 03:49 PM
Barium	0.0138	0.00300	0.0100		mg/L	1	05/20/19 03:49 PM
Beryllium	0.00341	0.000300	0.00100		mg/L	1	05/20/19 03:49 PM
Boron	8.12	0.200	0.600		mg/L	20	05/21/19 01:01 PM
Cadmium	0.00219	0.000300	0.00100		mg/L	1	05/20/19 03:49 PM
Calcium	95.9	2.00	6.00		mg/L	20	05/21/19 01:01 PM
Chromium	<0.00200	0.00200	0.00500		mg/L	1	05/20/19 03:49 PM
Cobalt	0.183	0.00300	0.00500		mg/L	1	05/20/19 03:49 PM
Iron	0.0521	0.0300	0.100	J	mg/L	1	05/20/19 03:49 PM
Lead	0.000543	0.000300	0.00100	J	mg/L	1	05/20/19 03:49 PM
Lithium	0.173	0.00500	0.0100		mg/L	1	05/20/19 03:49 PM
Magnesium	80.5	2.00	6.00		mg/L	20	05/21/19 01:01 PM
Molybdenum	<0.00200	0.00200	0.00500		mg/L	1	05/21/19 02:55 PM
Potassium	2.01	0.100	0.300		mg/L	1	05/20/19 03:49 PM
Selenium	0.00616	0.00200	0.00500		mg/L	1	05/20/19 03:49 PM
Sodium	211	2.00	6.00		mg/L	20	05/21/19 01:01 PM
Thallium	<0.000500	0.000500	0.00150		mg/L	1	05/20/19 03:49 PM
MERCURY TOTAL: AQUEOUS		**SW7470A**					Analyst: **BM**
Mercury	<0.0000800	0.0000800	0.000200		mg/L	1	05/22/19 10:31 AM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	81.8	3.00	10.0		mg/L	10	05/15/19 03:15 PM
Fluoride	0.104	0.100	0.400	J	mg/L	1	05/15/19 06:43 PM
Nitrate-N	0.121	0.100	0.500	J	mg/L	1	05/15/19 06:43 PM
Sulfate	780	10.0	30.0		mg/L	10	05/15/19 03:15 PM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.5	1	05/16/19 04:23 PM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.5	1	05/16/19 04:23 PM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.5	1	05/16/19 04:23 PM
Alkalinity, Total (As CaCO3)	<20.0	20.0	20.0		mg/L @ pH 4.5	1	05/16/19 04:23 PM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	0.0521	0.0500	0.100	JN	mg/L	1	05/24/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	05/20/19 03:56 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *14-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	H-29
Project:	Luminant-MLSES Ash Ponds	**Lab ID:**	1905168-04
Project No:	19122262-C	**Collection Date:**	05/14/19 11:25 AM
Lab Order:	1905168	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **CC**
Phosphorus, Total Orthophosphate (As P)	0.0570	0.0300	0.100	J	mg/L	1	05/15/19 12:49 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	1400	50.0	50.0		mg/L	1	05/17/19 11:40 AM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

CLIENT:	Golder	**Client Sample ID:**	H-28
Project:	Luminant-MLSES Ash Ponds	**Lab ID:**	1905168-05
Project No:	19122262-C	**Collection Date:**	05/14/19 12:30 PM
Lab Order:	1905168	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **RO**
Antimony	<0.000800	0.000800	0.00250		mg/L	1	05/20/19 03:51 PM
Arsenic	<0.00200	0.00200	0.00500		mg/L	1	05/20/19 03:51 PM
Barium	0.0141	0.00300	0.0100		mg/L	1	05/20/19 03:51 PM
Beryllium	0.00281	0.000300	0.00100		mg/L	1	05/20/19 03:51 PM
Boron	8.51	0.200	0.600		mg/L	20	05/21/19 01:03 PM
Cadmium	0.00212	0.000300	0.00100		mg/L	1	05/20/19 03:51 PM
Calcium	99.7	2.00	6.00		mg/L	20	05/21/19 01:03 PM
Chromium	<0.00200	0.00200	0.00500		mg/L	1	05/20/19 03:51 PM
Cobalt	0.187	0.00300	0.00500		mg/L	1	05/20/19 03:51 PM
Iron	0.0715	0.0300	0.100	J	mg/L	1	05/20/19 03:51 PM
Lead	0.000595	0.000300	0.00100	J	mg/L	1	05/20/19 03:51 PM
Lithium	0.172	0.00500	0.0100		mg/L	1	05/20/19 03:51 PM
Magnesium	81.4	2.00	6.00		mg/L	20	05/21/19 01:03 PM
Molybdenum	<0.00200	0.00200	0.00500		mg/L	1	05/21/19 02:57 PM
Potassium	2.06	0.100	0.300		mg/L	1	05/20/19 03:51 PM
Selenium	0.00619	0.00200	0.00500		mg/L	1	05/20/19 03:51 PM
Sodium	210	2.00	6.00		mg/L	20	05/21/19 01:03 PM
Thallium	<0.000500	0.000500	0.00150		mg/L	1	05/20/19 03:51 PM
MERCURY TOTAL: AQUEOUS		**SW7470A**					Analyst: **BM**
Mercury	<0.0000800	0.0000800	0.000200		mg/L	1	05/22/19 10:34 AM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	98.9	3.00	10.0		mg/L	10	05/15/19 03:31 PM
Fluoride	<0.100	0.100	0.400		mg/L	1	05/15/19 06:59 PM
Nitrate-N	<0.100	0.100	0.500		mg/L	1	05/15/19 06:59 PM
Sulfate	935	10.0	30.0		mg/L	10	05/15/19 03:31 PM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.5	1	05/16/19 04:27 PM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.5	1	05/16/19 04:27 PM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.5	1	05/16/19 04:27 PM
Alkalinity, Total (As CaCO3)	<20.0	20.0	20.0		mg/L @ pH 4.5	1	05/16/19 04:27 PM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	0.0715	0.0500	0.100	JN	mg/L	1	05/24/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	05/20/19 03:57 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

CLIENT:	Golder	**Client Sample ID:**	H-28
Project:	Luminant-MLSES Ash Ponds	**Lab ID:**	1905168-05
Project No:	19122262-C	**Collection Date:**	05/14/19 12:30 PM
Lab Order:	1905168	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **CC**
Phosphorus, Total Orthophosphate (As P)	0.0460	0.0300	0.100	J	mg/L	1	05/15/19 12:50 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	1680	50.0	50.0		mg/L	1	05/17/19 11:40 AM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

CLIENT:	Golder	**Client Sample ID:**	H-26
Project:	Luminant-MLSES Ash Ponds	**Lab ID:**	1905168-06
Project No:	19122262-C	**Collection Date:**	05/14/19 02:25 PM
Lab Order:	1905168	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **RO**
Antimony	<0.000800	0.000800	0.00250		mg/L	1	05/20/19 03:53 PM
Arsenic	0.00410	0.00200	0.00500	J	mg/L	1	05/20/19 03:53 PM
Barium	0.190	0.00300	0.0100		mg/L	1	05/20/19 03:53 PM
Beryllium	0.00147	0.000300	0.00100		mg/L	1	05/20/19 03:53 PM
Boron	0.0507	0.0100	0.0300		mg/L	1	05/21/19 02:16 PM
Cadmium	<0.000300	0.000300	0.00100		mg/L	1	05/20/19 03:53 PM
Calcium	85.2	1.00	3.00		mg/L	10	05/21/19 01:05 PM
Chromium	0.0406	0.00200	0.00500		mg/L	1	05/20/19 03:53 PM
Cobalt	0.0795	0.00300	0.00500		mg/L	1	05/20/19 03:53 PM
Iron	8.81	0.0300	0.100		mg/L	1	05/20/19 03:53 PM
Lead	0.000972	0.000300	0.00100	J	mg/L	1	05/20/19 03:53 PM
Lithium	0.147	0.00500	0.0100		mg/L	1	05/20/19 03:53 PM
Magnesium	9.31	0.100	0.300		mg/L	1	05/20/19 03:53 PM
Molybdenum	<0.00200	0.00200	0.00500		mg/L	1	05/21/19 02:16 PM
Potassium	11.6	0.100	0.300		mg/L	1	05/20/19 03:53 PM
Selenium	0.00222	0.00200	0.00500	J	mg/L	1	05/20/19 03:53 PM
Sodium	69.5	1.00	3.00		mg/L	10	05/21/19 01:05 PM
Thallium	<0.000500	0.000500	0.00150		mg/L	1	05/20/19 03:53 PM
MERCURY TOTAL: AQUEOUS		**SW7470A**					Analyst: **BM**
Mercury	<0.0000800	0.0000800	0.000200		mg/L	1	05/22/19 10:36 AM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	61.7	3.00	10.0		mg/L	10	05/15/19 03:47 PM
Fluoride	0.140	0.100	0.400	J	mg/L	1	05/15/19 07:15 PM
Nitrate-N	0.239	0.100	0.500	J	mg/L	1	05/15/19 07:15 PM
Sulfate	88.2	1.00	3.00		mg/L	1	05/15/19 07:15 PM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	157	10.0	20.0		mg/L @ pH 4.51	1	05/16/19 04:42 PM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.51	1	05/16/19 04:42 PM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.51	1	05/16/19 04:42 PM
Alkalinity, Total (As CaCO3)	157	20.0	20.0		mg/L @ pH 4.51	1	05/16/19 04:42 PM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	8.81	0.0500	0.100	N	mg/L	1	05/24/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	05/20/19 03:57 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

CLIENT:	Golder	**Client Sample ID:**	H-26
Project:	Luminant-MLSES Ash Ponds	**Lab ID:**	1905168-06
Project No:	19122262-C	**Collection Date:**	05/14/19 02:25 PM
Lab Order:	1905168	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **CC**
Phosphorus, Total Orthophosphate (As P)	0.0310	0.0300	0.100	J	mg/L	1	05/15/19 12:50 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	453	10.0	10.0		mg/L	1	05/17/19 11:40 AM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

CLIENT:	Golder	**Client Sample ID:**	H-33
Project:	Luminant-MLSES Ash Ponds	**Lab ID:**	1905168-07
Project No:	19122262-C	**Collection Date:**	05/14/19 03:30 PM
Lab Order:	1905168	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **RO**
Antimony	<0.000800	0.000800	0.00250		mg/L	1	05/20/19 03:54 PM
Arsenic	0.00355	0.00200	0.00500	J	mg/L	1	05/20/19 03:54 PM
Barium	0.158	0.00300	0.0100		mg/L	1	05/20/19 03:54 PM
Beryllium	0.00114	0.000300	0.00100		mg/L	1	05/20/19 03:54 PM
Boron	0.0592	0.0100	0.0300		mg/L	1	05/21/19 02:19 PM
Cadmium	<0.000300	0.000300	0.00100		mg/L	1	05/20/19 03:54 PM
Calcium	68.6	1.00	3.00		mg/L	10	05/21/19 01:08 PM
Chromium	0.0342	0.00200	0.00500		mg/L	1	05/20/19 03:54 PM
Cobalt	0.0648	0.00300	0.00500		mg/L	1	05/20/19 03:54 PM
Iron	7.61	0.0300	0.100		mg/L	1	05/20/19 03:54 PM
Lead	0.000772	0.000300	0.00100	J	mg/L	1	05/20/19 03:54 PM
Lithium	0.161	0.00500	0.0100		mg/L	1	05/20/19 03:54 PM
Magnesium	10.6	0.100	0.300		mg/L	1	05/20/19 03:54 PM
Molybdenum	<0.00200	0.00200	0.00500		mg/L	1	05/21/19 02:19 PM
Potassium	13.2	0.100	0.300		mg/L	1	05/20/19 03:54 PM
Selenium	<0.00200	0.00200	0.00500		mg/L	1	05/20/19 03:54 PM
Sodium	79.5	1.00	3.00		mg/L	10	05/21/19 01:08 PM
Thallium	<0.000500	0.000500	0.00150		mg/L	1	05/20/19 03:54 PM
MERCURY TOTAL: AQUEOUS		**SW7470A**					Analyst: **BM**
Mercury	<0.0000800	0.0000800	0.000200		mg/L	1	05/22/19 10:38 AM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	80.4	3.00	10.0		mg/L	10	05/15/19 04:03 PM
Fluoride	0.166	0.100	0.400	J	mg/L	1	05/15/19 07:31 PM
Nitrate-N	0.287	0.100	0.500	J	mg/L	1	05/15/19 07:31 PM
Sulfate	104	10.0	30.0		mg/L	10	05/15/19 04:03 PM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	181	10.0	20.0		mg/L @ pH 4.51	1	05/16/19 04:49 PM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.51	1	05/16/19 04:49 PM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.51	1	05/16/19 04:49 PM
Alkalinity, Total (As CaCO3)	181	20.0	20.0		mg/L @ pH 4.51	1	05/16/19 04:49 PM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	7.61	0.0500	0.100	N	mg/L	1	05/24/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	05/20/19 03:58 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *14-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	H-33
Project:	Luminant-MLSES Ash Ponds	**Lab ID:**	1905168-07
Project No:	19122262-C	**Collection Date:**	05/14/19 03:30 PM
Lab Order:	1905168	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **CC**
Phosphorus, Total Orthophosphate (As P)	0.123	0.0300	0.100		mg/L	1	05/15/19 12:50 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	559	10.0	10.0		mg/L	1	05/17/19 11:40 AM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **CETAC2_HG_190522A**

The QC data in batch 91017 applies to the following samples: 1905168-01B, 1905168-02B, 1905168-03B, 1905168-04B, 1905168-05B, 1905168-06B, 1905168-07B

Sample ID **MB-91017** Batch ID: **91017** TestNo: **SW7470A** Units: **mg/L**
SampType: **MBLK** Run ID: **CETAC2_HG_190522A** Analysis Date: **5/22/2019 10:02:31 AM** Prep Date: **5/21/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	<0.0000800	0.000200								

Sample ID **LCS-91017** Batch ID: **91017** TestNo: **SW7470A** Units: **mg/L**
SampType: **LCS** Run ID: **CETAC2_HG_190522A** Analysis Date: **5/22/2019 10:04:46 AM** Prep Date: **5/21/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00187	0.000200	0.00200	0	93.5	85	115			

Sample ID **LCSD-91017** Batch ID: **91017** TestNo: **SW7470A** Units: **mg/L**
SampType: **LCSD** Run ID: **CETAC2_HG_190522A** Analysis Date: **5/22/2019 10:07:02 AM** Prep Date: **5/21/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00186	0.000200	0.00200	0	93.0	85	115	0.536	15	

Sample ID **1905168-01B MS** Batch ID: **91017** TestNo: **SW7470A** Units: **mg/L**
SampType: **MS** Run ID: **CETAC2_HG_190522A** Analysis Date: **5/22/2019 11:23:23 AM** Prep Date: **5/21/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00196	0.00100	0.00200	0	97.8	80	120			

Sample ID **1905168-01B MSD** Batch ID: **91017** TestNo: **SW7470A** Units: **mg/L**
SampType: **MSD** Run ID: **CETAC2_HG_190522A** Analysis Date: **5/22/2019 11:25:39 AM** Prep Date: **5/21/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00194	0.00100	0.00200	0	97.0	80	120	0.770	15	

Sample ID **1905168-01B SD** Batch ID: **91017** TestNo: **SW7470A** Units: **mg/L**
SampType: **SD** Run ID: **CETAC2_HG_190522A** Analysis Date: **5/22/2019 11:27:56 AM** Prep Date: **5/21/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	<0.00200	0.00500	0	0				0	10	

Sample ID **1905168-01B PDS** Batch ID: **91017** TestNo: **SW7470A** Units: **mg/L**
SampType: **PDS** Run ID: **CETAC2_HG_190522A** Analysis Date: **5/22/2019 11:30:13 AM** Prep Date: **5/21/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.0122	0.00100	0.0125	0	97.6	85	115			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **CETAC2_HG_190522A**

Sample ID **ICV-190522**	Batch ID: **R104223**	TestNo: **SW7470A**	Units: **mg/L**
SampType: **ICV**	Run ID: **CETAC2_HG_190522A**	Analysis Date: **5/22/2019 9:57:56 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00383	0.000200	0.00400	0	95.8	90	110			

Sample ID **CCV1-190522**	Batch ID: **R104223**	TestNo: **SW7470A**	Units: **mg/L**
SampType: **CCV**	Run ID: **CETAC2_HG_190522A**	Analysis Date: **5/22/2019 10:41:04 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00202	0.000200	0.00200	0	101	90	110			

Sample ID **CCV2-190522**	Batch ID: **R104223**	TestNo: **SW7470A**	Units: **mg/L**
SampType: **CCV**	Run ID: **CETAC2_HG_190522A**	Analysis Date: **5/22/2019 11:08:23 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00203	0.000200	0.00200	0	102	90	110			

Sample ID **CCV3-190522**	Batch ID: **R104223**	TestNo: **SW7470A**	Units: **mg/L**
SampType: **CCV**	Run ID: **CETAC2_HG_190522A**	Analysis Date: **5/22/2019 2:51:11 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00203	0.000200	0.00200	0	102	90	110			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **ICP-MS4_190520B**

The QC data in batch 90959 applies to the following samples: 1905168-01B, 1905168-02B, 1905168-03B, 1905168-04B, 1905168-05B, 1905168-06B, 1905168-07B

Sample ID **MB-90959** Batch ID: **90959** TestNo: **SW6020A** Units: **mg/L**
SampType: **MBLK** Run ID: **ICP-MS4_190520B** Analysis Date: **5/20/2019 3:23:00 PM** Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	<0.000800	0.00250								
Arsenic	<0.00200	0.00500								
Barium	<0.00300	0.0100								
Beryllium	<0.000300	0.00100								
Cadmium	<0.000300	0.00100								
Calcium	<0.100	0.300								
Chromium	<0.00200	0.00500								
Cobalt	<0.00300	0.00500								
Iron	<0.0300	0.100								
Lead	<0.000300	0.00100								
Lithium	<0.00500	0.0100								
Magnesium	<0.100	0.300								
Potassium	<0.100	0.300								
Selenium	<0.00200	0.00500								
Sodium	<0.100	0.300								
Thallium	<0.000500	0.00150								

Sample ID **LCS-90959** Batch ID: **90959** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCS** Run ID: **ICP-MS4_190520B** Analysis Date: **5/20/2019 3:27:00 PM** Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.190	0.00250	0.200	0	94.8	80	120			
Arsenic	0.204	0.00500	0.200	0	102	80	120			
Barium	0.190	0.0100	0.200	0	94.9	80	120			
Beryllium	0.211	0.00100	0.200	0	105	80	120			
Cadmium	0.192	0.00100	0.200	0	95.8	80	120			
Calcium	4.65	0.300	5.00	0	93.1	80	120			
Chromium	0.195	0.00500	0.200	0	97.7	80	120			
Cobalt	0.203	0.00500	0.200	0	101	80	120			
Iron	5.14	0.100	5.00	0	103	80	120			
Lead	0.187	0.00100	0.200	0	93.6	80	120			
Lithium	0.217	0.0100	0.200	0	108	80	120			
Magnesium	5.03	0.300	5.00	0	101	80	120			
Potassium	5.02	0.300	5.00	0	100	80	120			
Selenium	0.204	0.00500	0.200	0	102	80	120			
Sodium	5.07	0.300	5.00	0	101	80	120			
Thallium	0.199	0.00150	0.200	0	99.7	80	120			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_190520B

Sample ID **LCSD-90959** Batch ID: **90959** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCSD** Run ID: **ICP-MS4_190520B** Analysis Date: **5/20/2019 3:29:00 PM** Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.195	0.00250	0.200	0	97.7	80	120	2.98	15	
Arsenic	0.201	0.00500	0.200	0	100	80	120	1.34	15	
Barium	0.194	0.0100	0.200	0	97.2	80	120	2.37	15	
Beryllium	0.210	0.00100	0.200	0	105	80	120	0.345	15	
Cadmium	0.198	0.00100	0.200	0	98.8	80	120	3.14	15	
Calcium	4.68	0.300	5.00	0	93.5	80	120	0.492	15	
Chromium	0.198	0.00500	0.200	0	99.1	80	120	1.40	15	
Cobalt	0.200	0.00500	0.200	0	100	80	120	1.46	15	
Iron	5.15	0.100	5.00	0	103	80	120	0.209	15	
Lead	0.190	0.00100	0.200	0	95.0	80	120	1.54	15	
Lithium	0.211	0.0100	0.200	0	106	80	120	2.37	15	
Magnesium	5.15	0.300	5.00	0	103	80	120	2.30	15	
Potassium	5.07	0.300	5.00	0	101	80	120	1.08	15	
Selenium	0.200	0.00500	0.200	0	99.9	80	120	1.96	15	
Sodium	5.10	0.300	5.00	0	102	80	120	0.502	15	
Thallium	0.200	0.00150	0.200	0	100	80	120	0.279	15	

Sample ID **1905178-02C SD** Batch ID: **90959** TestNo: **SW6020A** Units: **mg/L**
SampType: **SD** Run ID: **ICP-MS4_190520B** Analysis Date: **5/20/2019 3:37:00 PM** Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	<0.00400	0.0125	0	0				0	10	
Arsenic	0.0115	0.0250	0	0.0113				1.19	10	
Barium	0.0249	0.0500	0	0.0269				7.62	10	
Beryllium	<0.00150	0.00500	0	0				0	10	
Cadmium	<0.00150	0.00500	0	0				0	10	
Chromium	0.0104	0.0250	0	0.0104				0.596	10	
Cobalt	<0.0150	0.0250	0	0				0	10	
Iron	0.313	0.500	0	0.303				3.55	10	
Lead	<0.00150	0.00500	0	0				0	10	
Lithium	0.0378	0.0500	0	0.0361				4.57	10	
Potassium	1.53	1.50	0	1.52				0.244	10	
Selenium	<0.0100	0.0250	0	0				0	10	
Thallium	<0.00250	0.00750	0	0				0	10	

Sample ID **1905178-02C PDS** Batch ID: **90959** TestNo: **SW6020A** Units: **mg/L**
SampType: **PDS** Run ID: **ICP-MS4_190520B** Analysis Date: **5/20/2019 3:56:00 PM** Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.193	0.00250	0.200	0	96.4	80	120			
Arsenic	0.209	0.00500	0.200	0.0113	98.9	80	120			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_190520B

Sample ID **1905178-02C PDS**	Batch ID: **90959**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **PDS**	Run ID: **ICP-MS4_190520B**	Analysis Date: **5/20/2019 3:56:00 PM**	Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Barium	0.214	0.0100	0.200	0.0269	93.7	80	120			
Beryllium	0.184	0.00100	0.200	0	91.9	80	120			
Cadmium	0.184	0.00100	0.200	0	91.8	80	120			
Chromium	0.198	0.00500	0.200	0.0104	93.6	80	120			
Cobalt	0.193	0.00500	0.200	0	96.5	80	120			
Iron	5.19	0.100	5.00	0.303	97.7	80	120			
Lead	0.185	0.00100	0.200	0	92.4	80	120			
Lithium	0.224	0.0100	0.200	0.0361	93.9	80	120			
Potassium	6.27	0.300	5.00	1.52	94.9	80	120			
Selenium	0.195	0.00500	0.200	0	97.6	80	120			
Thallium	0.203	0.00150	0.200	0	101	80	120			

Sample ID **1905178-02C MS**	Batch ID: **90959**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **MS**	Run ID: **ICP-MS4_190520B**	Analysis Date: **5/20/2019 3:58:00 PM**	Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.197	0.00250	0.200	0	98.3	80	120			
Arsenic	0.217	0.00500	0.200	0.0113	103	80	120			
Barium	0.223	0.0100	0.200	0.0269	97.8	80	120			
Beryllium	0.187	0.00100	0.200	0	93.6	80	120			
Cadmium	0.185	0.00100	0.200	0	92.5	80	120			
Calcium	65.6	0.300	5.00	62.5	62.2	80	120			S
Chromium	0.198	0.00500	0.200	0.0104	93.7	80	120			
Cobalt	0.196	0.00500	0.200	0	98.1	80	120			
Iron	5.25	0.100	5.00	0.303	98.9	80	120			
Lead	0.188	0.00100	0.200	0	93.9	80	120			
Lithium	0.221	0.0100	0.200	0.0361	92.5	80	120			
Magnesium	65.8	0.300	5.00	63.5	45.8	80	120			S
Potassium	6.56	0.300	5.00	1.52	101	80	120			
Selenium	0.204	0.00500	0.200	0	102	80	120			
Sodium	223	0.300	5.00	229	-120	80	120			S
Thallium	0.201	0.00150	0.200	0	100	80	120			

Sample ID **1905178-02C MSD**	Batch ID: **90959**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **MSD**	Run ID: **ICP-MS4_190520B**	Analysis Date: **5/20/2019 4:00:00 PM**	Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.199	0.00250	0.200	0	99.4	80	120	1.06	15	
Arsenic	0.214	0.00500	0.200	0.0113	101	80	120	1.22	15	
Barium	0.228	0.0100	0.200	0.0269	100	80	120	2.27	15	
Beryllium	0.186	0.00100	0.200	0	92.8	80	120	0.831	15	

Qualifiers:				
	B	Analyte detected in the associated Method Blank	DF	Dilution Factor
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
	RL	Reporting Limit	S	Spike Recovery outside control limits
	J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **ICP-MS4_190520B**

Sample ID **1905178-02C MSD**	Batch ID: **90959**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **MSD**	Run ID: **ICP-MS4_190520B**	Analysis Date: **5/20/2019 4:00:00 PM**	Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cadmium	0.188	0.00100	0.200	0	94.1	80	120	1.65	15	
Calcium	65.6	0.300	5.00	62.5	61.4	80	120	0.058	15	S
Chromium	0.197	0.00500	0.200	0.0104	93.2	80	120	0.455	15	
Cobalt	0.195	0.00500	0.200	0	97.6	80	120	0.571	15	
Iron	5.20	0.100	5.00	0.303	97.9	80	120	0.922	15	
Lead	0.186	0.00100	0.200	0	93.1	80	120	0.842	15	
Lithium	0.227	0.0100	0.200	0.0361	95.5	80	120	2.65	15	
Magnesium	66.6	0.300	5.00	63.5	62.8	80	120	1.28	15	S
Potassium	6.53	0.300	5.00	1.52	100	80	120	0.365	15	
Selenium	0.201	0.00500	0.200	0	101	80	120	1.07	15	
Sodium	224	0.300	5.00	229	-105	80	120	0.347	15	S
Thallium	0.205	0.00150	0.200	0	103	80	120	2.13	15	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_190520B

Sample ID **ICV-190520**	Batch ID: **R104182**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **ICV**	Run ID: **ICP-MS4_190520B**	Analysis Date: **5/20/2019 11:23:00 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.0968	0.00250	0.100	0	96.8	90	110			
Arsenic	0.0991	0.00500	0.100	0	99.1	90	110			
Barium	0.0948	0.0100	0.100	0	94.8	90	110			
Beryllium	0.102	0.00100	0.100	0	102	90	110			
Cadmium	0.0974	0.00100	0.100	0	97.4	90	110			
Calcium	2.44	0.300	2.50	0	97.7	90	110			
Chromium	0.102	0.00500	0.100	0	102	90	110			
Cobalt	0.101	0.00500	0.100	0	101	90	110			
Iron	2.61	0.100	2.50	0	104	90	110			
Lead	0.0932	0.00100	0.100	0	93.2	90	110			
Lithium	0.106	0.0100	0.100	0	106	90	110			
Magnesium	2.50	0.300	2.50	0	100	90	110			
Potassium	2.53	0.300	2.50	0	101	90	110			
Selenium	0.0979	0.00500	0.100	0	97.9	90	110			
Sodium	2.59	0.300	2.50	0	104	90	110			
Thallium	0.0911	0.00150	0.100	0	91.1	90	110			

Sample ID **LCVL-190520**	Batch ID: **R104182**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS4_190520B**	Analysis Date: **5/20/2019 11:29:00 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.00176	0.00250	0.00200	0	87.9	70	130			
Arsenic	0.00489	0.00500	0.00500	0	97.7	70	130			
Barium	0.00432	0.0100	0.00500	0	86.5	70	130			
Beryllium	0.000893	0.00100	0.00100	0	89.3	70	130			
Cadmium	0.000871	0.00100	0.00100	0	87.1	70	130			
Calcium	0.0919	0.300	0.100	0	91.9	70	130			
Chromium	0.00481	0.00500	0.00500	0	96.1	70	130			
Cobalt	0.00485	0.00500	0.00500	0	97.0	70	130			
Iron	0.107	0.100	0.100	0	107	70	130			
Lead	0.000831	0.00100	0.00100	0	83.1	70	130			
Lithium	0.0104	0.0100	0.0100	0	104	70	130			
Magnesium	0.0970	0.300	0.100	0	97.0	70	130			
Potassium	0.0964	0.300	0.100	0	96.4	70	130			
Selenium	0.00489	0.00500	0.00500	0	97.8	70	130			
Sodium	0.0958	0.300	0.100	0	95.8	70	130			
Thallium	0.000816	0.00150	0.00100	0	81.6	70	130			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **ICP-MS4_190520B**

Sample ID **CCV5-190520**	Batch ID: **R104182**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **CCV**	Run ID: **ICP-MS4_190520B**	Analysis Date: **5/20/2019 2:53:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.195	0.00250	0.200	0	97.6	90	110			
Arsenic	0.203	0.00500	0.200	0	102	90	110			
Barium	0.193	0.0100	0.200	0	96.5	90	110			
Beryllium	0.202	0.00100	0.200	0	101	90	110			
Cadmium	0.197	0.00100	0.200	0	98.4	90	110			
Calcium	4.64	0.300	5.00	0	92.9	90	110			
Chromium	0.195	0.00500	0.200	0	97.5	90	110			
Cobalt	0.201	0.00500	0.200	0	100	90	110			
Iron	5.06	0.100	5.00	0	101	90	110			
Lead	0.192	0.00100	0.200	0	96.1	90	110			
Lithium	0.206	0.0100	0.200	0	103	90	110			
Magnesium	5.06	0.300	5.00	0	101	90	110			
Potassium	5.03	0.300	5.00	0	101	90	110			
Selenium	0.205	0.00500	0.200	0	102	90	110			
Sodium	5.17	0.300	5.00	0	103	90	110			
Thallium	0.199	0.00150	0.200	0	99.7	90	110			

Sample ID **LCVL5-190520**	Batch ID: **R104182**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS4_190520B**	Analysis Date: **5/20/2019 3:01:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.00174	0.00250	0.00200	0	87.2	70	130			
Arsenic	0.00487	0.00500	0.00500	0	97.5	70	130			
Barium	0.00423	0.0100	0.00500	0	84.6	70	130			
Beryllium	0.00110	0.00100	0.00100	0	110	70	130			
Cadmium	0.000921	0.00100	0.00100	0	92.1	70	130			
Calcium	0.0952	0.300	0.100	0	95.2	70	130			
Chromium	0.00485	0.00500	0.00500	0	97.1	70	130			
Cobalt	0.00489	0.00500	0.00500	0	97.9	70	130			
Iron	0.108	0.100	0.100	0	108	70	130			
Lead	0.000805	0.00100	0.00100	0	80.5	70	130			
Lithium	0.0108	0.0100	0.0100	0	108	70	130			
Magnesium	0.0983	0.300	0.100	0	98.3	70	130			
Potassium	0.0975	0.300	0.100	0	97.5	70	130			
Selenium	0.00517	0.00500	0.00500	0	103	70	130			
Sodium	0.102	0.300	0.100	0	102	70	130			
Thallium	0.000787	0.00150	0.00100	0	78.7	70	130			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **ICP-MS4_190520B**

Sample ID **CCV6-190520**	Batch ID: **R104182**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **CCV**	Run ID: **ICP-MS4_190520B**	Analysis Date: **5/20/2019 4:02:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.194	0.00250	0.200	0	96.9	90	110			
Arsenic	0.205	0.00500	0.200	0	102	90	110			
Barium	0.192	0.0100	0.200	0	96.2	90	110			
Beryllium	0.199	0.00100	0.200	0	99.7	90	110			
Cadmium	0.193	0.00100	0.200	0	96.3	90	110			
Calcium	4.67	0.300	5.00	0	93.4	90	110			
Chromium	0.194	0.00500	0.200	0	96.8	90	110			
Cobalt	0.203	0.00500	0.200	0	101	90	110			
Iron	5.07	0.100	5.00	0	101	90	110			
Lead	0.195	0.00100	0.200	0	97.6	90	110			
Lithium	0.204	0.0100	0.200	0	102	90	110			
Magnesium	5.01	0.300	5.00	0	100	90	110			
Potassium	4.98	0.300	5.00	0	99.6	90	110			
Selenium	0.205	0.00500	0.200	0	103	90	110			
Sodium	5.14	0.300	5.00	0	103	90	110			
Thallium	0.205	0.00150	0.200	0	102	90	110			

Sample ID **LCVL6-190520**	Batch ID: **R104182**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS4_190520B**	Analysis Date: **5/20/2019 4:06:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.00178	0.00250	0.00200	0	89.2	70	130			
Arsenic	0.00492	0.00500	0.00500	0	98.4	70	130			
Barium	0.00435	0.0100	0.00500	0	87.0	70	130			
Beryllium	0.00105	0.00100	0.00100	0	105	70	130			
Cadmium	0.000933	0.00100	0.00100	0	93.3	70	130			
Calcium	0.0988	0.300	0.100	0	98.8	70	130			
Chromium	0.00475	0.00500	0.00500	0	95.0	70	130			
Cobalt	0.00485	0.00500	0.00500	0	97.1	70	130			
Iron	0.107	0.100	0.100	0	107	70	130			
Lead	0.000828	0.00100	0.00100	0	82.8	70	130			
Lithium	0.0104	0.0100	0.0100	0	104	70	130			
Magnesium	0.0986	0.300	0.100	0	98.6	70	130			
Potassium	0.0940	0.300	0.100	0	94.0	70	130			
Selenium	0.00483	0.00500	0.00500	0	96.6	70	130			
Sodium	0.131	0.300	0.100	0	131	70	130			S
Thallium	0.000822	0.00150	0.00100	0	82.2	70	130			

Qualifiers:			
B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

ANALYTICAL QC SUMMARY REPORT

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds
RunID: ICP-MS5_190521A

The QC data in batch 90959 applies to the following samples: 1905168-01B, 1905168-02B, 1905168-03B, 1905168-04B, 1905168-05B, 1905168-06B, 1905168-07B

Sample ID **MB-90959** | Batch ID: **90959** | TestNo: **SW6020A** | Units: **mg/L**
SampType: **MBLK** | Run ID: **ICP-MS5_190521A** | Analysis Date: **5/21/2019 12:36:00 PM** | Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	<0.0100	0.0300								
Molybdenum	<0.00200	0.00500								

Sample ID **LCS-90959** | Batch ID: **90959** | TestNo: **SW6020A** | Units: **mg/L**
SampType: **LCS** | Run ID: **ICP-MS5_190521A** | Analysis Date: **5/21/2019 12:38:00 PM** | Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.201	0.0300	0.200	0	101	80	120			
Molybdenum	0.195	0.00500	0.200	0	97.3	80	120			

Sample ID **LCSD-90959** | Batch ID: **90959** | TestNo: **SW6020A** | Units: **mg/L**
SampType: **LCSD** | Run ID: **ICP-MS5_190521A** | Analysis Date: **5/21/2019 12:41:00 PM** | Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.208	0.0300	0.200	0	104	80	120	3.23	15	
Molybdenum	0.192	0.00500	0.200	0	96.2	80	120	1.18	15	

Sample ID **1905178-02C SD** | Batch ID: **90959** | TestNo: **SW6020A** | Units: **mg/L**
SampType: **SD** | Run ID: **ICP-MS5_190521A** | Analysis Date: **5/21/2019 12:47:00 PM** | Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	<1.00	3.00	0	0.525				0	10	
Calcium	70.4	30.0	0	68.2				3.15	10	
Magnesium	63.5	30.0	0	63.5				0.085	10	
Molybdenum	<0.200	0.500	0	0				0	10	
Sodium	227	30.0	0	233				2.75	10	

Sample ID **1905178-02C PDS** | Batch ID: **90959** | TestNo: **SW6020A** | Units: **mg/L**
SampType: **PDS** | Run ID: **ICP-MS5_190521A** | Analysis Date: **5/21/2019 1:14:00 PM** | Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	4.53	0.600	4.00	0.525	100	80	120			
Calcium	170	6.00	100	68.2	102	80	120			
Magnesium	161	6.00	100	63.5	97.1	80	120			
Molybdenum	3.64	0.100	4.00	0	90.9	80	120			
Sodium	331	6.00	100	233	98.2	80	120			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS5_190521A

Sample ID **1905178-02C MS**	Batch ID: **90959**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **MS**	Run ID: **ICP-MS5_190521A**	Analysis Date: **5/21/2019 1:17:00 PM**	Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.866	0.600	0.200	0.525	170	80	120			S
Molybdenum	0.192	0.100	0.200	0	96.0	80	120			

Sample ID **1905178-02C MSD**	Batch ID: **90959**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **MSD**	Run ID: **ICP-MS5_190521A**	Analysis Date: **5/21/2019 1:19:00 PM**	Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.750	0.600	0.200	0.525	112	80	120	14.3	15	
Molybdenum	0.189	0.100	0.200	0	94.3	80	120	1.76	15	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS5_190521A

Sample ID **ICV-190521**	Batch ID: **R104204**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **ICV**	Run ID: **ICP-MS5_190521A**	Analysis Date: **5/21/2019 12:10:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.103	0.0300	0.100	0	103	90	110			
Calcium	2.52	0.300	2.50	0	101	90	110			
Iron	2.60	0.100	2.50	0	104	90	110			
Magnesium	2.49	0.300	2.50	0	99.7	90	110			
Molybdenum	0.0930	0.00500	0.100	0	93.0	90	110			
Sodium	2.56	0.300	2.50	0	103	90	110			

Sample ID **LCVL-190521**	Batch ID: **R104204**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS5_190521A**	Analysis Date: **5/21/2019 12:15:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.0223	0.0300	0.0200	0	111	70	130			
Calcium	0.104	0.300	0.100	0	104	70	130			
Iron	0.0979	0.100	0.100	0	97.9	70	130			
Magnesium	0.0983	0.300	0.100	0	98.3	70	130			
Molybdenum	0.00464	0.00500	0.00500	0	92.8	70	130			
Sodium	0.0960	0.300	0.100	0	96.0	70	130			

Sample ID **CCV1-190521**	Batch ID: **R104204**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **CCV**	Run ID: **ICP-MS5_190521A**	Analysis Date: **5/21/2019 1:26:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.196	0.0300	0.200	0	98.1	90	110			
Calcium	4.90	0.300	5.00	0	98.0	90	110			
Iron	5.04	0.100	5.00	0	101	90	110			
Magnesium	4.94	0.300	5.00	0	98.8	90	110			
Molybdenum	0.193	0.00500	0.200	0	96.3	90	110			
Sodium	4.93	0.300	5.00	0	98.6	90	110			

Sample ID **LCVL1-190521**	Batch ID: **R104204**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS5_190521A**	Analysis Date: **5/21/2019 1:30:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.0245	0.0300	0.0200	0	123	70	130			
Calcium	0.0976	0.300	0.100	0	97.6	70	130			
Iron	0.0980	0.100	0.100	0	98.0	70	130			
Magnesium	0.0940	0.300	0.100	0	94.0	70	130			
Molybdenum	0.00478	0.00500	0.00500	0	95.6	70	130			
Sodium	0.0986	0.300	0.100	0	98.6	70	130			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS5_190521A

Sample ID **CCV2-190521** Batch ID: **R104204** TestNo: **SW6020A** Units: **mg/L**
SampType: **CCV** Run ID: **ICP-MS5_190521A** Analysis Date: **5/21/2019 2:05:00 PM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.208	0.0300	0.200	0	104	90	110			
Molybdenum	0.201	0.00500	0.200	0	101	90	110			

Sample ID **LCVL2-190521** Batch ID: **R104204** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCVL** Run ID: **ICP-MS5_190521A** Analysis Date: **5/21/2019 2:09:00 PM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.0258	0.0300	0.0200	0	129	70	130			
Molybdenum	0.00474	0.00500	0.00500	0	94.7	70	130			

Sample ID **CCV3-190521** Batch ID: **R104204** TestNo: **SW6020A** Units: **mg/L**
SampType: **CCV** Run ID: **ICP-MS5_190521A** Analysis Date: **5/21/2019 2:34:00 PM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.199	0.0300	0.200	0	99.5	90	110			
Molybdenum	0.199	0.00500	0.200	0	99.7	90	110			

Sample ID **LCVL3-190521** Batch ID: **R104204** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCVL** Run ID: **ICP-MS5_190521A** Analysis Date: **5/21/2019 2:46:00 PM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.0227	0.0300	0.0200	0	113	70	130			
Molybdenum	0.00484	0.00500	0.00500	0	96.8	70	130			

Sample ID **CCV4-190521** Batch ID: **R104204** TestNo: **SW6020A** Units: **mg/L**
SampType: **CCV** Run ID: **ICP-MS5_190521A** Analysis Date: **5/21/2019 3:00:00 PM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Molybdenum	0.199	0.00500	0.200	0	99.7	90	110			

Sample ID **LCVL4-190521** Batch ID: **R104204** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCVL** Run ID: **ICP-MS5_190521A** Analysis Date: **5/21/2019 3:05:00 PM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Molybdenum	0.00483	0.00500	0.00500	0	96.6	70	130			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: IC2_190515A

The QC data in batch 90908 applies to the following samples: 1905168-01C, 1905168-02C, 1905168-03C, 1905168-04C, 1905168-05C, 1905168-06C, 1905168-07C

Sample ID **MB-90908** Batch ID: **90908** TestNo: **E300** Units: **mg/L**
SampType: **MBLK** Run ID: **IC2_190515A** Analysis Date: **5/15/2019 10:10:50 AM** Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	<0.300	1.00								
Fluoride	<0.100	0.400								
Nitrate-N	<0.100	0.500								
Sulfate	<1.00	3.00								

Sample ID **LCS-90908** Batch ID: **90908** TestNo: **E300** Units: **mg/L**
SampType: **LCS** Run ID: **IC2_190515A** Analysis Date: **5/15/2019 10:26:50 AM** Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	10.1	1.00	10.00	0	101	90	110			
Fluoride	4.00	0.400	4.000	0	99.9	90	110			
Nitrate-N	5.09	0.500	5.000	0	102	90	110			
Sulfate	30.4	3.00	30.00	0	101	90	110			

Sample ID **LCSD-90908** Batch ID: **90908** TestNo: **E300** Units: **mg/L**
SampType: **LCSD** Run ID: **IC2_190515A** Analysis Date: **5/15/2019 10:42:50 AM** Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	10.2	1.00	10.00	0	102	90	110	0.674	20	
Fluoride	4.05	0.400	4.000	0	101	90	110	1.26	20	
Nitrate-N	5.08	0.500	5.000	0	102	90	110	0.146	20	
Sulfate	30.9	3.00	30.00	0	103	90	110	1.55	20	

Sample ID **1905167-01CMS** Batch ID: **90908** TestNo: **E300** Units: **mg/L**
SampType: **MS** Run ID: **IC2_190515A** Analysis Date: **5/15/2019 1:07:36 PM** Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	222	10.0	200.0	12.69	105	90	110			
Fluoride	211	4.00	200.0	0	106	90	110			
Nitrate-N	45.6	5.00	45.16	0	101	90	110			
Sulfate	239	30.0	200.0	41.32	98.7	90	110			

Sample ID **1905167-01CMSD** Batch ID: **90908** TestNo: **E300** Units: **mg/L**
SampType: **MSD** Run ID: **IC2_190515A** Analysis Date: **5/15/2019 1:23:36 PM** Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	221	10.0	200.0	12.69	104	90	110	0.308	20	
Fluoride	210	4.00	200.0	0	105	90	110	0.286	20	
Nitrate-N	45.8	5.00	45.16	0	101	90	110	0.495	20	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT:	Golder		
Work Order:	1905168		
Project:	Luminant-MLSES Ash Ponds	**RunID:**	**IC2_190515A**

ANALYTICAL QC SUMMARY REPORT

Sample ID **1905167-01CMSD**	Batch ID: **90908**	TestNo: **E300**	Units: **mg/L**
SampType: **MSD**	Run ID: **IC2_190515A**	Analysis Date: **5/15/2019 1:23:36 PM**	Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	237	30.0	200.0	41.32	97.7	90	110	0.821	20	

Sample ID **1905167-02CMS**	Batch ID: **90908**	TestNo: **E300**	Units: **mg/L**
SampType: **MS**	Run ID: **IC2_190515A**	Analysis Date: **5/15/2019 1:55:36 PM**	Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	686	10.0	200.0	528.8	78.8	90	110			S
Fluoride	229	4.00	200.0	24.26	102	90	110			
Nitrate-N	56.2	5.00	45.16	10.55	101	90	110			
Sulfate	2520	30.0	200.0	0	1260	90	110			S

Sample ID **1905167-02CMSD**	Batch ID: **90908**	TestNo: **E300**	Units: **mg/L**
SampType: **MSD**	Run ID: **IC2_190515A**	Analysis Date: **5/15/2019 2:11:36 PM**	Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	688	10.0	200.0	528.8	79.8	90	110	0.292	20	S
Fluoride	229	4.00	200.0	24.26	102	90	110	0.251	20	
Nitrate-N	57.3	5.00	45.16	10.55	103	90	110	1.85	20	
Sulfate	<10.0	30.0	200.0	0	0	90	110	0	20	S

Qualifiers:				
	B	Analyte detected in the associated Method Blank	DF	Dilution Factor
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
	RL	Reporting Limit	S	Spike Recovery outside control limits
	J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT:	Golder		
Work Order:	1905168		
Project:	Luminant-MLSES Ash Ponds	**RunID:**	IC2_190515A

ANALYTICAL QC SUMMARY REPORT

Sample ID **ICV-190515** Batch ID: **R104097** TestNo: **E300** Units: **mg/L**

SampType: **ICV** Run ID: **IC2_190515A** Analysis Date: **5/15/2019 9:38:50 AM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	25.8	1.00	25.00	0	103	90	110			
Fluoride	10.3	0.400	10.00	0	103	90	110			
Nitrate-N	13.0	0.500	12.50	0	104	90	110			
Sulfate	77.8	3.00	75.00	0	104	90	110			

Sample ID **CCV1-190515** Batch ID: **R104097** TestNo: **E300** Units: **mg/L**

SampType: **CCV** Run ID: **IC2_190515A** Analysis Date: **5/15/2019 4:51:36 PM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	10.4	1.00	10.00	0	104	90	110			
Fluoride	4.15	0.400	4.000	0	104	90	110			
Nitrate-N	5.13	0.500	5.000	0	103	90	110			
Sulfate	30.8	3.00	30.00	0	103	90	110			

Sample ID **CCV2-190515** Batch ID: **R104097** TestNo: **E300** Units: **mg/L**

SampType: **CCV** Run ID: **IC2_190515A** Analysis Date: **5/15/2019 8:35:35 PM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	10.6	1.00	10.00	0	106	90	110			
Fluoride	4.20	0.400	4.000	0	105	90	110			
Nitrate-N	5.20	0.500	5.000	0	104	90	110			
Sulfate	31.5	3.00	30.00	0	105	90	110			

Qualifiers:				
B	Analyte detected in the associated Method Blank	DF	Dilution Factor	
J	Analyte detected between MDL and RL	MDL	Method Detection Limit	
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits	
RL	Reporting Limit	S	Spike Recovery outside control limits	
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified	

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **IC4_190516A**

The QC data in batch 90935 applies to the following samples: 1905168-01C

Sample ID **MB-90935** | Batch ID: **90935** | TestNo: **E300** | Units: **mg/L**
SampType: **MBLK** | Run ID: **IC4_190516A** | Analysis Date: **5/16/2019 10:26:21 AM** | Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	<1.00	3.00								

Sample ID **LCS-90935** | Batch ID: **90935** | TestNo: **E300** | Units: **mg/L**
SampType: **LCS** | Run ID: **IC4_190516A** | Analysis Date: **5/16/2019 10:42:21 AM** | Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	29.5	3.00	30.00	0	98.3	90	110			

Sample ID **LCSD-90935** | Batch ID: **90935** | TestNo: **E300** | Units: **mg/L**
SampType: **LCSD** | Run ID: **IC4_190516A** | Analysis Date: **5/16/2019 10:58:21 AM** | Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	29.8	3.00	30.00	0	99.2	90	110	0.935	20	

Sample ID **1905167-02CMS** | Batch ID: **90935** | TestNo: **E300** | Units: **mg/L**
SampType: **MS** | Run ID: **IC4_190516A** | Analysis Date: **5/16/2019 5:10:27 PM** | Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	4830	300	2000	2897	96.9	90	110			

Sample ID **1905167-02CMSD** | Batch ID: **90935** | TestNo: **E300** | Units: **mg/L**
SampType: **MSD** | Run ID: **IC4_190516A** | Analysis Date: **5/16/2019 5:26:27 PM** | Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	4880	300	2000	2897	99.1	90	110	0.920	20	

Sample ID **1905168-01CMS** | Batch ID: **90935** | TestNo: **E300** | Units: **mg/L**
SampType: **MS** | Run ID: **IC4_190516A** | Analysis Date: **5/16/2019 5:58:26 PM** | Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	4380	300	2000	2468	95.6	90	110			

Sample ID **1905168-01CMSD** | Batch ID: **90935** | TestNo: **E300** | Units: **mg/L**
SampType: **MSD** | Run ID: **IC4_190516A** | Analysis Date: **5/16/2019 6:14:27 PM** | Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	4390	300	2000	2468	96.2	90	110	0.273	20	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **IC4_190516A**

Sample ID **ICV-190516**	Batch ID: **R104119**	TestNo: **E300**	Units: **mg/L**
SampType: **ICV**	Run ID: **IC4_190516A**	Analysis Date: **5/16/2019 9:54:21 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	74.5	3.00	75.00	0	99.4	90	110			

Sample ID **CCV1-190516**	Batch ID: **R104119**	TestNo: **E300**	Units: **mg/L**
SampType: **CCV**	Run ID: **IC4_190516A**	Analysis Date: **5/16/2019 9:10:26 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	30.2	3.00	30.00	0	101	90	110			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **TITRATOR_190516A**

The QC data in batch 90940 applies to the following samples: 1905168-01C, 1905168-02C, 1905168-03C, 1905168-04C, 1905168-05C, 1905168-06C, 1905168-07C

Sample ID **MB-90940** | Batch ID: **90940** | TestNo: **M2320 B** | Units: **mg/L @ pH 4.47**
SampType: **MBLK** | Run ID: **TITRATOR_190516A** | Analysis Date: **5/16/2019 2:00:00 PM** | Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	<10.0	20.0								
Alkalinity, Carbonate (As CaCO3)	<10.0	20.0								
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0								
Alkalinity, Total (As CaCO3)	<20.0	20.0								

Sample ID **LCS-90940** | Batch ID: **90940** | TestNo: **M2320 B** | Units: **mg/L @ pH 4.08**
SampType: **LCS** | Run ID: **TITRATOR_190516A** | Analysis Date: **5/16/2019 2:04:00 PM** | Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Total (As CaCO3)	52.3	20.0	50.00	0	105	74	129			

Sample ID **1905134-01C DUP** | Batch ID: **90940** | TestNo: **M2320 B** | Units: **mg/L @ pH 4.52**
SampType: **DUP** | Run ID: **TITRATOR_190516A** | Analysis Date: **5/16/2019 2:15:00 PM** | Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	205	20.0	0	205.8				0.536	20	
Alkalinity, Carbonate (As CaCO3)	<10.0	20.0	0	0				0	20	
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0	0	0				0	20	
Alkalinity, Total (As CaCO3)	205	20.0	0	205.8				0.536	20	

Sample ID **1905168-05C DUP** | Batch ID: **90940** | TestNo: **M2320 B** | Units: **mg/L @ pH 4.51**
SampType: **DUP** | Run ID: **TITRATOR_190516A** | Analysis Date: **5/16/2019 4:30:00 PM** | Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	<10.0	20.0	0	0				0	20	
Alkalinity, Carbonate (As CaCO3)	<10.0	20.0	0	0				0	20	
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0	0	0				0	20	
Alkalinity, Total (As CaCO3)	<20.0	20.0	0	0				0	20	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **TITRATOR_190516A**

Sample ID **ICV-190516**	Batch ID: **R104124**	TestNo: **M2320 B**	Units: **mg/L @ pH 4.34**
SampType: **ICV**	Run ID: **TITRATOR_190516A**	Analysis Date: **5/16/2019 1:58:00 PM**	Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	8.64	20.0	0							
Alkalinity, Carbonate (As CaCO3)	89.3	20.0	0							
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0	0							
Alkalinity, Total (As CaCO3)	97.9	20.0	100.0	0	97.9	98	102			

Sample ID **CCV1-190516**	Batch ID: **R104124**	TestNo: **M2320 B**	Units: **mg/L @ pH 4.25**
SampType: **CCV**	Run ID: **TITRATOR_190516A**	Analysis Date: **5/16/2019 3:39:00 PM**	Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	21.7	20.0	0							
Alkalinity, Carbonate (As CaCO3)	76.8	20.0	0							
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0	0							
Alkalinity, Total (As CaCO3)	98.5	20.0	100.0	0	98.5	90	110			

Sample ID **CCV2-190516**	Batch ID: **R104124**	TestNo: **M2320 B**	Units: **mg/L @ pH 4.21**
SampType: **CCV**	Run ID: **TITRATOR_190516A**	Analysis Date: **5/16/2019 4:35:00 PM**	Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	17.7	20.0	0							
Alkalinity, Carbonate (As CaCO3)	81.3	20.0	0							
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0	0							
Alkalinity, Total (As CaCO3)	99.0	20.0	100.0	0	99.0	90	110			

Sample ID **CCV3-190516**	Batch ID: **R104124**	TestNo: **M2320 B**	Units: **mg/L @ pH 4.39**
SampType: **CCV**	Run ID: **TITRATOR_190516A**	Analysis Date: **5/16/2019 4:54:00 PM**	Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	20.3	20.0	0							
Alkalinity, Carbonate (As CaCO3)	77.1	20.0	0							
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0	0							
Alkalinity, Total (As CaCO3)	97.4	20.0	100.0	0	97.4	90	110			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: UV/VIS_2_190515B

The QC data in batch 90921 applies to the following samples: 1905168-01C, 1905168-02C, 1905168-03C, 1905168-04C, 1905168-05C, 1905168-06C, 1905168-07C

Sample ID **MB-90921** Batch ID: **90921** TestNo: **M4500-P E** Units: **mg/L**
SampType: **MBLK** Run ID: **UV/VIS_2_190515B** Analysis Date: **5/15/2019 12:42:00 PM** Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	<0.0300	0.100								

Sample ID **LCS-90921** Batch ID: **90921** TestNo: **M4500-P E** Units: **mg/L**
SampType: **LCS** Run ID: **UV/VIS_2_190515B** Analysis Date: **5/15/2019 12:43:00 PM** Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.513	0.100	0.5000	0	103	80	120			

Sample ID **LCSD-90921** Batch ID: **90921** TestNo: **M4500-P E** Units: **mg/L**
SampType: **LCSD** Run ID: **UV/VIS_2_190515B** Analysis Date: **5/15/2019 12:43:00 PM** Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.504	0.100	0.5000	0	101	80	120	1.77	15	

Sample ID **1905168-01CMS** Batch ID: **90921** TestNo: **M4500-P E** Units: **mg/L**
SampType: **MS** Run ID: **UV/VIS_2_190515B** Analysis Date: **5/15/2019 12:45:00 PM** Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.587	0.100	0.5000	0.07700	102	80	120			

Sample ID **1905168-01CMSD** Batch ID: **90921** TestNo: **M4500-P E** Units: **mg/L**
SampType: **MSD** Run ID: **UV/VIS_2_190515B** Analysis Date: **5/15/2019 12:45:00 PM** Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.525	0.100	0.5000	0.07700	89.6	80	120	11.2	15	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: UV/VIS_2_190515B

Sample ID **ICV-190515**	Batch ID: **R104071**	TestNo: **M4500-P E**	Units: **mg/L**
SampType: **ICV**	Run ID: **UV/VIS_2_190515B**	Analysis Date: **5/15/2019 12:41:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.204	0.100	0.2000	0	102	85	115			

Sample ID **CCV1-190515**	Batch ID: **R104071**	TestNo: **M4500-P E**	Units: **mg/L**
SampType: **CCV**	Run ID: **UV/VIS_2_190515B**	Analysis Date: **5/15/2019 12:51:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.509	0.100	0.5000	0	102	85	115			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: UV/VIS_2_190520A

The QC data in batch 91002 applies to the following samples: 1905168-01A, 1905168-02A, 1905168-03A, 1905168-04A, 1905168-05A, 1905168-06A, 1905168-07A

Sample ID **MB-91002** Batch ID: **91002** TestNo: **M3500-Fe D** Units: **mg/L**
SampType: **MBLK** Run ID: **UV/VIS_2_190520A** Analysis Date: **5/20/2019 3:53:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	<0.0500	0.100								N

Sample ID **LCS-91002** Batch ID: **91002** TestNo: **M3500-Fe D** Units: **mg/L**
SampType: **LCS** Run ID: **UV/VIS_2_190520A** Analysis Date: **5/20/2019 3:53:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.0888	0.100	0.1000	0	88.8	85	115			N

Sample ID **LCSD-91002** Batch ID: **91002** TestNo: **M3500-Fe D** Units: **mg/L**
SampType: **LCSD** Run ID: **UV/VIS_2_190520A** Analysis Date: **5/20/2019 3:53:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.0879	0.100	0.1000	0	87.9	85	115	1.05	15	N

Sample ID **1905185-11AMS** Batch ID: **91002** TestNo: **M3500-Fe D** Units: **mg/L**
SampType: **MS** Run ID: **UV/VIS_2_190520A** Analysis Date: **5/20/2019 4:03:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.0860	0.100	0.1000	0	86.0	85	115			N

Sample ID **1905185-11AMSD** Batch ID: **91002** TestNo: **M3500-Fe D** Units: **mg/L**
SampType: **MSD** Run ID: **UV/VIS_2_190520A** Analysis Date: **5/20/2019 4:03:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.0861	0.100	0.1000	0	86.1	85	115	0.116	15	N

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **UV/VIS_2_190520A**

Sample ID **ICV-190520**	Batch ID: **R104177**	TestNo: **M3500-Fe D**	Units: **mg/L**
SampType: **ICV**	Run ID: **UV/VIS_2_190520A**	Analysis Date: **5/20/2019 3:52:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.0875	0.100	0.1000	0	87.5	85	115			N

Sample ID **CCV1-190520**	Batch ID: **R104177**	TestNo: **M3500-Fe D**	Units: **mg/L**
SampType: **CCV**	Run ID: **UV/VIS_2_190520A**	Analysis Date: **5/20/2019 3:59:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.197	0.100	0.2000	0	98.4	85	115			N

Sample ID **CCV2-190520**	Batch ID: **R104177**	TestNo: **M3500-Fe D**	Units: **mg/L**
SampType: **CCV**	Run ID: **UV/VIS_2_190520A**	Analysis Date: **5/20/2019 4:12:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.183	0.100	0.2000	0	91.7	85	115			N

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905168
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **WC_190517D**

The QC data in batch 90953 applies to the following samples: 1905168-01C, 1905168-02C, 1905168-03C, 1905168-04C, 1905168-05C, 1905168-06C, 1905168-07C

Sample ID **MB-90953** Batch ID: **90953** TestNo: **M2540C** Units: **mg/L**
SampType: **MBLK** Run ID: **WC_190517D** Analysis Date: **5/17/2019 11:40:00 AM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids (Residue, Filtera	<10.0	10.0								

Sample ID **LCS-90953** Batch ID: **90953** TestNo: **M2540C** Units: **mg/L**
SampType: **LCS** Run ID: **WC_190517D** Analysis Date: **5/17/2019 11:40:00 AM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids (Residue, Filtera	745	10.0	745.6	0	99.9	90	113			

Sample ID **1905167-02C-DUP** Batch ID: **90953** TestNo: **M2540C** Units: **mg/L**
SampType: **DUP** Run ID: **WC_190517D** Analysis Date: **5/17/2019 11:40:00 AM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids (Residue, Filtera	5340	50.0	0	5375				0.747	5	

Sample ID **1905168-02C-DUP** Batch ID: **90953** TestNo: **M2540C** Units: **mg/L**
SampType: **DUP** Run ID: **WC_190517D** Analysis Date: **5/17/2019 11:40:00 AM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids (Residue, Filtera	940	50.0	0	910.0				3.24	5	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

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ANALYTICAL REPORT

June 10, 2019

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

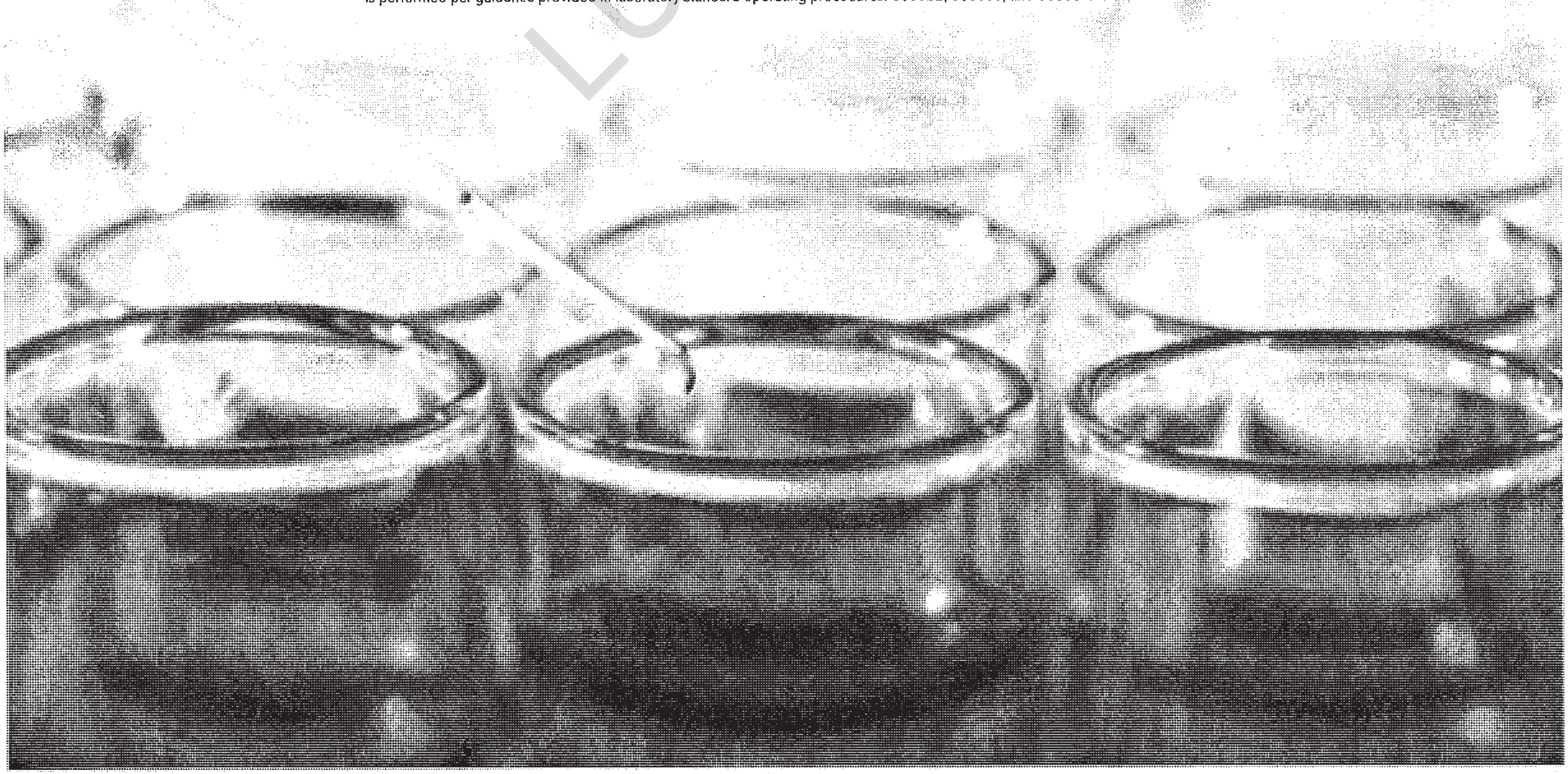
DHL Analytical, Inc.

Sample Delivery Group:	L1100989
Samples Received:	05/21/2019
Project Number:	1905168
Description:	
Report To:	John DuPont 2300 Double Creek Drive Round Rock, TX 78664

Entire Report Reviewed By: DEidson

Donna Eidson
Project Manager

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by Pace National is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.



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H-31 L1100989-01 Non-Potable Water

Collected by | Collected date/time 05/14/19 07:40 | Received date/time 05/21/19 10:10

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 904	WG1285651	1	05/24/19 09:05	05/31/19 11:10	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1287234	1	05/29/19 08:27	06/03/19 17:48	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1287234	1	05/29/19 08:27	06/03/19 17:48	RGT	Mt. Juliet, TN

H-32 L1100989-02 Non-Potable Water

Collected by | Collected date/time 05/14/19 08:25 | Received date/time 05/21/19 10:10

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 904	WG1285651	1	05/24/19 09:05	05/31/19 11:10	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1287234	1	05/29/19 08:27	06/03/19 17:48	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1287234	1	05/29/19 08:27	06/03/19 17:48	RGT	Mt. Juliet, TN

H-27 L1100989-03 Non-Potable Water

Collected by | Collected date/time 05/14/19 09:40 | Received date/time 05/21/19 10:10

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 904	WG1285651	1	05/24/19 09:05	05/31/19 11:10	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1287234	1	05/29/19 08:27	06/03/19 17:48	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1287234	1	05/29/19 08:27	06/03/19 17:48	RGT	Mt. Juliet, TN

H-29 L1100989-04 Non-Potable Water

Collected by | Collected date/time 05/14/19 11:25 | Received date/time 05/21/19 10:10

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 904	WG1285651	1	05/24/19 09:05	05/31/19 11:10	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1287234	1	05/29/19 08:27	06/03/19 17:48	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1287234	1	05/29/19 08:27	06/03/19 17:48	RGT	Mt. Juliet, TN

H-28 L1100989-05 Non-Potable Water

Collected by | Collected date/time 05/14/19 12:30 | Received date/time 05/21/19 10:10

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 904	WG1285651	1	05/24/19 09:05	05/31/19 11:10	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1287234	1	05/29/19 08:27	06/03/19 17:48	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1287234	1	05/29/19 08:27	06/03/19 17:48	RGT	Mt. Juliet, TN

H-26 L1100989-06 Non-Potable Water

Collected by | Collected date/time 05/14/19 14:25 | Received date/time 05/21/19 10:10

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 904	WG1285651	1	05/24/19 09:05	05/31/19 11:10	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1287234	1	05/29/19 08:27	06/03/19 17:48	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1287234	1	05/29/19 08:27	06/03/19 17:48	RGT	Mt. Juliet, TN

H-33 L1100989-07 Non-Potable Water			Collected by	Collected date/time	Received date/time	
				05/14/19 15:30	05/21/19 10:10	

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 904	WG1285651	1	05/24/19 09:05	05/31/19 11:10	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1287234	1	05/29/19 08:27	06/03/19 17:48	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1287234	1	05/29/19 08:27	06/03/19 17:48	RGT	Mt. Juliet, TN

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. Where applicable, all MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

D Eidson

Donna Eidson
Project Manager

Radiochemistry by Method 904

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.531		0.515	0.789	05/31/2019 11:10	WG1285651
(T) Barium	*120*			*62.0-143*	*05/31/2019 11:10*	WG1285651
(T) Yttrium	*93.0*			*79.0-136*	*05/31/2019 11:10*	WG1285651

Radiochemistry by Method Calculation

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
Combined Radium	3.15		1.09	0.978	06/03/2019 17:48	WG1287234

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-226	2.62		0.578	0.189	06/03/2019 17:48	WG1287234
(T) Barium-133	*104*			*30.0-143*	*06/03/2019 17:48*	WG1287234

Radiochemistry by Method 904

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.147		0.380	0.546	05/31/2019 11:10	WG1285651
(T) Barium	*100*			*62.0-143*	*05/31/2019 11:10*	WG1285651
(T) Yttrium	*109*			*79.0-136*	*05/31/2019 11:10*	WG1285651

Radiochemistry by Method Calculation

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
Combined Radium	0.450		0.625	0.833	06/03/2019 17:48	WG1287234

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-226	0.303		0.245	0.287	06/03/2019 17:48	WG1287234
(T) Barium-133	*105*			*30.0-143*	*06/03/2019 17:48*	WG1287234

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Radiochemistry by Method 904

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.928		0.365	0.563	05/31/2019 11:10	WG1285651
(T) Barium	*96.7*			*62.0-143*	*05/31/2019 11:10*	WG1285651
(T) Yttrium	*98.1*			*79.0-136*	*05/31/2019 11:10*	WG1285651

Radiochemistry by Method Calculation

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
Combined Radium	2.03		0.814	0.854	06/03/2019 17:48	WG1287234

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-226	1.10		0.449	0.291	06/03/2019 17:48	WG1287234
(T) Barium-133	*85.4*			*30.0-143*	*06/03/2019 17:48*	WG1287234

Radiochemistry by Method 904

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.352		0.428	0.707	05/31/2019 11:10	WG1285651
(T) Barium	*116*			*62.0-143*	*05/31/2019 11:10*	WG1285651
(T) Yttrium	*96.5*			*79.0-136*	*05/31/2019 11:10*	WG1285651

Radiochemistry by Method Calculation

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
Combined Radium	0.474		0.641	1.05	06/03/2019 17:48	WG1287234

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-226	0.122		0.213	0.339	06/03/2019 17:48	WG1287234
(T) Barium-133	*72.2*			*30.0-143*	*06/03/2019 17:48*	WG1287234

Radiochemistry by Method 904

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.615		0.370	0.575	05/31/2019 11:10	WG1285651
(T) Barium	*106*			*62.0-143*	*05/31/2019 11:10*	WG1285651
(T) Yttrium	*95.5*			*79.0-136*	*05/31/2019 11:10*	WG1285651

Radiochemistry by Method Calculation

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
Combined Radium	1.06		0.634	0.777	06/03/2019 17:48	WG1287234

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-226	0.444		0.264	0.202	06/03/2019 17:48	WG1287234
(T) Barium-133	*90.7*			*30.0-143*	*06/03/2019 17:48*	WG1287234

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Radiochemistry by Method 904

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.598		0.330	0.545	05/31/2019 11:10	WG1285651
(T) Barium	*98.4*			*62.0-143*	*05/31/2019 11:10*	WG1285651
(T) Yttrium	*113*			*79.0-136*	*05/31/2019 11:10*	WG1285651

Radiochemistry by Method Calculation

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
Combined Radium	2.03		0.761	0.783	06/03/2019 17:48	WG1287234

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-226	1.43		0.431	0.238	06/03/2019 17:48	WG1287234
(T) Barium-133	*103*			*30.0-143*	*06/03/2019 17:48*	WG1287234

Radiochemistry by Method 904

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	1.35		0.414	0.627	05/31/2019 11:10	WG1285651
(T) Barium	*97.4*			*62.0-143*	*05/31/2019 11:10*	WG1285651
(T) Yttrium	*96.3*			*79.0-136*	*05/31/2019 11:10*	WG1285651

Radiochemistry by Method Calculation

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
Combined Radium	2.20		0.764	0.846	06/03/2019 17:48	WG1287234

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-226	0.850		0.350	0.219	06/03/2019 17:48	WG1287234
(T) Barium-133	*102*			*30.0-143*	*06/03/2019 17:48*	WG1287234

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Method Blank (MB)

(MB) R3417363-1 05/30/19 12:10

Analyte	MB Result pCi/l	MB Qualifier	MB MDA pCi/l
Radium-228	-0.0581		0.396
(T) Barium	*105*		
(T) Yttrium	*110*		

L1100977-01 Original Sample (OS) • Duplicate (DUP)

(OS) L1100977-01 05/30/19 12:10 • (DUP) R3417363-5 05/30/19 12:10

Analyte	Original Result pCi/l	DUP Result pCi/l	Dilution	DUP RPD %	DUP RER	DUP Qualifier	DUP RPD Limits %	DUP RER Limit
Radium-228	-0.0695	0.650	1	200	0.741		20	3
(T) Barium	*109*	*111*						
(T) Yttrium	*113*	*107*						

Laboratory Control Sample (LCS)

(LCS) R3417363-2 05/30/19 12:10

Analyte	Spike Amount pCi/l	LCS Result pCi/l	LCS Rec. %	Rec. Limits %	LCS Qualifier
Radium-228	5.00	5.29	106	80.0-120	
(T) Barium			*104*		
(T) Yttrium			*114*		

L1100989-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1100989-01 05/31/19 11:10 • (MS) R3417363-3 05/30/19 12:10 • (MSD) R3417363-4 05/30/19 12:10

Analyte	Spike Amount pCi/l	Original Result pCi/l	MS Result pCi/l	MSD Result pCi/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	MS RER	RPD Limits %
Radium-228	20.0	0.531	20.9	19.5	102	94.8	1	70.0-130			7.08		20
(T) Barium		*120*			*102*	*115*							
(T) Yttrium		*93.0*			*117*	*114*							

Method Blank (MB)

(MB) R3419580-1 06/03/19 17:43

Analyte	MB Result pCi/l	MB Qualifier	MB MDA pCi/l
Radium-226	0.00994		0.0573
(T) Barium-133	*67.4*		

L1103100-01 Original Sample (OS) • Duplicate (DUP)

(OS) L1103100-01 06/03/19 17:43 • (DUP) R3419580-7 06/03/19 17:43

Analyte	Original Result pCi/l	DUP Result pCi/l	Dilution	DUP RPD %	DUP RER	DUP Qualifier	DUP RPD Limits %	DUP RER Limit
Radium-226	0.267	1.33	1	133	2.21		20	3
(T) Barium-133	*110*	*102*						

Laboratory Control Sample (LCS)

(LCS) R3419580-2 06/03/19 17:43

Analyte	Spike Amount pCi/l	LCS Result pCi/l	LCS Rec. %	Rec. Limits %	LCS Qualifier
Radium-226	5.02	5.10	102	80.0-120	
(T) Barium-133			*56.0*		

L1101875-03 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1101875-03 06/03/19 17:43 • (MS) R3419580-3 06/03/19 17:43 • (MSD) R3419580-6 06/03/19 17:43

Analyte	Spike Amount pCi/l	Original Result pCi/l	MS Result pCi/l	MSD Result pCi/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	MS RER	RPD Limits %
Radium-226	20.1	0.637	17.9	20.3	86.0	97.8	1	75.0-125			12.4		20
(T) Barium-133		*83.3*			*53.7*	*71.3*							

L1101881-03 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1101881-03 06/03/19 17:43 • (MS) R3419580-4 06/03/19 17:43 • (MSD) R3419580-5 06/03/19 17:43

Analyte	Spike Amount pCi/l	Original Result pCi/l	MS Result pCi/l	MSD Result pCi/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	MS RER	RPD Limits %
Radium-226	20.1	0.522	21.1	19.2	102	93.1	1	75.0-125			9.23		20
(T) Barium-133		*105*			*89.6*	*99.7*							

Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

Abbreviations and Definitions

MDA	Minimum Detectable Activity.
Rec.	Recovery.
RER	Replicate Error Ratio.
RPD	Relative Percent Difference.
SDG	Sample Delivery Group.
(T)	Tracer - A radioisotope of known concentration added to a solution of chemically equivalent radioisotopes at a known concentration to assist in monitoring the yield of the chemical separation.
Analyte	The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported.
Dilution	If the sample matrix contains an interfering material, the sample preparation volume or weight values differ from the standard, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor.
Limits	These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges.
Original Sample	The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG.
Qualifier	This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable.
Result	The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state "ND" (Not Detected) or "BDL" (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte.
Uncertainty (Radiochemistry)	Confidence level of 2 sigma.
Case Narrative (Cn)	A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report.
Quality Control Summary (Qc)	This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material.
Sample Chain of Custody (Sc)	This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis.
Sample Results (Sr)	This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported.
Sample Summary (Ss)	This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis.

Qualifier	Description
	The remainder of this page intentionally left blank, there are no qualifiers applied to this SDG.

Pace National is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our one location design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be YOUR LAB OF CHOICE.
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.
* Accreditation is only applicable to the test methods specified on each scope of accreditation held by Pace National.

State Accreditations

Alabama	40660
Alaska	17-026
Arizona	AZ0612
Arkansas	88-0469
California	2932
Colorado	TN00003
Connecticut	PH-0197
Florida	E87487
Georgia	NELAP
Georgia [1]	923
Idaho	TN00003
Illinois	200008
Indiana	C-TN-01
Iowa	364
Kansas	E-10277
Kentucky [1 6]	90010
Kentucky [2]	16
Louisiana	AI30792
Louisiana [1]	LA180010
Maine	TN0002
Maryland	324
Massachusetts	M-TN003
Michigan	9958
Minnesota	047-999-395
Mississippi	TN00003
Missouri	340
Montana	CERT0086
Nebraska	NE-OS-15-05
Nevada	TN-03-2002-34
New Hampshire	2975
New Jersey–NELAP	TN002
New Mexico [1]	n/a
New York	11742
North Carolina	Env375
North Carolina [1]	DW21704
North Carolina [3]	41
North Dakota	R-140
Ohio–VAP	CL0069
Oklahoma	9915
Oregon	TN200002
Pennsylvania	68-02979
Rhode Island	LAO00356
South Carolina	84004
South Dakota	n/a
Tennessee [1 4]	2006
Texas	T104704245-18-15
Texas [5]	LAB0152
Utah	TN00003
Vermont	VT2006
Virginia	460132
Washington	C847
West Virginia	233
Wisconsin	9980939910
Wyoming	A2LA

Third Party Federal Accreditations

A2LA – ISO 17025	1461.01
A2LA – ISO 17025 [5]	1461.02
Canada	1461.01
EPA–Crypto	TN00003
AIHA-LAP,LLC EMLAP	100789
DOD	1461.01
USDA	P330-15-00234

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [6] Wastewater n/a Accreditation not applicable

Our Locations

Pace National has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. Pace National performs all testing at our central laboratory.

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
Al
9 Sc

Pace Analytical National Center for Testing & Innovation
Cooler Receipt Form

Client: DHLRRTX	SDG#:	1100989	
Cooler Received/Opened On: 5/21 /19	Temperature:	Amb	
Received By: Brock Fariss			
Signature: BF Fariss			

Receipt Check List	NP	Yes	No
COC Seal Present / Intact?	✓		
COC Signed / Accurate?		✓	
Bottles arrive intact?		✓	
Correct bottles used?		✓	
Sufficient volume sent?		✓	
If Applicable			
VOA Zero headspace?			
Preservation Correct / Checked?		✓	

Pace Analytical®
National Center for Testing & Innovation

Login #: L1100989	Client:DHLRRTX	Date:05/21	Evaluated by:Kelsey S

Non-Conformance (check applicable items)

	Sample Integrity		Chain of Custody Clarification		
	Parameter(s) past holding time		Login Clarification Needed		**If Broken Container:**
	Temperature not in range		Chain of custody is incomplete		Insufficient packing material around container
	Improper container type		Please specify Metals requested.		Insufficient packing material inside cooler
x	pH not in range.		Please specify TCLP requested.		Improper handling by carrier (FedEx / UPS / Courie
	Insufficient sample volume.		Received additional samples not listed on coc.		Sample was frozen
	Sample is biphasic.		Sample ids on containers do not match ids on coc		Container lid not intact
	Vials received with headspace.		Trip Blank not received.		**If no Chain of Custody:**
	Broken container		Client did not "X" analysis.		Received by:
	Broken container:		Chain of Custody is missing		Date/Time:
	Sufficient sample remains				Temp./Cont. Rec./pH:
					Carrier:
					Tracking#

Login Comments: 1 of 2 H-32 was received with a pH of 6. pH adj in login 1511 5/21

Client informed by:		Call		Email		Voice Mail		Date:	Time:
TSR Initials:	Client Contact:								

Login Instructions:

Noted 5/21/19 1547

1100989

CHAIN-OF-CUSTODY RECORD

DHL Analytical, Inc.
2300 Double Creek Drive
Round Rock, TX 78664
TEL: *(512) 388-8222* FAX: *(512) 388-8229*

H007

Work Order: 1905168

Subcontractor:
Pace Analytical
12065 Lebanon Rd
Mt. Juliet, TN 37122

TEL: (615) 773-5923
FAX:
Acct #: DHLRRTX

15-May-19

Sample Id	Matrix	DHL#	Date Collected	Bottle Type	Ra-228 E904.0	Ra-226 M7500 Ra B M	Requested Tests			
					<2	<2				
H-31	Aqueous	-01D	05/14/19 07:40 AM	1LHDPEHNO3		1				01
H-31	Aqueous	-01E	05/14/19 07:40 AM	1LHDPEHNO3	1					
H-32	Aqueous	-02D	05/14/19 08:25 AM	1LHDPEHNO3		1				02
H-32	Aqueous	-02E	05/14/19 08:25 AM	1LHDPEHNO3	1					
H-27	Aqueous	-03D	05/14/19 09:40 AM	1LHDPEHNO3		1				03
H-27	Aqueous	-03E	05/14/19 09:40 AM	1LHDPEHNO3	1					
H-29	Aqueous	-04D	05/14/19 11:25 AM	1LHDPEHNO3		1				04
H-29	Aqueous	-04E	05/14/19 11:25 AM	1LHDPEHNO3	1					
H-28	Aqueous	-05D	05/14/19 12:30 PM	1LHDPEHNO3		1				05
H-28	Aqueous	-05E	05/14/19 12:30 PM	1LHDPEHNO3	1					
H-26	Aqueous	-06D	05/14/19 02:25 PM	1LHDPEHNO3		1				06
H-26	Aqueous	-06E	05/14/19 02:25 PM	1LHDPEHNO3	1					
H-33	Aqueous	-07D	05/14/19 03:30 PM	1LHDPEHNO3		1				07
H-33	Aqueous	-07E	05/14/19 03:30 PM	1LHDPEHNO3	1					

General Comments:
Please analyze these samples with Normal Turnaround Time.
Report RA-226, Ra-228 & Combined per Specs.
Quality Control Package Needed: Standard - NELAC Rad Test compliant
Email to cac@dhlanalytical.com & dupont@dhlanalytical.com

UPS
Rec: 14

Relinquished by:		**Date/Time** 5/17/19 1700	**Received by:**		**Date/Time** 5/21/19 1010
Relinquished by:			**Received by:**		

pH adj @ 1511

RAD SCREEN: <0.5 mR/hr AmW

May 30, 2019

Will Vienne
Golder
2201 Double Creek Dr #4004
Round Rock, Texas 78664
TEL: (512) 671-3434
FAX (512) 671-3446

Order No.: 1905167

RE: Luminant-MLSES Ash Ponds

Dear Will Vienne:

DHL Analytical, Inc. received 2 sample(s) on 5/15/2019 for the analyses presented in the following report.

There were no problems with the analyses and all data met requirements of NELAP except where noted in the Case Narrative. All non-NELAP methods will be identified accordingly in the case narrative and all estimated uncertainties of test results are within method or EPA specifications.

If you have any questions regarding these tests results, please feel free to call. Thank you for using DHL Analytical.

Sincerely,

John DuPont
General Manager

This report was performed under the accreditation of the State of Texas Laboratory Certification Number: T104704211-19-24

Table of Contents

DHL ANALYTICAL
2300 Double Creek Dr. ■ Round Rock, TX 78664
Phone (512) 388-8222 ■ FAX (512) 388-8229
Web: www.dhlanalytical.com
E-Mail: login@dhlanalytical.com

№ 86480

CHAIN-OF-CUSTODY

CLIENT: GOLDER
ADDRESS: 2201 DOUBLE CREEK DR, ROUND ROCK, TX 78664
PHONE: 512-671-3434 FAX/E-MAIL: 512-671-3446
DATA REPORTED TO: WILL VIENNE
ADDITIONAL REPORT COPIES TO:

DATE: 5-14-19 PAGE 1 OF 1
PO #:
DHL WORK ORDER #: 1905167
PROJECT LOCATION OR NAME: LUMINANT - MLSES ASH PONDS
CLENT PROJECT #: 19122262-C COLLECTOR: J. BRAYTON

Authorize 5% surcharge for TRRP Report? ☐ Yes ☐ No

S=SOIL W=WATER A=AIR L=LIQUID SE=SEDIMENT P=PAINT SL=SLUDGE O=OTHER SO=SOLID

ANALYSES: BTEX ☐ MTBE ☐ [METHOD 8021] TPH 1005 ☐ TPH 1006 ☐ HOLD 1006 ☐ GRO [METHOD 8015] ☐ DRO [METHOD 8015] ☐ VOC 8260 ☐ VOC 624 ☐ VOC 8260/5035 ☐ SVOC 8270 ☐ PAH 8270 ☐ HOLD PAH ☐ SVOC 625 ☐ 8270 PEST ☐ 625 PEST/PCB ☐ 608 PCB ☐ 8270 O-P PEST ☐ 8082 PCB ☐ 8270 PCB ☐ 8321 HERB ☐ T PHOS, AMMONIA ☐ METALS 6020 ☐ METALS 200.8 ☐ DISS. METALS ☐ RCRA ☐ TX11 ☐ PH ☐ HEX CHROM ☐ ALKALINITY ☐ COD ☐ CHLORIDE ☐ ANIONS ☐ TCLP-SVOC ☐ VOC ☐ PEST ☐ HERB ☐ TCLP-METALS ☐ RCRA 8 ☐ TX-11 ☐ Pb ☐ RCI ☐ FLASHPOINT ☐ DGAS ☐ TDS ☐ TSS ☐ % MOISTURE ☐ CYANIDE ☐ APPENDIX III ETU ALK, NO3, PO4, Na, Mg, K FERROUS + FERRIC IRON

Field Sample I.D.	DHL Lab #	Date	Time	Matrix	Container Type	# of Containers	HCl	HNO_3	H_2SO_4 ☐ NaOH ☐	ICE	UNPRESERVED	APPENDIX III ETU	ALK, NO3, PO4, Na, Mg, K	FERROUS + FERRIC IRON	FIELD NOTES
LAKE SAMPLE	01	5-14-19	1005	W		7		X		X		X	X	X	
POND SAMPLE	02	5-14-19	1020	W		7		X		X		X	X	X	

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)
[signature]	5-14-19 1800	FedEx
FedEx	5/15/19 0943	[signature]

☐ DHL DISPOSAL @ $5.00 each ☐ Return 3

TURN AROUND TIME
RUSH ☐ CALL FIRST
1 DAY ☐ CALL FIRST
2 DAY ☐
NORMAL ☒
OTHER ☐

LABORATORY USE ONLY:
RECEIVING TEMP: 4.5°C THERM #: 78
CUSTODY SEALS: ☐ BROKEN ☐ INTACT ☒ NOT USED
CARRIER: ☐ LONE STAR ☒ FEDEX ☐ UPS ☐ OTHER
☐ COURIER DELIVERY
☐ HAND DELIVERED

DHL COC Rev 1 | FEB 2010

Eric Lau

From: John DuPont
Sent: Tuesday, May 28, 2019 11:35 AM
To: Eric Lau
Subject: FW: CCR Analysis

Appendix III Parameters:
Metals (Ca and B)
Anions (Cl, F, and SO4)
TDS

Appendix IV Parameters:

Metals (As, Ba, Be, Cd, Co, Cr, Hg, Li, Mo, Pb, Sb, Se, and Tl)
Ra-226
Ra-228

From: Vienne, Will [mailto:William_Vienne@golder.com]
Sent: Tuesday, April 09, 2019 12:48 PM
To: John DuPont <dupont@dhlanalytical.com>
Subject: CCR Analysis

ORIGIN ID:GGGA (512) 671-3434
J . BRAYTON
GOLDER
2201 DOUBLE CREEK DR

ROUND ROCK, TX 78664
UNITED STATES US

SHIP DATE: 14MAY19
ACTWGT: 50.90 LB
CAD: 006994166/SSFE2002
DIMS: 23x14x14 IN

BILL THIRD PARTY

TO

DHL
2300 DOUBLE CREEK DR

ROUND ROCK TX 78664
(512) 388-8222
INV:
PO:
REF:
DEPT:

FedEx
Express

E

J191019010701uv

2 of 4
MPS# 0263 7872 5506 5857
Mstr# 7872 5506 5846 0201

WED - 15 MAY 10:30A
PRIORITY OVERNIGHT

A8 BSMA

78664
TX-US AUS

DHL Analytical, Inc.

Sample Receipt Checklist

Client Name Golder | Date Received: 5/15/2019

Work Order Number 1905167 | Received by EL

Checklist completed by: [signature] (Signature) 5/15/2019 (Date) | Reviewed by DL (Initials) 5/15/2019 (Date)

Carrier name FedEx 1day

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shippping container/cooler?	Yes ☐	No ☐	Not Present ☑
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐	4.5 °C
Water - VOA vials have zero headspace?	Yes ☑	No ☐	No VOA vials submitted ☐
Water - pH<2 acceptable upon receipt?	Yes ☑	No ☐	NA ☐ LOT # 11837
	Adjusted? no		Checked by EL
Water - ph>9 (S) or ph>10 (CN) acceptable upon receipt?	Yes ☐	No ☐	NA ☑ LOT #
	Adjusted?		Checked by

Any No response must be detailed in the comments section below.

Client contacted | Date contacted: | Person contacted

Contacted by: | Regarding:

Comments:

Corrective Action

Page 1 of 1

DHL Analytical, Inc.

Date: *30-May-19*

CLIENT: Golder
Project: Luminant-MLSES Ash Ponds
Lab Order: 1905167

CASE NARRATIVE

Samples were analyzed using the methods outlined in the following references:

Method SW6020A - Metals Analysis
Method SW7470A - Mercury Analysis
Method E300 - Anions Analysis
Method M2320 B - Alkalinity Analysis
Method M3500-Fe D - Ferrous Iron Analysis (this parameter is not NELAP certified)
Method M3500-Fe D - Ferric Iron (calculation) (this calculation is not NELAP certified).
Method M4500-P E - Orthophosphate Analysis
Method M2540C - TDS Analysis
Sub-contract - Radium-228 and Radium-226 analyses by methods E904 and SM 7500 Ra B M. Analyzed at Pace Analytical.

LOG IN

The samples were received and log-in performed on 5/15/19. A total of 2 samples were received. The samples arrived in good condition and were properly packaged.

METALS ANALYSIS

For Metals analysis performed on 5/21/19 the matrix spike and matrix spike duplicate recoveries were below control limits for Calcium and Sodium. These are flagged accordingly in the QC summary report. The sample selected for the matrix spike and matrix spike duplicate was not from this work order. The LCS was within control limits for these analytes. No further corrective actions were taken.

For Metals analysis performed on 5/21/19 the RPD for the serial dilution was slightly above control limits for Potassium. This is flagged accordingly. The PDS was within control limits for this analyte. No further corrective actions were taken.

For Metals analysis performed on 5/21/19 the PDS recovery was out of control limits for three analytes. These are flagged accordingly. The serial dilution was within control limits for these analytes. No further corrective actions were taken.

For Metals analysis peformed on 5/21/19 three LCVLs were out of control limits for Potassium and/or Sodium. These are flagged accordingly. The associated CCVs were within control limits for these analytes. No further corrective actions were taken.

ANIONS ANALYSIS

CLIENT:	Golder	
Project:	Luminant-MLSES Ash Ponds	**CASE NARRATIVE**
Lab Order:	1905167	

For Anions analysis performed on 5/15/19 (batch 90908) the matrix spike and matrix spike duplicate recoveries (1905167-02 MS/MSD) were out of control limits for Chloride and Sulfate. These are flagged accordingly in the QC summary report. The sample selected for the matrix spike and matrix spike duplicate was from this work order. The LCS was within control limits for these analytes. No further corrective actions were taken.

DHL Analytical, Inc.

Date: *30-May-19*

CLIENT: Golder
Project: Luminant-MLSES Ash Ponds
Lab Order: 1905167

Work Order Sample Summary

Lab Smp ID	Client Sample ID	Tag Number	Date Collected	Date Recved
1905167-01	Lake Sample		05/14/19 10:05 AM	5/15/2019
1905167-02	Pond Sample		05/14/19 10:20 AM	5/15/2019

Lab Order: 1905167
Client: Golder
Project: Luminant-MLSES Ash Ponds

PREP DATES REPORT

Sample ID	Client Sample ID	Collection Date	Matrix	Test Number	Test Name	Prep Date	Batch ID
1905167-01A	Lake Sample	05/14/19 10:05 AM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002
1905167-01B	Lake Sample	05/14/19 10:05 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:34 AM	90990
	Lake Sample	05/14/19 10:05 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:34 AM	90990
	Lake Sample	05/14/19 10:05 AM	Aqueous	SW7470A	Mercury Aq Prep	05/21/19 09:56 AM	91017
1905167-01C	Lake Sample	05/14/19 10:05 AM	Aqueous	M2320 B	Alkalinity Preparation	05/16/19 10:12 AM	90940
	Lake Sample	05/14/19 10:05 AM	Aqueous	E300	Anion Preparation	05/15/19 09:07 AM	90908
	Lake Sample	05/14/19 10:05 AM	Aqueous	E300	Anion Preparation	05/15/19 09:07 AM	90908
	Lake Sample	05/14/19 10:05 AM	Aqueous	M4500-P E	Orthophosphate Prep	05/15/19 12:12 PM	90921
	Lake Sample	05/14/19 10:05 AM	Aqueous	M2540C	TDS Preparation	05/16/19 03:23 PM	90953
1905167-02A	Pond Sample	05/14/19 10:20 AM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002
1905167-02B	Pond Sample	05/14/19 10:20 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:34 AM	90990
	Pond Sample	05/14/19 10:20 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:34 AM	90990
	Pond Sample	05/14/19 10:20 AM	Aqueous	SW7470A	Mercury Aq Prep	05/21/19 09:56 AM	91017
1905167-02C	Pond Sample	05/14/19 10:20 AM	Aqueous	M2320 B	Alkalinity Preparation	05/16/19 10:12 AM	90940
	Pond Sample	05/14/19 10:20 AM	Aqueous	E300	Anion Preparation	05/15/19 09:07 AM	90908
	Pond Sample	05/14/19 10:20 AM	Aqueous	E300	Anion Preparation	05/15/19 09:07 AM	90908
	Pond Sample	05/14/19 10:20 AM	Aqueous	E300	Anion Preparation	05/16/19 09:16 AM	90935
	Pond Sample	05/14/19 10:20 AM	Aqueous	M4500-P E	Orthophosphate Prep	05/15/19 12:12 PM	90921
	Pond Sample	05/14/19 10:20 AM	Aqueous	M2540C	TDS Preparation	05/16/19 03:23 PM	90953

Lab Order: 1905167
Client: Golder
Project: Luminant-MLSES Ash Ponds

ANALYTICAL DATES REPORT

Sample ID	Client Sample ID	Matrix	Test Number	Test Name	Batch ID	Dilution	Analysis Date	Run ID
1905167-01A	Lake Sample	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91002	1	05/24/19	UV/VIS_2_190524A
	Lake Sample	Aqueous	M3500-Fe D	Ferrous Iron	91002	1	05/20/19 03:54 PM	UV/VIS_2_190520A
1905167-01B	Lake Sample	Aqueous	SW7470A	Mercury Total: Aqueous	91017	1	05/22/19 10:11 AM	CETAC2_HG_190522A
	Lake Sample	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90990	1	05/22/19 12:01 PM	ICP-MS4_190522B
	Lake Sample	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90990	1	05/21/19 03:24 PM	ICP-MS5_190521A
1905167-01C	Lake Sample	Aqueous	M2320 B	Alkalinity	90940	1	05/16/19 04:05 PM	TITRATOR_190516A
	Lake Sample	Aqueous	E300	Anions by IC method - Water	90908	10	05/15/19 12:51 PM	IC2_190515A
	Lake Sample	Aqueous	E300	Anions by IC method - Water	90908	1	05/15/19 05:23 PM	IC2_190515A
	Lake Sample	Aqueous	M4500-P E	Orthophosphate	90921	1	05/15/19 02:47 PM	UV/VIS_2_190515B
	Lake Sample	Aqueous	M2540C	Total Dissolved Solids	90953	1	05/17/19 11:40 AM	WC_190517D
1905167-02A	Pond Sample	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91002	1	05/24/19	UV/VIS_2_190524A
	Pond Sample	Aqueous	M3500-Fe D	Ferrous Iron	91002	1	05/20/19 03:54 PM	UV/VIS_2_190520A
1905167-02B	Pond Sample	Aqueous	SW7470A	Mercury Total: Aqueous	91017	1	05/22/19 10:13 AM	CETAC2_HG_190522A
	Pond Sample	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90990	100	05/22/19 12:03 PM	ICP-MS4_190522B
	Pond Sample	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90990	1	05/21/19 03:26 PM	ICP-MS5_190521A
1905167-02C	Pond Sample	Aqueous	M2320 B	Alkalinity	90940	1	05/16/19 04:08 PM	TITRATOR_190516A
	Pond Sample	Aqueous	E300	Anions by IC method - Water	90908	10	05/15/19 01:39 PM	IC2_190515A
	Pond Sample	Aqueous	E300	Anions by IC method - Water	90908	1	05/15/19 05:39 PM	IC2_190515A
	Pond Sample	Aqueous	E300	Anions by IC method - Water	90935	100	05/16/19 04:54 PM	IC4_190516A
	Pond Sample	Aqueous	M4500-P E	Orthophosphate	90921	1	05/15/19 02:47 PM	UV/VIS_2_190515B
	Pond Sample	Aqueous	M2540C	Total Dissolved Solids	90953	1	05/17/19 11:40 AM	WC_190517D

DHL Analytical, Inc.

Date: *30-May-19*

CLIENT:	Golder	**Client Sample ID:**	Lake Sample
Project:	Luminant-MLSES Ash Ponds	**Lab ID:**	1905167-01
Project No:	19122262-C	**Collection Date:**	05/14/19 10:05 AM
Lab Order:	1905167	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **RO**
Antimony	<0.000800	0.000800	0.00250		mg/L	1	05/21/19 03:24 PM
Arsenic	<0.00200	0.00200	0.00500		mg/L	1	05/21/19 03:24 PM
Barium	0.0535	0.00300	0.0100		mg/L	1	05/21/19 03:24 PM
Beryllium	<0.000300	0.000300	0.00100		mg/L	1	05/21/19 03:24 PM
Boron	0.0632	0.0100	0.0300		mg/L	1	05/22/19 12:01 PM
Cadmium	<0.000300	0.000300	0.00100		mg/L	1	05/21/19 03:24 PM
Calcium	12.5	0.100	0.300		mg/L	1	05/21/19 03:24 PM
Chromium	<0.00200	0.00200	0.00500		mg/L	1	05/21/19 03:24 PM
Cobalt	<0.00300	0.00300	0.00500		mg/L	1	05/21/19 03:24 PM
Iron	0.365	0.0300	0.100		mg/L	1	05/21/19 03:24 PM
Lead	<0.000300	0.000300	0.00100		mg/L	1	05/21/19 03:24 PM
Lithium	<0.00500	0.00500	0.0100		mg/L	1	05/21/19 03:24 PM
Magnesium	6.09	0.100	0.300		mg/L	1	05/21/19 03:24 PM
Molybdenum	<0.00200	0.00200	0.00500		mg/L	1	05/21/19 03:24 PM
Potassium	2.56	0.100	0.300		mg/L	1	05/21/19 03:24 PM
Selenium	<0.00200	0.00200	0.00500		mg/L	1	05/21/19 03:24 PM
Sodium	11.9	0.100	0.300		mg/L	1	05/21/19 03:24 PM
Thallium	<0.000500	0.000500	0.00150		mg/L	1	05/21/19 03:24 PM
MERCURY TOTAL: AQUEOUS		**SW7470A**					Analyst: **BM**
Mercury	<0.0000800	0.0000800	0.000200		mg/L	1	05/22/19 10:11 AM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	12.2	0.300	1.00		mg/L	1	05/15/19 05:23 PM
Fluoride	0.140	0.100	0.400	J	mg/L	1	05/15/19 05:23 PM
Nitrate-N	<0.100	0.100	0.500		mg/L	1	05/15/19 05:23 PM
Sulfate	37.3	1.00	3.00		mg/L	1	05/15/19 05:23 PM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	55.4	10.0	20.0		mg/L @ pH 4.5	1	05/16/19 04:05 PM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.5	1	05/16/19 04:05 PM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.5	1	05/16/19 04:05 PM
Alkalinity, Total (As CaCO3)	55.4	20.0	20.0		mg/L @ pH 4.5	1	05/16/19 04:05 PM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	0.365	0.0500	0.100	N	mg/L	1	05/24/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	05/20/19 03:54 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

CLIENT:	Golder	**Client Sample ID:**	Lake Sample
Project:	Luminant-MLSES Ash Ponds	**Lab ID:**	1905167-01
Project No:	19122262-C	**Collection Date:**	05/14/19 10:05 AM
Lab Order:	1905167	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **CC**
Phosphorus, Total Orthophosphate (As P)	<0.0300	0.0300	0.100		mg/L	1	05/15/19 02:47 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	119	10.0	10.0		mg/L	1	05/17/19 11:40 AM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *30-May-19*

CLIENT:	Golder	**Client Sample ID:**	Pond Sample
Project:	Luminant-MLSES Ash Ponds	**Lab ID:**	1905167-02
Project No:	19122262-C	**Collection Date:**	05/14/19 10:20 AM
Lab Order:	1905167	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **RO**
Antimony	0.00199	0.000800	0.00250	J	mg/L	1	05/21/19 03:26 PM
Arsenic	0.00305	0.00200	0.00500	J	mg/L	1	05/21/19 03:26 PM
Barium	0.0589	0.00300	0.0100		mg/L	1	05/21/19 03:26 PM
Beryllium	<0.000300	0.000300	0.00100		mg/L	1	05/21/19 03:26 PM
Boron	28.2	1.00	3.00		mg/L	100	05/22/19 12:03 PM
Cadmium	<0.000300	0.000300	0.00100		mg/L	1	05/21/19 03:26 PM
Calcium	319	10.0	30.0		mg/L	100	05/22/19 12:03 PM
Chromium	0.00336	0.00200	0.00500	J	mg/L	1	05/21/19 03:26 PM
Cobalt	<0.00300	0.00300	0.00500		mg/L	1	05/21/19 03:26 PM
Iron	<0.0300	0.0300	0.100		mg/L	1	05/21/19 03:26 PM
Lead	<0.000300	0.000300	0.00100		mg/L	1	05/21/19 03:26 PM
Lithium	0.119	0.00500	0.0100		mg/L	1	05/21/19 03:26 PM
Magnesium	553	10.0	30.0		mg/L	100	05/22/19 12:03 PM
Molybdenum	0.0550	0.00200	0.00500		mg/L	1	05/21/19 03:26 PM
Potassium	34.6	10.0	30.0		mg/L	100	05/22/19 12:03 PM
Selenium	2.96	0.200	0.500		mg/L	100	05/22/19 12:03 PM
Sodium	240	10.0	30.0		mg/L	100	05/22/19 12:03 PM
Thallium	<0.000500	0.000500	0.00150		mg/L	1	05/21/19 03:26 PM
MERCURY TOTAL: AQUEOUS		**SW7470A**					Analyst: **BM**
Mercury	0.000119	0.0000800	0.000200	J	mg/L	1	05/22/19 10:13 AM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	513	30.0	100		mg/L	100	05/16/19 04:54 PM
Fluoride	24.3	1.00	4.00		mg/L	10	05/15/19 01:39 PM
Nitrate-N	11.1	0.100	0.500		mg/L	1	05/15/19 05:39 PM
Sulfate	2900	100	300		mg/L	100	05/16/19 04:54 PM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	79.1	10.0	20.0		mg/L @ pH 4.52	1	05/16/19 04:08 PM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.52	1	05/16/19 04:08 PM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.52	1	05/16/19 04:08 PM
Alkalinity, Total (As CaCO3)	79.1	20.0	20.0		mg/L @ pH 4.52	1	05/16/19 04:08 PM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	<0.0500	0.0500	0.100	N	mg/L	1	05/24/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	05/20/19 03:54 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *30-May-19*

CLIENT:	Golder	**Client Sample ID:**	Pond Sample
Project:	Luminant-MLSES Ash Ponds	**Lab ID:**	1905167-02
Project No:	19122262-C	**Collection Date:**	05/14/19 10:20 AM
Lab Order:	1905167	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **CC**
Phosphorus, Total Orthophosphate (As P)	<0.0300	0.0300	0.100		mg/L	1	05/15/19 02:47 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	5380	50.0	50.0		mg/L	1	05/17/19 11:40 AM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
S	Spike Recovery outside control limits	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905167
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **CETAC2_HG_190522A**

The QC data in batch 91017 applies to the following samples: 1905167-01B, 1905167-02B

Sample ID **MB-91017** Batch ID: **91017** TestNo: **SW7470A** Units: **mg/L**
SampType: **MBLK** Run ID: **CETAC2_HG_190522A** Analysis Date: **5/22/2019 10:02:31 AM** Prep Date: **5/21/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	<0.0000800	0.000200								

Sample ID **LCS-91017** Batch ID: **91017** TestNo: **SW7470A** Units: **mg/L**
SampType: **LCS** Run ID: **CETAC2_HG_190522A** Analysis Date: **5/22/2019 10:04:46 AM** Prep Date: **5/21/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00187	0.000200	0.00200	0	93.5	85	115			

Sample ID **LCSD-91017** Batch ID: **91017** TestNo: **SW7470A** Units: **mg/L**
SampType: **LCSD** Run ID: **CETAC2_HG_190522A** Analysis Date: **5/22/2019 10:07:02 AM** Prep Date: **5/21/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00186	0.000200	0.00200	0	93.0	85	115	0.536	15	

Sample ID **1905168-01B MS** Batch ID: **91017** TestNo: **SW7470A** Units: **mg/L**
SampType: **MS** Run ID: **CETAC2_HG_190522A** Analysis Date: **5/22/2019 11:23:23 AM** Prep Date: **5/21/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00196	0.00100	0.00200	0	97.8	80	120			

Sample ID **1905168-01B MSD** Batch ID: **91017** TestNo: **SW7470A** Units: **mg/L**
SampType: **MSD** Run ID: **CETAC2_HG_190522A** Analysis Date: **5/22/2019 11:25:39 AM** Prep Date: **5/21/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00194	0.00100	0.00200	0	97.0	80	120	0.770	15	

Sample ID **1905168-01B SD** Batch ID: **91017** TestNo: **SW7470A** Units: **mg/L**
SampType: **SD** Run ID: **CETAC2_HG_190522A** Analysis Date: **5/22/2019 11:27:56 AM** Prep Date: **5/21/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	<0.00200	0.00500	0	0				0	10	

Sample ID **1905168-01B PDS** Batch ID: **91017** TestNo: **SW7470A** Units: **mg/L**
SampType: **PDS** Run ID: **CETAC2_HG_190522A** Analysis Date: **5/22/2019 11:30:13 AM** Prep Date: **5/21/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.0122	0.00100	0.0125	0	97.6	85	115			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905167
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **CETAC2_HG_190522A**

Sample ID **ICV-190522**	Batch ID: **R104223**	TestNo: **SW7470A**	Units: **mg/L**
SampType: **ICV**	Run ID: **CETAC2_HG_190522A**	Analysis Date: **5/22/2019 9:57:56 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00383	0.000200	0.00400	0	95.8	90	110			

Sample ID **CCV1-190522**	Batch ID: **R104223**	TestNo: **SW7470A**	Units: **mg/L**
SampType: **CCV**	Run ID: **CETAC2_HG_190522A**	Analysis Date: **5/22/2019 10:41:04 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00202	0.000200	0.00200	0	101	90	110			

Sample ID **CCV2-190522**	Batch ID: **R104223**	TestNo: **SW7470A**	Units: **mg/L**
SampType: **CCV**	Run ID: **CETAC2_HG_190522A**	Analysis Date: **5/22/2019 11:08:23 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00203	0.000200	0.00200	0	102	90	110			

Sample ID **CCV3-190522**	Batch ID: **R104223**	TestNo: **SW7470A**	Units: **mg/L**
SampType: **CCV**	Run ID: **CETAC2_HG_190522A**	Analysis Date: **5/22/2019 2:51:11 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00203	0.000200	0.00200	0	102	90	110			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905167
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **ICP-MS4_190522B**

The QC data in batch 90990 applies to the following samples: 1905167-01B, 1905167-02B

Sample ID **MB-90990** Batch ID: **90990** TestNo: **SW6020A** Units: **mg/L**
SampType: **MBLK** Run ID: **ICP-MS4_190522B** Analysis Date: **5/22/2019 11:49:00 AM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	<0.0100	0.0300								

Sample ID **LCS-90990** Batch ID: **90990** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCS** Run ID: **ICP-MS4_190522B** Analysis Date: **5/22/2019 11:51:00 AM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.203	0.0300	0.200	0	102	80	120			

Sample ID **LCSD-90990** Batch ID: **90990** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCSD** Run ID: **ICP-MS4_190522B** Analysis Date: **5/22/2019 11:53:00 AM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.202	0.0300	0.200	0	101	80	120	0.579	15	

Sample ID **1905218-06A SD** Batch ID: **90990** TestNo: **SW6020A** Units: **mg/L**
SampType: **SD** Run ID: **ICP-MS4_190522B** Analysis Date: **5/22/2019 11:59:00 AM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.103	0.150	0	0.0953				7.85	10	

Sample ID **1905218-06A PDS** Batch ID: **90990** TestNo: **SW6020A** Units: **mg/L**
SampType: **PDS** Run ID: **ICP-MS4_190522B** Analysis Date: **5/22/2019 12:23:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.277	0.0300	0.200	0.0953	91.1	80	120			

Sample ID **1905218-06A MS** Batch ID: **90990** TestNo: **SW6020A** Units: **mg/L**
SampType: **MS** Run ID: **ICP-MS4_190522B** Analysis Date: **5/22/2019 12:25:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.288	0.0300	0.200	0.0953	96.1	80	120			

Sample ID **1905218-06A MSD** Batch ID: **90990** TestNo: **SW6020A** Units: **mg/L**
SampType: **MSD** Run ID: **ICP-MS4_190522B** Analysis Date: **5/22/2019 12:27:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.282	0.0300	0.200	0.0953	93.3	80	120	2.01	15	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_190522B

Sample ID **ICV-190522** Batch ID: **R104220** TestNo: **SW6020A** Units: **mg/L**
SampType: **ICV** Run ID: **ICP-MS4_190522B** Analysis Date: **5/22/2019 11:38:00 AM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.104	0.0300	0.100	0	104	90	110			
Calcium	2.35	0.300	2.50	0	94.2	90	110			
Magnesium	2.45	0.300	2.50	0	98.2	90	110			
Potassium	2.52	0.300	2.50	0	101	90	110			
Selenium	0.102	0.00500	0.100	0	102	90	110			
Sodium	2.53	0.300	2.50	0	101	90	110			

Sample ID **LCVL-190522** Batch ID: **R104220** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCVL** Run ID: **ICP-MS4_190522B** Analysis Date: **5/22/2019 11:43:00 AM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.0197	0.0300	0.0200	0	98.5	70	130			
Calcium	0.0981	0.300	0.100	0	98.1	70	130			
Magnesium	0.0967	0.300	0.100	0	96.7	70	130			
Potassium	0.0964	0.300	0.100	0	96.4	70	130			
Selenium	0.00494	0.00500	0.00500	0	98.8	70	130			
Sodium	0.0966	0.300	0.100	0	96.6	70	130			

Sample ID **CCV1-190522** Batch ID: **R104220** TestNo: **SW6020A** Units: **mg/L**
SampType: **CCV** Run ID: **ICP-MS4_190522B** Analysis Date: **5/22/2019 12:33:00 PM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.210	0.0300	0.200	0	105	90	110			
Calcium	4.65	0.300	5.00	0	92.9	90	110			
Magnesium	5.05	0.300	5.00	0	101	90	110			
Potassium	5.15	0.300	5.00	0	103	90	110			
Selenium	0.215	0.00500	0.200	0	107	90	110			
Sodium	5.08	0.300	5.00	0	102	90	110			

Sample ID **LCVL1-190522** Batch ID: **R104220** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCVL** Run ID: **ICP-MS4_190522B** Analysis Date: **5/22/2019 12:38:00 PM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.0203	0.0300	0.0200	0	102	70	130			
Calcium	0.0876	0.300	0.100	0	87.6	70	130			
Magnesium	0.0970	0.300	0.100	0	97.0	70	130			
Potassium	0.0932	0.300	0.100	0	93.2	70	130			
Selenium	0.00547	0.00500	0.00500	0	109	70	130			
Sodium	0.102	0.300	0.100	0	102	70	130			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905167
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS5_190521A

The QC data in batch 90990 applies to the following samples: 1905167-01B, 1905167-02B

Sample ID **MB-90990**	Batch ID: **90990**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **MBLK**	Run ID: **ICP-MS5_190521A**	Analysis Date: **5/21/2019 3:11:00 PM**	Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	<0.000800	0.00250								
Arsenic	<0.00200	0.00500								
Barium	<0.00300	0.0100								
Beryllium	<0.000300	0.00100								
Cadmium	<0.000300	0.00100								
Calcium	<0.100	0.300								
Chromium	<0.00200	0.00500								
Cobalt	<0.00300	0.00500								
Iron	<0.0300	0.100								
Lead	<0.000300	0.00100								
Lithium	<0.00500	0.0100								
Magnesium	<0.100	0.300								
Molybdenum	<0.00200	0.00500								
Potassium	<0.100	0.300								
Selenium	<0.00200	0.00500								
Sodium	<0.100	0.300								
Thallium	<0.000500	0.00150								

Sample ID **LCS-90990**	Batch ID: **90990**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCS**	Run ID: **ICP-MS5_190521A**	Analysis Date: **5/21/2019 3:13:00 PM**	Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.209	0.00250	0.200	0	104	80	120			
Arsenic	0.208	0.00500	0.200	0	104	80	120			
Barium	0.208	0.0100	0.200	0	104	80	120			
Beryllium	0.200	0.00100	0.200	0	99.8	80	120			
Cadmium	0.211	0.00100	0.200	0	105	80	120			
Calcium	5.18	0.300	5.00	0	104	80	120			
Chromium	0.209	0.00500	0.200	0	105	80	120			
Cobalt	0.216	0.00500	0.200	0	108	80	120			
Iron	5.40	0.100	5.00	0	108	80	120			
Lead	0.203	0.00100	0.200	0	101	80	120			
Lithium	0.214	0.0100	0.200	0	107	80	120			
Magnesium	5.35	0.300	5.00	0	107	80	120			
Molybdenum	0.204	0.00500	0.200	0	102	80	120			
Potassium	4.99	0.300	5.00	0	99.9	80	120			
Selenium	0.208	0.00500	0.200	0	104	80	120			
Sodium	5.38	0.300	5.00	0	108	80	120			
Thallium	0.200	0.00150	0.200	0	100	80	120			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905167
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **ICP-MS5_190521A**

Sample ID **LCSD-90990** Batch ID: **90990** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCSD** Run ID: **ICP-MS5_190521A** Analysis Date: **5/21/2019 3:15:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.209	0.00250	0.200	0	105	80	120	0.307	15	
Arsenic	0.207	0.00500	0.200	0	104	80	120	0.318	15	
Barium	0.207	0.0100	0.200	0	103	80	120	0.392	15	
Beryllium	0.198	0.00100	0.200	0	99.0	80	120	0.810	15	
Cadmium	0.211	0.00100	0.200	0	105	80	120	0.119	15	
Calcium	5.16	0.300	5.00	0	103	80	120	0.293	15	
Chromium	0.209	0.00500	0.200	0	105	80	120	0.129	15	
Cobalt	0.215	0.00500	0.200	0	108	80	120	0.352	15	
Iron	5.41	0.100	5.00	0	108	80	120	0.077	15	
Lead	0.204	0.00100	0.200	0	102	80	120	0.722	15	
Lithium	0.211	0.0100	0.200	0	105	80	120	1.44	15	
Magnesium	5.37	0.300	5.00	0	107	80	120	0.251	15	
Molybdenum	0.202	0.00500	0.200	0	101	80	120	0.822	15	
Potassium	5.00	0.300	5.00	0	100	80	120	0.175	15	
Selenium	0.208	0.00500	0.200	0	104	80	120	0.274	15	
Sodium	5.38	0.300	5.00	0	108	80	120	0.080	15	
Thallium	0.202	0.00150	0.200	0	101	80	120	0.737	15	

Sample ID **1905218-06A SD** Batch ID: **90990** TestNo: **SW6020A** Units: **mg/L**
SampType: **SD** Run ID: **ICP-MS5_190521A** Analysis Date: **5/21/2019 3:22:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	<0.00400	0.0125	0	0				0	10	
Arsenic	<0.0100	0.0250	0	0				0	10	
Barium	0.0519	0.0500	0	0.0510				1.62	10	
Beryllium	<0.00150	0.00500	0	0				0	10	
Cadmium	<0.00150	0.00500	0	0				0	10	
Calcium	23.9	1.50	0	23.8				0.464	10	
Chromium	<0.0100	0.0250	0	0				0	10	
Cobalt	<0.0150	0.0250	0	0				0	10	
Iron	0.185	0.500	0	0.186				0.629	10	
Lead	<0.00150	0.00500	0	0				0	10	
Lithium	0.0477	0.0500	0	0.0462				3.27	10	
Magnesium	12.2	1.50	0	12.2				0.282	10	
Molybdenum	<0.0100	0.0250	0	0				0	10	
Potassium	1.83	1.50	0	2.08				12.6	10	R
Selenium	<0.0100	0.0250	0	0				0	10	
Sodium	53.2	1.50	0	51.9				2.54	10	
Thallium	<0.00250	0.00750	0	0				0	10	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS5_190521A

Sample ID **1905218-06A PDS** Batch ID: **90990** TestNo: **SW6020A** Units: **mg/L**
SampType: **PDS** Run ID: **ICP-MS5_190521A** Analysis Date: **5/21/2019 3:44:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.192	0.00250	0.200	0	96.2	80	120			
Arsenic	0.183	0.00500	0.200	0	91.7	80	120			
Barium	0.237	0.0100	0.200	0.0510	92.9	80	120			
Beryllium	0.179	0.00100	0.200	0	89.3	80	120			
Cadmium	0.194	0.00100	0.200	0	97.0	80	120			
Calcium	26.2	0.300	5.00	23.8	48.1	80	120			S
Chromium	0.198	0.00500	0.200	0	98.8	80	120			
Cobalt	0.191	0.00500	0.200	0	95.6	80	120			
Iron	5.16	0.100	5.00	0.186	99.5	80	120			
Lead	0.190	0.00100	0.200	0	94.8	80	120			
Lithium	0.238	0.0100	0.200	0.0462	96.1	80	120			
Magnesium	15.8	0.300	5.00	12.2	72.5	80	120			S
Molybdenum	0.179	0.00500	0.200	0	89.4	80	120			
Potassium	6.49	0.300	5.00	2.08	88.3	80	120			
Selenium	0.178	0.00500	0.200	0	89.1	80	120			
Sodium	51.5	0.300	5.00	51.9	-7.46	80	120			S
Thallium	0.189	0.00150	0.200	0	94.5	80	120			

Sample ID **1905218-06A MS** Batch ID: **90990** TestNo: **SW6020A** Units: **mg/L**
SampType: **MS** Run ID: **ICP-MS5_190521A** Analysis Date: **5/21/2019 3:46:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.196	0.00250	0.200	0	98.1	80	120			
Arsenic	0.189	0.00500	0.200	0	94.4	80	120			
Barium	0.244	0.0100	0.200	0.0510	96.3	80	120			
Beryllium	0.183	0.00100	0.200	0	91.6	80	120			
Cadmium	0.196	0.00100	0.200	0	98.0	80	120			
Calcium	27.3	0.300	5.00	23.8	69.1	80	120			S
Chromium	0.197	0.00500	0.200	0	98.5	80	120			
Cobalt	0.194	0.00500	0.200	0	96.9	80	120			
Iron	5.24	0.100	5.00	0.186	101	80	120			
Lead	0.193	0.00100	0.200	0	96.5	80	120			
Lithium	0.241	0.0100	0.200	0.0462	97.6	80	120			
Magnesium	16.6	0.300	5.00	12.2	89.7	80	120			
Molybdenum	0.189	0.00500	0.200	0	94.4	80	120			
Potassium	6.74	0.300	5.00	2.08	93.2	80	120			
Selenium	0.183	0.00500	0.200	0	91.3	80	120			
Sodium	53.9	0.300	5.00	51.9	39.6	80	120			S
Thallium	0.192	0.00150	0.200	0	95.8	80	120			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905167
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS5_190521A

Sample ID **1905218-06A MSD**	Batch ID: **90990**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **MSD**	Run ID: **ICP-MS5_190521A**	Analysis Date: **5/21/2019 3:49:00 PM**	Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.199	0.00250	0.200	0	99.3	80	120	1.17	15	
Arsenic	0.189	0.00500	0.200	0	94.3	80	120	0.111	15	
Barium	0.246	0.0100	0.200	0.0510	97.3	80	120	0.778	15	
Beryllium	0.181	0.00100	0.200	0	90.4	80	120	1.36	15	
Cadmium	0.197	0.00100	0.200	0	98.7	80	120	0.775	15	
Calcium	27.4	0.300	5.00	23.8	72.7	80	120	0.665	15	S
Chromium	0.198	0.00500	0.200	0	99.1	80	120	0.607	15	
Cobalt	0.196	0.00500	0.200	0	97.8	80	120	0.893	15	
Iron	5.30	0.100	5.00	0.186	102	80	120	1.09	15	
Lead	0.192	0.00100	0.200	0	96.1	80	120	0.414	15	
Lithium	0.238	0.0100	0.200	0.0462	96.0	80	120	1.33	15	
Magnesium	16.8	0.300	5.00	12.2	92.6	80	120	0.883	15	
Molybdenum	0.191	0.00500	0.200	0	95.7	80	120	1.34	15	
Potassium	6.80	0.300	5.00	2.08	94.5	80	120	0.968	15	
Selenium	0.183	0.00500	0.200	0	91.7	80	120	0.351	15	
Sodium	54.6	0.300	5.00	51.9	54.2	80	120	1.35	15	S
Thallium	0.192	0.00150	0.200	0	96.0	80	120	0.248	15	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905167
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS5_190521A

Sample ID	**ICV-190521**	Batch ID:	**R104204**	TestNo:	**SW6020A**	Units:	**mg/L**
SampType:	**ICV**	Run ID:	**ICP-MS5_190521A**	Analysis Date:	**5/21/2019 12:10:00 PM**	Prep Date:	

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.102	0.00250	0.100	0	102	90	110			
Arsenic	0.103	0.00500	0.100	0	103	90	110			
Barium	0.0990	0.0100	0.100	0	99.0	90	110			
Beryllium	0.0972	0.00100	0.100	0	97.2	90	110			
Cadmium	0.102	0.00100	0.100	0	102	90	110			
Calcium	2.52	0.300	2.50	0	101	90	110			
Chromium	0.103	0.00500	0.100	0	103	90	110			
Cobalt	0.108	0.00500	0.100	0	108	90	110			
Iron	2.60	0.100	2.50	0	104	90	110			
Lead	0.0982	0.00100	0.100	0	98.2	90	110			
Lithium	0.103	0.0100	0.100	0	103	90	110			
Magnesium	2.49	0.300	2.50	0	99.7	90	110			
Molybdenum	0.0930	0.00500	0.100	0	93.0	90	110			
Potassium	2.38	0.300	2.50	0	95.3	90	110			
Selenium	0.104	0.00500	0.100	0	104	90	110			
Sodium	2.56	0.300	2.50	0	103	90	110			
Thallium	0.0977	0.00150	0.100	0	97.7	90	110			

Sample ID	**LCVL-190521**	Batch ID:	**R104204**	TestNo:	**SW6020A**	Units:	**mg/L**
SampType:	**LCVL**	Run ID:	**ICP-MS5_190521A**	Analysis Date:	**5/21/2019 12:15:00 PM**	Prep Date:	

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.00183	0.00250	0.00200	0	91.4	70	130			
Arsenic	0.00504	0.00500	0.00500	0	101	70	130			
Barium	0.00459	0.0100	0.00500	0	91.8	70	130			
Beryllium	0.000968	0.00100	0.00100	0	96.8	70	130			
Cadmium	0.00106	0.00100	0.00100	0	106	70	130			
Calcium	0.104	0.300	0.100	0	104	70	130			
Chromium	0.00482	0.00500	0.00500	0	96.4	70	130			
Cobalt	0.00494	0.00500	0.00500	0	98.7	70	130			
Iron	0.0979	0.100	0.100	0	97.9	70	130			
Lead	0.000882	0.00100	0.00100	0	88.2	70	130			
Lithium	0.00996	0.0100	0.0100	0	99.6	70	130			
Magnesium	0.0983	0.300	0.100	0	98.3	70	130			
Molybdenum	0.00464	0.00500	0.00500	0	92.8	70	130			
Potassium	0.0691	0.300	0.100	0	69.1	70	130			S
Selenium	0.00633	0.00500	0.00500	0	127	70	130			
Sodium	0.0960	0.300	0.100	0	96.0	70	130			
Thallium	0.000944	0.00150	0.00100	0	94.4	70	130			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905167
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **ICP-MS5_190521A**

Sample ID **CCV4-190521**	Batch ID: **R104204**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **CCV**	Run ID: **ICP-MS5_190521A**	Analysis Date: **5/21/2019 3:00:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.203	0.00250	0.200	0	101	90	110			
Arsenic	0.203	0.00500	0.200	0	102	90	110			
Barium	0.202	0.0100	0.200	0	101	90	110			
Beryllium	0.192	0.00100	0.200	0	95.9	90	110			
Cadmium	0.204	0.00100	0.200	0	102	90	110			
Calcium	4.96	0.300	5.00	0	99.3	90	110			
Chromium	0.203	0.00500	0.200	0	101	90	110			
Cobalt	0.213	0.00500	0.200	0	106	90	110			
Iron	5.15	0.100	5.00	0	103	90	110			
Lead	0.198	0.00100	0.200	0	98.8	90	110			
Lithium	0.205	0.0100	0.200	0	103	90	110			
Magnesium	5.15	0.300	5.00	0	103	90	110			
Molybdenum	0.199	0.00500	0.200	0	99.7	90	110			
Potassium	4.83	0.300	5.00	0	96.6	90	110			
Selenium	0.200	0.00500	0.200	0	100	90	110			
Sodium	5.26	0.300	5.00	0	105	90	110			
Thallium	0.197	0.00150	0.200	0	98.4	90	110			

Sample ID **LCVL4-190521**	Batch ID: **R104204**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS5_190521A**	Analysis Date: **5/21/2019 3:05:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.00207	0.00250	0.00200	0	104	70	130			
Arsenic	0.00491	0.00500	0.00500	0	98.1	70	130			
Barium	0.00487	0.0100	0.00500	0	97.5	70	130			
Beryllium	0.000934	0.00100	0.00100	0	93.4	70	130			
Cadmium	0.00104	0.00100	0.00100	0	104	70	130			
Calcium	0.0913	0.300	0.100	0	91.3	70	130			
Chromium	0.00486	0.00500	0.00500	0	97.1	70	130			
Cobalt	0.00525	0.00500	0.00500	0	105	70	130			
Iron	0.101	0.100	0.100	0	101	70	130			
Lead	0.000868	0.00100	0.00100	0	86.8	70	130			
Lithium	0.0102	0.0100	0.0100	0	102	70	130			
Magnesium	0.104	0.300	0.100	0	104	70	130			
Molybdenum	0.00483	0.00500	0.00500	0	96.6	70	130			
Potassium	0.0524	0.300	0.100	0	52.4	70	130			S
Selenium	0.00506	0.00500	0.00500	0	101	70	130			
Sodium	0.144	0.300	0.100	0	144	70	130			S
Thallium	0.000962	0.00150	0.00100	0	96.2	70	130			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905167
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **ICP-MS5_190521A**

Sample ID **CCV5-190521** Batch ID: **R104204** TestNo: **SW6020A** Units: **mg/L**
SampType: **CCV** Run ID: **ICP-MS5_190521A** Analysis Date: **5/21/2019 3:51:00 PM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.197	0.00250	0.200	0	98.5	90	110			
Arsenic	0.199	0.00500	0.200	0	99.7	90	110			
Barium	0.194	0.0100	0.200	0	96.8	90	110			
Beryllium	0.181	0.00100	0.200	0	90.6	90	110			
Cadmium	0.197	0.00100	0.200	0	98.4	90	110			
Calcium	4.83	0.300	5.00	0	96.7	90	110			
Chromium	0.199	0.00500	0.200	0	99.4	90	110			
Cobalt	0.207	0.00500	0.200	0	104	90	110			
Iron	5.09	0.100	5.00	0	102	90	110			
Lead	0.192	0.00100	0.200	0	96.2	90	110			
Lithium	0.198	0.0100	0.200	0	99.0	90	110			
Magnesium	5.01	0.300	5.00	0	100	90	110			
Molybdenum	0.192	0.00500	0.200	0	95.8	90	110			
Potassium	4.71	0.300	5.00	0	94.2	90	110			
Selenium	0.200	0.00500	0.200	0	99.8	90	110			
Sodium	5.09	0.300	5.00	0	102	90	110			
Thallium	0.192	0.00150	0.200	0	95.8	90	110			

Sample ID **LCVL5-190521** Batch ID: **R104204** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCVL** Run ID: **ICP-MS5_190521A** Analysis Date: **5/21/2019 3:55:00 PM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.00208	0.00250	0.00200	0	104	70	130			
Arsenic	0.00481	0.00500	0.00500	0	96.1	70	130			
Barium	0.00469	0.0100	0.00500	0	93.8	70	130			
Beryllium	0.000861	0.00100	0.00100	0	86.1	70	130			
Cadmium	0.000998	0.00100	0.00100	0	99.8	70	130			
Calcium	0.102	0.300	0.100	0	102	70	130			
Chromium	0.00463	0.00500	0.00500	0	92.5	70	130			
Cobalt	0.00508	0.00500	0.00500	0	102	70	130			
Iron	0.0987	0.100	0.100	0	98.7	70	130			
Lead	0.000837	0.00100	0.00100	0	83.7	70	130			
Lithium	0.00978	0.0100	0.0100	0	97.8	70	130			
Magnesium	0.0989	0.300	0.100	0	98.9	70	130			
Molybdenum	0.00479	0.00500	0.00500	0	95.8	70	130			
Potassium	0.0352	0.300	0.100	0	35.2	70	130			S
Selenium	0.00485	0.00500	0.00500	0	97.0	70	130			
Sodium	0.135	0.300	0.100	0	135	70	130			S
Thallium	0.000929	0.00150	0.00100	0	92.9	70	130			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT:	Golder		
Work Order:	1905167		
Project:	Luminant-MLSES Ash Ponds	**RunID:**	**IC2_190515A**

ANALYTICAL QC SUMMARY REPORT

The QC data in batch 90908 applies to the following samples: 1905167-01C, 1905167-02C

Sample ID **MB-90908** Batch ID: **90908** TestNo: **E300** Units: **mg/L**
SampType: **MBLK** Run ID: **IC2_190515A** Analysis Date: **5/15/2019 10:10:50 AM** Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	<0.300	1.00								
Fluoride	<0.100	0.400								
Nitrate-N	<0.100	0.500								
Sulfate	<1.00	3.00								

Sample ID **LCS-90908** Batch ID: **90908** TestNo: **E300** Units: **mg/L**
SampType: **LCS** Run ID: **IC2_190515A** Analysis Date: **5/15/2019 10:26:50 AM** Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	10.1	1.00	10.00	0	101	90	110			
Fluoride	4.00	0.400	4.000	0	99.9	90	110			
Nitrate-N	5.09	0.500	5.000	0	102	90	110			
Sulfate	30.4	3.00	30.00	0	101	90	110			

Sample ID **LCSD-90908** Batch ID: **90908** TestNo: **E300** Units: **mg/L**
SampType: **LCSD** Run ID: **IC2_190515A** Analysis Date: **5/15/2019 10:42:50 AM** Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	10.2	1.00	10.00	0	102	90	110	0.674	20	
Fluoride	4.05	0.400	4.000	0	101	90	110	1.26	20	
Nitrate-N	5.08	0.500	5.000	0	102	90	110	0.146	20	
Sulfate	30.9	3.00	30.00	0	103	90	110	1.55	20	

Sample ID **1905167-01CMS** Batch ID: **90908** TestNo: **E300** Units: **mg/L**
SampType: **MS** Run ID: **IC2_190515A** Analysis Date: **5/15/2019 1:07:36 PM** Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	222	10.0	200.0	12.69	105	90	110			
Fluoride	211	4.00	200.0	0	106	90	110			
Nitrate-N	45.6	5.00	45.16	0	101	90	110			
Sulfate	239	30.0	200.0	41.32	98.7	90	110			

Sample ID **1905167-01CMSD** Batch ID: **90908** TestNo: **E300** Units: **mg/L**
SampType: **MSD** Run ID: **IC2_190515A** Analysis Date: **5/15/2019 1:23:36 PM** Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	221	10.0	200.0	12.69	104	90	110	0.308	20	
Fluoride	210	4.00	200.0	0	105	90	110	0.286	20	
Nitrate-N	45.8	5.00	45.16	0	101	90	110	0.495	20	
Sulfate	237	30.0	200.0	41.32	97.7	90	110	0.821	20	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905167
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: IC2_190515A

Sample ID **1905167-02CMS**	Batch ID: **90908**	TestNo: **E300**	Units: **mg/L**
SampType: **MS**	Run ID: **IC2_190515A**	Analysis Date: **5/15/2019 1:55:36 PM**	Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	686	10.0	200.0	528.8	78.8	90	110			S
Fluoride	229	4.00	200.0	24.26	102	90	110			
Nitrate-N	56.2	5.00	45.16	10.55	101	90	110			
Sulfate	2520	30.0	200.0	0	1260	90	110			S

Sample ID **1905167-02CMSD**	Batch ID: **90908**	TestNo: **E300**	Units: **mg/L**
SampType: **MSD**	Run ID: **IC2_190515A**	Analysis Date: **5/15/2019 2:11:36 PM**	Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	688	10.0	200.0	528.8	79.8	90	110	0.292	20	S
Fluoride	229	4.00	200.0	24.26	102	90	110	0.251	20	
Nitrate-N	57.3	5.00	45.16	10.55	103	90	110	1.85	20	
Sulfate	<10.0	30.0	200.0	0	0	90	110	0	20	S

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905167
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: IC2_190515A

Sample ID	**ICV-190515**	Batch ID:	**R104097**	TestNo:	**E300**	Units:	**mg/L**
SampType:	**ICV**	Run ID:	**IC2_190515A**	Analysis Date:	**5/15/2019 9:38:50 AM**	Prep Date:	

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	25.8	1.00	25.00	0	103	90	110			
Fluoride	10.3	0.400	10.00	0	103	90	110			
Nitrate-N	13.0	0.500	12.50	0	104	90	110			
Sulfate	77.8	3.00	75.00	0	104	90	110			

Sample ID	**CCV1-190515**	Batch ID:	**R104097**	TestNo:	**E300**	Units:	**mg/L**
SampType:	**CCV**	Run ID:	**IC2_190515A**	Analysis Date:	**5/15/2019 4:51:36 PM**	Prep Date:	

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	10.4	1.00	10.00	0	104	90	110			
Fluoride	4.15	0.400	4.000	0	104	90	110			
Nitrate-N	5.13	0.500	5.000	0	103	90	110			
Sulfate	30.8	3.00	30.00	0	103	90	110			

Sample ID	**CCV2-190515**	Batch ID:	**R104097**	TestNo:	**E300**	Units:	**mg/L**
SampType:	**CCV**	Run ID:	**IC2_190515A**	Analysis Date:	**5/15/2019 8:35:35 PM**	Prep Date:	

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	10.6	1.00	10.00	0	106	90	110			
Fluoride	4.20	0.400	4.000	0	105	90	110			
Nitrate-N	5.20	0.500	5.000	0	104	90	110			
Sulfate	31.5	3.00	30.00	0	105	90	110			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905167
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: IC4_190516A

The QC data in batch 90935 applies to the following samples: 1905167-02C

Sample ID **MB-90935** Batch ID: **90935** TestNo: **E300** Units: **mg/L**
SampType: **MBLK** Run ID: **IC4_190516A** Analysis Date: **5/16/2019 10:26:21 AM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	<0.300	1.00								
Sulfate	<1.00	3.00								

Sample ID **LCS-90935** Batch ID: **90935** TestNo: **E300** Units: **mg/L**
SampType: **LCS** Run ID: **IC4_190516A** Analysis Date: **5/16/2019 10:42:21 AM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	9.61	1.00	10.00	0	96.1	90	110			
Sulfate	29.5	3.00	30.00	0	98.3	90	110			

Sample ID **LCSD-90935** Batch ID: **90935** TestNo: **E300** Units: **mg/L**
SampType: **LCSD** Run ID: **IC4_190516A** Analysis Date: **5/16/2019 10:58:21 AM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	9.68	1.00	10.00	0	96.8	90	110	0.745	20	
Sulfate	29.8	3.00	30.00	0	99.2	90	110	0.935	20	

Sample ID **1905167-02CMS** Batch ID: **90935** TestNo: **E300** Units: **mg/L**
SampType: **MS** Run ID: **IC4_190516A** Analysis Date: **5/16/2019 5:10:27 PM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	2490	100	2000	512.8	98.6	90	110			
Sulfate	4830	300	2000	2897	96.9	90	110			

Sample ID **1905167-02CMSD** Batch ID: **90935** TestNo: **E300** Units: **mg/L**
SampType: **MSD** Run ID: **IC4_190516A** Analysis Date: **5/16/2019 5:26:27 PM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	2500	100	2000	512.8	99.4	90	110	0.622	20	
Sulfate	4880	300	2000	2897	99.1	90	110	0.920	20	

Sample ID **1905168-01CMS** Batch ID: **90935** TestNo: **E300** Units: **mg/L**
SampType: **MS** Run ID: **IC4_190516A** Analysis Date: **5/16/2019 5:58:26 PM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	2170	100	2000	212.8	98.1	90	110			
Sulfate	4380	300	2000	2468	95.6	90	110			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905167
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **IC4_190516A**

Sample ID **1905168-01CMSD**	Batch ID: **90935**	TestNo: **E300**	Units: **mg/L**
SampType: **MSD**	Run ID: **IC4_190516A**	Analysis Date: **5/16/2019 6:14:27 PM**	Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	2170	100	2000	212.8	97.8	90	110	0.235	20	
Sulfate	4390	300	2000	2468	96.2	90	110	0.273	20	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905167
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: IC4_190516A

Sample ID **ICV-190516**	Batch ID: **R104119**	TestNo: **E300**	Units: **mg/L**
SampType: **ICV**	Run ID: **IC4_190516A**	Analysis Date: **5/16/2019 9:54:21 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	24.7	1.00	25.00	0	99.0	90	110			
Sulfate	74.5	3.00	75.00	0	99.4	90	110			

Sample ID **CCV1-190516**	Batch ID: **R104119**	TestNo: **E300**	Units: **mg/L**
SampType: **CCV**	Run ID: **IC4_190516A**	Analysis Date: **5/16/2019 9:10:26 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	9.75	1.00	10.00	0	97.5	90	110			
Sulfate	30.2	3.00	30.00	0	101	90	110			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905167
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **TITRATOR_190516A**

The QC data in batch 90940 applies to the following samples: 1905167-01C, 1905167-02C

Sample ID **MB-90940** Batch ID: **90940** TestNo: **M2320 B** Units: **mg/L @ pH 4.47**
SampType: **MBLK** Run ID: **TITRATOR_190516A** Analysis Date: **5/16/2019 2:00:00 PM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	<10.0	20.0								
Alkalinity, Carbonate (As CaCO3)	<10.0	20.0								
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0								
Alkalinity, Total (As CaCO3)	<20.0	20.0								

Sample ID **LCS-90940** Batch ID: **90940** TestNo: **M2320 B** Units: **mg/L @ pH 4.08**
SampType: **LCS** Run ID: **TITRATOR_190516A** Analysis Date: **5/16/2019 2:04:00 PM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Total (As CaCO3)	52.3	20.0	50.00	0	105	74	129			

Sample ID **1905134-01C DUP** Batch ID: **90940** TestNo: **M2320 B** Units: **mg/L @ pH 4.52**
SampType: **DUP** Run ID: **TITRATOR_190516A** Analysis Date: **5/16/2019 2:15:00 PM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	205	20.0	0	205.8				0.536	20	
Alkalinity, Carbonate (As CaCO3)	<10.0	20.0	0	0				0	20	
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0	0	0				0	20	
Alkalinity, Total (As CaCO3)	205	20.0	0	205.8				0.536	20	

Sample ID **1905168-05C DUP** Batch ID: **90940** TestNo: **M2320 B** Units: **mg/L @ pH 4.51**
SampType: **DUP** Run ID: **TITRATOR_190516A** Analysis Date: **5/16/2019 4:30:00 PM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	<10.0	20.0	0	0				0	20	
Alkalinity, Carbonate (As CaCO3)	<10.0	20.0	0	0				0	20	
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0	0	0				0	20	
Alkalinity, Total (As CaCO3)	<20.0	20.0	0	0				0	20	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905167
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **TITRATOR_190516A**

Sample ID **ICV-190516**	Batch ID: **R104124**	TestNo: **M2320 B**	Units: **mg/L @ pH 4.34**
SampType: **ICV**	Run ID: **TITRATOR_190516A**	Analysis Date: **5/16/2019 1:58:00 PM**	Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	8.64	20.0	0							
Alkalinity, Carbonate (As CaCO3)	89.3	20.0	0							
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0	0							
Alkalinity, Total (As CaCO3)	97.9	20.0	100.0	0	97.9	98	102			

Sample ID **CCV1-190516**	Batch ID: **R104124**	TestNo: **M2320 B**	Units: **mg/L @ pH 4.25**
SampType: **CCV**	Run ID: **TITRATOR_190516A**	Analysis Date: **5/16/2019 3:39:00 PM**	Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	21.7	20.0	0							
Alkalinity, Carbonate (As CaCO3)	76.8	20.0	0							
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0	0							
Alkalinity, Total (As CaCO3)	98.5	20.0	100.0	0	98.5	90	110			

Sample ID **CCV2-190516**	Batch ID: **R104124**	TestNo: **M2320 B**	Units: **mg/L @ pH 4.21**
SampType: **CCV**	Run ID: **TITRATOR_190516A**	Analysis Date: **5/16/2019 4:35:00 PM**	Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	17.7	20.0	0							
Alkalinity, Carbonate (As CaCO3)	81.3	20.0	0							
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0	0							
Alkalinity, Total (As CaCO3)	99.0	20.0	100.0	0	99.0	90	110			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905167
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: UV/VIS_2_190515B

The QC data in batch 90921 applies to the following samples: 1905167-01C, 1905167-02C

Sample ID **MB-90921** Batch ID: **90921** TestNo: **M4500-P E** Units: **mg/L**
SampType: **MBLK** Run ID: **UV/VIS_2_190515B** Analysis Date: **5/15/2019 12:42:00 PM** Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	<0.0300	0.100								

Sample ID **LCS-90921** Batch ID: **90921** TestNo: **M4500-P E** Units: **mg/L**
SampType: **LCS** Run ID: **UV/VIS_2_190515B** Analysis Date: **5/15/2019 12:43:00 PM** Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.513	0.100	0.5000	0	103	80	120			

Sample ID **LCSD-90921** Batch ID: **90921** TestNo: **M4500-P E** Units: **mg/L**
SampType: **LCSD** Run ID: **UV/VIS_2_190515B** Analysis Date: **5/15/2019 12:43:00 PM** Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.504	0.100	0.5000	0	101	80	120	1.77	15	

Sample ID **1905168-01CMS** Batch ID: **90921** TestNo: **M4500-P E** Units: **mg/L**
SampType: **MS** Run ID: **UV/VIS_2_190515B** Analysis Date: **5/15/2019 12:45:00 PM** Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.587	0.100	0.5000	0.07700	102	80	120			

Sample ID **1905168-01CMSD** Batch ID: **90921** TestNo: **M4500-P E** Units: **mg/L**
SampType: **MSD** Run ID: **UV/VIS_2_190515B** Analysis Date: **5/15/2019 12:45:00 PM** Prep Date: **5/15/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.525	0.100	0.5000	0.07700	89.6	80	120	11.2	15	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905167
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: UV/VIS_2_190515B

Sample ID **ICV-190515**	Batch ID: **R104071**	TestNo: **M4500-P E**	Units: **mg/L**
SampType: **ICV**	Run ID: **UV/VIS_2_190515B**	Analysis Date: **5/15/2019 12:41:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.204	0.100	0.2000	0	102	85	115			

Sample ID **CCV1-190515**	Batch ID: **R104071**	TestNo: **M4500-P E**	Units: **mg/L**
SampType: **CCV**	Run ID: **UV/VIS_2_190515B**	Analysis Date: **5/15/2019 12:51:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.509	0.100	0.5000	0	102	85	115			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905167
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: UV/VIS_2_190520A

The QC data in batch 91002 applies to the following samples: 1905167-01A, 1905167-02A

Sample ID **MB-91002** Batch ID: **91002** TestNo: **M3500-Fe D** Units: **mg/L**
SampType: **MBLK** Run ID: **UV/VIS_2_190520A** Analysis Date: **5/20/2019 3:53:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	<0.0500	0.100								N

Sample ID **LCS-91002** Batch ID: **91002** TestNo: **M3500-Fe D** Units: **mg/L**
SampType: **LCS** Run ID: **UV/VIS_2_190520A** Analysis Date: **5/20/2019 3:53:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.0888	0.100	0.1000	0	88.8	85	115			N

Sample ID **LCSD-91002** Batch ID: **91002** TestNo: **M3500-Fe D** Units: **mg/L**
SampType: **LCSD** Run ID: **UV/VIS_2_190520A** Analysis Date: **5/20/2019 3:53:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.0879	0.100	0.1000	0	87.9	85	115	1.05	15	N

Sample ID **1905185-11AMS** Batch ID: **91002** TestNo: **M3500-Fe D** Units: **mg/L**
SampType: **MS** Run ID: **UV/VIS_2_190520A** Analysis Date: **5/20/2019 4:03:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.0860	0.100	0.1000	0	86.0	85	115			N

Sample ID **1905185-11AMSD** Batch ID: **91002** TestNo: **M3500-Fe D** Units: **mg/L**
SampType: **MSD** Run ID: **UV/VIS_2_190520A** Analysis Date: **5/20/2019 4:03:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.0861	0.100	0.1000	0	86.1	85	115	0.116	15	N

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905167
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **UV/VIS_2_190520A**

Sample ID **ICV-190520**	Batch ID: **R104177**	TestNo: **M3500-Fe D**	Units: **mg/L**
SampType: **ICV**	Run ID: **UV/VIS_2_190520A**	Analysis Date: **5/20/2019 3:52:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.0875	0.100	0.1000	0	87.5	85	115			N

Sample ID **CCV1-190520**	Batch ID: **R104177**	TestNo: **M3500-Fe D**	Units: **mg/L**
SampType: **CCV**	Run ID: **UV/VIS_2_190520A**	Analysis Date: **5/20/2019 3:59:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.197	0.100	0.2000	0	98.4	85	115			N

Sample ID **CCV2-190520**	Batch ID: **R104177**	TestNo: **M3500-Fe D**	Units: **mg/L**
SampType: **CCV**	Run ID: **UV/VIS_2_190520A**	Analysis Date: **5/20/2019 4:12:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.183	0.100	0.2000	0	91.7	85	115			N

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905167
Project: Luminant-MLSES Ash Ponds

ANALYTICAL QC SUMMARY REPORT

RunID: **WC_190517D**

The QC data in batch 90953 applies to the following samples: 1905167-01C, 1905167-02C

Sample ID **MB-90953** Batch ID: **90953** TestNo: **M2540C** Units: **mg/L**
SampType: **MBLK** Run ID: **WC_190517D** Analysis Date: **5/17/2019 11:40:00 AM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids (Residue, Filtera	<10.0	10.0								

Sample ID **LCS-90953** Batch ID: **90953** TestNo: **M2540C** Units: **mg/L**
SampType: **LCS** Run ID: **WC_190517D** Analysis Date: **5/17/2019 11:40:00 AM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids (Residue, Filtera	745	10.0	745.6	0	99.9	90	113			

Sample ID **1905167-02C-DUP** Batch ID: **90953** TestNo: **M2540C** Units: **mg/L**
SampType: **DUP** Run ID: **WC_190517D** Analysis Date: **5/17/2019 11:40:00 AM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids (Residue, Filtera	5340	50.0	0	5375				0.747	5	

Sample ID **1905168-02C-DUP** Batch ID: **90953** TestNo: **M2540C** Units: **mg/L**
SampType: **DUP** Run ID: **WC_190517D** Analysis Date: **5/17/2019 11:40:00 AM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids (Residue, Filtera	940	50.0	0	910.0				3.24	5	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

Pace Analytical®
National Center for Testing & Innovation

ANALYTICAL REPORT

May 29, 2019

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
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8 Al
9 Sc

DHL Analytical, Inc.

Sample Delivery Group:	L1100947
Samples Received:	05/21/2019
Project Number:	1905167
Description:	
Report To:	John DuPont 2300 Double Creek Drive Round Rock, TX 78664

Entire Report Reviewed By: D Eidson

Donna Eidson
Project Manager

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by Pace National is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

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LAKE SAMPLE L1100947-01 Non-Potable Water

Collected by	Collected date/time	Received date/time
	05/14/19 10:05	05/21/19 10:10

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 904	WG1284744	1	05/22/19 08:25	05/28/19 10:55	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1284773	1	05/23/19 15:02	05/28/19 10:55	RRE	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1284773	1	05/23/19 15:02	05/24/19 17:05	RRE	Mt. Juliet, TN

LAKE SAMPLE L1100947-02 Non-Potable Water

Collected by	Collected date/time	Received date/time
	05/14/19 10:20	05/21/19 10:10

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 904	WG1284744	1	05/22/19 08:25	05/28/19 10:55	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1284773	1	05/23/19 15:02	05/28/19 10:55	RRE	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1284773	1	05/23/19 15:02	05/24/19 17:05	RRE	Mt. Juliet, TN

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. Where applicable, all MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

DEidson

Donna Eidson
Project Manager

Radiochemistry by Method 904

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.369		0.449	0.769	05/28/2019 10:55	WG1284744
(T) Barium	*102*			*62.0-143*	*05/28/2019 10:55*	WG1284744
(T) Yttrium	*118*			*79.0-136*	*05/28/2019 10:55*	WG1284744

Radiochemistry by Method Calculation

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
Combined Radium	0.772		0.734	1.08	05/28/2019 10:55	WG1284773

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-226	0.403		0.285	0.311	05/24/2019 17:05	WG1284773
(T) Barium-133	*92.1*			*30.0-143*	*05/24/2019 17:05*	WG1284773

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Radiochemistry by Method 904

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	-0.0402		0.349	0.599	05/28/2019 10:55	WG1284744
(T) Barium	*113*			*62.0-143*	*05/28/2019 10:55*	WG1284744
(T) Yttrium	*114*			*79.0-136*	*05/28/2019 10:55*	WG1284744

Radiochemistry by Method Calculation

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
Combined Radium	0.853		0.752	0.895	05/28/2019 10:55	WG1284773

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-226	0.853		0.403	0.296	05/24/2019 17:05	WG1284773
(T) Barium-133	*83.8*			*30.0-143*	*05/24/2019 17:05*	WG1284773

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Method Blank (MB)

(MB) R3415641-1 05/28/19 10:55

Analyte	MB Result	MB Qualifier	MB MDA
	pCi/l		pCi/l
Radium-228	-0.164		0.413
(T) Barium	*108*		
(T) Yttrium	*115*		

L1100192-01 Original Sample (OS) • Duplicate (DUP)

(OS) L1100192-01 05/28/19 10:55 • (DUP) R3415641-5 05/28/19 10:55

Analyte	Original Result	DUP Result	Dilution	DUP RPD	DUP RER	DUP Qualifier	DUP RPD Limits	DUP RER Limit
	pCi/l	pCi/l		%			%	
Radium-228	0.157	-0.0367	1	200	0.366		20	3
(T) Barium	*91.7*	*102*						
(T) Yttrium	*110*	*107*						

Laboratory Control Sample (LCS)

(LCS) R3415641-2 05/28/19 10:55

Analyte	Spike Amount	LCS Result	LCS Rec.	Rec. Limits	LCS Qualifier
	pCi/l	pCi/l	%	%	
Radium-228	5.00	4.47	89.4	80.0-120	
(T) Barium			*103*		
(T) Yttrium			*107*		

L1100922-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1100922-01 05/28/19 10:55 • (MS) R3415641-3 05/28/19 10:55 • (MSD) R3415641-4 05/28/19 10:55

Analyte	Spike Amount	Original Result	MS Result	MSD Result	MS Rec.	MSD Rec.	Dilution	Rec. Limits	MS Qualifier	MSD Qualifier	RPD	MS RER	RPD Limits
	pCi/l	pCi/l	pCi/l	pCi/l	%	%		%			%		%
Radium-228	7.14	-0.136	7.62	7.50	107	105	1	70.0-130			1.50		20
(T) Barium		*111*			*107*	*110*							
(T) Yttrium		*114*			*107*	*110*							

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2 Tc
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Method Blank (MB)

(MB) R3415635-1 05/24/19 17:04

Analyte	MB Result	MB Qualifier	MB MDA
	pCi/l		pCi/l
Radium-226	0.459		0.209
(T) Barium-133	*84.6*		

L1100844-01 Original Sample (OS) • Duplicate (DUP)

(OS) L1100844-01 05/24/19 17:04 • (DUP) R3415635-5 05/24/19 17:04

Analyte	Original Result	DUP Result	Dilution	DUP RPD	DUP RER	DUP Qualifier	DUP RPD Limits	DUP RER Limit
	pCi/l	pCi/l		%			%	
Radium-226	0.495	0.573	1	14.6	0.182		20	3
(T) Barium-133	*90.4*	*88.8*						

Laboratory Control Sample (LCS)

(LCS) R3415635-2 05/24/19 17:04

Analyte	Spike Amount	LCS Result	LCS Rec.	Rec. Limits	LCS Qualifier
	pCi/l	pCi/l	%	%	
Radium-226	20.1	19.1	95.0	80.0-120	
(T) Barium-133			*79.1*		

L1100433-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1100433-01 05/24/19 17:04 • (MS) R3415635-3 05/24/19 17:04 • (MSD) R3415635-4 05/24/19 17:04

Analyte	Spike Amount	Original Result	MS Result	MSD Result	MS Rec.	MSD Rec.	Dilution	Rec. Limits	MS Qualifier	MSD Qualifier	RPD	MS RER	RPD Limits
	pCi/l	pCi/l	pCi/l	pCi/l	%	%		%			%		%
Radium-226	20.1	1.16	19.9	20.9	93.2	98.0	1	75.0-125			4.71		20
(T) Barium-133		*83.2*			*81.1*	*84.7*							

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
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9 Sc

Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

Abbreviations and Definitions

MDA	Minimum Detectable Activity.
Rec.	Recovery.
RER	Replicate Error Ratio.
RPD	Relative Percent Difference.
SDG	Sample Delivery Group.
(T)	Tracer - A radioisotope of known concentration added to a solution of chemically equivalent radioisotopes at a known concentration to assist in monitoring the yield of the chemical separation.
Analyte	The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported.
Dilution	If the sample matrix contains an interfering material, the sample preparation volume or weight values differ from the standard, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor.
Limits	These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges.
Original Sample	The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG.
Qualifier	This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable.
Result	The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state "ND" (Not Detected) or "BDL" (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte.
Uncertainty (Radiochemistry)	Confidence level of 2 sigma.
Case Narrative (Cn)	A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report.
Quality Control Summary (Qc)	This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material.
Sample Chain of Custody (Sc)	This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis.
Sample Results (Sr)	This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported.
Sample Summary (Ss)	This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis.

Qualifier	Description
	The remainder of this page intentionally left blank, there are no qualifiers applied to this SDG.

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
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9 Sc

Pace National is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our one location design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be YOUR LAB OF CHOICE.
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.
* Accreditation is only applicable to the test methods specified on each scope of accreditation held by Pace National.

State Accreditations

Alabama	40660
Alaska	17-026
Arizona	AZ0612
Arkansas	88-0469
California	2932
Colorado	TN00003
Connecticut	PH-0197
Florida	E87487
Georgia	NELAP
Georgia [1]	923
Idaho	TN00003
Illinois	200008
Indiana	C-TN-01
Iowa	364
Kansas	E-10277
Kentucky [1 6]	90010
Kentucky [2]	16
Louisiana	AI30792
Louisiana [1]	LA180010
Maine	TN0002
Maryland	324
Massachusetts	M-TN003
Michigan	9958
Minnesota	047-999-395
Mississippi	TN00003
Missouri	340
Montana	CERT0086
Nebraska	NE-OS-15-05
Nevada	TN-03-2002-34
New Hampshire	2975
New Jersey–NELAP	TN002
New Mexico [1]	n/a
New York	11742
North Carolina	Env375
North Carolina [1]	DW21704
North Carolina [3]	41
North Dakota	R-140
Ohio–VAP	CL0069
Oklahoma	9915
Oregon	TN200002
Pennsylvania	68-02979
Rhode Island	LAO00356
South Carolina	84004
South Dakota	n/a
Tennessee [1 4]	2006
Texas	T104704245-18-15
Texas [5]	LAB0152
Utah	TN00003
Vermont	VT2006
Virginia	460132
Washington	C847
West Virginia	233
Wisconsin	9980939910
Wyoming	A2LA

Third Party Federal Accreditations

A2LA – ISO 17025	1461.01
A2LA – ISO 17025 [5]	1461.02
Canada	1461.01
EPA–Crypto	TN00003
AIHA-LAP,LLC EMLAP	100789
DOD	1461.01
USDA	P330-15-00234

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [6] Wastewater n/a Accreditation not applicable

Our Locations

Pace National has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. Pace National performs all testing at our central laboratory.

Pace Analytical National Center for Testing & Innovation
Cooler Receipt Form

Client: DHLRRTX	SDG#: 1100947
Cooler Received/Opened On: 5/21/19	Temperature: Amb
Received By: Brock Fariss	
Signature: Fariss	

Receipt Check List	NP	Yes	No
COC Seal Present / Intact?	✓		
COC Signed / Accurate?		✓	
Bottles arrive intact?		✓	
Correct bottles used?		✓	
Sufficient volume sent?		✓	
If Applicable			
VOA Zero headspace?			
Preservation Correct / Checked?		✓	

1100947

CHAIN-OF-CUSTODY RECORD

H004

DHL Analytical, Inc.
2300 Double Creek Drive
Round Rock, TX 78664
TEL: (512) 388-8222 FAX: (512) 388-8229

Work Order: 1905167

Subcontractor:
Pace Analytical
12065 Lebanon Rd
Mt. Juliet, TN 37122

TEL: (615) 773-5923
FAX:
Acct #: DHLRRTX

15-May-19

Sample Id	Matrix	DHL#	Date Collected	Bottle Type	E904.0 (Ra-228)	M7500 Ra B M (Ra-226)	Requested Tests			
Lake Sample	Aqueous	-01D	05/14/19 10:05 AM	1LHDPEHNO3		1				-01
Lake Sample	Aqueous	-01E	05/14/19 10:05 AM	1LHDPEHNO3	1					01
Pond Sample	Aqueous	-02D	05/14/19 10:20 AM	1LHDPEHNO3		1				02
Pond Sample	Aqueous	-02E	05/14/19 10:20 AM	1LHDPEHNO3	1					02

General Comments: Please analyze these samples with Normal Turnaround Time.
Report RA-226, Ra-228 & Combined per Specs.
Quality Control Package Needed: Standard - NELAC Rad Test compliant
Email to cac@dhlanalytical.com & dupont@dhlanalytical.com

		Date/Time			Date/Time
Relinquished by:	[signature]	5/17/19 1700	**Received by:**	[signature]	5/21/19 1010
Relinquished by:			**Received by:**		

AWO

VPS
Rec: 4

... 5 mR/hr

Quantitative X-Ray Diffraction by Rietveld Refinement

Report Prepared for:	*Golder Associates - Will Vienne*
Project Number/ LIMS No.	*17431-01 / MI7012-JUN19*
Batch:	*Martin Lake Ash Ponds*
Sample Receipt:	*June 13, 2019*
Sample Analysis:	*June 28, 2019*
Reporting Date:	*July 19, 2019*
Instrument:	Panalytical X'pert Pro Diffractometer
Test Conditions:	Co radiation, 40 kV, 45 mA Regular Scanning: Step: 0.033°, Step time:0.15s, 2θ range: 6-70°
Interpretations :	HighScore Plus software using Crystallography Open Database (COD) and Joint Committee on Powder Diffraction Standards -International Center for Diffraction Data (JCPDS-ICDD).
Detection Limit :	0.5-2%. Strongly dependent on crystallinity.

Contents:

Ben Eaton
Junior Mineralogist

Lain Glossop H.B.Sc
Senior Mineralogist

SGS Minerals
a division of SGS Canada Inc.
3260 Production Way, Burnaby, British Columbia, Canada V5A 4W4
Tel: (604) 638-2349 Fax: (604) 444-5486 www.sgs.com www.sgs.com/met
Member of the SGS Group (SGS SA)

Method Summary

Mineral Identification and Interpretation:

Mineral identification and interpretation involve matching the diffraction pattern of a test sample material to patterns of single-phase reference materials. The reference patterns from the Crystallography Open Database (COD) and the Joint Committee on Powder Diffraction Standards - International Center for Diffraction Data (JCPDS-ICDD).

Interpretations do not reflect the presence of non-crystalline and/or amorphous compounds, except when internal standards have been added by request. Mineral proportions may be strongly influenced by crystallinity, crystal structure and preferred orientations. Mineral or compound identification and quantitative analysis results should be accompanied by supporting chemical assay data or other additional tests.

Quantitative Rietveld Analysis:

Panalytical HighScore Plus software was used to perform the quantitative Rietveld Analysis. This software uses a graphics based profile analysis program built around a non-linear least squares fitting system, to quantitatively determine the amount of different phases present in a multicomponent sample. Whole pattern analyses are predicated by the fact that the X-ray diffraction pattern is a total sum of both instrumental and specimen factors. Unlike other peak intensity-based methods, the Rietveld method uses a least squares approach to refine a theoretical line profile (shown as a blue pattern in the analyses plots) until it matches the obtained experimental patterns (shown as the coloured pattern in the analyses plots).

Rietveld refinement is completed with a set of minerals specifically identified for the sample. Zero values indicate that the mineral was included in the refinement calculations, but the calculated concentration was less than 0.5 wt%. Minerals not identified by the analyst are not included in refinement calculations for specific samples and are indicated with a dash.

SGS Minerals
a division of SGS Canada Inc.
3260 Production Way, Burnaby, British Columbia, Canada V5A 4W4
Tel: (604) 638-2349 Fax: (604) 444-5486 www.sgs.com www.sgs.com/met
Member of the SGS Group (SGS SA)

Summary of Rietveld Quantitative Analysis X-ray Diffraction Results

Quantitative X-ray Diffraction Results

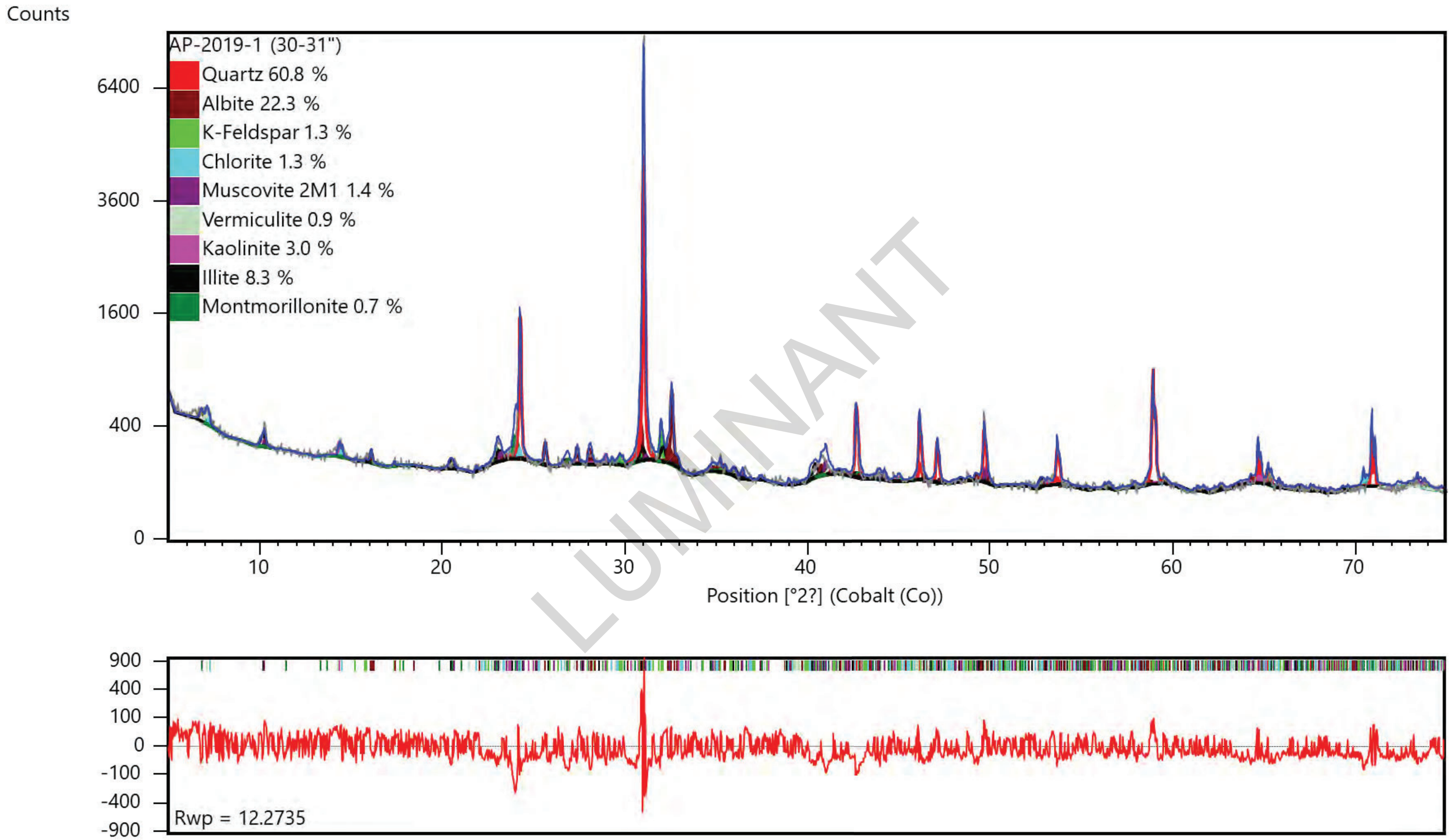
Mineral/Compound	1 AP-2019-1 (30-31") (wt %)	2 AP-2019-2 (35-36") (wt %)	3 AP-2019-3 (18-19") (wt %)
Quartz	60.8	66.0	99.2
Albite	22.3	16.2	0.8
K-Feldspar	1.3	1.4	--
Chlorite	1.3	2.7	--
Muscovite	1.4	3.2	--
*Vermiculite	0.9	0.7	--
*Kaolinite	3.0	3.4	--
Illite	8.3	6.1	--
*Montmorillonite	0.7	0.4	--
TOTAL	100	100	100

Zero values indicate that the mineral was included in the refinement, but the calculated concentration is below a measurable value.

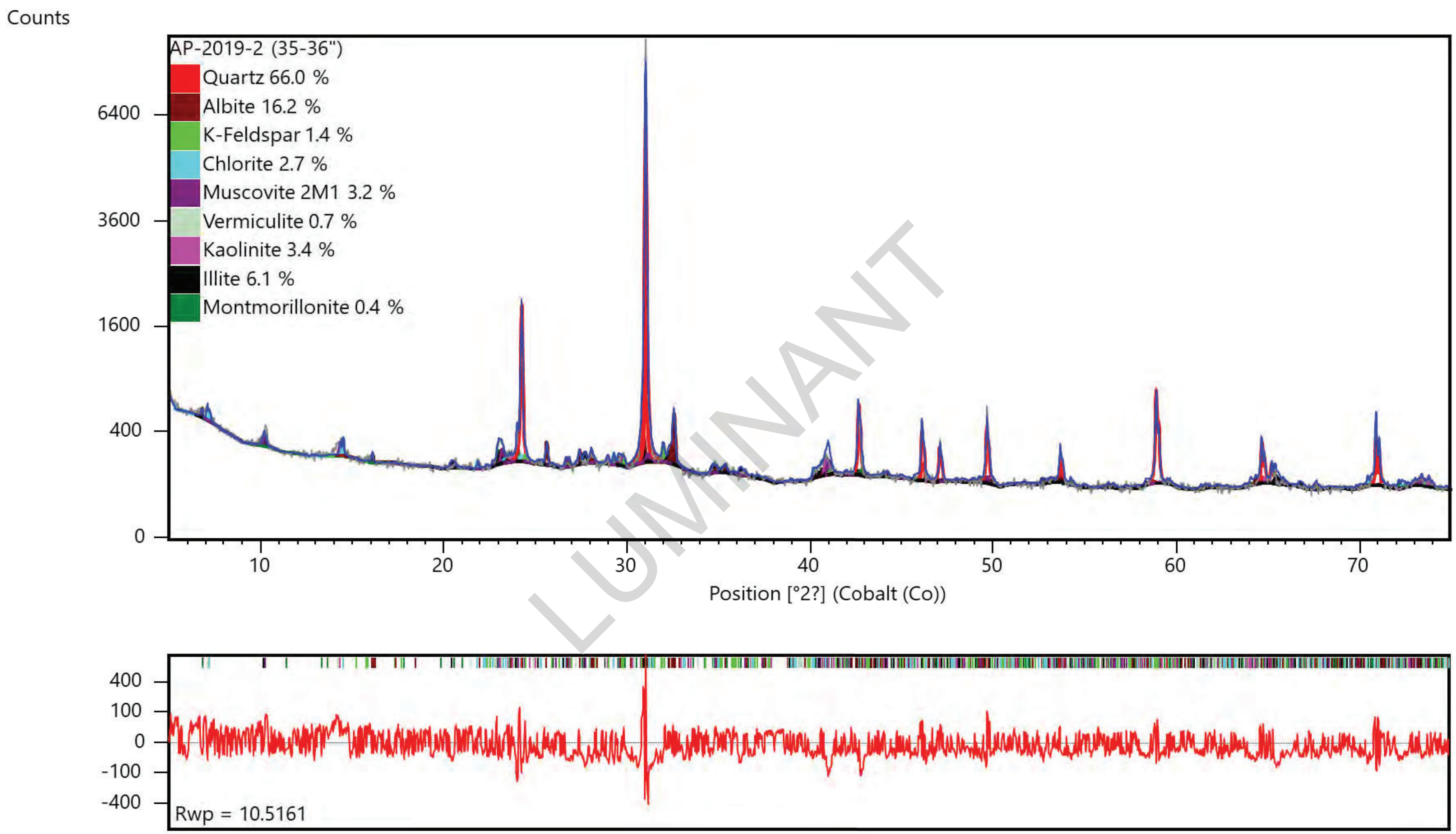
Dashes indicate that the mineral was not identified by the analyst and not included in the refinement calculation for the sample.

** Tentative identification of clays only, further clay XRD analysis will be required for positive identification*

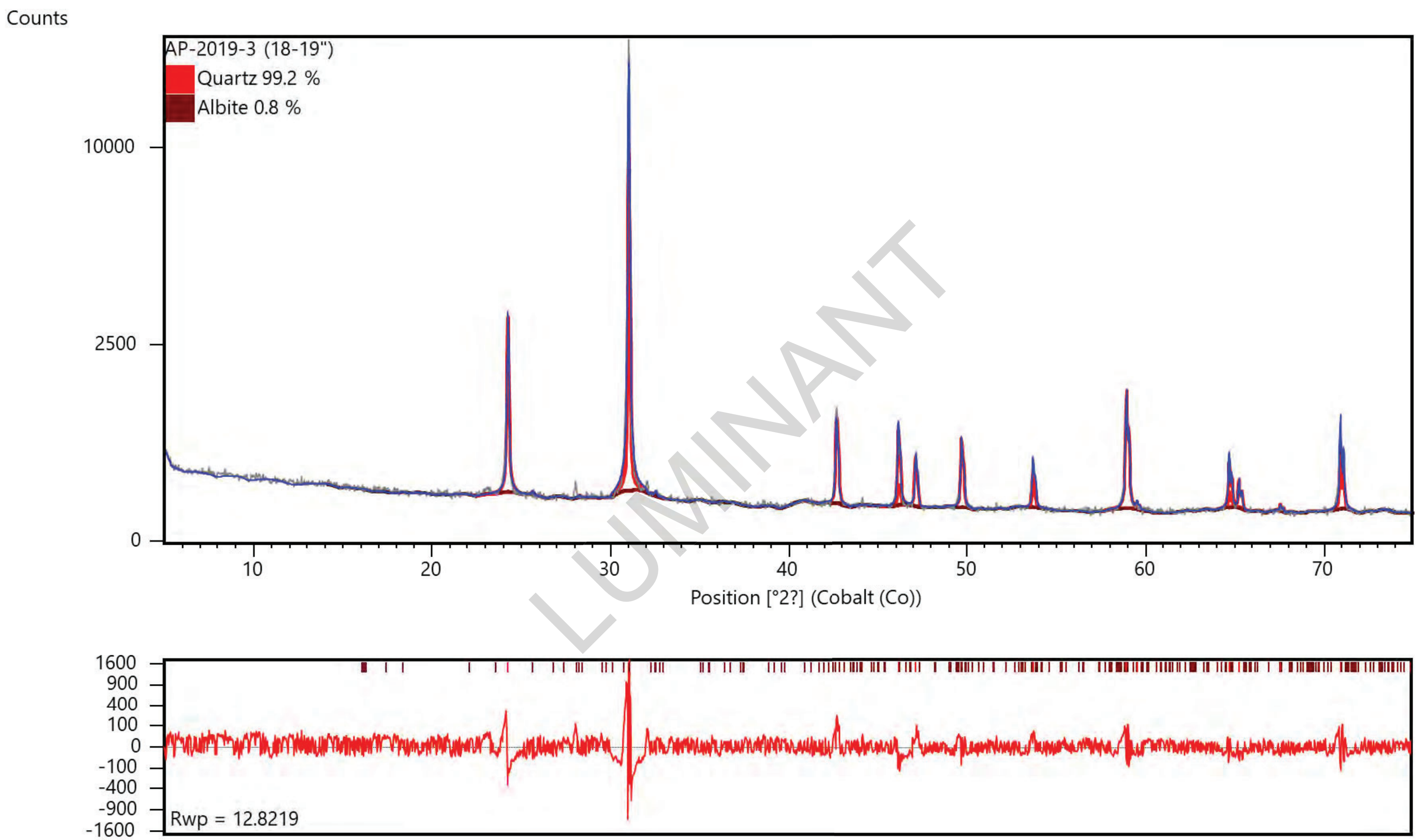
Mineral/Compound	Formula
Quartz	SiO_2
Albite	$NaAlSi_3O_8$
K-Feldspar	$KAlSi_3O_8$
Chlorite	$(Mg_3,Fe_2)Al(AlSi_3)O_{10}(OH)_8$
Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$
Vermiculite	$(Mg,Fe,Al)_2(Al,Si)_4O_{10}(OH)_2\cdot4(H_2O)$
Kaolinite	$Al_2Si_2O_5(OH)_4$
Illite	$(K,H_3O)(Al,Mg,Fe)_2(Si,Al)_4O_{10}[(OH)_2,(H_2O)]$
Montmorillonite	$Na_{0.2}Ca_{0.1}Al_{1.5}Mg_{0.5}Si_4O_{10}(OH)_2\cdot4(H_2O)$



X-ray diffractogram. The upper pattern is the measured diffractogram, the blue curve is the calculated pattern from the Rietveld Refinement and the lower red curve is the difference plot.



X-ray diffractogram. The upper pattern is the measured diffractogram, the blue curve is the calculated pattern from the Rietveld Refinement and the lower red curve is the difference plot.



X-ray diffractogram. The upper pattern is the measured diffractogram, the blue curve is the calculated pattern from the Rietveld Refinement and the lower red curve is the difference plot.

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TestAmerica

1 2 3 4 5 6 7 8 9 10 11 12 13

ANALYTICAL REPORT

Eurofins TestAmerica, Knoxville
5815 Middlebrook Pike
Knoxville, TN 37921
Tel: (865)291-3000

Laboratory Job ID: 140-15490-1
Client Project/Site: Martin Lake Ash Ponds - SEP + Totals

For:
Golder Associates Inc.
2201 Double Creek Dr
Suite 4004
Round Rock, Texas 78664

Attn: Will Vienne

Terry Walker Wasmund

Authorized for release by:
7/18/2019 5:51:37 PM

Terry Walker Wasmund, Project Manager II
(865)291-3000
terry.wasmund@testamericainc.com

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Definitions/Glossary

Client: Golder Associates Inc. Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Qualifiers

Metals

Qualifier	Qualifier Description
*	LCS or LCSD is outside acceptance limits.
*	RPD of the LCS and LCSD exceeds the control limits
B	Compound was found in the blank and sample.
F1	MS and/or MSD Recovery is outside acceptance limits.
F5	Duplicate RPD exceeds limit, and one or both sample results are less than 5 times RL. The data are considered valid because the absolute difference is less than the RL.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Job ID: 140-15490-1

Laboratory: Eurofins TestAmerica, Knoxville

Narrative

Job Narrative
140-15490-1

Receipt
The samples were received on 6/5/2019 at 9:20 AM. The samples arrived in good condition, properly preserved, and on ice. The temperature of the cooler at receipt was 1.2º C.

Metals
7 Step Sequential Extraction Procedure

These soil samples were prepared and analyzed using Eurofins TestAmerica Knoxville standard operating procedure KNOX-MT-0008, "7 Step Sequential Extraction Procedure". SW-846 Method 6010B as incorporated in Eurofins TestAmerica Knoxville standard operating procedure KNOX-MT-0007 was used to perform the final instrument analyses.

An aliquot of each sample was sequentially extracted using the steps listed below:

- ***Step 1 - Exchangeable Fraction:*** A 5 gram aliquot of sample was extracted with 25 mL of 1M magnesium sulfate (MgSO4), centrifuged and filtered. 5 mL of the resulting leachate was digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
- ***Step 2 - Carbonate Fraction:*** The sample residue from step 1 was extracted with 25 mL of 1M sodium acetate/acetic acid (NaOAc/HOAc) at pH 5, centrifuged and filtered. 5 mL of the resulting leachate was digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
- ***Step 3 - Non-crystalline Materials Fraction:*** The sample residue from step 2 was extracted with 25 mL of 0.2M ammonium oxalate (pH 3), centrifuged and filtered. 5 mL of the resulting leachate was digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
- ***Step 4 - Metal Hydroxide Fraction***: The sample residue from step 3 was extracted with 25 mL of 1M hydroxylamine hydrochloride solution in 25% v/v acetic acid, centrifuged and filtered. 5 mL of the resulting leachate was digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
- ***Step 5 - Organic-bound Fraction:*** The sample residue from step 4 was extracted three times with 25 mL of 5% sodium hypochlorite (NaClO) at pH 9.5, centrifuged and filtered. The resulting leachates were combined and 5 mL were digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
- ***Step 6 - Acid/Sulfide Fraction:*** The sample residue from step 5 was extracted with 25 mL of a 3:1:2 v/v solution of HCl-HNO3-H2O, centrifuged and filtered. 5 mL of the resulting leachate was diluted to 50 mL with reagent water and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
- ***Step 7 - Residual Fraction:*** A 1.0 g aliquot of the sample residue from step 6 was digested using HF, HNO3, HCl and H3BO3. The digestate was analyzed by ICP using method 6010B. Results are reported in mg/kg on a dry weight basis.

In addition, a 1.0 g aliquot of the original sample was digested using HF, HNO3, HCl and H3BO3. The digestate was analyzed by ICP using method 6010B. Total metal results are reported in mg/kg on a dry weight basis.

Results were calculated using the following equation:

Result, µg/g or mg/Kg, dry weight = $(C \times V \times V1 \times D) / (W \times S \times V2)$

Where:
C = Concentration from instrument readout, µg/mL
V = Final volume of digestate, mL
D = Instrument dilution factor
V1 = Total volume of leachate, mL
V2 = Volume of leachate digested, mL
W = Wet weight of sample, g
S = Percent solids/100

A method blank, laboratory control sample and laboratory control sample duplicate were prepared and analyzed with each SEP step in order to provide information about both the presence of elements of interest in the extraction solutions, and the recovery of elements of

Job ID: 140-15490-1 (Continued)

Laboratory: Eurofins TestAmerica, Knoxville (Continued)

interest from the extraction solutions. Results outside of laboratory QC limits do not reflect out of control performance, but rather the effect of the extraction solution upon the analyte.

A laboratory sample duplicate was prepared and analyzed with each batch of samples in order to provide information regarding the reproducibility of the procedure.

SEP Report Notes
The final report lists the results for each step, the result for the total digestion of the sample, and a sum of the results of steps 1 through 7 by element.

Magnesium was not reported for step 1 because the extraction solution for this step (magnesium sulfate) contains high levels of magnesium. Sodium was not reported for steps 2 and 5 since the extraction solutions for these steps contain high levels of sodium. The sum of steps 1 through 7 is much higher than the total result for sodium and magnesium due to the magnesium and sodium introduced by the extraction solutions.

The step 1 digestates were reanalyzed for vanadium at a 1/10 dilution due to positive interelement interferences resulting from the high magnesium results. The reporting limits were adjusted accordingly.

The digestates for steps 1, 2 and 5 were analyzed at a dilution due to instrument problems caused by the high solids content of the digestates. The reporting limits were adjusted accordingly.

The serial dilution performed for samples (140-15490-A-1-A SD ^5) and (140-15490-A-1-AD SD ^50) associated with batch 140-31713 was outside control limits.

Samples AP-2019-1 (30-31) (140-15490-1), AP-2019-2 (35-36) (140-15490-2), AP-2019-3 (18-19) (140-15490-3), (140-15490-A-1-AE DU) and (140-15490-A-1-B DU) were diluted due to the presence of Silicon or Titanium which interferes with Arsenic, Cobalt, Selenium and Thallium. Elevated reporting limits (RLs) are provided.

Samples AP-2019-1 (30-31) (140-15490-1), AP-2019-2 (35-36) (140-15490-2), AP-2019-3 (18-19) (140-15490-3), (140-15490-A-1-AE DU) and (140-15490-A-1-B DU) were diluted for Aluminum and Barium due to the nature of the sample matrix. Elevated reporting limits (RLs) are provided.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

General Chemistry - % Moisture
The samples were analyzed for percent moisture using SOP number KNOX-WC-0012 (based on Modified MCAWW 160.3 and SM2540B and on the percent moisture determinations described in methods 3540C and 3550B).

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Comments
No additional comments.

Detection Summary

Client: Golder Associates Inc. Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Client Sample ID: AP-2019-1 (30-31) Lab Sample ID: 140-15490-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Barium	0.88	J	13	0.63	mg/Kg	4	☼	6010B SEP	Step 1
Cobalt	0.54	J	13	0.24	mg/Kg	4	☼	6010B SEP	Step 1
Manganese	3.1	J	3.9	0.16	mg/Kg	4	☼	6010B SEP	Step 1
Aluminum	9.7	J *	39	6.3	mg/Kg	3	☼	6010B SEP	Step 2
Barium	0.76	J *	9.9	0.47	mg/Kg	3	☼	6010B SEP	Step 2
Selenium	0.76	J B	2.0	0.67	mg/Kg	3	☼	6010B SEP	Step 2
Aluminum	88		13	2.8	mg/Kg	1	☼	6010B SEP	Step 3
Arsenic	1.8		0.66	0.17	mg/Kg	1	☼	6010B SEP	Step 3
Barium	4.3	B	3.3	0.16	mg/Kg	1	☼	6010B SEP	Step 3
Beryllium	0.067	J	0.33	0.020	mg/Kg	1	☼	6010B SEP	Step 3
Cobalt	0.34	J	3.3	0.059	mg/Kg	1	☼	6010B SEP	Step 3
Iron	580		6.6	3.8	mg/Kg	1	☼	6010B SEP	Step 3
Manganese	2.4	B	0.99	0.036	mg/Kg	1	☼	6010B SEP	Step 3
Selenium	0.22	J B	0.66	0.22	mg/Kg	1	☼	6010B SEP	Step 3
Aluminum	1700		13	2.1	mg/Kg	1	☼	6010B SEP	Step 4
Arsenic	2.8	B	0.66	0.29	mg/Kg	1	☼	6010B SEP	Step 4
Barium	16		3.3	0.16	mg/Kg	1	☼	6010B SEP	Step 4
Beryllium	0.13	J	0.33	0.021	mg/Kg	1	☼	6010B SEP	Step 4
Cobalt	1.5	J	3.3	0.070	mg/Kg	1	☼	6010B SEP	Step 4
Iron	3900		6.6	3.8	mg/Kg	1	☼	6010B SEP	Step 4
Li	3.0	J	3.3	0.20	mg/Kg	1	☼	6010B SEP	Step 4
Manganese	18		0.99	0.17	mg/Kg	1	☼	6010B SEP	Step 4
Aluminum	62	J *	200	31	mg/Kg	5	☼	6010B SEP	Step 5
Barium	7.0	J *	49	2.4	mg/Kg	5	☼	6010B SEP	Step 5
Aluminum	2300		13	2.1	mg/Kg	1	☼	6010B SEP	Step 6
Arsenic	0.94		0.66	0.20	mg/Kg	1	☼	6010B SEP	Step 6
Barium	18		3.3	0.16	mg/Kg	1	☼	6010B SEP	Step 6
Beryllium	0.067	J	0.33	0.016	mg/Kg	1	☼	6010B SEP	Step 6
Cobalt	0.90	J	3.3	0.061	mg/Kg	1	☼	6010B SEP	Step 6
Iron	2500		6.6	3.8	mg/Kg	1	☼	6010B SEP	Step 6
Li	2.1	J	3.3	0.20	mg/Kg	1	☼	6010B SEP	Step 6
Manganese	16		0.99	0.33	mg/Kg	1	☼	6010B SEP	Step 6
Aluminum	29000		130	21	mg/Kg	10	☼	6010B SEP	Step 7
Arsenic	1.2		0.66	0.17	mg/Kg	1	☼	6010B SEP	Step 7
Barium	390		33	1.6	mg/Kg	10	☼	6010B SEP	Step 7
Beryllium	0.56		0.33	0.0099	mg/Kg	1	☼	6010B SEP	Step 7
Cobalt	0.79	J	6.6	0.39	mg/Kg	2	☼	6010B SEP	Step 7
Iron	5200		6.6	5.4	mg/Kg	1	☼	6010B SEP	Step 7
Li	9.6		3.3	0.20	mg/Kg	1	☼	6010B SEP	Step 7
Manganese	26		0.99	0.068	mg/Kg	1	☼	6010B SEP	Step 7
Mo	0.19	J	2.6	0.11	mg/Kg	1	☼	6010B SEP	Step 7
Thallium	0.48	J	4.6	0.47	mg/Kg	2	☼	6010B SEP	Step 7
Aluminum	33000		10	1.6	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Arsenic	6.9		0.50	0.13	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Barium	440		2.5	0.12	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Beryllium	0.83		0.25	0.0075	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Cobalt	4.0		2.5	0.023	mg/Kg	1		6010B SEP	Sum of Steps 1-7

This Detection Summary does not include radiochemical test results.

Detection Summary

Client: Golder Associates Inc. Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Client Sample ID: AP-2019-1 (30-31) (Continued) Lab Sample ID: 140-15490-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Iron	12000		5.0	4.1	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Li	15		2.5	0.15	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Manganese	66		0.75	0.052	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Mo	0.19	J	2.0	0.082	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Selenium	0.98		0.50	0.17	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Thallium	0.48	J	1.8	0.18	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Chromium	13	F1	1.8	0.27	mg/Kg	1	☼	6010B	Total/NA
Lead	6.4		1.8	0.34	mg/Kg	1	☼	6010B	Total/NA
Aluminum	60000		130	21	mg/Kg	10	☼	6010B	Total/NA
Arsenic	6.8		0.66	0.17	mg/Kg	1	☼	6010B	Total/NA
Barium	680		33	1.6	mg/Kg	10	☼	6010B	Total/NA
Beryllium	0.89		0.33	0.0099	mg/Kg	1	☼	6010B	Total/NA
Cobalt	3.8	J	6.6	0.39	mg/Kg	2	☼	6010B	Total/NA
Iron	11000		6.6	5.4	mg/Kg	1	☼	6010B	Total/NA
Lithium	18		3.3	0.20	mg/Kg	1	☼	6010B	Total/NA
Manganese	66		0.99	0.068	mg/Kg	1	☼	6010B	Total/NA
Molybdenum	0.40	J	2.6	0.11	mg/Kg	1	☼	6010B	Total/NA
Hg	0.081	J	0.13	0.053	mg/Kg	1	☼	7470A	Total/NA

Client Sample ID: AP-2019-2 (35-36) Lab Sample ID: 140-15490-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Aluminum	19	J	51	8.2	mg/Kg	4	☼	6010B SEP	Step 1
Barium	0.88	J	13	0.61	mg/Kg	4	☼	6010B SEP	Step 1
Cobalt	1.6	J	13	0.23	mg/Kg	4	☼	6010B SEP	Step 1
Iron	23	J	25	15	mg/Kg	4	☼	6010B SEP	Step 1
Manganese	33		3.8	0.16	mg/Kg	4	☼	6010B SEP	Step 1
Aluminum	18	J *	38	6.1	mg/Kg	3	☼	6010B SEP	Step 2
Barium	0.67	J *	9.6	0.46	mg/Kg	3	☼	6010B SEP	Step 2
Cobalt	0.27	J	9.6	0.24	mg/Kg	3	☼	6010B SEP	Step 2
Iron	110	*	19	11	mg/Kg	3	☼	6010B SEP	Step 2
Manganese	4.2		2.9	1.1	mg/Kg	3	☼	6010B SEP	Step 2
Selenium	0.90	J B	1.9	0.65	mg/Kg	3	☼	6010B SEP	Step 2
Aluminum	97		13	2.7	mg/Kg	1	☼	6010B SEP	Step 3
Arsenic	0.97		0.64	0.17	mg/Kg	1	☼	6010B SEP	Step 3
Barium	4.1	B	3.2	0.15	mg/Kg	1	☼	6010B SEP	Step 3
Beryllium	0.028	J	0.32	0.019	mg/Kg	1	☼	6010B SEP	Step 3
Cobalt	0.17	J	3.2	0.057	mg/Kg	1	☼	6010B SEP	Step 3
Iron	1100		6.4	3.7	mg/Kg	1	☼	6010B SEP	Step 3
Manganese	1.5	B	0.96	0.034	mg/Kg	1	☼	6010B SEP	Step 3
Aluminum	1800		13	2.0	mg/Kg	1	☼	6010B SEP	Step 4
Arsenic	0.78	B	0.64	0.28	mg/Kg	1	☼	6010B SEP	Step 4
Barium	23		3.2	0.15	mg/Kg	1	☼	6010B SEP	Step 4
Beryllium	0.078	J	0.32	0.020	mg/Kg	1	☼	6010B SEP	Step 4
Cobalt	1.5	J	3.2	0.068	mg/Kg	1	☼	6010B SEP	Step 4
Iron	3800		6.4	3.7	mg/Kg	1	☼	6010B SEP	Step 4
Li	4.2		3.2	0.19	mg/Kg	1	☼	6010B SEP	Step 4

This Detection Summary does not include radiochemical test results.

Client Sample ID: AP-2019-2 (35-36) (Continued) Lab Sample ID: 140-15490-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Manganese	31		0.96	0.17	mg/Kg	1	☼	6010B SEP	Step 4
Aluminum	55	J *	190	30	mg/Kg	5	☼	6010B SEP	Step 5
Barium	11	J *	48	2.3	mg/Kg	5	☼	6010B SEP	Step 5
Cobalt	0.85	J *	48	0.76	mg/Kg	5	☼	6010B SEP	Step 5
Manganese	3.9	J *	14	2.4	mg/Kg	5	☼	6010B SEP	Step 5
Aluminum	2000		13	2.0	mg/Kg	1	☼	6010B SEP	Step 6
Arsenic	0.74		0.64	0.19	mg/Kg	1	☼	6010B SEP	Step 6
Barium	16		3.2	0.15	mg/Kg	1	☼	6010B SEP	Step 6
Beryllium	0.061	J	0.32	0.015	mg/Kg	1	☼	6010B SEP	Step 6
Cobalt	0.80	J	3.2	0.059	mg/Kg	1	☼	6010B SEP	Step 6
Iron	3300		6.4	3.7	mg/Kg	1	☼	6010B SEP	Step 6
Li	2.1	J	3.2	0.19	mg/Kg	1	☼	6010B SEP	Step 6
Manganese	19		0.96	0.32	mg/Kg	1	☼	6010B SEP	Step 6
Aluminum	26000		130	20	mg/Kg	10	☼	6010B SEP	Step 7
Arsenic	0.71		0.64	0.17	mg/Kg	1	☼	6010B SEP	Step 7
Barium	330		32	1.5	mg/Kg	10	☼	6010B SEP	Step 7
Beryllium	0.51		0.32	0.0096	mg/Kg	1	☼	6010B SEP	Step 7
Cobalt	1.1	J	6.4	0.38	mg/Kg	2	☼	6010B SEP	Step 7
Iron	5600		6.4	5.2	mg/Kg	1	☼	6010B SEP	Step 7
Li	11		3.2	0.19	mg/Kg	1	☼	6010B SEP	Step 7
Manganese	34		0.96	0.066	mg/Kg	1	☼	6010B SEP	Step 7
Mo	0.17	J	2.5	0.10	mg/Kg	1	☼	6010B SEP	Step 7
Thallium	0.70	J	4.5	0.46	mg/Kg	2	☼	6010B SEP	Step 7
Aluminum	30000		10	1.6	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Arsenic	3.2		0.50	0.13	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Barium	390		2.5	0.12	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Beryllium	0.68		0.25	0.0075	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Cobalt	6.3		2.5	0.023	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Iron	14000		5.0	4.1	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Li	18		2.5	0.15	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Manganese	130		0.75	0.052	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Mo	0.17	J	2.0	0.082	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Selenium	0.90		0.50	0.17	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Thallium	0.70	J	1.8	0.18	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Chromium	12		1.8	0.27	mg/Kg	1	☼	6010B	Total/NA
Lead	6.2		1.8	0.34	mg/Kg	1	☼	6010B	Total/NA
Aluminum	62000		130	20	mg/Kg	10	☼	6010B	Total/NA
Arsenic	3.0		0.64	0.17	mg/Kg	1	☼	6010B	Total/NA
Barium	560		32	1.5	mg/Kg	10	☼	6010B	Total/NA
Beryllium	0.72		0.32	0.0096	mg/Kg	1	☼	6010B	Total/NA
Cobalt	6.2	J	16	0.96	mg/Kg	5	☼	6010B	Total/NA
Iron	13000		6.4	5.2	mg/Kg	1	☼	6010B	Total/NA
Lithium	26		3.2	0.19	mg/Kg	1	☼	6010B	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: AP-2019-2 (35-36) (Continued) Lab Sample ID: 140-15490-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Manganese	150		0.96	0.066	mg/Kg	1	☼	6010B	Total/NA
Molybdenum	0.41	J	2.5	0.10	mg/Kg	1	☼	6010B	Total/NA
Hg	0.12	J	0.13	0.051	mg/Kg	1	☼	7470A	Total/NA

Client Sample ID: AP-2019-3 (18-19) Lab Sample ID: 140-15490-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Aluminum	14	J	50	8.0	mg/Kg	4	☼	6010B SEP	Step 1
Cobalt	0.87	J	13	0.23	mg/Kg	4	☼	6010B SEP	Step 1
Iron	15	J	25	15	mg/Kg	4	☼	6010B SEP	Step 1
Manganese	1.2	J	3.8	0.16	mg/Kg	4	☼	6010B SEP	Step 1
Selenium	0.68	J B	1.9	0.64	mg/Kg	3	☼	6010B SEP	Step 2
Aluminum	30		13	2.6	mg/Kg	1	☼	6010B SEP	Step 3
Barium	2.3	J B	3.1	0.15	mg/Kg	1	☼	6010B SEP	Step 3
Beryllium	0.025	J	0.31	0.019	mg/Kg	1	☼	6010B SEP	Step 3
Iron	57		6.3	3.6	mg/Kg	1	☼	6010B SEP	Step 3
Manganese	0.11	J B	0.94	0.034	mg/Kg	1	☼	6010B SEP	Step 3
Selenium	0.23	J B	0.63	0.21	mg/Kg	1	☼	6010B SEP	Step 3
Aluminum	880		13	2.0	mg/Kg	1	☼	6010B SEP	Step 4
Arsenic	0.63	B	0.63	0.28	mg/Kg	1	☼	6010B SEP	Step 4
Barium	6.9		3.1	0.15	mg/Kg	1	☼	6010B SEP	Step 4
Beryllium	0.069	J	0.31	0.020	mg/Kg	1	☼	6010B SEP	Step 4
Cobalt	0.53	J	3.1	0.066	mg/Kg	1	☼	6010B SEP	Step 4
Iron	2300		6.3	3.6	mg/Kg	1	☼	6010B SEP	Step 4
Li	0.53	J	3.1	0.19	mg/Kg	1	☼	6010B SEP	Step 4
Manganese	4.2		0.94	0.16	mg/Kg	1	☼	6010B SEP	Step 4
Selenium	0.65	B *	0.63	0.59	mg/Kg	1	☼	6010B SEP	Step 4
Aluminum	120	J *	190	29	mg/Kg	5	☼	6010B SEP	Step 5
Aluminum	1200		13	2.0	mg/Kg	1	☼	6010B SEP	Step 6
Arsenic	0.24	J	0.63	0.19	mg/Kg	1	☼	6010B SEP	Step 6
Barium	2.1	J	3.1	0.15	mg/Kg	1	☼	6010B SEP	Step 6
Beryllium	0.026	J	0.31	0.015	mg/Kg	1	☼	6010B SEP	Step 6
Cobalt	0.28	J	3.1	0.058	mg/Kg	1	☼	6010B SEP	Step 6
Iron	820		6.3	3.6	mg/Kg	1	☼	6010B SEP	Step 6
Li	0.62	J	3.1	0.19	mg/Kg	1	☼	6010B SEP	Step 6
Manganese	2.9		0.94	0.31	mg/Kg	1	☼	6010B SEP	Step 6
Aluminum	12000		130	20	mg/Kg	10	☼	6010B SEP	Step 7
Arsenic	0.79	J	1.3	0.33	mg/Kg	2	☼	6010B SEP	Step 7
Barium	180		31	1.5	mg/Kg	10	☼	6010B SEP	Step 7
Beryllium	0.11	J	0.31	0.0094	mg/Kg	1	☼	6010B SEP	Step 7
Iron	2000		6.3	5.1	mg/Kg	1	☼	6010B SEP	Step 7
Li	6.0		3.1	0.19	mg/Kg	1	☼	6010B SEP	Step 7
Manganese	26		0.94	0.065	mg/Kg	1	☼	6010B SEP	Step 7
Mo	0.12	J	2.5	0.10	mg/Kg	1	☼	6010B SEP	Step 7
Aluminum	14000		10	1.6	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Arsenic	1.7		0.50	0.13	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Barium	190		2.5	0.12	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Beryllium	0.23	J	0.25	0.0075	mg/Kg	1		6010B SEP	Sum of Steps 1-7

This Detection Summary does not include radiochemical test results.

Detection Summary

Client: Golder Associates Inc.
Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Client Sample ID: AP-2019-3 (18-19) (Continued) Lab Sample ID: 140-15490-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Cobalt	1.7	J	2.5	0.023	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Iron	5200		5.0	4.1	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Li	7.2		2.5	0.15	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Manganese	35		0.75	0.052	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Mo	0.12	J	2.0	0.082	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Selenium	1.6		0.50	0.17	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Chromium	4.4		1.8	0.26	mg/Kg	1	☼	6010B	Total/NA
Lead	3.9		1.8	0.33	mg/Kg	1	☼	6010B	Total/NA
Aluminum	20000		130	20	mg/Kg	10	☼	6010B	Total/NA
Arsenic	2.9	J	3.1	0.81	mg/Kg	5	☼	6010B	Total/NA
Barium	240		31	1.5	mg/Kg	10	☼	6010B	Total/NA
Beryllium	0.42		0.31	0.0094	mg/Kg	1	☼	6010B	Total/NA
Cobalt	3.3	J	16	0.94	mg/Kg	5	☼	6010B	Total/NA
Iron	8000		6.3	5.1	mg/Kg	1	☼	6010B	Total/NA
Lithium	9.6		3.1	0.19	mg/Kg	1	☼	6010B	Total/NA
Manganese	47		0.94	0.065	mg/Kg	1	☼	6010B	Total/NA
Molybdenum	0.28	J	2.5	0.10	mg/Kg	1	☼	6010B	Total/NA

This Detection Summary does not include radiochemical test results.

Client: Golder Associates Inc.	Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Client Sample ID: AP-2019-1 (30-31) **Lab Sample ID: 140-15490-1**
Date Collected: 06/03/19 11:36 **Matrix: Solid**
Date Received: 06/05/19 09:20 **Percent Solids: 76.0**

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		53	8.4	mg/Kg	☼	06/29/19 08:00	07/11/19 12:49	4
Antimony	ND		16	1.5	mg/Kg	☼	06/29/19 08:00	07/11/19 12:49	4
Arsenic	ND		2.6	0.68	mg/Kg	☼	06/29/19 08:00	07/11/19 12:49	4
Barium	**0.88**	**J**	13	0.63	mg/Kg	☼	06/29/19 08:00	07/11/19 12:49	4
Beryllium	ND		1.3	0.41	mg/Kg	☼	06/29/19 08:00	07/11/19 12:49	4
Cobalt	**0.54**	**J**	13	0.24	mg/Kg	☼	06/29/19 08:00	07/11/19 12:49	4
Iron	ND		26	15	mg/Kg	☼	06/29/19 08:00	07/11/19 12:49	4
Li	ND		13	0.79	mg/Kg	☼	06/29/19 08:00	07/11/19 12:49	4
Manganese	**3.1**	**J**	3.9	0.16	mg/Kg	☼	06/29/19 08:00	07/11/19 12:49	4
Mo	ND		11	0.43	mg/Kg	☼	06/29/19 08:00	07/11/19 12:49	4
Selenium	ND		2.6	0.89	mg/Kg	☼	06/29/19 08:00	07/11/19 12:49	4
Thallium	ND		9.2	1.1	mg/Kg	☼	06/29/19 08:00	07/11/19 12:49	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**9.7**	**J ***	39	6.3	mg/Kg	☼	06/30/19 08:00	07/11/19 14:21	3
Antimony	ND		12	1.1	mg/Kg	☼	06/30/19 08:00	07/11/19 14:21	3
Arsenic	ND		2.0	0.51	mg/Kg	☼	06/30/19 08:00	07/11/19 14:21	3
Barium	**0.76**	**J ***	9.9	0.47	mg/Kg	☼	06/30/19 08:00	07/11/19 14:21	3
Beryllium	ND	*	0.99	0.063	mg/Kg	☼	06/30/19 08:00	07/11/19 14:21	3
Cobalt	ND		9.9	0.25	mg/Kg	☼	06/30/19 08:00	07/11/19 14:21	3
Iron	ND	*	20	11	mg/Kg	☼	06/30/19 08:00	07/11/19 14:21	3
Li	ND		9.9	0.59	mg/Kg	☼	06/30/19 08:00	07/11/19 14:21	3
Manganese	ND		3.0	1.1	mg/Kg	☼	06/30/19 08:00	07/11/19 14:21	3
Mo	ND		7.9	0.32	mg/Kg	☼	06/30/19 08:00	07/11/19 14:21	3
Selenium	**0.76**	**J B**	2.0	0.67	mg/Kg	☼	06/30/19 08:00	07/11/19 14:21	3
Thallium	ND		6.9	0.83	mg/Kg	☼	06/30/19 08:00	07/11/19 14:21	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**88**		13	2.8	mg/Kg	☼	07/02/19 08:00	07/11/19 16:06	1
Antimony	ND		3.9	0.37	mg/Kg	☼	07/02/19 08:00	07/11/19 16:06	1
Arsenic	**1.8**		0.66	0.17	mg/Kg	☼	07/02/19 08:00	07/11/19 16:06	1
Barium	**4.3**	**B**	3.3	0.16	mg/Kg	☼	07/02/19 08:00	07/11/19 16:06	1
Beryllium	**0.067**	**J**	0.33	0.020	mg/Kg	☼	07/02/19 08:00	07/11/19 16:06	1
Cobalt	**0.34**	**J**	3.3	0.059	mg/Kg	☼	07/02/19 08:00	07/11/19 16:06	1
Iron	**580**		6.6	3.8	mg/Kg	☼	07/02/19 08:00	07/11/19 16:06	1
Li	ND		3.3	0.20	mg/Kg	☼	07/02/19 08:00	07/11/19 16:06	1
Manganese	**2.4**	**B**	0.99	0.036	mg/Kg	☼	07/02/19 08:00	07/11/19 16:06	1
Mo	ND		2.6	0.11	mg/Kg	☼	07/02/19 08:00	07/11/19 16:06	1
Selenium	**0.22**	**J B**	0.66	0.22	mg/Kg	☼	07/02/19 08:00	07/11/19 16:06	1
Thallium	ND		2.3	0.28	mg/Kg	☼	07/02/19 08:00	07/11/19 16:06	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**1700**		13	2.1	mg/Kg	☼	07/03/19 08:00	07/11/19 17:49	1
Antimony	ND		3.9	0.59	mg/Kg	☼	07/03/19 08:00	07/11/19 17:49	1
Arsenic	**2.8**	**B**	0.66	0.29	mg/Kg	☼	07/03/19 08:00	07/11/19 17:49	1
Barium	**16**		3.3	0.16	mg/Kg	☼	07/03/19 08:00	07/11/19 17:49	1
Beryllium	**0.13**	**J**	0.33	0.021	mg/Kg	☼	07/03/19 08:00	07/11/19 17:49	1

Client Sample ID: AP-2019-1 (30-31)

Lab Sample ID: 140-15490-1

Date Collected: 06/03/19 11:36
Matrix: Solid
Date Received: 06/05/19 09:20
Percent Solids: 76.0

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cobalt	**1.5**	**J**	3.3	0.070	mg/Kg	☼	07/03/19 08:00	07/11/19 17:49	1
Iron	**3900**		6.6	3.8	mg/Kg	☼	07/03/19 08:00	07/11/19 17:49	1
Li	**3.0**	**J**	3.3	0.20	mg/Kg	☼	07/03/19 08:00	07/11/19 17:49	1
Manganese	**18**		0.99	0.17	mg/Kg	☼	07/03/19 08:00	07/11/19 17:49	1
Mo	ND		2.6	0.11	mg/Kg	☼	07/03/19 08:00	07/11/19 17:49	1
Selenium	ND	*	0.66	0.62	mg/Kg	☼	07/03/19 08:00	07/11/19 17:49	1
Thallium	ND		2.3	0.38	mg/Kg	☼	07/03/19 08:00	07/11/19 17:49	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**62**	**J ***	200	31	mg/Kg	☼	07/10/19 08:00	07/12/19 11:54	5
Antimony	ND		59	5.5	mg/Kg	☼	07/10/19 08:00	07/12/19 11:54	5
Arsenic	ND		9.9	2.5	mg/Kg	☼	07/10/19 08:00	07/12/19 11:54	5
Barium	**7.0**	**J ***	49	2.4	mg/Kg	☼	07/10/19 08:00	07/12/19 11:54	5
Beryllium	ND	*	4.9	0.41	mg/Kg	☼	07/10/19 08:00	07/12/19 11:54	5
Cobalt	ND	*	49	0.79	mg/Kg	☼	07/10/19 08:00	07/12/19 11:54	5
Iron	ND	*	99	58	mg/Kg	☼	07/10/19 08:00	07/12/19 11:54	5
Li	ND		49	2.9	mg/Kg	☼	07/10/19 08:00	07/12/19 11:54	5
Manganese	ND	*	15	2.4	mg/Kg	☼	07/10/19 08:00	07/12/19 11:54	5
Mo	ND		39	1.6	mg/Kg	☼	07/10/19 08:00	07/12/19 11:54	5
Selenium	ND		9.9	3.4	mg/Kg	☼	07/10/19 08:00	07/12/19 11:54	5
Thallium	ND	*	35	4.6	mg/Kg	☼	07/10/19 08:00	07/12/19 11:54	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**2300**		13	2.1	mg/Kg	☼	07/10/19 08:00	07/12/19 13:29	1
Antimony	ND		3.9	0.37	mg/Kg	☼	07/10/19 08:00	07/12/19 13:29	1
Arsenic	**0.94**		0.66	0.20	mg/Kg	☼	07/10/19 08:00	07/12/19 13:29	1
Barium	**18**		3.3	0.16	mg/Kg	☼	07/10/19 08:00	07/12/19 13:29	1
Beryllium	**0.067**	**J**	0.33	0.016	mg/Kg	☼	07/10/19 08:00	07/12/19 13:29	1
Cobalt	**0.90**	**J**	3.3	0.061	mg/Kg	☼	07/10/19 08:00	07/12/19 13:29	1
Iron	**2500**		6.6	3.8	mg/Kg	☼	07/10/19 08:00	07/12/19 13:29	1
Li	**2.1**	**J**	3.3	0.20	mg/Kg	☼	07/10/19 08:00	07/12/19 13:29	1
Manganese	**16**		0.99	0.33	mg/Kg	☼	07/10/19 08:00	07/12/19 13:29	1
Mo	ND		2.6	0.13	mg/Kg	☼	07/10/19 08:00	07/12/19 13:29	1
Selenium	ND		0.66	0.22	mg/Kg	☼	07/10/19 08:00	07/12/19 13:29	1
Thallium	ND		2.3	0.28	mg/Kg	☼	07/10/19 08:00	07/12/19 13:29	1

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**29000**		130	21	mg/Kg	☼	07/12/19 09:08	07/15/19 13:08	10
Antimony	ND		3.9	0.18	mg/Kg	☼	07/12/19 09:08	07/15/19 11:39	1
Arsenic	**1.2**		0.66	0.17	mg/Kg	☼	07/12/19 09:08	07/15/19 11:39	1
Barium	**390**		33	1.6	mg/Kg	☼	07/12/19 09:08	07/15/19 13:08	10
Beryllium	**0.56**		0.33	0.0099	mg/Kg	☼	07/12/19 09:08	07/15/19 11:39	1
Cobalt	**0.79**	**J**	6.6	0.39	mg/Kg	☼	07/12/19 09:08	07/15/19 17:11	2
Iron	**5200**		6.6	5.4	mg/Kg	☼	07/12/19 09:08	07/15/19 11:39	1
Li	**9.6**		3.3	0.20	mg/Kg	☼	07/12/19 09:08	07/15/19 11:39	1
Manganese	**26**		0.99	0.068	mg/Kg	☼	07/12/19 09:08	07/15/19 11:39	1
Mo	**0.19**	**J**	2.6	0.11	mg/Kg	☼	07/12/19 09:08	07/15/19 11:39	1

Client Sample ID: AP-2019-1 (30-31) **Lab Sample ID: 140-15490-1**
Date Collected: 06/03/19 11:36 **Matrix: Solid**
Date Received: 06/05/19 09:20 **Percent Solids: 76.0**

Method: 6010B SEP - SEP Metals (ICP) - Step 7 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	ND		0.66	0.22	mg/Kg	☼	07/12/19 09:08	07/15/19 11:39	1
Thallium	0.48	J	4.6	0.47	mg/Kg	☼	07/12/19 09:08	07/15/19 17:11	2

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	33000		10	1.6	mg/Kg			07/16/19 17:31	1
Antimony	ND		3.0	0.14	mg/Kg			07/16/19 17:31	1
Arsenic	6.9		0.50	0.13	mg/Kg			07/16/19 17:31	1
Barium	440		2.5	0.12	mg/Kg			07/16/19 17:31	1
Beryllium	0.83		0.25	0.0075	mg/Kg			07/16/19 17:31	1
Cobalt	4.0		2.5	0.023	mg/Kg			07/16/19 17:31	1
Iron	12000		5.0	4.1	mg/Kg			07/16/19 17:31	1
Li	15		2.5	0.15	mg/Kg			07/16/19 17:31	1
Manganese	66		0.75	0.052	mg/Kg			07/16/19 17:31	1
Mo	0.19	J	2.0	0.082	mg/Kg			07/16/19 17:31	1
Selenium	0.98		0.50	0.17	mg/Kg			07/16/19 17:31	1
Thallium	0.48	J	1.8	0.18	mg/Kg			07/16/19 17:31	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	ND		25	12	mg/Kg	☼	06/26/19 08:00	07/10/19 12:59	1
Chromium	13	F1	1.8	0.27	mg/Kg	☼	06/26/19 08:00	07/10/19 12:59	1
Lead	6.4		1.8	0.34	mg/Kg	☼	06/26/19 08:00	07/10/19 12:59	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	60000		130	21	mg/Kg	☼	06/11/19 08:00	07/15/19 15:45	10
Antimony	ND		3.9	0.18	mg/Kg	☼	06/11/19 08:00	07/15/19 14:24	1
Arsenic	6.8		0.66	0.17	mg/Kg	☼	06/11/19 08:00	07/15/19 14:24	1
Barium	680		33	1.6	mg/Kg	☼	06/11/19 08:00	07/15/19 15:45	10
Beryllium	0.89		0.33	0.0099	mg/Kg	☼	06/11/19 08:00	07/15/19 14:24	1
Cobalt	3.8	J	6.6	0.39	mg/Kg	☼	06/11/19 08:00	07/15/19 18:28	2
Iron	11000		6.6	5.4	mg/Kg	☼	06/11/19 08:00	07/15/19 14:24	1
Lithium	18		3.3	0.20	mg/Kg	☼	06/11/19 08:00	07/15/19 14:24	1
Manganese	66		0.99	0.068	mg/Kg	☼	06/11/19 08:00	07/15/19 14:24	1
Molybdenum	0.40	J	2.6	0.11	mg/Kg	☼	06/11/19 08:00	07/15/19 14:24	1
Selenium	ND		0.66	0.22	mg/Kg	☼	06/11/19 08:00	07/15/19 14:24	1
Thallium	ND		4.6	0.47	mg/Kg	☼	06/11/19 08:00	07/15/19 18:28	2

Method: 7470A - SEP Mercury (CVAA) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Hg	0.081	J	0.13	0.053	mg/Kg	☼	06/11/19 08:00	06/16/19 14:04	1

Client Sample Results

Client: Golder Associates Inc.　　Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Client Sample ID: AP-2019-2 (35-36)　　Lab Sample ID: 140-15490-2

Date Collected: 06/03/19 13:20　　Matrix: Solid
Date Received: 06/05/19 09:20　　Percent Solids: 78.5

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	19	J	51	8.2	mg/Kg	☼	06/29/19 08:00	07/11/19 12:59	4
Antimony	ND		15	1.4	mg/Kg	☼	06/29/19 08:00	07/11/19 12:59	4
Arsenic	ND		2.5	0.66	mg/Kg	☼	06/29/19 08:00	07/11/19 12:59	4
Barium	0.88	J	13	0.61	mg/Kg	☼	06/29/19 08:00	07/11/19 12:59	4
Beryllium	ND		1.3	0.39	mg/Kg	☼	06/29/19 08:00	07/11/19 12:59	4
Cobalt	1.6	J	13	0.23	mg/Kg	☼	06/29/19 08:00	07/11/19 12:59	4
Iron	23	J	25	15	mg/Kg	☼	06/29/19 08:00	07/11/19 12:59	4
Li	ND		13	0.76	mg/Kg	☼	06/29/19 08:00	07/11/19 12:59	4
Manganese	33		3.8	0.16	mg/Kg	☼	06/29/19 08:00	07/11/19 12:59	4
Mo	ND		10	0.42	mg/Kg	☼	06/29/19 08:00	07/11/19 12:59	4
Selenium	ND		2.5	0.87	mg/Kg	☼	06/29/19 08:00	07/11/19 12:59	4
Thallium	ND		8.9	1.1	mg/Kg	☼	06/29/19 08:00	07/11/19 12:59	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	18	J *	38	6.1	mg/Kg	☼	06/30/19 08:00	07/11/19 14:42	3
Antimony	ND		11	1.1	mg/Kg	☼	06/30/19 08:00	07/11/19 14:42	3
Arsenic	ND		1.9	0.50	mg/Kg	☼	06/30/19 08:00	07/11/19 14:42	3
Barium	0.67	J *	9.6	0.46	mg/Kg	☼	06/30/19 08:00	07/11/19 14:42	3
Beryllium	ND	*	0.96	0.061	mg/Kg	☼	06/30/19 08:00	07/11/19 14:42	3
Cobalt	0.27	J	9.6	0.24	mg/Kg	☼	06/30/19 08:00	07/11/19 14:42	3
Iron	110	*	19	11	mg/Kg	☼	06/30/19 08:00	07/11/19 14:42	3
Li	ND		9.6	0.57	mg/Kg	☼	06/30/19 08:00	07/11/19 14:42	3
Manganese	4.2		2.9	1.1	mg/Kg	☼	06/30/19 08:00	07/11/19 14:42	3
Mo	ND		7.6	0.31	mg/Kg	☼	06/30/19 08:00	07/11/19 14:42	3
Selenium	0.90	J B	1.9	0.65	mg/Kg	☼	06/30/19 08:00	07/11/19 14:42	3
Thallium	ND		6.7	0.80	mg/Kg	☼	06/30/19 08:00	07/11/19 14:42	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	97		13	2.7	mg/Kg	☼	07/02/19 08:00	07/11/19 16:16	1
Antimony	ND		3.8	0.36	mg/Kg	☼	07/02/19 08:00	07/11/19 16:16	1
Arsenic	0.97		0.64	0.17	mg/Kg	☼	07/02/19 08:00	07/11/19 16:16	1
Barium	4.1	B	3.2	0.15	mg/Kg	☼	07/02/19 08:00	07/11/19 16:16	1
Beryllium	0.028	J	0.32	0.019	mg/Kg	☼	07/02/19 08:00	07/11/19 16:16	1
Cobalt	0.17	J	3.2	0.057	mg/Kg	☼	07/02/19 08:00	07/11/19 16:16	1
Iron	1100		6.4	3.7	mg/Kg	☼	07/02/19 08:00	07/11/19 16:16	1
Li	ND		3.2	0.19	mg/Kg	☼	07/02/19 08:00	07/11/19 16:16	1
Manganese	1.5	B	0.96	0.034	mg/Kg	☼	07/02/19 08:00	07/11/19 16:16	1
Mo	ND		2.5	0.10	mg/Kg	☼	07/02/19 08:00	07/11/19 16:16	1
Selenium	ND		0.64	0.22	mg/Kg	☼	07/02/19 08:00	07/11/19 16:16	1
Thallium	ND		2.2	0.27	mg/Kg	☼	07/02/19 08:00	07/11/19 16:16	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	1800		13	2.0	mg/Kg	☼	07/03/19 08:00	07/11/19 17:59	1
Antimony	ND		3.8	0.57	mg/Kg	☼	07/03/19 08:00	07/11/19 17:59	1
Arsenic	0.78	B	0.64	0.28	mg/Kg	☼	07/03/19 08:00	07/11/19 17:59	1
Barium	23		3.2	0.15	mg/Kg	☼	07/03/19 08:00	07/11/19 17:59	1
Beryllium	0.078	J	0.32	0.020	mg/Kg	☼	07/03/19 08:00	07/11/19 17:59	1

Client Sample ID: AP-2019-2 (35-36) Lab Sample ID: 140-15490-2

Date Collected: 06/03/19 13:20 **Matrix: Solid**
Date Received: 06/05/19 09:20 **Percent Solids: 78.5**

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cobalt	1.5	J	3.2	0.068	mg/Kg	☼	07/03/19 08:00	07/11/19 17:59	1
Iron	3800		6.4	3.7	mg/Kg	☼	07/03/19 08:00	07/11/19 17:59	1
Li	4.2		3.2	0.19	mg/Kg	☼	07/03/19 08:00	07/11/19 17:59	1
Manganese	31		0.96	0.17	mg/Kg	☼	07/03/19 08:00	07/11/19 17:59	1
Mo	ND		2.5	0.10	mg/Kg	☼	07/03/19 08:00	07/11/19 17:59	1
Selenium	ND	*	0.64	0.60	mg/Kg	☼	07/03/19 08:00	07/11/19 17:59	1
Thallium	ND		2.2	0.37	mg/Kg	☼	07/03/19 08:00	07/11/19 17:59	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	55	J *	190	30	mg/Kg	☼	07/10/19 08:00	07/12/19 12:05	5
Antimony	ND		57	5.4	mg/Kg	☼	07/10/19 08:00	07/12/19 12:05	5
Arsenic	ND		9.6	2.4	mg/Kg	☼	07/10/19 08:00	07/12/19 12:05	5
Barium	11	J *	48	2.3	mg/Kg	☼	07/10/19 08:00	07/12/19 12:05	5
Beryllium	ND	*	4.8	0.40	mg/Kg	☼	07/10/19 08:00	07/12/19 12:05	5
Cobalt	0.85	J *	48	0.76	mg/Kg	☼	07/10/19 08:00	07/12/19 12:05	5
Iron	ND	*	96	56	mg/Kg	☼	07/10/19 08:00	07/12/19 12:05	5
Li	ND		48	2.8	mg/Kg	☼	07/10/19 08:00	07/12/19 12:05	5
Manganese	3.9	J *	14	2.4	mg/Kg	☼	07/10/19 08:00	07/12/19 12:05	5
Mo	ND		38	1.6	mg/Kg	☼	07/10/19 08:00	07/12/19 12:05	5
Selenium	ND		9.6	3.3	mg/Kg	☼	07/10/19 08:00	07/12/19 12:05	5
Thallium	ND	*	33	4.5	mg/Kg	☼	07/10/19 08:00	07/12/19 12:05	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	2000		13	2.0	mg/Kg	☼	07/10/19 08:00	07/12/19 13:49	1
Antimony	ND		3.8	0.36	mg/Kg	☼	07/10/19 08:00	07/12/19 13:49	1
Arsenic	0.74		0.64	0.19	mg/Kg	☼	07/10/19 08:00	07/12/19 13:49	1
Barium	16		3.2	0.15	mg/Kg	☼	07/10/19 08:00	07/12/19 13:49	1
Beryllium	0.061	J	0.32	0.015	mg/Kg	☼	07/10/19 08:00	07/12/19 13:49	1
Cobalt	0.80	J	3.2	0.059	mg/Kg	☼	07/10/19 08:00	07/12/19 13:49	1
Iron	3300		6.4	3.7	mg/Kg	☼	07/10/19 08:00	07/12/19 13:49	1
Li	2.1	J	3.2	0.19	mg/Kg	☼	07/10/19 08:00	07/12/19 13:49	1
Manganese	19		0.96	0.32	mg/Kg	☼	07/10/19 08:00	07/12/19 13:49	1
Mo	ND		2.5	0.13	mg/Kg	☼	07/10/19 08:00	07/12/19 13:49	1
Selenium	ND		0.64	0.22	mg/Kg	☼	07/10/19 08:00	07/12/19 13:49	1
Thallium	ND		2.2	0.27	mg/Kg	☼	07/10/19 08:00	07/12/19 13:49	1

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	26000		130	20	mg/Kg	☼	07/12/19 09:08	07/15/19 13:19	10
Antimony	ND		3.8	0.18	mg/Kg	☼	07/12/19 09:08	07/15/19 12:05	1
Arsenic	0.71		0.64	0.17	mg/Kg	☼	07/12/19 09:08	07/15/19 12:05	1
Barium	330		32	1.5	mg/Kg	☼	07/12/19 09:08	07/15/19 13:19	10
Beryllium	0.51		0.32	0.0096	mg/Kg	☼	07/12/19 09:08	07/15/19 12:05	1
Cobalt	1.1	J	6.4	0.38	mg/Kg	☼	07/12/19 09:08	07/15/19 17:21	2
Iron	5600		6.4	5.2	mg/Kg	☼	07/12/19 09:08	07/15/19 12:05	1
Li	11		3.2	0.19	mg/Kg	☼	07/12/19 09:08	07/15/19 12:05	1
Manganese	34		0.96	0.066	mg/Kg	☼	07/12/19 09:08	07/15/19 12:05	1
Mo	0.17	J	2.5	0.10	mg/Kg	☼	07/12/19 09:08	07/15/19 12:05	1

Client: Golder Associates Inc. Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Client Sample ID: AP-2019-2 (35-36) Lab Sample ID: 140-15490-2
Date Collected: 06/03/19 13:20 **Matrix: Solid**
Date Received: 06/05/19 09:20 **Percent Solids: 78.5**

Method: 6010B SEP - SEP Metals (ICP) - Step 7 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	ND		0.64	0.22	mg/Kg	☼	07/12/19 09:08	07/15/19 12:05	1
Thallium	0.70	J	4.5	0.46	mg/Kg	☼	07/12/19 09:08	07/15/19 17:21	2

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	30000		10	1.6	mg/Kg			07/16/19 17:31	1
Antimony	ND		3.0	0.14	mg/Kg			07/16/19 17:31	1
Arsenic	3.2		0.50	0.13	mg/Kg			07/16/19 17:31	1
Barium	390		2.5	0.12	mg/Kg			07/16/19 17:31	1
Beryllium	0.68		0.25	0.0075	mg/Kg			07/16/19 17:31	1
Cobalt	6.3		2.5	0.023	mg/Kg			07/16/19 17:31	1
Iron	14000		5.0	4.1	mg/Kg			07/16/19 17:31	1
Li	18		2.5	0.15	mg/Kg			07/16/19 17:31	1
Manganese	130		0.75	0.052	mg/Kg			07/16/19 17:31	1
Mo	0.17	J	2.0	0.082	mg/Kg			07/16/19 17:31	1
Selenium	0.90		0.50	0.17	mg/Kg			07/16/19 17:31	1
Thallium	0.70	J	1.8	0.18	mg/Kg			07/16/19 17:31	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	ND		24	12	mg/Kg	☼	06/26/19 08:00	07/10/19 13:13	1
Chromium	12		1.8	0.27	mg/Kg	☼	06/26/19 08:00	07/10/19 13:13	1
Lead	6.2		1.8	0.34	mg/Kg	☼	06/26/19 08:00	07/10/19 13:13	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	62000		130	20	mg/Kg	☼	06/11/19 08:00	07/15/19 16:10	10
Antimony	ND		3.8	0.18	mg/Kg	☼	06/11/19 08:00	07/15/19 14:36	1
Arsenic	3.0		0.64	0.17	mg/Kg	☼	06/11/19 08:00	07/15/19 14:36	1
Barium	560		32	1.5	mg/Kg	☼	06/11/19 08:00	07/15/19 16:10	10
Beryllium	0.72		0.32	0.0096	mg/Kg	☼	06/11/19 08:00	07/15/19 14:36	1
Cobalt	6.2	J	16	0.96	mg/Kg	☼	06/11/19 08:00	07/15/19 18:38	5
Iron	13000		6.4	5.2	mg/Kg	☼	06/11/19 08:00	07/15/19 14:36	1
Lithium	26		3.2	0.19	mg/Kg	☼	06/11/19 08:00	07/15/19 14:36	1
Manganese	150		0.96	0.066	mg/Kg	☼	06/11/19 08:00	07/15/19 14:36	1
Molybdenum	0.41	J	2.5	0.10	mg/Kg	☼	06/11/19 08:00	07/15/19 14:36	1
Selenium	ND		0.64	0.22	mg/Kg	☼	06/11/19 08:00	07/15/19 14:36	1
Thallium	ND		11	1.1	mg/Kg	☼	06/11/19 08:00	07/15/19 18:38	5

Method: 7470A - SEP Mercury (CVAA) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Hg	0.12	J	0.13	0.051	mg/Kg	☼	06/11/19 08:00	06/16/19 14:09	1

Client Sample Results

Client: Golder Associates Inc. Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Client Sample ID: AP-2019-3 (18-19) Lab Sample ID: 140-15490-3

Date Collected: 06/03/19 15:20 **Matrix: Solid**
Date Received: 06/05/19 09:20 **Percent Solids: 80.0**

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**14**	**J**	50	8.0	mg/Kg	☼	06/29/19 08:00	07/11/19 13:04	4
Antimony	ND		15	1.4	mg/Kg	☼	06/29/19 08:00	07/11/19 13:04	4
Arsenic	ND		2.5	0.65	mg/Kg	☼	06/29/19 08:00	07/11/19 13:04	4
Barium	ND		13	0.60	mg/Kg	☼	06/29/19 08:00	07/11/19 13:04	4
Beryllium	ND		1.3	0.39	mg/Kg	☼	06/29/19 08:00	07/11/19 13:04	4
Cobalt	**0.87**	**J**	13	0.23	mg/Kg	☼	06/29/19 08:00	07/11/19 13:04	4
Iron	**15**	**J**	25	15	mg/Kg	☼	06/29/19 08:00	07/11/19 13:04	4
Li	ND		13	0.75	mg/Kg	☼	06/29/19 08:00	07/11/19 13:04	4
Manganese	**1.2**	**J**	3.8	0.16	mg/Kg	☼	06/29/19 08:00	07/11/19 13:04	4
Mo	ND		10	0.41	mg/Kg	☼	06/29/19 08:00	07/11/19 13:04	4
Selenium	ND		2.5	0.85	mg/Kg	☼	06/29/19 08:00	07/11/19 13:04	4
Thallium	ND		8.8	1.1	mg/Kg	☼	06/29/19 08:00	07/11/19 13:04	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND	*	38	6.0	mg/Kg	☼	06/30/19 08:00	07/11/19 14:47	3
Antimony	ND		11	1.1	mg/Kg	☼	06/30/19 08:00	07/11/19 14:47	3
Arsenic	ND		1.9	0.49	mg/Kg	☼	06/30/19 08:00	07/11/19 14:47	3
Barium	ND	*	9.4	0.45	mg/Kg	☼	06/30/19 08:00	07/11/19 14:47	3
Beryllium	ND	*	0.94	0.060	mg/Kg	☼	06/30/19 08:00	07/11/19 14:47	3
Cobalt	ND		9.4	0.24	mg/Kg	☼	06/30/19 08:00	07/11/19 14:47	3
Iron	ND	*	19	11	mg/Kg	☼	06/30/19 08:00	07/11/19 14:47	3
Li	ND		9.4	0.56	mg/Kg	☼	06/30/19 08:00	07/11/19 14:47	3
Manganese	ND		2.8	1.1	mg/Kg	☼	06/30/19 08:00	07/11/19 14:47	3
Mo	ND		7.5	0.31	mg/Kg	☼	06/30/19 08:00	07/11/19 14:47	3
Selenium	**0.68**	**J B**	1.9	0.64	mg/Kg	☼	06/30/19 08:00	07/11/19 14:47	3
Thallium	ND		6.6	0.79	mg/Kg	☼	06/30/19 08:00	07/11/19 14:47	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**30**		13	2.6	mg/Kg	☼	07/02/19 08:00	07/11/19 16:21	1
Antimony	ND		3.8	0.35	mg/Kg	☼	07/02/19 08:00	07/11/19 16:21	1
Arsenic	ND		0.63	0.16	mg/Kg	☼	07/02/19 08:00	07/11/19 16:21	1
Barium	**2.3**	**J B**	3.1	0.15	mg/Kg	☼	07/02/19 08:00	07/11/19 16:21	1
Beryllium	**0.025**	**J**	0.31	0.019	mg/Kg	☼	07/02/19 08:00	07/11/19 16:21	1
Cobalt	ND		3.1	0.056	mg/Kg	☼	07/02/19 08:00	07/11/19 16:21	1
Iron	**57**		6.3	3.6	mg/Kg	☼	07/02/19 08:00	07/11/19 16:21	1
Li	ND		3.1	0.19	mg/Kg	☼	07/02/19 08:00	07/11/19 16:21	1
Manganese	**0.11**	**J B**	0.94	0.034	mg/Kg	☼	07/02/19 08:00	07/11/19 16:21	1
Mo	ND		2.5	0.10	mg/Kg	☼	07/02/19 08:00	07/11/19 16:21	1
Selenium	**0.23**	**J B**	0.63	0.21	mg/Kg	☼	07/02/19 08:00	07/11/19 16:21	1
Thallium	ND		2.2	0.26	mg/Kg	☼	07/02/19 08:00	07/11/19 16:21	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**880**		13	2.0	mg/Kg	☼	07/03/19 08:00	07/11/19 18:04	1
Antimony	ND		3.8	0.56	mg/Kg	☼	07/03/19 08:00	07/11/19 18:04	1
Arsenic	**0.63**	**B**	0.63	0.28	mg/Kg	☼	07/03/19 08:00	07/11/19 18:04	1
Barium	**6.9**		3.1	0.15	mg/Kg	☼	07/03/19 08:00	07/11/19 18:04	1
Beryllium	**0.069**	**J**	0.31	0.020	mg/Kg	☼	07/03/19 08:00	07/11/19 18:04	1

Client Sample Results

Client: Golder Associates Inc. Job ID: 140-15490-1

Project/Site: Martin Lake Ash Ponds - SEP + Totals

Client Sample ID: AP-2019-3 (18-19) Lab Sample ID: 140-15490-3

Date Collected: 06/03/19 15:20 **Matrix: Solid**

Date Received: 06/05/19 09:20 **Percent Solids: 80.0**

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cobalt	**0.53**	**J**	3.1	0.066	mg/Kg	☼	07/03/19 08:00	07/11/19 18:04	1
Iron	**2300**		6.3	3.6	mg/Kg	☼	07/03/19 08:00	07/11/19 18:04	1
Li	**0.53**	**J**	3.1	0.19	mg/Kg	☼	07/03/19 08:00	07/11/19 18:04	1
Manganese	**4.2**		0.94	0.16	mg/Kg	☼	07/03/19 08:00	07/11/19 18:04	1
Mo	ND		2.5	0.10	mg/Kg	☼	07/03/19 08:00	07/11/19 18:04	1
Selenium	**0.65**	**B ***	0.63	0.59	mg/Kg	☼	07/03/19 08:00	07/11/19 18:04	1
Thallium	ND		2.2	0.36	mg/Kg	☼	07/03/19 08:00	07/11/19 18:04	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**120**	**J ***	190	29	mg/Kg	☼	07/10/19 08:00	07/12/19 12:10	5
Antimony	ND		56	5.3	mg/Kg	☼	07/10/19 08:00	07/12/19 12:10	5
Arsenic	ND		9.4	2.4	mg/Kg	☼	07/10/19 08:00	07/12/19 12:10	5
Barium	ND	*	47	2.3	mg/Kg	☼	07/10/19 08:00	07/12/19 12:10	5
Beryllium	ND	*	4.7	0.39	mg/Kg	☼	07/10/19 08:00	07/12/19 12:10	5
Cobalt	ND	*	47	0.75	mg/Kg	☼	07/10/19 08:00	07/12/19 12:10	5
Iron	ND	*	94	55	mg/Kg	☼	07/10/19 08:00	07/12/19 12:10	5
Li	ND		47	2.8	mg/Kg	☼	07/10/19 08:00	07/12/19 12:10	5
Manganese	ND	*	14	2.3	mg/Kg	☼	07/10/19 08:00	07/12/19 12:10	5
Mo	ND		38	1.6	mg/Kg	☼	07/10/19 08:00	07/12/19 12:10	5
Selenium	ND		9.4	3.3	mg/Kg	☼	07/10/19 08:00	07/12/19 12:10	5
Thallium	ND	*	33	4.4	mg/Kg	☼	07/10/19 08:00	07/12/19 12:10	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**1200**		13	2.0	mg/Kg	☼	07/10/19 08:00	07/12/19 13:55	1
Antimony	ND		3.8	0.35	mg/Kg	☼	07/10/19 08:00	07/12/19 13:55	1
Arsenic	**0.24**	**J**	0.63	0.19	mg/Kg	☼	07/10/19 08:00	07/12/19 13:55	1
Barium	**2.1**	**J**	3.1	0.15	mg/Kg	☼	07/10/19 08:00	07/12/19 13:55	1
Beryllium	**0.026**	**J**	0.31	0.015	mg/Kg	☼	07/10/19 08:00	07/12/19 13:55	1
Cobalt	**0.28**	**J**	3.1	0.058	mg/Kg	☼	07/10/19 08:00	07/12/19 13:55	1
Iron	**820**		6.3	3.6	mg/Kg	☼	07/10/19 08:00	07/12/19 13:55	1
Li	**0.62**	**J**	3.1	0.19	mg/Kg	☼	07/10/19 08:00	07/12/19 13:55	1
Manganese	**2.9**		0.94	0.31	mg/Kg	☼	07/10/19 08:00	07/12/19 13:55	1
Mo	ND		2.5	0.12	mg/Kg	☼	07/10/19 08:00	07/12/19 13:55	1
Selenium	ND		0.63	0.21	mg/Kg	☼	07/10/19 08:00	07/12/19 13:55	1
Thallium	ND		2.2	0.26	mg/Kg	☼	07/10/19 08:00	07/12/19 13:55	1

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**12000**		130	20	mg/Kg	☼	07/12/19 09:08	07/15/19 13:24	10
Antimony	ND		3.8	0.18	mg/Kg	☼	07/12/19 09:08	07/15/19 12:11	1
Arsenic	**0.79**	**J**	1.3	0.33	mg/Kg	☼	07/12/19 09:08	07/15/19 17:27	2
Barium	**180**		31	1.5	mg/Kg	☼	07/12/19 09:08	07/15/19 13:24	10
Beryllium	**0.11**	**J**	0.31	0.0094	mg/Kg	☼	07/12/19 09:08	07/15/19 12:11	1
Cobalt	ND		6.3	0.38	mg/Kg	☼	07/12/19 09:08	07/15/19 17:27	2
Iron	**2000**		6.3	5.1	mg/Kg	☼	07/12/19 09:08	07/15/19 12:11	1
Li	**6.0**		3.1	0.19	mg/Kg	☼	07/12/19 09:08	07/15/19 12:11	1
Manganese	**26**		0.94	0.065	mg/Kg	☼	07/12/19 09:08	07/15/19 12:11	1
Mo	**0.12**	**J**	2.5	0.10	mg/Kg	☼	07/12/19 09:08	07/15/19 12:11	1

1 2 3 4 5 6 7 8 9 10 11 12 13

Client Sample ID: AP-2019-3 (18-19)

Lab Sample ID: 140-15490-3

Date Collected: 06/03/19 15:20
Date Received: 06/05/19 09:20
Matrix: Solid
Percent Solids: 80.0

Method: 6010B SEP - SEP Metals (ICP) - Step 7 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	ND		1.3	0.43	mg/Kg	☼	07/12/19 09:08	07/15/19 17:27	2
Thallium	ND		4.4	0.45	mg/Kg	☼	07/12/19 09:08	07/15/19 17:27	2

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**14000**		10	1.6	mg/Kg			07/16/19 17:31	1
Antimony	ND		3.0	0.14	mg/Kg			07/16/19 17:31	1
Arsenic	**1.7**		0.50	0.13	mg/Kg			07/16/19 17:31	1
Barium	**190**		2.5	0.12	mg/Kg			07/16/19 17:31	1
Beryllium	**0.23**	**J**	0.25	0.0075	mg/Kg			07/16/19 17:31	1
Cobalt	**1.7**	**J**	2.5	0.023	mg/Kg			07/16/19 17:31	1
Iron	**5200**		5.0	4.1	mg/Kg			07/16/19 17:31	1
Li	**7.2**		2.5	0.15	mg/Kg			07/16/19 17:31	1
Manganese	**35**		0.75	0.052	mg/Kg			07/16/19 17:31	1
Mo	**0.12**	**J**	2.0	0.082	mg/Kg			07/16/19 17:31	1
Selenium	**1.6**		0.50	0.17	mg/Kg			07/16/19 17:31	1
Thallium	ND		1.8	0.18	mg/Kg			07/16/19 17:31	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	ND		24	12	mg/Kg	☼	06/26/19 08:00	07/10/19 13:18	1
Chromium	**4.4**		1.8	0.26	mg/Kg	☼	06/26/19 08:00	07/10/19 13:18	1
Lead	**3.9**		1.8	0.33	mg/Kg	☼	06/26/19 08:00	07/10/19 13:18	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**20000**		130	20	mg/Kg	☼	06/11/19 08:00	07/15/19 16:15	10
Antimony	ND		3.8	0.18	mg/Kg	☼	06/11/19 08:00	07/15/19 14:41	1
Arsenic	**2.9**	**J**	3.1	0.81	mg/Kg	☼	06/11/19 08:00	07/15/19 18:43	5
Barium	**240**		31	1.5	mg/Kg	☼	06/11/19 08:00	07/15/19 16:15	10
Beryllium	**0.42**		0.31	0.0094	mg/Kg	☼	06/11/19 08:00	07/15/19 14:41	1
Cobalt	**3.3**	**J**	16	0.94	mg/Kg	☼	06/11/19 08:00	07/15/19 18:43	5
Iron	**8000**		6.3	5.1	mg/Kg	☼	06/11/19 08:00	07/15/19 14:41	1
Lithium	**9.6**		3.1	0.19	mg/Kg	☼	06/11/19 08:00	07/15/19 14:41	1
Manganese	**47**		0.94	0.065	mg/Kg	☼	06/11/19 08:00	07/15/19 14:41	1
Molybdenum	**0.28**	**J**	2.5	0.10	mg/Kg	☼	06/11/19 08:00	07/15/19 14:41	1
Selenium	ND		3.1	1.1	mg/Kg	☼	06/11/19 08:00	07/15/19 18:43	5
Thallium	ND		11	1.1	mg/Kg	☼	06/11/19 08:00	07/15/19 18:43	5

Method: 7470A - SEP Mercury (CVAA) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Hg	ND		0.13	0.050	mg/Kg	☼	06/11/19 08:00	06/16/19 14:17	1

Default Detection Limits

Client: Golder Associates Inc.
Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Prep: 3010A
SEP: Exchangeable

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Antimony	3.0	0.28	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Barium	2.5	0.12	mg/Kg
Beryllium	0.25	0.077	mg/Kg
Cobalt	2.5	0.045	mg/Kg
Iron	5.0	2.9	mg/Kg
Li	2.5	0.15	mg/Kg
Manganese	0.75	0.031	mg/Kg
Mo	2.0	0.082	mg/Kg
Selenium	0.50	0.17	mg/Kg
Thallium	1.8	0.21	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Prep: 3010A
SEP: Carbonate

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Antimony	3.0	0.28	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Barium	2.5	0.12	mg/Kg
Beryllium	0.25	0.016	mg/Kg
Cobalt	2.5	0.063	mg/Kg
Iron	5.0	2.9	mg/Kg
Li	2.5	0.15	mg/Kg
Manganese	0.75	0.28	mg/Kg
Mo	2.0	0.082	mg/Kg
Selenium	0.50	0.17	mg/Kg
Thallium	1.8	0.21	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Prep: 3010A
SEP: Non-Crystalline

Analyte	RL	MDL	Units
Aluminum	10	2.1	mg/Kg
Antimony	3.0	0.28	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Barium	2.5	0.12	mg/Kg
Beryllium	0.25	0.015	mg/Kg
Cobalt	2.5	0.045	mg/Kg
Iron	5.0	2.9	mg/Kg
Li	2.5	0.15	mg/Kg
Manganese	0.75	0.027	mg/Kg
Mo	2.0	0.082	mg/Kg
Selenium	0.50	0.17	mg/Kg
Thallium	1.8	0.21	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Prep: 3010A
SEP: Metal Hydroxide

Default Detection Limits

Client: Golder Associates Inc. Job ID: 140-15490-1

Project/Site: Martin Lake Ash Ponds - SEP + Totals

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Prep: 3010A

SEP: Metal Hydroxide

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Antimony	3.0	0.45	mg/Kg
Arsenic	0.50	0.22	mg/Kg
Barium	2.5	0.12	mg/Kg
Beryllium	0.25	0.016	mg/Kg
Cobalt	2.5	0.053	mg/Kg
Iron	5.0	2.9	mg/Kg
Li	2.5	0.15	mg/Kg
Manganese	0.75	0.13	mg/Kg
Mo	2.0	0.082	mg/Kg
Selenium	0.50	0.47	mg/Kg
Thallium	1.8	0.29	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Prep: 3010A

SEP: Organic-Bound

Analyte	RL	MDL	Units
Aluminum	30	4.7	mg/Kg
Antimony	9.0	0.84	mg/Kg
Arsenic	1.5	0.38	mg/Kg
Barium	7.5	0.36	mg/Kg
Beryllium	0.75	0.063	mg/Kg
Cobalt	7.5	0.12	mg/Kg
Iron	15	8.8	mg/Kg
Li	7.5	0.44	mg/Kg
Manganese	2.3	0.37	mg/Kg
Mo	6.0	0.25	mg/Kg
Selenium	1.5	0.52	mg/Kg
Thallium	5.3	0.70	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 6

SEP: Acid/Sulfide

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Antimony	3.0	0.28	mg/Kg
Arsenic	0.50	0.15	mg/Kg
Barium	2.5	0.12	mg/Kg
Beryllium	0.25	0.012	mg/Kg
Cobalt	2.5	0.046	mg/Kg
Iron	5.0	2.9	mg/Kg
Li	2.5	0.15	mg/Kg
Manganese	0.75	0.25	mg/Kg
Mo	2.0	0.099	mg/Kg
Selenium	0.50	0.17	mg/Kg
Thallium	1.8	0.21	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Prep: Residual

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 7 (Continued)

Prep: Residual

Analyte	RL	MDL	Units
Antimony	3.0	0.14	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Barium	2.5	0.12	mg/Kg
Beryllium	0.25	0.0075	mg/Kg
Cobalt	2.5	0.15	mg/Kg
Iron	5.0	4.1	mg/Kg
Li	2.5	0.15	mg/Kg
Manganese	0.75	0.052	mg/Kg
Mo	2.0	0.082	mg/Kg
Selenium	0.50	0.17	mg/Kg
Thallium	1.8	0.18	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Antimony	3.0	0.14	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Barium	2.5	0.12	mg/Kg
Beryllium	0.25	0.0075	mg/Kg
Cobalt	2.5	0.023	mg/Kg
Iron	5.0	4.1	mg/Kg
Li	2.5	0.15	mg/Kg
Manganese	0.75	0.052	mg/Kg
Mo	2.0	0.082	mg/Kg
Selenium	0.50	0.17	mg/Kg
Thallium	1.8	0.18	mg/Kg

Method: 6010B - Metals (ICP)

Prep: 3050B

Analyte	RL	MDL	Units
Boron	20	10	mg/Kg
Chromium	1.5	0.22	mg/Kg
Lead	1.5	0.28	mg/Kg

Method: 6010B - SEP Metals (ICP) - Total

Prep: Total

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Antimony	3.0	0.14	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Barium	2.5	0.12	mg/Kg
Beryllium	0.25	0.0075	mg/Kg
Cobalt	2.5	0.15	mg/Kg
Iron	5.0	4.1	mg/Kg
Lithium	2.5	0.15	mg/Kg
Manganese	0.75	0.052	mg/Kg
Molybdenum	2.0	0.082	mg/Kg
Selenium	0.50	0.17	mg/Kg
Thallium	1.8	0.18	mg/Kg

Method: 7470A - SEP Mercury (CVAA) - Total

Default Detection Limits

Client: Golder Associates Inc.	Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Method: 7470A - SEP Mercury (CVAA) - Total
Prep: Total

Analyte	RL	MDL	Units
Hg	0.10	0.040	mg/Kg

Client: Golder Associates Inc.
Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Method: 6010B - Metals (ICP)

Lab Sample ID: MB 140-31128/14-A
Matrix: Solid
Analysis Batch: 31553
Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 31128

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	ND		20	10	mg/Kg		06/26/19 08:00	07/10/19 11:42	1
Chromium	ND		1.5	0.22	mg/Kg		06/26/19 08:00	07/10/19 11:42	1
Lead	ND		1.5	0.28	mg/Kg		06/26/19 08:00	07/10/19 11:42	1

Lab Sample ID: LCS 140-31128/15-A
Matrix: Solid
Analysis Batch: 31553
Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 31128

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Boron	100	101		mg/Kg		101	80 - 120
Chromium	20.0	20.3		mg/Kg		101	90 - 110
Lead	10.0	10.1		mg/Kg		101	90 - 110

Lab Sample ID: 140-15490-1 MS
Matrix: Solid
Analysis Batch: 31553
Client Sample ID: AP-2019-1 (30-31)
Prep Type: Total/NA
Prep Batch: 31128

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Boron	ND		124	124		mg/Kg	☼	100	75 - 125
Chromium	13	F1	24.8	45.6	F1	mg/Kg	☼	131	75 - 125
Lead	6.4		12.4	17.4		mg/Kg	☼	89	75 - 125

Lab Sample ID: 140-15490-1 MSD
Matrix: Solid
Analysis Batch: 31553
Client Sample ID: AP-2019-1 (30-31)
Prep Type: Total/NA
Prep Batch: 31128

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Boron	ND		122	123		mg/Kg	☼	101	75 - 125	0	20
Chromium	13	F1	24.4	45.6	F1	mg/Kg	☼	133	75 - 125	0	20
Lead	6.4		12.2	17.5		mg/Kg	☼	91	75 - 125	0	20

Method: 6010B - SEP Metals (ICP) - Total

Lab Sample ID: MB 140-30683/13-A
Matrix: Solid
Analysis Batch: 31713
Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 30683

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		10	1.6	mg/Kg		06/11/19 08:00	07/15/19 11:13	1
Antimony	ND		3.0	0.14	mg/Kg		06/11/19 08:00	07/15/19 11:13	1
Arsenic	ND		0.50	0.13	mg/Kg		06/11/19 08:00	07/15/19 11:13	1
Barium	ND		2.5	0.12	mg/Kg		06/11/19 08:00	07/15/19 11:13	1
Beryllium	ND		0.25	0.0075	mg/Kg		06/11/19 08:00	07/15/19 11:13	1
Cobalt	ND		2.5	0.15	mg/Kg		06/11/19 08:00	07/15/19 11:13	1
Iron	ND		5.0	4.1	mg/Kg		06/11/19 08:00	07/15/19 11:13	1
Lithium	ND		2.5	0.15	mg/Kg		06/11/19 08:00	07/15/19 11:13	1
Manganese	ND		0.75	0.052	mg/Kg		06/11/19 08:00	07/15/19 11:13	1
Molybdenum	ND		2.0	0.082	mg/Kg		06/11/19 08:00	07/15/19 11:13	1
Selenium	ND		0.50	0.17	mg/Kg		06/11/19 08:00	07/15/19 11:13	1
Thallium	ND		1.8	0.18	mg/Kg		06/11/19 08:00	07/15/19 11:13	1

Client: Golder Associates Inc. Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Method: 6010B - SEP Metals (ICP) - Total

Lab Sample ID: LCS 140-30683/14-A **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 31713 **Prep Batch: 30683**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	97.6		mg/Kg		98	75 - 125
Antimony	25.0	25.9		mg/Kg		103	75 - 125
Arsenic	5.00	5.29		mg/Kg		106	75 - 125
Barium	5.00	4.99		mg/Kg		100	75 - 125
Beryllium	2.50	2.51		mg/Kg		100	75 - 125
Cobalt	5.00	5.20		mg/Kg		104	75 - 125
Iron	50.0	51.1		mg/Kg		102	75 - 125
Lithium	5.00	5.12		mg/Kg		102	75 - 125
Manganese	5.00	5.21		mg/Kg		104	75 - 125
Molybdenum	25.0	26.6		mg/Kg		106	75 - 125
Selenium	7.50	7.55		mg/Kg		101	75 - 125
Thallium	20.0	21.2		mg/Kg		106	75 - 125

Lab Sample ID: LCSD 140-30683/15-A **Client Sample ID: Lab Control Sample Dup**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 31713 **Prep Batch: 30683**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	97.0		mg/Kg		97	75 - 125	1	30
Antimony	25.0	25.9		mg/Kg		104	75 - 125	0	30
Arsenic	5.00	5.24		mg/Kg		105	75 - 125	1	30
Barium	5.00	4.95		mg/Kg		99	75 - 125	1	30
Beryllium	2.50	2.48		mg/Kg		99	75 - 125	1	30
Cobalt	5.00	5.16		mg/Kg		103	75 - 125	1	30
Iron	50.0	50.4		mg/Kg		101	75 - 125	1	30
Lithium	5.00	5.04		mg/Kg		101	75 - 125	2	30
Manganese	5.00	5.16		mg/Kg		103	75 - 125	1	30
Molybdenum	25.0	26.5		mg/Kg		106	75 - 125	0	30
Selenium	7.50	7.47		mg/Kg		100	75 - 125	1	30
Thallium	20.0	21.2		mg/Kg		106	75 - 125	0	30

Lab Sample ID: 140-15490-1 DU **Client Sample ID: AP-2019-1 (30-31)**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 31713 **Prep Batch: 30683**

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Antimony	ND		ND		mg/Kg	☼	NC	30
Arsenic	6.8		7.11		mg/Kg	☼	5	30
Beryllium	0.89		0.959		mg/Kg	☼	7	30
Iron	11000		12200		mg/Kg	☼	7	30
Lithium	18		19.7		mg/Kg	☼	7	30
Manganese	66		71.7		mg/Kg	☼	8	30
Molybdenum	0.40	J	0.434	J	mg/Kg	☼	7	30
Selenium	ND		ND		mg/Kg	☼	NC	30

QC Sample Results

Client: Golder Associates Inc. Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Method: 6010B - SEP Metals (ICP) - Total (Continued)

Lab Sample ID: 140-15490-1 DU **Client Sample ID: AP-2019-1 (30-31)**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 31713 **Prep Batch: 30683**

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Aluminum	60000		64600		mg/Kg	☼	7	30
Barium	680		733		mg/Kg	☼	7	30

Lab Sample ID: 140-15490-1 DU **Client Sample ID: AP-2019-1 (30-31)**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 31713 **Prep Batch: 30683**

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Cobalt	3.8	J	4.35	J	mg/Kg	☼	13	30
Thallium	ND		0.657	J	mg/Kg	☼	NC	30

Method: 6010B SEP - SEP Metals (ICP)

Lab Sample ID: MB 140-31148/13-B ^4 **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: Step 1**
Analysis Batch: 31604 **Prep Batch: 31252**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		40	6.4	mg/Kg		06/29/19 08:00	07/11/19 12:33	4
Antimony	ND		12	1.1	mg/Kg		06/29/19 08:00	07/11/19 12:33	4
Arsenic	ND		2.0	0.52	mg/Kg		06/29/19 08:00	07/11/19 12:33	4
Barium	ND		10	0.48	mg/Kg		06/29/19 08:00	07/11/19 12:33	4
Beryllium	ND		1.0	0.31	mg/Kg		06/29/19 08:00	07/11/19 12:33	4
Cobalt	ND		10	0.18	mg/Kg		06/29/19 08:00	07/11/19 12:33	4
Iron	ND		20	12	mg/Kg		06/29/19 08:00	07/11/19 12:33	4
Li	ND		10	0.60	mg/Kg		06/29/19 08:00	07/11/19 12:33	4
Manganese	ND		3.0	0.12	mg/Kg		06/29/19 08:00	07/11/19 12:33	4
Mo	ND		8.0	0.33	mg/Kg		06/29/19 08:00	07/11/19 12:33	4
Selenium	ND		2.0	0.68	mg/Kg		06/29/19 08:00	07/11/19 12:33	4
Thallium	ND		7.0	0.84	mg/Kg		06/29/19 08:00	07/11/19 12:33	4

Lab Sample ID: LCS 140-31148/14-B ^5 **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Step 1**
Analysis Batch: 31604 **Prep Batch: 31252**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	97.0		mg/Kg		97	75 - 125
Antimony	25.0	24.5		mg/Kg		98	75 - 125
Arsenic	5.00	4.89		mg/Kg		98	75 - 125
Barium	5.00	4.35	J	mg/Kg		87	75 - 125
Beryllium	2.50	2.58		mg/Kg		103	75 - 125
Cobalt	5.00	4.93	J	mg/Kg		99	75 - 125
Iron	50.0	49.6		mg/Kg		99	75 - 125
Li	5.00	4.72	J	mg/Kg		94	75 - 125
Manganese	5.00	5.09		mg/Kg		102	75 - 125
Mo	25.0	25.0		mg/Kg		100	75 - 125
Selenium	7.50	7.82		mg/Kg		104	75 - 125
Thallium	20.0	19.7		mg/Kg		98	75 - 125

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: LCSD 140-31148/15-B ^5 **Client Sample ID: Lab Control Sample Dup**
Matrix: Solid **Prep Type: Step 1**
Analysis Batch: 31604 **Prep Batch: 31252**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	99.5		mg/Kg		100	75 - 125	3	30
Antimony	25.0	24.7		mg/Kg		99	75 - 125	1	30
Arsenic	5.00	4.78		mg/Kg		96	75 - 125	2	30
Barium	5.00	4.30	J	mg/Kg		86	75 - 125	1	30
Beryllium	2.50	2.59		mg/Kg		104	75 - 125	0	30
Cobalt	5.00	4.89	J	mg/Kg		98	75 - 125	1	30
Iron	50.0	49.5		mg/Kg		99	75 - 125	0	30
Li	5.00	4.84	J	mg/Kg		97	75 - 125	3	30
Manganese	5.00	5.06		mg/Kg		101	75 - 125	1	30
Mo	25.0	25.1		mg/Kg		100	75 - 125	0	30
Selenium	7.50	8.06		mg/Kg		108	75 - 125	3	30
Thallium	20.0	20.1		mg/Kg		101	75 - 125	2	30

Lab Sample ID: 140-15490-1 DU **Client Sample ID: AP-2019-1 (30-31)**
Matrix: Solid **Prep Type: Step 1**
Analysis Batch: 31604 **Prep Batch: 31252**

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Aluminum	ND		ND		mg/Kg	☼	NC	30
Antimony	ND		ND		mg/Kg	☼	NC	30
Arsenic	ND		ND		mg/Kg	☼	NC	30
Barium	0.88	J	0.934	J	mg/Kg	☼	5	30
Beryllium	ND		ND		mg/Kg	☼	NC	30
Cobalt	0.54	J	0.626	J	mg/Kg	☼	15	30
Iron	ND		ND		mg/Kg	☼	NC	30
Li	ND		ND		mg/Kg	☼	NC	30
Manganese	3.1	J	3.66	J	mg/Kg	☼	16	30
Mo	ND		ND		mg/Kg	☼	NC	30
Selenium	ND		ND		mg/Kg	☼	NC	30
Thallium	ND		ND		mg/Kg	☼	NC	30

Lab Sample ID: MB 140-31253/13-B ^3 **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: Step 2**
Analysis Batch: 31604 **Prep Batch: 31256**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		30	4.8	mg/Kg		06/30/19 08:00	07/11/19 14:06	3
Antimony	ND		9.0	0.84	mg/Kg		06/30/19 08:00	07/11/19 14:06	3
Arsenic	ND		1.5	0.39	mg/Kg		06/30/19 08:00	07/11/19 14:06	3
Barium	ND		7.5	0.36	mg/Kg		06/30/19 08:00	07/11/19 14:06	3
Beryllium	ND		0.75	0.048	mg/Kg		06/30/19 08:00	07/11/19 14:06	3
Cobalt	ND		7.5	0.19	mg/Kg		06/30/19 08:00	07/11/19 14:06	3
Iron	ND		15	8.7	mg/Kg		06/30/19 08:00	07/11/19 14:06	3
Li	ND		7.5	0.45	mg/Kg		06/30/19 08:00	07/11/19 14:06	3
Manganese	ND		2.3	0.84	mg/Kg		06/30/19 08:00	07/11/19 14:06	3
Mo	ND		6.0	0.25	mg/Kg		06/30/19 08:00	07/11/19 14:06	3
Selenium	0.587	J	1.5	0.51	mg/Kg		06/30/19 08:00	07/11/19 14:06	3
Thallium	ND		5.3	0.63	mg/Kg		06/30/19 08:00	07/11/19 14:06	3

QC Sample Results

Client: Golder Associates Inc. Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: LCS 140-31253/14-B ^5 **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Step 2**
Analysis Batch: 31604 **Prep Batch: 31256**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	ND	*	mg/Kg		1	75 - 125
Antimony	25.0	21.1		mg/Kg		84	75 - 125
Arsenic	5.00	3.95		mg/Kg		79	75 - 125
Barium	5.00	2.28	J *	mg/Kg		46	75 - 125
Beryllium	2.50	1.35	*	mg/Kg		54	75 - 125
Cobalt	5.00	4.62	J	mg/Kg		92	75 - 125
Iron	50.0	ND	*	mg/Kg		2	75 - 125
Li	5.00	4.14	J	mg/Kg		83	75 - 125
Manganese	5.00	4.79		mg/Kg		96	75 - 125
Mo	25.0	20.7		mg/Kg		83	75 - 125
Selenium	7.50	7.34		mg/Kg		98	75 - 125
Thallium	20.0	18.4		mg/Kg		92	75 - 125

Lab Sample ID: LCSD 140-31253/15-B ^5 **Client Sample ID: Lab Control Sample Dup**
Matrix: Solid **Prep Type: Step 2**
Analysis Batch: 31604 **Prep Batch: 31256**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	ND	*	mg/Kg		-0.3	75 - 125	289	30
Antimony	25.0	21.4		mg/Kg		86	75 - 125	1	30
Arsenic	5.00	4.00		mg/Kg		80	75 - 125	1	30
Barium	5.00	2.28	J *	mg/Kg		46	75 - 125	0	30
Beryllium	2.50	1.32	*	mg/Kg		53	75 - 125	2	30
Cobalt	5.00	4.62	J	mg/Kg		92	75 - 125	0	30
Iron	50.0	ND	*	mg/Kg		3	75 - 125	28	30
Li	5.00	4.15	J	mg/Kg		83	75 - 125	0	30
Manganese	5.00	4.76		mg/Kg		95	75 - 125	1	30
Mo	25.0	20.9		mg/Kg		84	75 - 125	1	30
Selenium	7.50	6.68		mg/Kg		89	75 - 125	10	30
Thallium	20.0	18.6		mg/Kg		93	75 - 125	1	30

Lab Sample ID: 140-15490-1 DU **Client Sample ID: AP-2019-1 (30-31)**
Matrix: Solid **Prep Type: Step 2**
Analysis Batch: 31604 **Prep Batch: 31256**

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Aluminum	9.7	J *	11.8	J *	mg/Kg	☼	19	30
Antimony	ND		ND		mg/Kg	☼	NC	30
Arsenic	ND		ND		mg/Kg	☼	NC	30
Barium	0.76	J *	0.792	J *	mg/Kg	☼	4	30
Beryllium	ND	*	ND	*	mg/Kg	☼	NC	30
Cobalt	ND		ND		mg/Kg	☼	NC	30
Iron	ND	*	ND	*	mg/Kg	☼	NC	30
Li	ND		ND		mg/Kg	☼	NC	30
Manganese	ND		ND		mg/Kg	☼	NC	30
Mo	ND		ND		mg/Kg	☼	NC	30
Selenium	0.76	J B	0.794	J	mg/Kg	☼	4	30
Thallium	ND		ND		mg/Kg	☼	NC	30

Client: Golder Associates Inc. Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: MB 140-31257/13-B **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: Step 3**
Analysis Batch: 31604 **Prep Batch: 31338**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		10	2.1	mg/Kg		07/02/19 08:00	07/11/19 15:50	1
Antimony	ND		3.0	0.28	mg/Kg		07/02/19 08:00	07/11/19 15:50	1
Arsenic	ND		0.50	0.13	mg/Kg		07/02/19 08:00	07/11/19 15:50	1
Barium	0.151	J	2.5	0.12	mg/Kg		07/02/19 08:00	07/11/19 15:50	1
Beryllium	ND		0.25	0.015	mg/Kg		07/02/19 08:00	07/11/19 15:50	1
Cobalt	ND		2.5	0.045	mg/Kg		07/02/19 08:00	07/11/19 15:50	1
Iron	ND		5.0	2.9	mg/Kg		07/02/19 08:00	07/11/19 15:50	1
Li	ND		2.5	0.15	mg/Kg		07/02/19 08:00	07/11/19 15:50	1
Manganese	0.0515	J	0.75	0.027	mg/Kg		07/02/19 08:00	07/11/19 15:50	1
Mo	ND		2.0	0.082	mg/Kg		07/02/19 08:00	07/11/19 15:50	1
Selenium	0.197	J	0.50	0.17	mg/Kg		07/02/19 08:00	07/11/19 15:50	1
Thallium	ND		1.8	0.21	mg/Kg		07/02/19 08:00	07/11/19 15:50	1

Lab Sample ID: LCS 140-31257/14-B **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Step 3**
Analysis Batch: 31604 **Prep Batch: 31338**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	95.8		mg/Kg		96	75 - 125
Antimony	25.0	24.3		mg/Kg		97	75 - 125
Arsenic	5.00	4.90		mg/Kg		98	75 - 125
Barium	5.00	4.34		mg/Kg		87	75 - 125
Beryllium	2.50	2.56		mg/Kg		102	75 - 125
Cobalt	5.00	4.90		mg/Kg		98	75 - 125
Iron	50.0	54.0		mg/Kg		108	75 - 125
Li	5.00	4.87		mg/Kg		97	75 - 125
Manganese	5.00	5.03		mg/Kg		101	75 - 125
Mo	25.0	24.8		mg/Kg		99	75 - 125
Selenium	7.50	7.37		mg/Kg		98	75 - 125
Thallium	20.0	20.2		mg/Kg		101	75 - 125

Lab Sample ID: LCSD 140-31257/15-B **Client Sample ID: Lab Control Sample Dup**
Matrix: Solid **Prep Type: Step 3**
Analysis Batch: 31604 **Prep Batch: 31338**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	98.1		mg/Kg		98	75 - 125	2	30
Antimony	25.0	24.6		mg/Kg		98	75 - 125	1	30
Arsenic	5.00	5.06		mg/Kg		101	75 - 125	3	30
Barium	5.00	4.49		mg/Kg		90	75 - 125	3	30
Beryllium	2.50	2.61		mg/Kg		104	75 - 125	2	30
Cobalt	5.00	4.97		mg/Kg		99	75 - 125	1	30
Iron	50.0	51.0		mg/Kg		102	75 - 125	6	30
Li	5.00	4.95		mg/Kg		99	75 - 125	2	30
Manganese	5.00	5.06		mg/Kg		101	75 - 125	1	30
Mo	25.0	24.9		mg/Kg		100	75 - 125	0	30
Selenium	7.50	7.63		mg/Kg		102	75 - 125	3	30
Thallium	20.0	20.5		mg/Kg		103	75 - 125	2	30

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: 140-15490-1 DU **Client Sample ID: AP-2019-1 (30-31)**
Matrix: Solid **Prep Type: Step 3**
Analysis Batch: 31604 **Prep Batch: 31338**

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Aluminum	88		90.2		mg/Kg	☼	3	30
Antimony	ND		ND		mg/Kg	☼	NC	30
Arsenic	1.8		1.75		mg/Kg	☼	5	30
Barium	4.3	B	4.58		mg/Kg	☼	7	30
Beryllium	0.067	J	0.0665	J	mg/Kg	☼	1	30
Cobalt	0.34	J	0.478	J F5	mg/Kg	☼	32	30
Iron	580		553		mg/Kg	☼	4	30
Li	ND		ND		mg/Kg	☼	NC	30
Manganese	2.4	B	2.99		mg/Kg	☼	20	30
Mo	ND		ND		mg/Kg	☼	NC	30
Selenium	0.22	J B	0.249	J	mg/Kg	☼	14	30
Thallium	ND		ND		mg/Kg	☼	NC	30

Lab Sample ID: MB 140-31341/13-B **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: Step 4**
Analysis Batch: 31604 **Prep Batch: 31360**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		10	1.6	mg/Kg		07/03/19 08:00	07/11/19 17:24	1
Antimony	ND		3.0	0.45	mg/Kg		07/03/19 08:00	07/11/19 17:24	1
Arsenic	0.260	J	0.50	0.22	mg/Kg		07/03/19 08:00	07/11/19 17:24	1
Barium	ND		2.5	0.12	mg/Kg		07/03/19 08:00	07/11/19 17:24	1
Beryllium	ND		0.25	0.016	mg/Kg		07/03/19 08:00	07/11/19 17:24	1
Cobalt	ND		2.5	0.053	mg/Kg		07/03/19 08:00	07/11/19 17:24	1
Iron	ND		5.0	2.9	mg/Kg		07/03/19 08:00	07/11/19 17:24	1
Li	ND		2.5	0.15	mg/Kg		07/03/19 08:00	07/11/19 17:24	1
Manganese	ND		0.75	0.13	mg/Kg		07/03/19 08:00	07/11/19 17:24	1
Mo	ND		2.0	0.082	mg/Kg		07/03/19 08:00	07/11/19 17:24	1
Selenium	0.561		0.50	0.47	mg/Kg		07/03/19 08:00	07/11/19 17:24	1
Thallium	ND		1.8	0.29	mg/Kg		07/03/19 08:00	07/11/19 17:24	1

Lab Sample ID: LCS 140-31341/14-B **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Step 4**
Analysis Batch: 31604 **Prep Batch: 31360**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	98.4		mg/Kg		98	75 - 125
Antimony	25.0	25.6		mg/Kg		102	75 - 125
Arsenic	5.00	5.48		mg/Kg		110	75 - 125
Barium	5.00	4.90		mg/Kg		98	75 - 125
Beryllium	2.50	2.66		mg/Kg		106	75 - 125
Cobalt	5.00	4.92		mg/Kg		98	75 - 125
Iron	50.0	50.0		mg/Kg		100	75 - 125
Li	5.00	4.92		mg/Kg		98	75 - 125
Manganese	5.00	4.98		mg/Kg		100	75 - 125
Mo	25.0	25.7		mg/Kg		103	75 - 125
Selenium	7.50	0.762	*	mg/Kg		10	75 - 125
Thallium	20.0	17.2		mg/Kg		86	75 - 125

Client: Golder Associates Inc. Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: LCSD 140-31341/15-B **Client Sample ID: Lab Control Sample Dup**
Matrix: Solid **Prep Type: Step 4**
Analysis Batch: 31604 **Prep Batch: 31360**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	101		mg/Kg		101	75 - 125	3	30
Antimony	25.0	25.9		mg/Kg		103	75 - 125	1	30
Arsenic	5.00	5.55		mg/Kg		111	75 - 125	1	30
Barium	5.00	5.04		mg/Kg		101	75 - 125	3	30
Beryllium	2.50	2.74		mg/Kg		109	75 - 125	3	30
Cobalt	5.00	5.07		mg/Kg		101	75 - 125	3	30
Iron	50.0	51.5		mg/Kg		103	75 - 125	3	30
Li	5.00	5.09		mg/Kg		102	75 - 125	3	30
Manganese	5.00	5.13		mg/Kg		103	75 - 125	3	30
Mo	25.0	25.9		mg/Kg		104	75 - 125	1	30
Selenium	7.50	0.631	*	mg/Kg		8	75 - 125	19	30
Thallium	20.0	17.9		mg/Kg		89	75 - 125	4	30

Lab Sample ID: 140-15490-1 DU **Client Sample ID: AP-2019-1 (30-31)**
Matrix: Solid **Prep Type: Step 4**
Analysis Batch: 31604 **Prep Batch: 31360**

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Aluminum	1700		1740		mg/Kg	☼	0.1	30
Antimony	ND		ND		mg/Kg	☼	NC	30
Arsenic	2.8	B	2.56		mg/Kg	☼	10	30
Barium	16		18.8		mg/Kg	☼	15	30
Beryllium	0.13	J	0.135	J	mg/Kg	☼	1	30
Cobalt	1.5	J	1.59	J	mg/Kg	☼	8	30
Iron	3900		3860		mg/Kg	☼	2	30
Li	3.0	J	3.10	J	mg/Kg	☼	2	30
Manganese	18		18.2		mg/Kg	☼	0.4	30
Mo	ND		ND		mg/Kg	☼	NC	30
Selenium	ND	*	0.624	J *	mg/Kg	☼	NC	30
Thallium	ND		ND		mg/Kg	☼	NC	30

Lab Sample ID: MB 140-31436/13-B ^5 **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: Step 5**
Analysis Batch: 31651 **Prep Batch: 31500**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		150	24	mg/Kg		07/10/19 08:00	07/12/19 11:39	5
Antimony	ND		45	4.2	mg/Kg		07/10/19 08:00	07/12/19 11:39	5
Arsenic	ND		7.5	1.9	mg/Kg		07/10/19 08:00	07/12/19 11:39	5
Barium	ND		38	1.8	mg/Kg		07/10/19 08:00	07/12/19 11:39	5
Beryllium	ND		3.8	0.32	mg/Kg		07/10/19 08:00	07/12/19 11:39	5
Cobalt	ND		38	0.60	mg/Kg		07/10/19 08:00	07/12/19 11:39	5
Iron	ND		75	44	mg/Kg		07/10/19 08:00	07/12/19 11:39	5
Li	ND		38	2.2	mg/Kg		07/10/19 08:00	07/12/19 11:39	5
Manganese	ND		11	1.9	mg/Kg		07/10/19 08:00	07/12/19 11:39	5
Mo	ND		30	1.3	mg/Kg		07/10/19 08:00	07/12/19 11:39	5
Selenium	ND		7.5	2.6	mg/Kg		07/10/19 08:00	07/12/19 11:39	5
Thallium	ND		26	3.5	mg/Kg		07/10/19 08:00	07/12/19 11:39	5

Client: Golder Associates Inc. Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: LCS 140-31436/14-B ^5 **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Step 5**
Analysis Batch: 31651 **Prep Batch: 31500**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	300	ND	*	mg/Kg		6	75 - 125
Antimony	75.0	81.2		mg/Kg		108	75 - 125
Arsenic	15.0	12.3		mg/Kg		82	75 - 125
Barium	15.0	7.80	J *	mg/Kg		52	75 - 125
Beryllium	7.50	4.23	*	mg/Kg		56	75 - 125
Cobalt	15.0	4.86	J *	mg/Kg		32	75 - 125
Iron	150	ND	*	mg/Kg		2	75 - 125
Li	15.0	16.4	J	mg/Kg		109	75 - 125
Manganese	15.0	4.82	J *	mg/Kg		32	75 - 125
Mo	75.0	64.7		mg/Kg		86	75 - 125
Selenium	22.5	24.8		mg/Kg		110	75 - 125
Thallium	60.0	ND	*	mg/Kg		2	75 - 125

Lab Sample ID: LCSD 140-31436/15-B ^5 **Client Sample ID: Lab Control Sample Dup**
Matrix: Solid **Prep Type: Step 5**
Analysis Batch: 31651 **Prep Batch: 31500**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	300	ND	*	mg/Kg		7	75 - 125	14	30
Antimony	75.0	82.5		mg/Kg		110	75 - 125	2	30
Arsenic	15.0	12.5		mg/Kg		83	75 - 125	2	30
Barium	15.0	7.73	J *	mg/Kg		52	75 - 125	1	30
Beryllium	7.50	4.34	*	mg/Kg		58	75 - 125	2	30
Cobalt	15.0	5.05	J *	mg/Kg		34	75 - 125	4	30
Iron	150	ND	*	mg/Kg		3	75 - 125	55	30
Li	15.0	16.1	J	mg/Kg		107	75 - 125	2	30
Manganese	15.0	4.97	J *	mg/Kg		33	75 - 125	3	30
Mo	75.0	64.0		mg/Kg		85	75 - 125	1	30
Selenium	22.5	26.2		mg/Kg		116	75 - 125	6	30
Thallium	60.0	ND	*	mg/Kg		0.9	75 - 125	60	30

Lab Sample ID: 140-15490-1 DU **Client Sample ID: AP-2019-1 (30-31)**
Matrix: Solid **Prep Type: Step 5**
Analysis Batch: 31651 **Prep Batch: 31500**

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Aluminum	62	J *	54.9	J *	mg/Kg	☼	12	30
Antimony	ND		ND		mg/Kg	☼	NC	30
Arsenic	ND		ND		mg/Kg	☼	NC	30
Barium	7.0	J *	8.10	J *	mg/Kg	☼	15	30
Beryllium	ND	*	ND	*	mg/Kg	☼	NC	30
Cobalt	ND	*	ND	*	mg/Kg	☼	NC	30
Iron	ND	*	ND	*	mg/Kg	☼	NC	30
Li	ND		ND		mg/Kg	☼	NC	30
Manganese	ND	*	ND	*	mg/Kg	☼	NC	30
Mo	ND		ND		mg/Kg	☼	NC	30
Selenium	ND		ND		mg/Kg	☼	NC	30
Thallium	ND	*	ND	*	mg/Kg	☼	NC	30

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: MB 140-31502/13-A
Client Sample ID: Method Blank
Matrix: Solid
Prep Type: Step 6
Analysis Batch: 31651
Prep Batch: 31502

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		10	1.6	mg/Kg		07/10/19 08:00	07/12/19 13:14	1
Antimony	ND		3.0	0.28	mg/Kg		07/10/19 08:00	07/12/19 13:14	1
Arsenic	ND		0.50	0.15	mg/Kg		07/10/19 08:00	07/12/19 13:14	1
Barium	ND		2.5	0.12	mg/Kg		07/10/19 08:00	07/12/19 13:14	1
Beryllium	ND		0.25	0.012	mg/Kg		07/10/19 08:00	07/12/19 13:14	1
Cobalt	ND		2.5	0.046	mg/Kg		07/10/19 08:00	07/12/19 13:14	1
Iron	ND		5.0	2.9	mg/Kg		07/10/19 08:00	07/12/19 13:14	1
Li	ND		2.5	0.15	mg/Kg		07/10/19 08:00	07/12/19 13:14	1
Manganese	ND		0.75	0.25	mg/Kg		07/10/19 08:00	07/12/19 13:14	1
Mo	ND		2.0	0.099	mg/Kg		07/10/19 08:00	07/12/19 13:14	1
Selenium	ND		0.50	0.17	mg/Kg		07/10/19 08:00	07/12/19 13:14	1
Thallium	ND		1.8	0.21	mg/Kg		07/10/19 08:00	07/12/19 13:14	1

Lab Sample ID: LCS 140-31502/14-A
Client Sample ID: Lab Control Sample
Matrix: Solid
Prep Type: Step 6
Analysis Batch: 31651
Prep Batch: 31502

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	95.4		mg/Kg		95	75 - 125
Antimony	25.0	24.8		mg/Kg		99	75 - 125
Arsenic	5.00	4.94		mg/Kg		99	75 - 125
Barium	5.00	4.58		mg/Kg		92	75 - 125
Beryllium	2.50	2.57		mg/Kg		103	75 - 125
Cobalt	5.00	4.78		mg/Kg		96	75 - 125
Iron	50.0	47.4		mg/Kg		95	75 - 125
Li	5.00	4.71		mg/Kg		94	75 - 125
Manganese	5.00	4.83		mg/Kg		97	75 - 125
Mo	25.0	24.7		mg/Kg		99	75 - 125
Selenium	7.50	7.32		mg/Kg		98	75 - 125
Thallium	20.0	19.8		mg/Kg		99	75 - 125

Lab Sample ID: LCSD 140-31502/15-A
Client Sample ID: Lab Control Sample Dup
Matrix: Solid
Prep Type: Step 6
Analysis Batch: 31651
Prep Batch: 31502

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	98.8		mg/Kg		99	75 - 125	4	30
Antimony	25.0	25.5		mg/Kg		102	75 - 125	3	30
Arsenic	5.00	5.16		mg/Kg		103	75 - 125	4	30
Barium	5.00	4.77		mg/Kg		95	75 - 125	4	30
Beryllium	2.50	2.67		mg/Kg		107	75 - 125	4	30
Cobalt	5.00	4.97		mg/Kg		99	75 - 125	4	30
Iron	50.0	49.5		mg/Kg		99	75 - 125	4	30
Li	5.00	4.90		mg/Kg		98	75 - 125	4	30
Manganese	5.00	5.02		mg/Kg		100	75 - 125	4	30
Mo	25.0	25.2		mg/Kg		101	75 - 125	2	30
Selenium	7.50	7.50		mg/Kg		100	75 - 125	2	30
Thallium	20.0	20.6		mg/Kg		103	75 - 125	4	30

Client: Golder Associates Inc. Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: 140-15490-1 DU **Client Sample ID: AP-2019-1 (30-31)**
Matrix: Solid **Prep Type: Step 6**
Analysis Batch: 31651 **Prep Batch: 31502**

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Aluminum	2300		2370		mg/Kg	☼	2	30
Antimony	ND		ND		mg/Kg	☼	NC	30
Arsenic	0.94		0.869		mg/Kg	☼	8	30
Barium	18		18.6		mg/Kg	☼	6	30
Beryllium	0.067	J	0.0691	J	mg/Kg	☼	3	30
Cobalt	0.90	J	0.940	J	mg/Kg	☼	5	30
Iron	2500		2510		mg/Kg	☼	0.4	30
Li	2.1	J	2.17	J	mg/Kg	☼	3	30
Manganese	16		16.1		mg/Kg	☼	0.6	30
Mo	ND		ND		mg/Kg	☼	NC	30
Selenium	ND		ND		mg/Kg	☼	NC	30
Thallium	ND		ND		mg/Kg	☼	NC	30

Lab Sample ID: MB 140-31615/13-A **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: Step 7**
Analysis Batch: 31713 **Prep Batch: 31615**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		10	1.6	mg/Kg		07/12/19 09:08	07/15/19 10:58	1
Antimony	ND		3.0	0.14	mg/Kg		07/12/19 09:08	07/15/19 10:58	1
Arsenic	ND		0.50	0.13	mg/Kg		07/12/19 09:08	07/15/19 10:58	1
Barium	ND		2.5	0.12	mg/Kg		07/12/19 09:08	07/15/19 10:58	1
Beryllium	ND		0.25	0.0075	mg/Kg		07/12/19 09:08	07/15/19 10:58	1
Cobalt	ND		2.5	0.15	mg/Kg		07/12/19 09:08	07/15/19 10:58	1
Iron	ND		5.0	4.1	mg/Kg		07/12/19 09:08	07/15/19 10:58	1
Li	ND		2.5	0.15	mg/Kg		07/12/19 09:08	07/15/19 10:58	1
Manganese	ND		0.75	0.052	mg/Kg		07/12/19 09:08	07/15/19 10:58	1
Mo	ND		2.0	0.082	mg/Kg		07/12/19 09:08	07/15/19 10:58	1
Selenium	ND		0.50	0.17	mg/Kg		07/12/19 09:08	07/15/19 10:58	1
Thallium	ND		1.8	0.18	mg/Kg		07/12/19 09:08	07/15/19 10:58	1

Lab Sample ID: LCS 140-31615/14-A **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Step 7**
Analysis Batch: 31713 **Prep Batch: 31615**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	100	96.8		mg/Kg		97	75 - 125
Antimony	25.0	25.7		mg/Kg		103	75 - 125
Arsenic	5.00	5.23		mg/Kg		105	75 - 125
Barium	5.00	4.99		mg/Kg		100	75 - 125
Beryllium	2.50	2.52		mg/Kg		101	75 - 125
Cobalt	5.00	5.20		mg/Kg		104	75 - 125
Iron	50.0	51.7		mg/Kg		103	75 - 125
Li	5.00	5.15		mg/Kg		103	75 - 125
Manganese	5.00	5.21		mg/Kg		104	75 - 125
Mo	25.0	26.5		mg/Kg		106	75 - 125
Selenium	7.50	7.52		mg/Kg		100	75 - 125
Thallium	20.0	21.2		mg/Kg		106	75 - 125

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: LCSD 140-31615/15-A **Client Sample ID: Lab Control Sample Dup**
Matrix: Solid **Prep Type: Step 7**
Analysis Batch: 31713 **Prep Batch: 31615**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	100	98.0		mg/Kg		98	75 - 125	1	30
Antimony	25.0	25.8		mg/Kg		103	75 - 125	0	30
Arsenic	5.00	5.30		mg/Kg		106	75 - 125	1	30
Barium	5.00	4.99		mg/Kg		100	75 - 125	0	30
Beryllium	2.50	2.50		mg/Kg		100	75 - 125	1	30
Cobalt	5.00	5.21		mg/Kg		104	75 - 125	0	30
Iron	50.0	51.5		mg/Kg		103	75 - 125	0	30
Li	5.00	5.18		mg/Kg		104	75 - 125	1	30
Manganese	5.00	5.21		mg/Kg		104	75 - 125	0	30
Mo	25.0	26.7		mg/Kg		107	75 - 125	1	30
Selenium	7.50	7.55		mg/Kg		101	75 - 125	0	30
Thallium	20.0	21.3		mg/Kg		107	75 - 125	1	30

Lab Sample ID: 140-15490-1 DU **Client Sample ID: AP-2019-1 (30-31)**
Matrix: Solid **Prep Type: Step 7**
Analysis Batch: 31713 **Prep Batch: 31615**

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Antimony	ND		ND		mg/Kg	☼	NC	30
Arsenic	1.2		1.16		mg/Kg	☼	6	30
Beryllium	0.56		0.602		mg/Kg	☼	7	30
Iron	5200		5740		mg/Kg	☼	11	30
Li	9.6		10.9		mg/Kg	☼	13	30
Manganese	26		29.0		mg/Kg	☼	9	30
Mo	0.19	J	0.209	J	mg/Kg	☼	10	30
Selenium	ND		ND		mg/Kg	☼	NC	30

Lab Sample ID: 140-15490-1 DU **Client Sample ID: AP-2019-1 (30-31)**
Matrix: Solid **Prep Type: Step 7**
Analysis Batch: 31713 **Prep Batch: 31615**

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Aluminum	29000		35900		mg/Kg	☼	23	30
Barium	390		447		mg/Kg	☼	14	30

Lab Sample ID: 140-15490-1 DU **Client Sample ID: AP-2019-1 (30-31)**
Matrix: Solid **Prep Type: Step 7**
Analysis Batch: 31713 **Prep Batch: 31615**

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Cobalt	0.79	J	0.899	J	mg/Kg	☼	12	30
Thallium	0.48	J	ND		mg/Kg	☼	NC	30

Client: Golder Associates Inc. Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Method: 7470A - SEP Mercury (CVAA) - Total

Lab Sample ID: MB 140-30683/13-B **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 30868 **Prep Batch: 30683**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Hg	ND		0.10	0.040	mg/Kg		06/11/19 08:00	06/16/19 13:56	1

Lab Sample ID: LCS 140-30683/14-B **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 30868 **Prep Batch: 30683**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Hg	2.50	2.70		mg/Kg		108	75 - 125

Lab Sample ID: LCSD 140-30683/15-B **Client Sample ID: Lab Control Sample Dup**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 30868 **Prep Batch: 30683**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Hg	2.50	2.71		mg/Kg		108	75 - 125	0	30

Lab Sample ID: 140-15490-1 DU **Client Sample ID: AP-2019-1 (30-31)**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 30868 **Prep Batch: 30683**

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Hg	0.081	J	0.102	J	mg/Kg	☼	23	30

QC Association Summary

Metals

Prep Batch: 30683

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Total/NA	Solid	Total	
140-15490-2	AP-2019-2 (35-36)	Total/NA	Solid	Total	
140-15490-3	AP-2019-3 (18-19)	Total/NA	Solid	Total	
MB 140-30683/13-A	Method Blank	Total/NA	Solid	Total	
MB 140-30683/13-B	Method Blank	Total/NA	Solid	Total	
LCS 140-30683/14-A	Lab Control Sample	Total/NA	Solid	Total	
LCS 140-30683/14-B	Lab Control Sample	Total/NA	Solid	Total	
LCSD 140-30683/15-A	Lab Control Sample Dup	Total/NA	Solid	Total	
LCSD 140-30683/15-B	Lab Control Sample Dup	Total/NA	Solid	Total	
140-15490-1 DU	AP-2019-1 (30-31)	Total/NA	Solid	Total	

Prep Batch: 30859

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Total/NA	Solid	7470A	30683
140-15490-2	AP-2019-2 (35-36)	Total/NA	Solid	7470A	30683
140-15490-3	AP-2019-3 (18-19)	Total/NA	Solid	7470A	30683
MB 140-30683/13-B	Method Blank	Total/NA	Solid	7470A	30683
LCS 140-30683/14-B	Lab Control Sample	Total/NA	Solid	7470A	30683
LCSD 140-30683/15-B	Lab Control Sample Dup	Total/NA	Solid	7470A	30683
140-15490-1 DU	AP-2019-1 (30-31)	Total/NA	Solid	7470A	30683

Analysis Batch: 30868

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Total/NA	Solid	7470A	30859
140-15490-2	AP-2019-2 (35-36)	Total/NA	Solid	7470A	30859
140-15490-3	AP-2019-3 (18-19)	Total/NA	Solid	7470A	30859
MB 140-30683/13-B	Method Blank	Total/NA	Solid	7470A	30859
LCS 140-30683/14-B	Lab Control Sample	Total/NA	Solid	7470A	30859
LCSD 140-30683/15-B	Lab Control Sample Dup	Total/NA	Solid	7470A	30859
140-15490-1 DU	AP-2019-1 (30-31)	Total/NA	Solid	7470A	30859

Prep Batch: 31128

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Total/NA	Solid	3050B	
140-15490-2	AP-2019-2 (35-36)	Total/NA	Solid	3050B	
140-15490-3	AP-2019-3 (18-19)	Total/NA	Solid	3050B	
MB 140-31128/14-A	Method Blank	Total/NA	Solid	3050B	
LCS 140-31128/15-A	Lab Control Sample	Total/NA	Solid	3050B	
140-15490-1 MS	AP-2019-1 (30-31)	Total/NA	Solid	3050B	
140-15490-1 MSD	AP-2019-1 (30-31)	Total/NA	Solid	3050B	

SEP Batch: 31148

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Step 1	Solid	Exchangeable	
140-15490-2	AP-2019-2 (35-36)	Step 1	Solid	Exchangeable	
140-15490-3	AP-2019-3 (18-19)	Step 1	Solid	Exchangeable	
MB 140-31148/13-B ^4	Method Blank	Step 1	Solid	Exchangeable	
LCS 140-31148/14-B ^5	Lab Control Sample	Step 1	Solid	Exchangeable	
LCSD 140-31148/15-B ^5	Lab Control Sample Dup	Step 1	Solid	Exchangeable	
140-15490-1 DU	AP-2019-1 (30-31)	Step 1	Solid	Exchangeable	

Metals

Prep Batch: 31252

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Step 1	Solid	3010A	31148
140-15490-2	AP-2019-2 (35-36)	Step 1	Solid	3010A	31148
140-15490-3	AP-2019-3 (18-19)	Step 1	Solid	3010A	31148
MB 140-31148/13-B ^4	Method Blank	Step 1	Solid	3010A	31148
LCS 140-31148/14-B ^5	Lab Control Sample	Step 1	Solid	3010A	31148
LCSD 140-31148/15-B ^5	Lab Control Sample Dup	Step 1	Solid	3010A	31148
140-15490-1 DU	AP-2019-1 (30-31)	Step 1	Solid	3010A	31148

SEP Batch: 31253

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Step 2	Solid	Carbonate	
140-15490-2	AP-2019-2 (35-36)	Step 2	Solid	Carbonate	
140-15490-3	AP-2019-3 (18-19)	Step 2	Solid	Carbonate	
MB 140-31253/13-B ^3	Method Blank	Step 2	Solid	Carbonate	
LCS 140-31253/14-B ^5	Lab Control Sample	Step 2	Solid	Carbonate	
LCSD 140-31253/15-B ^5	Lab Control Sample Dup	Step 2	Solid	Carbonate	
140-15490-1 DU	AP-2019-1 (30-31)	Step 2	Solid	Carbonate	

Prep Batch: 31256

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Step 2	Solid	3010A	31253
140-15490-2	AP-2019-2 (35-36)	Step 2	Solid	3010A	31253
140-15490-3	AP-2019-3 (18-19)	Step 2	Solid	3010A	31253
MB 140-31253/13-B ^3	Method Blank	Step 2	Solid	3010A	31253
LCS 140-31253/14-B ^5	Lab Control Sample	Step 2	Solid	3010A	31253
LCSD 140-31253/15-B ^5	Lab Control Sample Dup	Step 2	Solid	3010A	31253
140-15490-1 DU	AP-2019-1 (30-31)	Step 2	Solid	3010A	31253

SEP Batch: 31257

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Step 3	Solid	Non-Crystalline	
140-15490-2	AP-2019-2 (35-36)	Step 3	Solid	Non-Crystalline	
140-15490-3	AP-2019-3 (18-19)	Step 3	Solid	Non-Crystalline	
MB 140-31257/13-B	Method Blank	Step 3	Solid	Non-Crystalline	
LCS 140-31257/14-B	Lab Control Sample	Step 3	Solid	Non-Crystalline	
LCSD 140-31257/15-B	Lab Control Sample Dup	Step 3	Solid	Non-Crystalline	
140-15490-1 DU	AP-2019-1 (30-31)	Step 3	Solid	Non-Crystalline	

Prep Batch: 31338

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Step 3	Solid	3010A	31257
140-15490-2	AP-2019-2 (35-36)	Step 3	Solid	3010A	31257
140-15490-3	AP-2019-3 (18-19)	Step 3	Solid	3010A	31257
MB 140-31257/13-B	Method Blank	Step 3	Solid	3010A	31257
LCS 140-31257/14-B	Lab Control Sample	Step 3	Solid	3010A	31257
LCSD 140-31257/15-B	Lab Control Sample Dup	Step 3	Solid	3010A	31257
140-15490-1 DU	AP-2019-1 (30-31)	Step 3	Solid	3010A	31257

SEP Batch: 31341

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Step 4	Solid	Metal Hydroxide	

Metals (Continued)

SEP Batch: 31341 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-2	AP-2019-2 (35-36)	Step 4	Solid	Metal Hydroxide	
140-15490-3	AP-2019-3 (18-19)	Step 4	Solid	Metal Hydroxide	
MB 140-31341/13-B	Method Blank	Step 4	Solid	Metal Hydroxide	
LCS 140-31341/14-B	Lab Control Sample	Step 4	Solid	Metal Hydroxide	
LCSD 140-31341/15-B	Lab Control Sample Dup	Step 4	Solid	Metal Hydroxide	
140-15490-1 DU	AP-2019-1 (30-31)	Step 4	Solid	Metal Hydroxide	

Prep Batch: 31360

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Step 4	Solid	3010A	31341
140-15490-2	AP-2019-2 (35-36)	Step 4	Solid	3010A	31341
140-15490-3	AP-2019-3 (18-19)	Step 4	Solid	3010A	31341
MB 140-31341/13-B	Method Blank	Step 4	Solid	3010A	31341
LCS 140-31341/14-B	Lab Control Sample	Step 4	Solid	3010A	31341
LCSD 140-31341/15-B	Lab Control Sample Dup	Step 4	Solid	3010A	31341
140-15490-1 DU	AP-2019-1 (30-31)	Step 4	Solid	3010A	31341

SEP Batch: 31436

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Step 5	Solid	Organic-Bound	
140-15490-2	AP-2019-2 (35-36)	Step 5	Solid	Organic-Bound	
140-15490-3	AP-2019-3 (18-19)	Step 5	Solid	Organic-Bound	
MB 140-31436/13-B ^5	Method Blank	Step 5	Solid	Organic-Bound	
LCS 140-31436/14-B ^5	Lab Control Sample	Step 5	Solid	Organic-Bound	
LCSD 140-31436/15-B ^5	Lab Control Sample Dup	Step 5	Solid	Organic-Bound	
140-15490-1 DU	AP-2019-1 (30-31)	Step 5	Solid	Organic-Bound	

Prep Batch: 31500

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Step 5	Solid	3010A	31436
140-15490-2	AP-2019-2 (35-36)	Step 5	Solid	3010A	31436
140-15490-3	AP-2019-3 (18-19)	Step 5	Solid	3010A	31436
MB 140-31436/13-B ^5	Method Blank	Step 5	Solid	3010A	31436
LCS 140-31436/14-B ^5	Lab Control Sample	Step 5	Solid	3010A	31436
LCSD 140-31436/15-B ^5	Lab Control Sample Dup	Step 5	Solid	3010A	31436
140-15490-1 DU	AP-2019-1 (30-31)	Step 5	Solid	3010A	31436

SEP Batch: 31502

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Step 6	Solid	Acid/Sulfide	
140-15490-2	AP-2019-2 (35-36)	Step 6	Solid	Acid/Sulfide	
140-15490-3	AP-2019-3 (18-19)	Step 6	Solid	Acid/Sulfide	
MB 140-31502/13-A	Method Blank	Step 6	Solid	Acid/Sulfide	
LCS 140-31502/14-A	Lab Control Sample	Step 6	Solid	Acid/Sulfide	
LCSD 140-31502/15-A	Lab Control Sample Dup	Step 6	Solid	Acid/Sulfide	
140-15490-1 DU	AP-2019-1 (30-31)	Step 6	Solid	Acid/Sulfide	

Analysis Batch: 31553

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Total/NA	Solid	6010B	31128
140-15490-2	AP-2019-2 (35-36)	Total/NA	Solid	6010B	31128

Metals (Continued)

Analysis Batch: 31553 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-3	AP-2019-3 (18-19)	Total/NA	Solid	6010B	31128
MB 140-31128/14-A	Method Blank	Total/NA	Solid	6010B	31128
LCS 140-31128/15-A	Lab Control Sample	Total/NA	Solid	6010B	31128
140-15490-1 MS	AP-2019-1 (30-31)	Total/NA	Solid	6010B	31128
140-15490-1 MSD	AP-2019-1 (30-31)	Total/NA	Solid	6010B	31128

Analysis Batch: 31604

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Step 1	Solid	6010B SEP	31252
140-15490-1	AP-2019-1 (30-31)	Step 2	Solid	6010B SEP	31256
140-15490-1	AP-2019-1 (30-31)	Step 3	Solid	6010B SEP	31338
140-15490-1	AP-2019-1 (30-31)	Step 4	Solid	6010B SEP	31360
140-15490-2	AP-2019-2 (35-36)	Step 1	Solid	6010B SEP	31252
140-15490-2	AP-2019-2 (35-36)	Step 2	Solid	6010B SEP	31256
140-15490-2	AP-2019-2 (35-36)	Step 3	Solid	6010B SEP	31338
140-15490-2	AP-2019-2 (35-36)	Step 4	Solid	6010B SEP	31360
140-15490-3	AP-2019-3 (18-19)	Step 1	Solid	6010B SEP	31252
140-15490-3	AP-2019-3 (18-19)	Step 2	Solid	6010B SEP	31256
140-15490-3	AP-2019-3 (18-19)	Step 3	Solid	6010B SEP	31338
140-15490-3	AP-2019-3 (18-19)	Step 4	Solid	6010B SEP	31360
MB 140-31148/13-B ^4	Method Blank	Step 1	Solid	6010B SEP	31252
MB 140-31253/13-B ^3	Method Blank	Step 2	Solid	6010B SEP	31256
MB 140-31257/13-B	Method Blank	Step 3	Solid	6010B SEP	31338
MB 140-31341/13-B	Method Blank	Step 4	Solid	6010B SEP	31360
LCS 140-31148/14-B ^5	Lab Control Sample	Step 1	Solid	6010B SEP	31252
LCS 140-31253/14-B ^5	Lab Control Sample	Step 2	Solid	6010B SEP	31256
LCS 140-31257/14-B	Lab Control Sample	Step 3	Solid	6010B SEP	31338
LCS 140-31341/14-B	Lab Control Sample	Step 4	Solid	6010B SEP	31360
LCSD 140-31148/15-B ^5	Lab Control Sample Dup	Step 1	Solid	6010B SEP	31252
LCSD 140-31253/15-B ^5	Lab Control Sample Dup	Step 2	Solid	6010B SEP	31256
LCSD 140-31257/15-B	Lab Control Sample Dup	Step 3	Solid	6010B SEP	31338
LCSD 140-31341/15-B	Lab Control Sample Dup	Step 4	Solid	6010B SEP	31360
140-15490-1 DU	AP-2019-1 (30-31)	Step 1	Solid	6010B SEP	31252
140-15490-1 DU	AP-2019-1 (30-31)	Step 2	Solid	6010B SEP	31256
140-15490-1 DU	AP-2019-1 (30-31)	Step 3	Solid	6010B SEP	31338
140-15490-1 DU	AP-2019-1 (30-31)	Step 4	Solid	6010B SEP	31360

Prep Batch: 31615

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Step 7	Solid	Residual	
140-15490-2	AP-2019-2 (35-36)	Step 7	Solid	Residual	
140-15490-3	AP-2019-3 (18-19)	Step 7	Solid	Residual	
MB 140-31615/13-A	Method Blank	Step 7	Solid	Residual	
LCS 140-31615/14-A	Lab Control Sample	Step 7	Solid	Residual	
LCSD 140-31615/15-A	Lab Control Sample Dup	Step 7	Solid	Residual	
140-15490-1 DU	AP-2019-1 (30-31)	Step 7	Solid	Residual	

Analysis Batch: 31651

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Step 5	Solid	6010B SEP	31500
140-15490-1	AP-2019-1 (30-31)	Step 6	Solid	6010B SEP	31502

Client: Golder Associates Inc. Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Metals (Continued)

Analysis Batch: 31651 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-2	AP-2019-2 (35-36)	Step 5	Solid	6010B SEP	31500
140-15490-2	AP-2019-2 (35-36)	Step 6	Solid	6010B SEP	31502
140-15490-3	AP-2019-3 (18-19)	Step 5	Solid	6010B SEP	31500
140-15490-3	AP-2019-3 (18-19)	Step 6	Solid	6010B SEP	31502
MB 140-31436/13-B ^5	Method Blank	Step 5	Solid	6010B SEP	31500
MB 140-31502/13-A	Method Blank	Step 6	Solid	6010B SEP	31502
LCS 140-31436/14-B ^5	Lab Control Sample	Step 5	Solid	6010B SEP	31500
LCS 140-31502/14-A	Lab Control Sample	Step 6	Solid	6010B SEP	31502
LCSD 140-31436/15-B ^5	Lab Control Sample Dup	Step 5	Solid	6010B SEP	31500
LCSD 140-31502/15-A	Lab Control Sample Dup	Step 6	Solid	6010B SEP	31502
140-15490-1 DU	AP-2019-1 (30-31)	Step 5	Solid	6010B SEP	31500
140-15490-1 DU	AP-2019-1 (30-31)	Step 6	Solid	6010B SEP	31502

Analysis Batch: 31713

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Step 7	Solid	6010B SEP	31615
140-15490-1	AP-2019-1 (30-31)	Step 7	Solid	6010B SEP	31615
140-15490-1	AP-2019-1 (30-31)	Step 7	Solid	6010B SEP	31615
140-15490-1	AP-2019-1 (30-31)	Total/NA	Solid	6010B	30683
140-15490-1	AP-2019-1 (30-31)	Total/NA	Solid	6010B	30683
140-15490-1	AP-2019-1 (30-31)	Total/NA	Solid	6010B	30683
140-15490-2	AP-2019-2 (35-36)	Step 7	Solid	6010B SEP	31615
140-15490-2	AP-2019-2 (35-36)	Step 7	Solid	6010B SEP	31615
140-15490-2	AP-2019-2 (35-36)	Step 7	Solid	6010B SEP	31615
140-15490-2	AP-2019-2 (35-36)	Total/NA	Solid	6010B	30683
140-15490-2	AP-2019-2 (35-36)	Total/NA	Solid	6010B	30683
140-15490-2	AP-2019-2 (35-36)	Total/NA	Solid	6010B	30683
140-15490-3	AP-2019-3 (18-19)	Step 7	Solid	6010B SEP	31615
140-15490-3	AP-2019-3 (18-19)	Step 7	Solid	6010B SEP	31615
140-15490-3	AP-2019-3 (18-19)	Step 7	Solid	6010B SEP	31615
140-15490-3	AP-2019-3 (18-19)	Total/NA	Solid	6010B	30683
140-15490-3	AP-2019-3 (18-19)	Total/NA	Solid	6010B	30683
140-15490-3	AP-2019-3 (18-19)	Total/NA	Solid	6010B	30683
MB 140-30683/13-A	Method Blank	Total/NA	Solid	6010B	30683
MB 140-31615/13-A	Method Blank	Step 7	Solid	6010B SEP	31615
LCS 140-30683/14-A	Lab Control Sample	Total/NA	Solid	6010B	30683
LCS 140-31615/14-A	Lab Control Sample	Step 7	Solid	6010B SEP	31615
LCSD 140-30683/15-A	Lab Control Sample Dup	Total/NA	Solid	6010B	30683
LCSD 140-31615/15-A	Lab Control Sample Dup	Step 7	Solid	6010B SEP	31615
140-15490-1 DU	AP-2019-1 (30-31)	Step 7	Solid	6010B SEP	31615
140-15490-1 DU	AP-2019-1 (30-31)	Step 7	Solid	6010B SEP	31615
140-15490-1 DU	AP-2019-1 (30-31)	Step 7	Solid	6010B SEP	31615
140-15490-1 DU	AP-2019-1 (30-31)	Total/NA	Solid	6010B	30683
140-15490-1 DU	AP-2019-1 (30-31)	Total/NA	Solid	6010B	30683
140-15490-1 DU	AP-2019-1 (30-31)	Total/NA	Solid	6010B	30683

Analysis Batch: 31744

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Sum of Steps 1-7	Solid	6010B SEP	
140-15490-2	AP-2019-2 (35-36)	Sum of Steps 1-7	Solid	6010B SEP	
140-15490-3	AP-2019-3 (18-19)	Sum of Steps 1-7	Solid	6010B SEP	

General Chemistry

Analysis Batch: 30602

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15490-1	AP-2019-1 (30-31)	Total/NA	Solid	Moisture	
140-15490-2	AP-2019-2 (35-36)	Total/NA	Solid	Moisture	
140-15490-3	AP-2019-3 (18-19)	Total/NA	Solid	Moisture	
140-15490-1 DU	AP-2019-1 (30-31)	Total/NA	Solid	Moisture	

Client Sample ID: AP-2019-1 (30-31) Lab Sample ID: 140-15490-1

Date Collected: 06/03/19 11:36 **Matrix: Solid**
Date Received: 06/05/19 09:20

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			31744	07/16/19 17:31	CLJ	TAL KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			30602	06/06/19 14:52	BKD	TAL KNX
	Instrument ID: W3									

Client Sample ID: AP-2019-1 (30-31) Lab Sample ID: 140-15490-1

Date Collected: 06/03/19 11:36 **Matrix: Solid**
Date Received: 06/05/19 09:20 **Percent Solids: 76.0**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.536 g	50 mL	31128	06/26/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31553	07/10/19 12:59	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31713	07/15/19 14:24	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		10			31713	07/15/19 15:45	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		2			31713	07/15/19 18:28	KNC	TAL KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5.000 g	25 mL	31148	06/26/19 09:47	KNC	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	31252	06/29/19 08:00	KNC	TAL KNX
Step 1	Analysis	6010B SEP		4			31604	07/11/19 12:49	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5.000 g	25 mL	31253	06/29/19 08:00	KNC	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	31256	06/30/19 08:00	KNC	TAL KNX
Step 2	Analysis	6010B SEP		3			31604	07/11/19 14:21	KNC	TAL KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5.000 g	25 mL	31257	06/30/19 08:00	KNC	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	31338	07/02/19 08:00	KNC	TAL KNX
Step 3	Analysis	6010B SEP		1			31604	07/11/19 16:06	KNC	TAL KNX
	Instrument ID: DUO									
Step 4	SEP	Metal Hydroxide			5.000 g	25 mL	31341	07/02/19 09:00	KNC	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	31360	07/03/19 08:00	KNC	TAL KNX
Step 4	Analysis	6010B SEP		1			31604	07/11/19 17:49	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5.000 g	75 mL	31436	07/08/19 07:00	KNC	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	31500	07/10/19 08:00	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			31651	07/12/19 11:54	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5.000 g	250 mL	31502	07/10/19 08:00	KNC	TAL KNX
Step 6	Analysis	6010B SEP		1			31651	07/12/19 13:29	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: AP-2019-1 (30-31) — Lab Sample ID: 140-15490-1

Date Collected: 06/03/19 11:36 — **Matrix: Solid**
Date Received: 06/05/19 09:20 — **Percent Solids: 76.0**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		1			31713	07/15/19 11:39	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		10			31713	07/15/19 13:08	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		2			31713	07/15/19 17:11	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Prep	7470A			5.0 mL	50.0 mL	30859	06/16/19 08:00	DKW	TAL KNX
Total/NA	Analysis	7470A		1			30868	06/16/19 14:04	DKW	TAL KNX
	Instrument ID: HG									

Client Sample ID: AP-2019-2 (35-36) — Lab Sample ID: 140-15490-2

Date Collected: 06/03/19 13:20 — **Matrix: Solid**
Date Received: 06/05/19 09:20

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			31744	07/16/19 17:31	CLJ	TAL KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			30602	06/06/19 14:52	BKD	TAL KNX
	Instrument ID: W3									

Client Sample ID: AP-2019-2 (35-36) — Lab Sample ID: 140-15490-2

Date Collected: 06/03/19 13:20 — **Matrix: Solid**
Date Received: 06/05/19 09:20 — **Percent Solids: 78.5**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.527 g	50 mL	31128	06/26/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31553	07/10/19 13:13	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31713	07/15/19 14:36	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		10			31713	07/15/19 16:10	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		5			31713	07/15/19 18:38	KNC	TAL KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5.000 g	25 mL	31148	06/26/19 09:47	KNC	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	31252	06/29/19 08:00	KNC	TAL KNX
Step 1	Analysis	6010B SEP		4			31604	07/11/19 12:59	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc. Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Client Sample ID: AP-2019-2 (35-36) **Lab Sample ID: 140-15490-2**
Date Collected: 06/03/19 13:20 **Matrix: Solid**
Date Received: 06/05/19 09:20 **Percent Solids: 78.5**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 2	SEP	Carbonate			5.000 g	25 mL	31253	06/29/19 08:00	KNC	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	31256	06/30/19 08:00	KNC	TAL KNX
Step 2	Analysis	6010B SEP		3			31604	07/11/19 14:42	KNC	TAL KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5.000 g	25 mL	31257	06/30/19 08:00	KNC	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	31338	07/02/19 08:00	KNC	TAL KNX
Step 3	Analysis	6010B SEP		1			31604	07/11/19 16:16	KNC	TAL KNX
	Instrument ID: DUO									
Step 4	SEP	Metal Hydroxide			5.000 g	25 mL	31341	07/02/19 09:00	KNC	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	31360	07/03/19 08:00	KNC	TAL KNX
Step 4	Analysis	6010B SEP		1			31604	07/11/19 17:59	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5.000 g	75 mL	31436	07/08/19 07:00	KNC	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	31500	07/10/19 08:00	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			31651	07/12/19 12:05	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5.000 g	250 mL	31502	07/10/19 08:00	KNC	TAL KNX
Step 6	Analysis	6010B SEP		1			31651	07/12/19 13:49	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		1			31713	07/15/19 12:05	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		10			31713	07/15/19 13:19	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		2			31713	07/15/19 17:21	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Prep	7470A			5.0 mL	50.0 mL	30859	06/16/19 08:00	DKW	TAL KNX
Total/NA	Analysis	7470A		1			30868	06/16/19 14:09	DKW	TAL KNX
	Instrument ID: HG									

Client Sample ID: AP-2019-3 (18-19) **Lab Sample ID: 140-15490-3**
Date Collected: 06/03/19 15:20 **Matrix: Solid**
Date Received: 06/05/19 09:20

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			31744	07/16/19 17:31	CLJ	TAL KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			30602	06/06/19 14:52	BKD	TAL KNX
	Instrument ID: W3									

Client: Golder Associates Inc. Job ID: 140-15490-1

Project/Site: Martin Lake Ash Ponds - SEP + Totals

Client Sample ID: AP-2019-3 (18-19) **Lab Sample ID: 140-15490-3**

Date Collected: 06/03/19 15:20 **Matrix: Solid**

Date Received: 06/05/19 09:20 **Percent Solids: 80.0**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.527 g	50 mL	31128	06/26/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31553	07/10/19 13:18	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31713	07/15/19 14:41	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		10			31713	07/15/19 16:15	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		5			31713	07/15/19 18:43	KNC	TAL KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5.000 g	25 mL	31148	06/26/19 09:47	KNC	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	31252	06/29/19 08:00	KNC	TAL KNX
Step 1	Analysis	6010B SEP		4			31604	07/11/19 13:04	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5.000 g	25 mL	31253	06/29/19 08:00	KNC	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	31256	06/30/19 08:00	KNC	TAL KNX
Step 2	Analysis	6010B SEP		3			31604	07/11/19 14:47	KNC	TAL KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5.000 g	25 mL	31257	06/30/19 08:00	KNC	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	31338	07/02/19 08:00	KNC	TAL KNX
Step 3	Analysis	6010B SEP		1			31604	07/11/19 16:21	KNC	TAL KNX
	Instrument ID: DUO									
Step 4	SEP	Metal Hydroxide			5.000 g	25 mL	31341	07/02/19 09:00	KNC	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	31360	07/03/19 08:00	KNC	TAL KNX
Step 4	Analysis	6010B SEP		1			31604	07/11/19 18:04	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5.000 g	75 mL	31436	07/08/19 07:00	KNC	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	31500	07/10/19 08:00	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			31651	07/12/19 12:10	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5.000 g	250 mL	31502	07/10/19 08:00	KNC	TAL KNX
Step 6	Analysis	6010B SEP		1			31651	07/12/19 13:55	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		1			31713	07/15/19 12:11	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		10			31713	07/15/19 13:24	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		2			31713	07/15/19 17:27	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: AP-2019-3 (18-19)
Lab Sample ID: 140-15490-3
Date Collected: 06/03/19 15:20
Matrix: Solid
Date Received: 06/05/19 09:20
Percent Solids: 80.0

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Prep	7470A			5.0 mL	50.0 mL	30859	06/16/19 08:00	DKW	TAL KNX
Total/NA	Analysis	7470A		1			30868	06/16/19 14:17	DKW	TAL KNX
	Instrument ID: HG									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-30683/13-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31713	07/15/19 11:13	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-30683/13-B
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Prep	7470A			5.0 mL	50.0 mL	30859	06/16/19 08:00	DKW	TAL KNX
Total/NA	Analysis	7470A		1			30868	06/16/19 13:56	DKW	TAL KNX
	Instrument ID: HG									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-31128/14-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.500 g	50 mL	31128	06/26/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31553	07/10/19 11:42	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-31148/13-B ^4
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 1	SEP	Exchangeable			5.000 g	25 mL	31148	06/26/19 09:47	KNC	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	31252	06/29/19 08:00	KNC	TAL KNX
Step 1	Analysis	6010B SEP		4			31604	07/11/19 12:33	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc.
Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Client Sample ID: Method Blank
Lab Sample ID: MB 140-31253/13-B ^3
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 2	SEP	Carbonate			5.000 g	25 mL	31253	06/29/19 08:00	KNC	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	31256	06/30/19 08:00	KNC	TAL KNX
Step 2	Analysis	6010B SEP		3			31604	07/11/19 14:06	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-31257/13-B
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 3	SEP	Non-Crystalline			5.000 g	25 mL	31257	06/30/19 08:00	KNC	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	31338	07/02/19 08:00	KNC	TAL KNX
Step 3	Analysis	6010B SEP		1			31604	07/11/19 15:50	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-31341/13-B
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 4	SEP	Metal Hydroxide			5.000 g	25 mL	31341	07/02/19 09:00	KNC	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	31360	07/03/19 08:00	KNC	TAL KNX
Step 4	Analysis	6010B SEP		1			31604	07/11/19 17:24	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-31436/13-B ^5
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 5	SEP	Organic-Bound			5.000 g	75 mL	31436	07/08/19 07:00	KNC	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	31500	07/10/19 08:00	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			31651	07/12/19 11:39	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-31502/13-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 6	SEP	Acid/Sulfide			5.000 g	250 mL	31502	07/10/19 08:00	KNC	TAL KNX
Step 6	Analysis	6010B SEP		1			31651	07/12/19 13:14	KNC	TAL KNX
	Instrument ID: DUO									

Client: Golder Associates Inc. Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Client Sample ID: Method Blank **Lab Sample ID: MB 140-31615/13-A**
Date Collected: N/A **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		1			31713	07/15/19 10:58	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample **Lab Sample ID: LCS 140-30683/14-A**
Date Collected: N/A **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31713	07/15/19 11:19	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample **Lab Sample ID: LCS 140-30683/14-B**
Date Collected: N/A **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Prep	7470A			5.0 mL	50.0 mL	30859	06/16/19 08:00	DKW	TAL KNX
Total/NA	Analysis	7470A		1			30868	06/16/19 13:59	DKW	TAL KNX
	Instrument ID: HG									

Client Sample ID: Lab Control Sample **Lab Sample ID: LCS 140-31128/15-A**
Date Collected: N/A **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.500 g	50 mL	31128	06/26/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31553	07/10/19 11:47	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample **Lab Sample ID: LCS 140-31148/14-B ^5**
Date Collected: N/A **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 1	SEP	Exchangeable			5.000 g	25 mL	31148	06/26/19 09:47	KNC	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	31252	06/29/19 08:00	KNC	TAL KNX
Step 1	Analysis	6010B SEP		5			31604	07/11/19 12:38	KNC	TAL KNX
	Instrument ID: DUO									

1 2 3 4 5 6 7 8 9 10 11 12 13

Lab Chronicle

Client: Golder Associates Inc. Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Client Sample ID: Lab Control Sample **Lab Sample ID: LCS 140-31253/14-B ^5**
Date Collected: N/A **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 2	SEP	Carbonate			5.000 g	25 mL	31253	06/29/19 08:00	KNC	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	31256	06/30/19 08:00	KNC	TAL KNX
Step 2	Analysis	6010B SEP		5			31604	07/11/19 14:11	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample **Lab Sample ID: LCS 140-31257/14-B**
Date Collected: N/A **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 3	SEP	Non-Crystalline			5.000 g	25 mL	31257	06/30/19 08:00	KNC	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	31338	07/02/19 08:00	KNC	TAL KNX
Step 3	Analysis	6010B SEP		1			31604	07/11/19 15:56	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample **Lab Sample ID: LCS 140-31341/14-B**
Date Collected: N/A **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 4	SEP	Metal Hydroxide			5.000 g	25 mL	31341	07/02/19 09:00	KNC	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	31360	07/03/19 08:00	KNC	TAL KNX
Step 4	Analysis	6010B SEP		1			31604	07/11/19 17:29	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample **Lab Sample ID: LCS 140-31436/14-B ^5**
Date Collected: N/A **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 5	SEP	Organic-Bound			5.000 g	75 mL	31436	07/08/19 07:00	KNC	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	31500	07/10/19 08:00	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			31651	07/12/19 11:44	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample **Lab Sample ID: LCS 140-31502/14-A**
Date Collected: N/A **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 6	SEP	Acid/Sulfide			5.000 g	250 mL	31502	07/10/19 08:00	KNC	TAL KNX
Step 6	Analysis	6010B SEP		1			31651	07/12/19 13:19	KNC	TAL KNX
	Instrument ID: DUO									

Client: Golder Associates Inc.
Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Client Sample ID: Lab Control Sample
Lab Sample ID: LCS 140-31615/14-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		1			31713	07/15/19 11:03	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup
Lab Sample ID: LCSD 140-30683/15-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31713	07/15/19 11:24	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup
Lab Sample ID: LCSD 140-30683/15-B
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Prep	7470A			5.0 mL	50.0 mL	30859	06/16/19 08:00	DKW	TAL KNX
Total/NA	Analysis	7470A		1			30868	06/16/19 14:02	DKW	TAL KNX
	Instrument ID: HG									

Client Sample ID: Lab Control Sample Dup
Lab Sample ID: LCSD 140-31148/15-B ^5
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 1	SEP	Exchangeable			5.000 g	25 mL	31148	06/26/19 09:47	KNC	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	31252	06/29/19 08:00	KNC	TAL KNX
Step 1	Analysis	6010B SEP		5			31604	07/11/19 12:43	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup
Lab Sample ID: LCSD 140-31253/15-B ^5
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 2	SEP	Carbonate			5.000 g	25 mL	31253	06/29/19 08:00	KNC	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	31256	06/30/19 08:00	KNC	TAL KNX
Step 2	Analysis	6010B SEP		5			31604	07/11/19 14:16	KNC	TAL KNX
	Instrument ID: DUO									

Client: Golder Associates Inc. | Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Client Sample ID: Lab Control Sample Dup | Lab Sample ID: LCSD 140-31257/15-B

Date Collected: N/A | **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 3	SEP	Non-Crystalline			5.000 g	25 mL	31257	06/30/19 08:00	KNC	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	31338	07/02/19 08:00	KNC	TAL KNX
Step 3	Analysis	6010B SEP		1			31604	07/11/19 16:01	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup | Lab Sample ID: LCSD 140-31341/15-B

Date Collected: N/A | **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 4	SEP	Metal Hydroxide			5.000 g	25 mL	31341	07/02/19 09:00	KNC	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	31360	07/03/19 08:00	KNC	TAL KNX
Step 4	Analysis	6010B SEP		1			31604	07/11/19 17:44	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup | Lab Sample ID: LCSD 140-31436/15-B ^5

Date Collected: N/A | **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 5	SEP	Organic-Bound			5.000 g	75 mL	31436	07/08/19 07:00	KNC	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	31500	07/10/19 08:00	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			31651	07/12/19 11:49	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup | Lab Sample ID: LCSD 140-31502/15-A

Date Collected: N/A | **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 6	SEP	Acid/Sulfide			5.000 g	250 mL	31502	07/10/19 08:00	KNC	TAL KNX
Step 6	Analysis	6010B SEP		1			31651	07/12/19 13:24	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup | Lab Sample ID: LCSD 140-31615/15-A

Date Collected: N/A | **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		1			31713	07/15/19 11:08	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc.
Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Client Sample ID: AP-2019-1 (30-31)
Lab Sample ID: 140-15490-1 MS

Date Collected: 06/03/19 11:36
Matrix: Solid
Date Received: 06/05/19 09:20
Percent Solids: 76.0

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.530 g	50 mL	31128	06/26/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31553	07/10/19 13:04	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: AP-2019-1 (30-31)
Lab Sample ID: 140-15490-1 MSD

Date Collected: 06/03/19 11:36
Matrix: Solid
Date Received: 06/05/19 09:20
Percent Solids: 76.0

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.539 g	50 mL	31128	06/26/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31553	07/10/19 13:08	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: AP-2019-1 (30-31)
Lab Sample ID: 140-15490-1 DU

Date Collected: 06/03/19 11:36
Matrix: Solid
Date Received: 06/05/19 09:20

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			30602	06/06/19 14:52	BKD	TAL KNX
	Instrument ID: W3									

Client Sample ID: AP-2019-1 (30-31)
Lab Sample ID: 140-15490-1 DU

Date Collected: 06/03/19 11:36
Matrix: Solid
Date Received: 06/05/19 09:20
Percent Solids: 76.0

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31713	07/15/19 14:30	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		10			31713	07/15/19 15:50	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		2			31713	07/15/19 18:33	KNC	TAL KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5.000 g	25 mL	31148	06/26/19 09:47	KNC	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	31252	06/29/19 08:00	KNC	TAL KNX
Step 1	Analysis	6010B SEP		4			31604	07/11/19 12:54	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5.000 g	25 mL	31253	06/29/19 08:00	KNC	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	31256	06/30/19 08:00	KNC	TAL KNX
Step 2	Analysis	6010B SEP		3			31604	07/11/19 14:37	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: AP-2019-1 (30-31)

Lab Sample ID: 140-15490-1 DU

Date Collected: 06/03/19 11:36

Matrix: Solid

Date Received: 06/05/19 09:20

Percent Solids: 76.0

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 3	SEP	Non-Crystalline			5.000 g	25 mL	31257	06/30/19 08:00	KNC	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	31338	07/02/19 08:00	KNC	TAL KNX
Step 3	Analysis	6010B SEP		1			31604	07/11/19 16:11	KNC	TAL KNX
	Instrument ID: DUO									
Step 4	SEP	Metal Hydroxide			5.000 g	25 mL	31341	07/02/19 09:00	KNC	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	31360	07/03/19 08:00	KNC	TAL KNX
Step 4	Analysis	6010B SEP		1			31604	07/11/19 17:54	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5.000 g	75 mL	31436	07/08/19 07:00	KNC	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	31500	07/10/19 08:00	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			31651	07/12/19 12:00	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5.000 g	250 mL	31502	07/10/19 08:00	KNC	TAL KNX
Step 6	Analysis	6010B SEP		1			31651	07/12/19 13:44	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		1			31713	07/15/19 12:00	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		10			31713	07/15/19 13:14	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		2			31713	07/15/19 17:16	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Prep	7470A			5.0 mL	50.0 mL	30859	06/16/19 08:00	DKW	TAL KNX
Total/NA	Analysis	7470A		1			30868	06/16/19 14:06	DKW	TAL KNX
	Instrument ID: HG									

Laboratory References:

TAL KNX = Eurofins TestAmerica, Knoxville, 5815 Middlebrook Pike, Knoxville, TN 37921, TEL (865)291-3000

Method Summary

Client: Golder Associates Inc.
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Job ID: 140-15490-1

Method	Method Description	Protocol	Laboratory
6010B	Metals (ICP)	SW846	TAL KNX
6010B	SEP Metals (ICP) - Total	SW846	TAL KNX
6010B SEP	SEP Metals (ICP)	SW846	TAL KNX
7470A	SEP Mercury (CVAA) - Total	SW846	TAL KNX
Moisture	Percent Moisture	EPA	TAL KNX
3010A	Preparation, Total Metals	SW846	TAL KNX
3050B	Preparation, Metals	SW846	TAL KNX
7470A	Preparation, Mercury	SW846	TAL KNX
Acid/Sulfide	Sequential Extraction Procedure, Acid/Sulfide Fraction	TAL-KNOX	TAL KNX
Carbonate	Sequential Extraction Procedure, Carbonate Fraction	TAL-KNOX	TAL KNX
Exchangeable	Sequential Extraction Procedure, Exchangeable Fraction	TAL-KNOX	TAL KNX
Metal Hydroxide	Sequential Extraction Procedure, Metal Hydroxide Fraction	TAL-KNOX	TAL KNX
Non-Crystalline	Sequential Extraction Procedure, Non-crystalline Materials	TAL-KNOX	TAL KNX
Organic-Bound	Sequential Extraction Procedure, Organic Bound Fraction	TAL-KNOX	TAL KNX
Residual	Sequential Extraction Procedure, Residual Fraction	TAL-KNOX	TAL KNX
Total	Preparation, Total Material	TAL-KNOX	TAL KNX

Protocol References:

EPA = US Environmental Protection Agency

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

TAL-KNOX = TestAmerica Laboratories, Knoxville, Facility Standard Operating Procedure.

Laboratory References:

TAL KNX = Eurofins TestAmerica, Knoxville, 5815 Middlebrook Pike, Knoxville, TN 37921, TEL (865)291-3000

Sample Summary

Client: Golder Associates Inc.
Job ID: 140-15490-1
Project/Site: Martin Lake Ash Ponds - SEP + Totals

Lab Sample ID	Client Sample ID	Matrix	Collected	Received	Asset ID
140-15490-1	AP-2019-1 (30-31)	Solid	06/03/19 11:36	06/05/19 09:20	
140-15490-2	AP-2019-2 (35-36)	Solid	06/03/19 13:20	06/05/19 09:20	
140-15490-3	AP-2019-3 (18-19)	Solid	06/03/19 15:20	06/05/19 09:20	

Eurofins TestAmerica, Knoxville
5815 Middlebrook Pike
Knoxville, TN 37921
Phone (865) 291-3000 Fax (865) 584-4315

Chain of Custody Record

eurofins | Environment Testing TestAmerica

Client Information	Sampler: Kelsey Worley	Lab PM: Walker Wasmund, Terry	Carrier Tracking No(s):
Client Contact: Will Vienne	Phone: 281-750-2734	E-Mail: terry.wasmund@testamericainc.com	COC No: 140-6683-2229.1
Company: Golder Associates Inc.			Page: Page 1 of 1
			Job #:

Address: 2201 Double Creek Dr Suite 4004	Due Date Requested:
City: Round Rock	TAT Requested (days): Standard
State, Zip: TX, 78664	
Phone: 512-671-3434(Tel)	PO #: 19122434-C
Email: William_Vienne@golder.com	WO #: 1922434-C
Project Name: Martin Lake Ash Ponds - SEP + Totals	Project #: 14005268
Site:	SSOW#:

Analysis Requested

140-15490 Chain of Custody

Preservation Codes:
A - HCL, B - NaOH, C - Zn Acetate, D - Nitric Acid, E - NaHSO4, F - MeOH, G - Amchlor, H - Ascorbic Acid, I - Ice, J - DI Water, K - EDTA, L - EDA
M - Hexane, N - None, O - AsNaO2, P - Na2O4S, Q - Na2SO3, R - Na2S2O3, S - H2SO4, T - TSP Dodecahydrate, U - Acetone, V - MCAA, W - pH 4-5, Z - other (specify)
Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	6010B_SEP - 7-Step SEP (12 Metals)	6010B - Total B, Cr, Pb	Total Number of containers	Special Instructions/Note:
			Preservation Code:				N	I		
AP-2019-1 (30-31)	06/03/19	1136	C	S			X	X		On Ice
AP-2019-2 (35-36)	06/03/19	1320	C	S			X	X		" "
AP-2019-3 (18-19)	06/03/19	1520	C	S			X	X		" "

BT: 1.2°C CT: 1.2°C, 1 cooler
FedEx ✓ Custody seal intact
trk# 7876 7328 2042
KW 6/5/19

LUMINANT

Possible Hazard Identification
☑ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☑ Disposal By Lab ☐ Archive For ______ Months

Deliverable Requested: I, II, III, IV, Other (specify)
Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
Kelsey Worley	06/04/19 1245	Golder	K. W.	6/5/19 0920	TA-Knox

Custody Seals Intact: Δ Yes Δ No | Custody Seal No.: | Cooler Temperature(s) °C and Other Remarks:

Ver: 01/16/2019

Loc: 140
15490

TESTAMERICA KNOXVILLE SAMPLE RECEIPT/CONDITION UPON RECEIPT ANOMALY CHECKLIST

Log In Number:

Review Items	Yes	No	NA	If No, what was the problem?	Comments/Actions Taken
1. Are the shipping containers intact?	✓			☐ Containers, Broken	
2. Were ambient air containers received intact?			✓	☐ Checked in lab	
3. The coolers/containers custody seal if present, is it intact?	✓			☐ Yes ☐ NA	
4. Is the cooler temperature within limits? (> freezing temp. of water to 6 °C, VOST: 10°C) Thermometer ID : 5C6 (handwritten) Correction factor: +0.0 (handwritten)	✓			☐ Cooler Out of Temp, Client Contacted, Proceed/Cancel ☐ Cooler Out of Temp, Same Day Receipt	
5. Were all of the sample containers received intact?	✓			☐ Containers, Broken	
6. Were samples received in appropriate containers?	✓			☐ Containers, Improper; Client Contacted; Proceed/Cancel	
7. Do sample container labels match COC? (IDs, Dates, Times)	✓			☐ COC & Samples Do Not Match ☐ COC Incorrect/Incomplete ☐ COC Not Received	
8. Were all of the samples listed on the COC received?	✓			☐ Sample Received, Not on COC ☐ Sample on COC, Not Received	
9. Is the date/time of sample collection noted?	✓			☐ COC; No Date/Time; Client Contacted	**Labeling Verified by:** **Date:**
10. Was the sampler identified on the COC?	✓			☐ Sampler Not Listed on COC	
11. Is the client and project name/# identified?	✓			☐ COC Incorrect/Incomplete	**pH test strip lot number:**
12. Are tests/parameters listed for each sample?	✓			☐ COC No tests on COC	
13. Is the matrix of the samples noted?	✓			☐ COC Incorrect/Incomplete	
14. Was COC relinquished? (Signed/Dated/Timed)	✓			☐ COC Incorrect/Incomplete	
15. Were samples received within holding time?	✓			☐ Holding Time - Receipt	
16. Were samples received with correct chemical preservative (excluding Encore)?			✓	☐ pH Adjusted, pH Included (See box 16A) ☐ Incorrect Preservative	
17. Were VOA samples received without headspace?			✓	☐ Headspace (VOA only)	
18. Did you check for residual chlorine, if necessary? (e.g. 1613B, 1668) Chlorine test strip lot number:			✓	☐ Residual Chlorine	
19. For 1613B water samples is pH<9?			✓	☐ If no, notify lab to adjust	
20. For rad samples was sample activity info. Provided?			✓	☐ Project missing info	

	Box 16A: pH Preservation	Box 18A: Residual Chlorine
Preservative:		
Lot Number:		
Exp Date:		
Analyst:		
Date:		
Time:		

Project #: 1400526? (handwritten) PM Instructions:

Sample Receiving Associate: [signature] Date: 6/5/19

QA026R31.doc, 112618

APPENDIX C

GROUNDWATER SAMPLING RECORDS

GOLDER

RECORD OF WATER LEVEL READINGS

Project Name: LUMINANT-MLSES-PONDS **Location:** TATUM, TX **Project No.:** 19122262-C

Borehole No.	Date	Time	Measuring Device / Serial No.	Measurement Point (M.P)	Water Level Below M.P.	Correction To Survey Mark	Survey Mark Elevation	Water Level Elevation	By	Comments
H-31	5-14-19	0704	SOLINST	TOC	22.73				JTB	
H-32	5-14-19	0759	SOLINST	TOC	23.16				JTB	
H-27	5-14-19	0903	SOLINST	TOC	22.02				JTB	
H-29	5-14-19	1050	SOLINST	TOC	22.61				JTB	
H-28	5-14-19	1155	SOLINST	TOC	7.12				JTB	
H-26	5-14-19	1350	SOLINST	TOC	13.21				JTB	
H-33	5-14-19	1449	SOLINST	TOC	13.42				JTB	

Sheet 1 of 1

GROUNDWATER SAMPLING RECORD

PAGE 1 of 1

Project Number: 19122262-C	Project Name: LUMINANT- MLSES		Date: 5-14-19
Sample Number: H-26		Starting Water Level (ft. BMP):	13.21
Sampling Location (well ID, etc.): H-26		Casing Stickup (ft.):	-
Sampled by: JJB		Starting Water Level (ft. BGL):	13.21
Measuring Point (MP) of Well: TOC/PVC		Total Depth (ft. BGL):	-
Screened Interval (ft. BGL): -		Casing Diameter (In ID):	2.0
Filter Pack Interval (ft. BGL): -		Casing Volume (gal.):	-

QUALITY ASSURANCE

METHODS (describe):

Cleaning Equipment: alconox & DI rinse

Purging: peristaltic / bladder   Sampling: Same

Disposal of Discharged Water: on site

INSTRUMENTS (Indicate make, model, I.d.)

Water Level:	KECK	Thermometer:	HORIBA
pH Meter:	HORIBA	Field Calibration:	7-4
Conductivity Meter:	HORIBA	Field Calibration:	1413
Filter / Filter Size:		Other:	

SAMPLING MEASUREMENTS

1352 Time	Cum. Vol. (gal. or L)	Purge Rate (gal. or L/m)	Temp. (oC)	pH	Spec. Cond. (mmhos/cm)	D.O	Redox (mV)	Turbidity & Color	Water Depth (ft BMP)
1401	—	.2	23.1	6.81	1730	0.86	-29	8.1	13.44
1406			22.7	6.82	1760	0.63	-37	7.1	13.46
1413			22.8	6.83	1760	0.64	-31	7.7	13.47

Water Level (ft. BMP) at End of Purge: 13.47   Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Bottles Collected				Filtration		Remarks
Time	Volume	Composition (G, P)	No.	(Y / N)	Preservation	(quality control sample, other)
1425	250mL	P	1	N	—	GEN CHEM
1425	500mL	P	1	N	HNO3	METALS

Comments:

Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
(512) 671-3434   Fax (512) 671-3446

GROUNDWATER SAMPLING RECORD

PAGE 1 of 1

Project Number: 19122262-C Project Name: LUMINANT MLSES Date: 5-14-19

Sample Number:	H-27	Starting Water Level (ft. BMP):	22.02
Sampling Location (well ID, etc.):	H-27	Casing Stickup (ft.):	–
Sampled by:	JTB	Starting Water Level (ft. BGL):	22.02
Measuring Point (MP) of Well:	TOC/PVC	Total Depth (ft. BGL):	–
Screened Interval (ft. BGL):	–	Casing Diameter (In ID):	2.0
Filter Pack Interval (ft. BGL):	–	Casing Volume (gal.):	–

QUALITY ASSURANCE

METHODS (describe):

Cleaning Equipment: alconox & DI rinse

Purging: prestaltic / bladder Sampling: Same

Disposal of Discharged Water: on site

INSTRUMENTS (Indicate make, model, I.d.)

Water Level:	KECK	Thermometer:	HORIBA
pH Meter:	HORIBA	Field Calibration:	7-4
Conductivity Meter:	HORIBA	Field Calibration:	1413
Filter / Filter Size:		Other:	

SAMPLING MEASUREMENTS

0906 Time	Cum. Vol. (gal. or L)	Purge Rate (gal. or L/m)	Temp. (oC)	pH	Spec. Cond. (mmhos/cm)	D.O	Redox (mV)	Turbidity & Color	Water Depth (ft BMP)
0916	–	.2	22.1	6.74	1610	0.49	-79	7.7	22.23
0921			22.4	6.77	1640	0.51	-81	7.9	22.24
0927			22.4	6.78	1630	0.52	-82	7.9	22.23

Water Level (ft. BMP) at End of Purge: 22.23 Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Bottles Collected				Filtration	Preservation	Remarks
Time	Volume	Composition (G, P)	No.	(Y / N)		(quality control sample, other)
0940	250mL	P	1	N	–	GEN CHEM
0940	500mL	P	1	N	HNO_3	METALS

Comments:

Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
(512) 671-3434 Fax (512) 671-3446

GROUNDWATER SAMPLING RECORD

Project Number: 19122262-C	Project Name: LUMINANT - MLSES		Date: 5-14-19
Sample Number: H-28		Starting Water Level (ft. BMP):	7.12
Sampling Location (well ID, etc.): H-28		Casing Stickup (ft.):	–
Sampled by: JTB		Starting Water Level (ft. BGL):	7.12
Measuring Point (MP) of Well: TOC/PVC		Total Depth (ft. BGL):	–
Screened Interval (ft. BGL): –		Casing Diameter (In ID):	2.0
Filter Pack Interval (ft. BGL.): –		Casing Volume (gal.):	–

QUALITY ASSURANCE

METHODS (describe):

Cleaning Equipment: alconox & DI rinse

Purging: peristaltic / bladder   Sampling: Same

Disposal of Discharged Water: on site

INSTRUMENTS (Indicate make, model, I.d.)

Water Level:	KECK	Thermometer:	HORIBA
pH Meter:	HORIBA	Field Calibration:	7-4
Conductivity Meter:	HORIBA	Field Calibration:	1413
Filter / Filter Size:		Other:	

SAMPLING MEASUREMENTS

1157 Time	Cum. Vol (gal. or L)	Purge Rate (gal. or L/m)	Temp. (oC)	pH	Spec. Cond. (mmhos/cm)	D.O	Redox (mV)	Turbidity & Color	Water Depth (ft BMP)
1207	–	.2	22.6	6.29	1580	0.39	-34	3.8	7.29
1211			22.9	6.31	1520	0.31	-39	4.6	7.31
1218			22.9	6.32	1510	0.32	-39	4.8	7.32

Water Level (ft. BMP) at End of Purge: 7.32   Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Bottles Collected				Filtration (Y / N)	Preservation	Remarks (quality control sample, other)
Time	Volume	Composition (G, P)	No.			
1230	250mL	P	1	N	–	GEN CHEM
1230	500mL	P	1	N	HNO_3	METALS

Comments:

Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
(512) 671-3434   Fax (512) 671-3446

GROUNDWATER SAMPLING RECORD

PAGE 1 of 1

Project Number: 19122262-C Project Name: LUMINANT- MLSES	Date: 5-14-19
Sample Number: H-29	Starting Water Level (ft. BMP): 22.61
Sampling Location (well ID, etc.): H-29	Casing Stickup (ft.): -
Sampled by: JTB	Starting Water Level (ft. BGL): 22.61
Measuring Point (MP) of Well: TOC/PVC	Total Depth (ft. BGL): -
Screened Interval (ft. BGL): -	Casing Diameter (In ID): 2.0
Filter Pack Interval (ft. BGL): -	Casing Volume (gal.): -

QUALITY ASSURANCE

METHODS (describe):

Cleaning Equipment: alconox & DI rinse

Purging: peristaltic / bladder Sampling: Same

Disposal of Discharged Water: on site

INSTRUMENTS (Indicate make, model, I.d.)

Water Level:	KECK	Thermometer:	HORIBA
pH Meter:	HORIBA	Field Calibration:	7-4
Conductivity Meter:	HORIBA	Field Calibration:	1413
Filter / Filter Size:		Other:	

SAMPLING MEASUREMENTS

Time 1053	Cum. Vol. (gal. or L)	Purge Rate (gal. or L/m)	Temp. (oC)	pH	Spec. Cond. (mmhos/cm)	D.O	Redox (mV)	Turbidity & Color	Water Depth (ft BMP)
1102	—	.2	21.9	6.46	1710	0.71	-86	7.2	22.88
1107			22.6	6.51	1730	0.62	-87	6.2	22.89
1114			22.7	6.52	1730	0.63	-87	6.1	22.89

Water Level (ft. BMP) at End of Purge: 22.89 Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Bottles Collected				Filtration		Remarks
Time	Volume	Composition (G, P)	No.	(Y / N)	Preservation	(quality control sample, other)
1125	250mL	P	1	N	—	GEN CHEM
1125	500mL	P	1	N	HNO3	METALS

Comments:

Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
(512) 671-3434 Fax (512) 671-3446

GROUNDWATER SAMPLING RECORD

Project Number: 19122262-C Project Name: LUMINANT - MLSES	Date: 5-14-19
Sample Number: H-31	Starting Water Level (ft. BMP): 22.73
Sampling Location (well ID, etc.): H-31	Casing Stickup (ft.): –
Sampled by: JPB	Starting Water Level (ft. BGL): 22.73
Measuring Point (MP) of Well: TOC PVC	Total Depth (ft. BGL): –
Screened Interval (ft. BGL): –	Casing Diameter (in ID): 2.0
Filter Pack Interval (ft. BGL): –	Casing Volume (gal.): –

QUALITY ASSURANCE

METHODS (describe):

Cleaning Equipment: alconox & DI rinse

Purging: peristaltic / bladder Sampling: Same

Disposal of Discharged Water: on site

INSTRUMENTS (Indicate make, model, I.d.)

Water Level: KECK Thermometer: HORIBA

pH Meter: HORIBA Field Calibration: 7-4

Conductivity Meter: HORIBA Field Calibration: 1413

Filter / Filter Size: Other:

SAMPLING MEASUREMENTS

0707 Time	Cum. Vol (gal. or L)	Purge Rate (gal. or L/m)	Temp. (oC)	pH	Spec. Cond. (mmhos/cm)	D.O	Redox (mV)	Turbidity & Color	Water Depth (ft BMP)
0717	–	.2	22.6	6.49	1670	0.79	-76	4.6	22.92
0722		↓	22.5	6.41	1630	0.61	-77	5.8	22.93
0726		↓	22.4	6.42	1620	0.60	-77	5.6	22.93

Water Level (ft. BMP) at End of Purge: 22.93 Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Bottles Collected				Filtration	Preservation	Remarks
Time	Volume	Composition (G, P)	No.	(Y / N)		(quality control sample, other)
0740	250mL	P	1	N	–	GEN CHEM
0740	500mL	P	1	N	HNO_3	METALS

Comments:

Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
(512) 671-3434 Fax (512) 671-3446

GROUNDWATER SAMPLING RECORD

PAGE 1 of 1

Project Number: 19122262-C	Project Name: LUMINANT-MLSES		Date: 5-14-19
Sample Number: H-32		Starting Water Level (ft. BMP):	23.16
Sampling Location (well ID, etc.): H-32		Casing Stickup (ft.):	–
Sampled by: JTB		Starting Water Level (ft. BGL):	23.16
Measuring Point (MP) of Well: TOC/PVC		Total Depth (ft. BGL):	–
Screened Interval (ft. BGL): –		Casing Diameter (In ID):	2.0
Filter Pack Interval (ft. BGL): –		Casing Volume (gal.):	–

QUALITY ASSURANCE

METHODS (describe):

Cleaning Equipment: alconox & DI rinse

Purging: peristaltic / bladder   Sampling: Same

Disposal of Discharged Water: on site

INSTRUMENTS (Indicate make, model, I.d.)

Water Level:	KECK	Thermometer:	HORIBA
pH Meter:	HORIBA	Field Calibration:	7-4
Conductivity Meter:	HORIBA	Field Calibration:	1413
Filter / Filter Size:		Other:	

SAMPLING MEASUREMENTS

0757 Time	Cum. Vol. (gal. or L)	Purge Rate (gal. or L/m)	Temp. (oC)	pH	Spec. Cond. (mmhos/cm)	D.O	Redox (mV)	Turbidity & Color	Water Depth (ft BMP)
0807	—	.2	22.4	5.99	1510	0.41	-71	4.8	23.34
0812			22.7	6.01	1540	0.31	-76	9.2	23.35
0818			22.6	6.02	1540	0.32	-77	8.7	23.35

Water Level (ft. BMP) at End of Purge: 23.35   Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Bottles Collected				Filtration		Remarks
Time	Volume	Composition (G, P)	No.	(Y / N)	Preservation	(quality control sample, other)
0825	250mL	P	1	N	—	GEN CHEM
0825	500mL	P	1	N	HNO3	METALS

Comments:

Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
(512) 671-3434   Fax (512) 671-3446

GROUNDWATER SAMPLING RECORD

PAGE 1 of 1

Project Number: 19122262-C	Project Name: LUMINANT - MCSES		Date: 5-14-19
Sample Number: H-33		Starting Water Level (ft. BMP):	13.42
Sampling Location (well ID, etc.): H-33		Casing Stickup (ft.):	–
Sampled by: JTB		Starting Water Level (ft. BGL):	13.42
Measuring Point (MP) of Well: TOC/PVC		Total Depth (ft. BGL):	–
Screened Interval (ft. BGL): –		Casing Diameter (in ID):	2.0
Filter Pack Interval (ft. BGL): –		Casing Volume (gal.):	–

QUALITY ASSURANCE

METHODS (describe):

Cleaning Equipment: alconox & DI rinse

Purging: peristaltic / bladder Sampling: Same

Disposal of Discharged Water: on site

INSTRUMENTS (Indicate make, model, I.d.)

Water Level:	KECK	Thermometer:	HORIBA
pH Meter:	HORIBA	Field Calibration:	7-4
Conductivity Meter:	HORIBA	Field Calibration:	1413
Filter / Filter Size:		Other:	

SAMPLING MEASUREMENTS

1451 Time	Cum. Vol. (gal. or L)	Purge Rate (gal. or L/m)	Temp. (oC)	pH	Spec. Cond. (mmhos/cm)	D.O.	Redox (mV)	Turbidity & Color	Water Depth (ft BMP)
1501	—	.2	23.4	6.81	1620	0.77	-29	5.9	13.67
1506		↓	23.6	6.82	1640	0.63	-26	7.8	13.66
1512		↓	23.6	6.81	1650	0.62	-26	7.4	13.66

Water Level (ft. BMP) at End of Purge: 13.66 Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Bottles Collected				Filtration	Preservation	Remarks
Time	Volume	Composition (G, P)	No.	(Y / N)		(quality control sample, other)
1530	250mL	P	1	N	–	GEN CHEM
1530	500mL	P	1	N	HNO_3	METALS

Comments:

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GOLDER

golder.com

APPENDIX F7 - SEMI-ANNUAL REMEDY SELECTION PROGRESS REPORTS (MARCH 4, 2020 AND SEPTEMBER 3, 2020)

Luminant

March 4, 2020

SEMIANNUAL REMEDY SELECTION PROGRESS REPORT
MARTIN LAKE STEAM ELECTRIC STATION – ASH POND AREA

In accordance with Title 40 Code of Federal Regulations (C.F.R.) § 257.97(a), the owner or operator of a coal combustion residuals (CCR) unit must prepare a semiannual report describing the progress in selecting and designing a remedy for statistically significant levels (SSLs) of constituents listed in Appendix IV of 40 C.F.R. Part 257 over the groundwater protection standards established in accordance with 40 C.F.R. § 257.95(h).

This report is for the Ash Pond Area at the Martin Lake Steam Electric Station.

As stated in the notifications dated February 6, 2019 and October 7, 2019, SSLs for beryllium and cobalt were identified at the Ash Pond Area during assessment monitoring completed in accordance with 40 C.F.R. § 257.95.

In response to the SSLs, an Assessment of Corrective Measures (ACM) report was completed for the Ash Pond Area in September 2019 as required by 40 C.F.R. § 257.96. The ACM report evaluated retrofitting the Ash Ponds liner systems for purposes of source control. Further evaluation of monitored natural attenuation, groundwater extraction and treatment or a vertical hydraulic barrier is ongoing for purposes of selecting a remedy under 40 C.F.R. § 257.97

A public meeting was held on November 13, 2019 at the Henderson Chamber of Commerce in Henderson, Texas to discuss the results of the of the ACM in accordance with 40 C.F.R. § 257.96(e).

Design of the Ash Pond liner system is in progress and the Retrofit Plan has been posted to the Operating Record. Selection of the groundwater remedy for the Ash Pond Area is currently in the feasibility study phase.

September 3, 2020

SEMI-ANNUAL REMEDY SELECTION PROGRESS REPORT
MARTIN LAKE STEAM ELECTRIC STATION – ASH POND AREA

In accordance with Title 40 Code of Federal Regulations (C.F.R.) § 257.97(a), the owner or operator of a coal combustion residuals (CCR) unit must prepare a semiannual report describing the progress in selecting and designing a remedy for statistically significant levels (SSLs) of constituents listed in Appendix IV of 40 C.F.R. Part 257 over the groundwater protection standards established in accordance with 40 C.F.R. § 257.95(h).

This report is for the Ash Pond Area at the Martin Lake Steam Electric Station.

As stated in the notification dated February 6, 2019, SSLs for beryllium, cobalt and lithium were identified at the Ash Ponds during 2018 assessment monitoring completed in accordance with 40 C.F.R. § 257.95. However, no SSLs for lithium were identified in subsequent semi-annual assessment monitoring events completed in 2019 and 2020. As stated in the notifications dated October 7, 2019, February 7, 2020 and August 21, 2020, SSLs for beryllium and cobalt were identified at the Ash Pond Area during 2019 and 2020 assessment monitoring completed in accordance with 40 C.F.R. § 257.95.

In response to the SSLs, an Assessment of Corrective Measures (ACM) report was completed for the Ash Pond Area in September 2019 as required by 40 C.F.R. § 257.96. The ACM report concluded that the source control remedy would be retrofitting the liner system in the Ash Ponds and the groundwater remedy would be monitored natural attenuation (MNA), groundwater extraction and treatment or a vertical hydraulic barrier.

A public meeting was held on November 13, 2019 at the Henderson Chamber of Commerce in Henderson, Texas to discuss the results of the of the ACM in accordance with 40 C.F.R. § 257.96(e).

A notification of intent to retrofit the Ash Pond Area liner system was posted on June 29, 2020. Design of the Ash Pond Area liner system retrofit has been completed and construction is underway.

A feasibility study to evaluate MNA as a potential groundwater remedy for the Ash Pond Area is currently being performed. Feasibility study activities completed since March 4, 2020 include collection of additional groundwater samples to supplement previous soil and groundwater data and development of site-specific geochemical and groundwater models in order to understand the natural attenuation mechanisms occurring at the Ash Pond Area and evaluate the effectiveness of natural attenuation in meeting applicable groundwater protection standards.

APPENDIX F8 - STRUCTURAL STABILITY ASSESSMENT

REPORT

STRUCTURAL STABILITY ASSESSMENT REPORT

Martin Lake Steam Electric Station

Submitted To: Luminant
1601 Bryan Street
Dallas, TX 75201

Submitted By: Golder Associates Inc.
500 Century Plaza Drive, Suite 190
Houston, TX 77073 USA

Professional Engineering Firm
Registration Number F-2578

October 2016 **Project No. 164816402**

Golder Associates

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1.0 INTRODUCTION

1.1 Purpose

The “Disposal of Coal Combustion Residuals (CCR) from Electric Utilities rule” (40 Code of Federal Regulations (40 CFR) Part 257), effective October 19, 2015, requires that existing CCR surface impoundments meeting the requirements of §257.73(b) conduct initial and periodic structural stability assessments in accordance with §257.73(d). This report provides the structural stability assessment for the Martin Lake Steam Electric Station’s (MLSES’s) CCR Impoundments, identified as the Bottom Ash Ponds (BAPs) – the West Ash Pond (WAP) and the East Ash Pond (EAP) – the New Scrubber Pond (NSP), and the Permanent Disposal Pond-5 (PDP-5).

1.2 Site Background

The MLSES generates bottom ash, fly ash, and flue gas desulfurization (FGD) material during electricity generation. The following surface impoundments, shown on Figure 1, are in operation at the MLSES and subject to the CCR rule.

1.2.1 The Bottom Ash Ponds (BAPs)

The BAPs include the West Ash Pond (WAP) and the East Ash Pond (EAP). The WAP and EAP receive sluice water from bottom ash dewatering bins and other process wastewater sources that typically include bottom ash fines. The BAPs were originally constructed in 1977 with a 2-feet thick compacted clay liner. In 1989, the WAP was relined with a 60-mil high density polyethylene (HDPE) geomembrane over 3 feet of clay on the sideslopes, and the floor with a double 60-mil HDPE geomembrane with a geonet leak detection layer overlying an 18-inch thick clay liner. Both the sideslopes and floor are overlain with a 4-inch thick concrete revetment mat. In 2010 the sideslopes and floor of the EAP were relined with a double 60-mil HDPE geomembrane with a geonet leak detection layer overlying an 18-inch thick clay layer. A geotextile layer was placed between the lower geomembrane and the clay. The liner system on the sideslopes and floor of the EAP are overlain with a 4-inch thick concrete revetment mat.

1.2.2 New Scrubber Pond (NSP)

The NSP, abutting the southeastern portion of the WAP and the southern portion of the EAP, is used to manage FGD wastes and discharge from the sludge thickener sumps, the plant yard sumps, and stormwater management areas. Water collecting in the NSP serves as wet-well make-up water as well as emergency make-up water in the scrubber area. The NSP was originally constructed with the BAPs and lined with clay liner. In 1989, the NSP was relined with a double 60-mil HDPE geomembrane with a geonet leak detection layer. A geotextile layer was placed between the lower geomembrane and the subgrade and a 4-inch thick concrete revetment mat covers the upper geomembrane.

1.2.3 Permanent Disposal Pond-5 (PDP-5)

PDP-5 is primarily used to manage excess liquids including stormwater and excess process wastewater from both the New Scrubber Pond and Bottom Ash Ponds. Recovered CCR wastewaters are received in PDP-5 during cleaning cycles. PDP-5 was constructed in 2010/2011, above PDP-1, PDP-2, and PDP-3, which were previously closed as landfills. PDP-5 is lined with a 3-foot thick clay liner on the sideslopes and a 2-foot thick clay liner on the floor, both overlain with a 0.5-foot thick protective cover soil layer.

1.3 Previous Slope Stability Evaluations

Golder and ETTL Engineers and Consultants (ETTL) have previously performed evaluations on the BAPs, the NSP and PDP-5 as part of the following reports submitted to Luminant:

- Ash and Scrubber Ponds and Permanent Disposal Pond #4, Stability Investigation Report, Luminant Martin Lake SES, Rusk County, Texas, Golder, dated December 2012.
- Geotechnical Investigation, Luminant Martin Lake SES, Reline East Ash Disposal Pond, Tatum, Texas, ETTL, dated December 2008.

The studies found the BAPs and NSP slopes to be adequately stable.

ETTL performed stability evaluations on PDP-5 in 2009, as presented in the following report:

- Geotechnical Investigation, Luminant Martin Lake SES, Vertical Expansion of Permanent Disposal Ponds 1, 2, and 3, Tatum, Texas. ETTL Engineers and Consultants Inc. Tyler, Texas, dated July 2008.
- Geotechnical Investigation, Luminant Martin Lake SES, Vertical Expansion of Permanent Disposal Ponds 1, 2, and 3, Tatum, Texas – Supplemental Seepage and Slope Stability. ETTL Engineers and Consultants Inc., dated October 2009.

The above reports found the design slopes of PDP-5 to be stable as long as drainage is functional, preventing the embankments from saturating.

2.0 SUBSURFACE CONDITIONS

The MLSES site is located in the Martin Creek area which is situated in the Sabine River Valley and lies on the west flank of the Sabine Uplift. The formations in the region comprise sedimentary deposits of continental and marine origin, mainly the lower Wilcox Group flanked by younger beds like the Carrizo Sand. In the Martin Creek area, the Wilcox formation is estimated to be about 650- to 700-feet thick and consists of sandy clays, silty sands, clays, and lignite in varying amounts. The Rockdale formation is the major component in the area among the sediments of the Wilcox group occupying approximately the middle four-fifths of the Wilcox Section. The Wilcox Group is underlain by the Paleocene Midway Group (containing Upper Willis and Lower Kincaid), which is estimated to be 900-feet thick around the site, and is composed mainly of silty clay and clay. The Midway Group overlies a section of Cretaceous Rocks that are approximately 7000-feet thick (Rone Engineers, 1984).

2.1 Site Geology

2.1.1 Bottom Ash Ponds and Scrubber Pond

2.1.1.1 Subsurface Investigations and Laboratory Testing

Information from previous subsurface investigations was used to characterize the subsurface site conditions. In 2008, ETTL conducted a subsurface investigation for the EAP as part of an effort to reline the pond. ETTL drilled twelve borings along the crest of the EAP embankment at approximate elevation 330 feet – mean sea level (ft-msl). All borings were 40-feet deep except one which was 100-feet deep. The boring map and boring logs are presented in Appendix A. Geotechnical laboratory testing – moisture contents, Atterberg limits, grain size distribution, and consolidated-undrained (CU) triaxial compression tests - was conducted on selected samples. The soil index testing results presented as part of the boring logs, while the CU test results from ETTL are summarized in Appendix B.

Golder conducted a subsurface investigation for the WAP and NSP in December 2012. Golder completed eight, 50- to 60-foot deep borings along the crest of the pond embankments at approximate elevation 330 ft-msl. The boring map and boring logs are presented in Appendix A. As part of the investigation, laboratory testing was performed on selected samples in accordance with commonly accepted methods and practices. Undisturbed and disturbed soil samples were tested to determine water content, Atterberg limits, grain size distribution, and shear strength. Water content determination was performed in accordance with ASTM D2216; Atterberg limits were determined in accordance with ASTM D4318; and grain size distribution was performed in accordance with ASTM D422. Shear strength testing consisted of unconsolidated-undrained (UU) triaxial compression in general accordance with ASTM D2850. Laboratory test results are presented in Appendix B.

The findings from the above subsurface investigations were reviewed for their applicability to this study, and are summarized in the following sections.

2.1.1.2 Subsurface Site Conditions

The above borings consisted of fill and native soils. The soils encountered in the borings generally consisted of stiff to hard sandy clays and firm to very dense sands. The subsurface stratigraphy generally consisted of interchanging layers of clays, sandy clays, clayey sands and non-plastic sands. The clayey sand layers ranged in thickness from 2 to 16 feet where encountered. The sandy clay and clay layers are described as firm to hard, low to high plasticity clays and vary in thickness from 2 to 38 feet. Loose to very dense, silty or poorly graded sand was typically encountered beneath or interlayered with the sandy clay/clayey sand strata. The 100-foot boring by ETTL showed deeper layers of very dense silty sand with intermittent layers of hard low plasticity clay.

Water was encountered in each of the eight borings performed by Golder, ranging between El. 296.1 to 303.3 ft-msl. The average water elevation measured in the Golder boreholes, during drilling, was at El. 300.3 ft-msl. The ETTL borings measured the water level to range between El. 304 to 309 ft-msl, with an average water level of El. 306 ft-msl, coinciding with the normal pool elevation of the adjacent Martin Lake (a man-made reservoir).

Groundwater levels measured in 2015, from wells surrounding the BAPs, varied from approximately El. 304 ft-msl in the southeast corner to El. 307 ft-msl in the northwest corner.

2.1.2 Permanent Disposal Pond - 5

2.1.2.1 Subsurface Investigations and Laboratory Testing

In 2008, ETTL performed a pre-construction subsurface investigation for PDP-5 that included a total of eleven borings within the PDP-5 footprint. In addition, three cone penetrometer tests (CPTs) were performed. As part of a supplemental investigation in 2009, ETTL drilled a further three borings within the pond footprint. The map of the borings, and boring and CPT logs are presented in Appendix A.

ETTL performed laboratory tests including natural moisture contents (ASTM D2216), Atterberg limits (ASTM D4318), particle size distributions (ASTM D 1140 and ASTM D422). Unconsolidated-undrained (UU) triaxial compression tests (ASTM D2850) were performed to determine the strength characteristics of cohesive substrata. Direct shear tests (ASTM D3080) were performed on coarser materials including remolded bulk ash samples. Consolidation tests (ASTM D2435) and permeability tests (ASTM D5084) were also performed but are not relevant to the current study. The results of the laboratory tests performed by ETTL are presented in Appendix B.

2.1.2.2 Subsurface Site Conditions

Most of the above borings were drilled through the bottom ash within closed PDP-1, 2, and 3. Based on particle size, the ash classifies as very loose to medium dense poorly graded sands in some locations, to silts in other locations and depths. The borings passing through existing embankments of PDP-1, 2, and 3 contained medium stiff to very stiff clay of low plasticity and/or high plasticity clay with clayey sand. Native soils were identified in deeper borings as very dense silt with hard low plasticity clay seams.

Two borings located outside of the ash encountered groundwater approximately between El. 355 to 368 ft-msl. Groundwater levels measured in 2015, from wells surrounding PDP-5, indicate that the groundwater level varies from approximately El. 355 ft-msl in the north to El. 375 ft-msl in the south.

3.0 STRUCTURAL STABILITY ASSESSMENT - §257.73(d)(1)(i)-(vii)

The CCR rules require conducting periodic structural stability assessments by a qualified professional engineer to document whether the design, construction, operation and maintenance is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater that can be impounded therein.

3.1 Foundations and Abutments - §257.73(d)(1)(i)

As noted above, the foundation soils for the BAPs and NSP generally consist of stiff to hard sandy clays and compact to dense sand. As discussed below, the embankment fill appears to be well-compacted. The foundation soils and abutments of the BAPs and NSP are stable.

Parts of the foundation soils for PDP-5 embankments are founded on the existing bottom ash of underlying PDP-1, 2, and 3 which were previously closed as landfills. Based on particle size, the bottom ash classifies as very loose to medium dense, poorly graded sand at some locations and silts at other locations and depths. Based on the above mentioned ETTL reports and the preparation of foundation materials during construction, the foundations and abutments are generally considered to be stable. The possibility of liquefaction of bottom ash in the foundation is considered in the Safety Factor Assessment report (Golder, 2016).

3.2 Slope Protection - §257.73(d)(1)(ii)

The downstream slopes of the BAPs, NSP and PDP-5 embankments are protected from erosion and deterioration by the establishment of a vegetative cover. Portions of the EAP and the NSP adjacent to Martin Lake are protected from wave action with roller compacted concrete The vegetative cover is inspected weekly for erosion, signs of seepage, animal burrows, sloughing, and plants that could negatively impact the embankment. For the BAPs and NSP, the interior slopes are protected from wave action by concrete revetment mats or riprap. The interior slopes of PDP-5 are covered with vegetative cover for erosion protection.

3.3 Dikes (Embankment) - §257.73(d)(1)(iii)

3.3.1 Bottom Ash Ponds and Scrubber Pond

No construction documentation or testing details of the original BAPs and NSP embankment fills are available. Based on the borings, the embankments were constructed using a clayey fill likely from an on-site borrow source. Golder's subsurface investigation of 2012 and ETTL's investigation of the EAP in 2008 comprised boreholes drilled into the embankment. These borings found the embankment soils to generally consist of stiff to hard sandy clay, clayey sand, and clay, consistent with well-compacted fill. No significant repairs have been performed to the BAPs and NSP embankments since their initial construction, except the relining of the WAP and NSP in 1989, and the relining of the EAP in 2010. Based on a review of past inspection reports and on recent observations, the BAPs and NSP embankments are sufficient to withstand the range of loading conditions they are subjected to.

3.3.2 Permanent Disposal Pond – 5

PDP-5 was constructed with on-site soils in 2010/2011. A 3-foot thick clay layer was placed over PDP-1, PDP-2 and PDP-3, beneath the new PDP-5 embankment. Sections of the embankment overlie the bottom ash from the closed ponds.

The clay liner was specified to be installed and compacted in 6-inch lifts, to at least 95% Standard Proctor maximum dry density at optimum moisture content to 4% above. The embankment was specified to be constructed in loose lifts of 8-inch maximum thickness, followed by compaction to 95% standard Proctor maximum dry density.

Based on a review of past inspection reports and on recent observations, each of the embankments are sufficient to withstand the range of loading conditions they are subjected to.

3.4 Vegetated Slopes - §257.73(d)(1)(iv)

As of June 14, 2016 the US Court of Appeals for the District of Columbia Circuit issued an Order that remanded and vacated the CCR rule requirement that vegetation on the exterior portions of dikes on CCR surface impoundments be maintained not to exceed six inches in height. EPA will issue a new rulemaking in the future to address this issue.

Each of the surface impoundments at the MLSES are inspected weekly. Luminant maintains the vegetation in a manner that ensures adequate inspections can be conducted.

3.5 Spillways - §257.73(d)(1)(v)

There are no spillways on any of the surface impoundments.

3.6 Hydraulic Structures - §257.73(d)(1)(vi)

The only subsurface penetrations in the BAPs and NSP are 24-inch dewatering lines that pass through the WAP and the NSP embankments, which are used for decanting process wastewater from within the ponds. These dewatering lines connect to a collection sump at the low pressure ash water pump station located to the south of the NSP. All other piping passes above the crest of the embankments.

According to as-built drawings prepared by HDR Engineering, Inc., a 14-inch diameter HDPE overflow pipe, encased in a 20-inch diameter HDPE pipe passes through the southern embankment. Flow through this pipe is controlled with a valve located near the toe of the embankment. Discharge from PDP-5 is accomplished using a submersible pump suspended from a pump platform adjacent to the overflow pipe along the southern embankment. All other piping passes above the crest of the embankment.

No significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, or debris were observed that may negatively affect the operation of the surface impoundments.

3.7 Downstream Slopes Adjacent to Water Body - §257.73(d)(1)(vii)

The east slope of the EAP and the south slope of the NSP are adjacent to Martin Lake. The normal pool elevation of Martin Lake is at El. 306 ft-msl. This water level is relatively shallow against the exterior slope. Moreover, the exterior slopes of both the east side of the EAP and the south side of the NSP are lined with roller compacted concrete to protect these slopes from erosion, as well as seepage. Nevertheless, the impact of drawdown of Martin Lake on the stability of the BAP and NSP embankments is considered in the Safety Factor Assessment report (Golder, 2016). The results of stability analysis indicate that the factor of safety for rapid drawdown conditions is approximately 1.6, which exceeds the typically required value of 1.30.

3.8 Structural Stability Deficiencies - §257.73(d)(2)

No structural stability deficiencies were identified during this assessment.

4.0 CONCLUSION

Based on our review of the information provided by Luminant, on information prepared by Golder Associates Inc., and on our on-site observations, no structural stability deficiencies were identified in the surface impoundments during this assessment.

Golder appreciates the opportunity to assist Luminant with this project. If you have any questions, or require further assistance from Golder, please contact the undersigned at (281) 821-6868.

GOLDER ASSOCIATES INC.

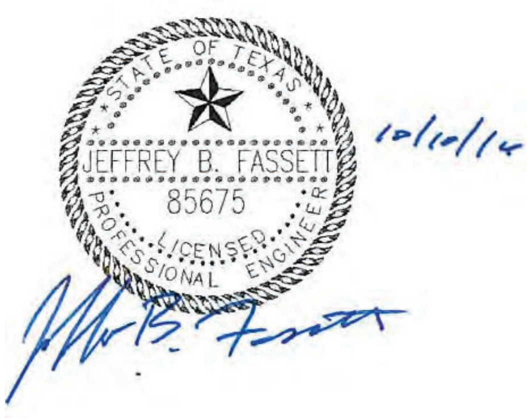
Varenya Kumar
Staff Engineer

Jeffrey B. Fassett, PE
Associate Geotechnical Engineer

VK/JBF/kc

5.0 CERTIFICATION

I hereby certify that this report has been prepared in general accordance with normally accepted civil engineering practices and in accordance with the requirements of 40 CFR 257.73(d).



Jeffrey B. Fassett, PE
Golder Associates Inc.
Firm Registration Number F-2578

6.0 REFERENCES

ETTL Engineers and Consultants Inc. 2008. Geotechnical Investigation, Luminant Martin Lake SES, Vertical Expansion of Permanent Disposal Ponds 1, 2, and 3, Tatum, Texas.

ETTL Engineers and Consultants Inc. 2009. Geotechnical Investigation, Luminant Martin Lake SES, Vertical Expansion of Permanent Disposal Ponds 1, 2, and 3, Tatum, Texas – Supplemental Seepage.

Golder Associates Inc. 2012. Ash and Scrubber Ponds and Permanent Disposal Pond #4 – Stability Investigation Report, Luminant Martin Lake Power Plant, Rusk County, Texas.

Golder Associates Inc. 2016. Safety Factor Assessment Report, Luminant Martin Lake Steam Electric Station.

HDR Engineering Inc. 2011. Martin Lake Steam Electric Station, Rusk County, Texas – Permanent Disposal Pond #5 – As Recorded Drawings.

Pastor, Behling & Wheeler Inc. 2016. Annual CCR Inspection Report. Luminant Martin Lake Steam Electric Station, Ash Pond Area, Permanent Disposal Pond No. 5 & A1 Area Landfill, Rusk & Panola County, Texas

REFERENCE(S)
AERIAL PHOTO SOURCED FROM GOOGLE EARTH PRO DATED: 2015-10-01

Professional Engineering Firm
Registration Number F-2578

0 1000 2000
1" = 2000' FEET

CLIENT
LUMINANT POWER
MARTIN LAKE
••

PROJECT
2016 COAL COMBUSTION RESIDUALS
ENGINEERING SERVICES
••

CONSULTANT		
Golder Associates	YYYY-MM-DD	2016-09-22
	PREPARED	VK
	DESIGNED	TNB
	REVIEWED	MX
	APPROVED	JBF

TITLE
GENERAL SITE MAP

PROJECT NO.		REV.	FIGURE
164816402	••	----	1

APPENDIX A

BORING LOCATION MAP & BORING LOGS

BOTTOM ASH PONDS AND SCRUBBER POND

LEGEND

BH-101 BORING LOCATION

REFERENCE

1.) AERIAL SHOWN LICENSED FROM GOOGLE EARTH PROFESSIONAL.

700 0 700
SCALE FEET

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT
LUMINANT - MARTIN LAKE
ASH & SCRUBBER POND SLOPE STABILITY INVESTIGATION REPORT
RUSK COUNTY, TEXAS

TITLE
BORING LOCATIONS

Golder Associates
Mt. Laurel, New Jersey
NJ Authorization #24GA28029100

PROJECT No.	123-94128		FILE No.	12394128A003
DESIGN	MGP	12/04/12	SCALE AS SHOWN	REV. 0
CADD	RG	12/04/12	**FIGURE 1**	
CHECK	MGP	12/04/12		
REVIEW	PCM	12/04/12		

Drawing file: 12394128A003.dwg Dec 06, 2012 – 11:05am

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BORING NUMBER BH-201

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake
DATE STARTED 10/28/12 **COMPLETED** 10/28/12
GROUND ELEVATION 330 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
▽ **AT TIME OF DRILLING** 28.30 ft / Elev 301.70 ft
LOGGED BY FW **CHECKED BY** MP
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0	Remove 8" sandy gravel as road base					
	(CL) SILTY CLAY, low plasticity, some sand, trace gravels, red, dry, hard	SH 1	44		5.0	
	(SC) CLAYEY SAND, non-plastic, some silt, tan and gray, dry, compact	SS 2	58	15-10-7 (17)		
5	(CL) SANDY CLAY, low plasticity, some silt, red, tan, and gray, mottled, dry, stiff	SH 3	44		3.5	
	(SC) CLAYEY SAND, fine, subangular, non-plastic, little silt, tan and gray, mottled, dry	SH 4	38		1.5	
10	(CL) SANDY CLAY, low plasticity, little silt and gravel, red, tan, and gray, mottled, dry, hard	SH 5	42		4.5	
15	some silt, no gravel, very stiff at 13.0'	SH 6	58		3.5	
20	some sand veins at 18.0'	SH 7	38		3.0	
25	gray, moist at 23.0'	SH 8	58		2.5	
30	▽ (SC) CLAYEY SAND, fine, subangular, low plasticity, some to little silt	SH 9	71		2.0	
35	some silt, tan and gray, mottled, moist at 33.0'	SS 10	100	9-7-9 (16)		

▲ SPT N VALUE ▲ 20 40 60 80
PL MC LL 20 40 60 80
□ FINES CONTENT (%) □ 20 40 60 80

LUMINANT

(Continued Next Page)

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BORING NUMBER BH-201

CLIENT Luminant **PROJECT NAME** Pond Slope Stability

PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / □ FINES CONTENT (%) □ 20 40 60 80
35								
40		some silty sand veins at 38.0'	SH 11	50		2.0		
45		(SM) SILTY SAND, fine, subangular, non-plastic, little clay, tan and red, wet, compact	SS 12	100	11-11-11 (22)			
		(SP) SAND, medium to fine, subangular, poorly graded, some silt, tan, wet, compact	SS 13	100	5-9-11 (20)			
50								

Bottom of borehole at 50.0 feet.

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BORING NUMBER BH-202

CLIENT Luminant | **PROJECT NAME** Pond Slope Stability
PROJECT NUMBER 123-94128 | **PROJECT LOCATION** Martin Lake
DATE STARTED 10/29/12 **COMPLETED** 10/29/12 | **GROUND ELEVATION** 330 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling | **GROUND WATER LEVELS:**
DRILLING METHOD Hollow Stem Auger | **AT TIME OF DRILLING** 26.70 ft / Elev 303.30 ft
LOGGED BY FW **CHECKED BY** MP | **AT END OF DRILLING** ---
NOTES | **AFTER DRILLING** ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0	Remove 6" sandy gravel from road bed					
	(CH) CLAY, medium to high plasticity, some silt, trace fine sand, tan and gray, dry, very stiff to hard	SH 1	50		4.5	
	some sand at 2.0'	SH 2	63		3.5	
5		SH 3	50		5.0	
		SH 4	63		3.75	
	(CL) SANDY CLAY, low plasticity, some to little silt, tan and gray, mottled, moist, firm	SH 5	42		4.0	
10						
	some sand seams, very stiff at 13.0'	SH 6	42		3.0	
15						
	(CL) SILTY CLAY, medium to high plasticity, little find sand, brown, moist, firm	SH 7	58		1.0	
20						
	low plasticity, gray, moist at 23.0'	SH 8	71		5.0	
25						
	(SM) SILTY SAND, fine, subangular, non-plastic, some clay, gray and tan, wet, compact	SS 9	83	7-7-9 (16)		
30						
	(SC) CLAYEY SAND, fine, subangular, low plasticity, some silt, tan and gray, wet, compact	SS 10	100	3-5-6 (11)		
35						

▲ SPT N VALUE ▲ 20 40 60 80
PL MC LL 20 40 60 80
☐ FINES CONTENT (%) ☐ 20 40 60 80

(Continued Next Page)

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BORING NUMBER BH-202

CLIENT Luminant **PROJECT NAME** Pond Slope Stability

PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / □ FINES CONTENT (%) □ 20 40 60 80
35								
		interbedded clay and sand seams at 38.0'	SS 11	100	8-7-8 (15)			
40								
		no seams at 43.0'	SS 12	89	4-4-4 (8)			
45								
		(SP) SAND, medium to fine, poorly graded, subangular, non-plastic, some silt and clay, wet, loose	SS 13	100	2-3-4 (7)			
50								

Bottom of borehole at 50.0 feet.

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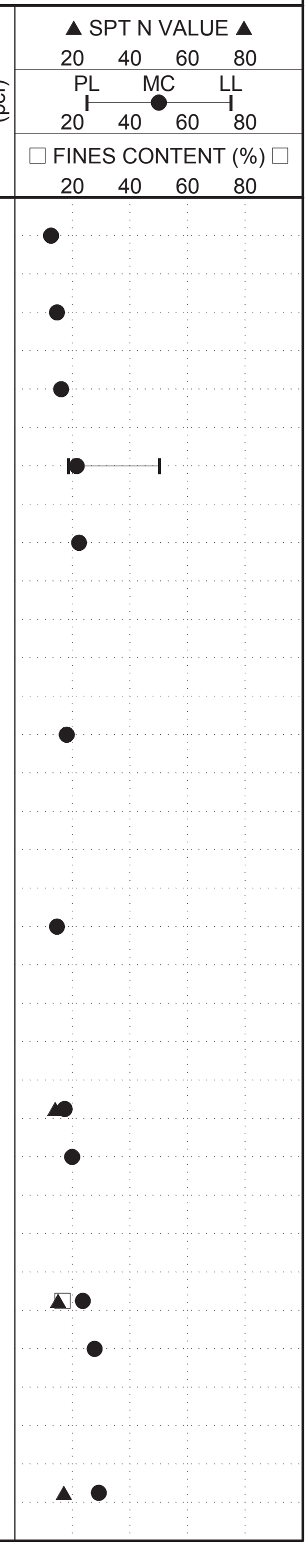
BORING NUMBER BH-203

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake
DATE STARTED 10/30/12 **COMPLETED** 10/30/12
GROUND ELEVATION 330 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING 28.80 ft / Elev 301.20 ft
LOGGED BY FW **CHECKED BY** MP
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0	remove 14" sandy GRAVEL as roadbed					
	(CL) SILTY CLAY, low plasticity, little sand, gray and tan, mottled, dry, very stiff	SH 1	44		2.75	
	(CL) SANDY CLAY, low plasticity, some silt, gray and tan, mottled, dry, stiff	SH 2	50		1.5	
5	low plasticity, some sand veins, soft	SH 3	42		1.25	
	(CL-CH) CLAY, low plasticity to medium plasticity, some silt, dark to light gray, dry, stiff	SH 4	67		1.75	
	very stiff at 8.0'	SH 5	50		3.25	
10						
15	low plasticity, some silt and fine sand, little coarse sand and fine gravels, subrounded, red and tan, stiff at 13.0'	SH 6	38		1.5	
20	(CL) SANDY CLAY, low plasticity, some silt, tan and gray, mottled, dry, stiff	SH 7	44		2.0	
25	(SC) CLAYEY SAND, low plasticity, some silt, tan and gray, mottled, compact, moist	SS 8	94	3-7-7 (14)		
30	low plasticity, with grey silty clay, some sand, tan at 28.0'	SS 9	94	4-7-8 (15)		
35	(SM) SILTY SAND, non-plastic, grading to sand, some silt, little to trace clay, gray, wet, compact	SS 10	100	3-8-9 (17)		



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BORING NUMBER BH-203

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
35								
40		some clay and silt veins, tan at 38.0'	SS 11	100	3-6-6 (12)			
45		(SC) CLAYEY SAND, low plasticity, some silt, tan and brown, wet, compact	SS 12	100	4-8-10 (18)			
50		(SM) SILTY SAND, non-plastic, trace clay, tan and gray, wet, dense	SS 13	100	8-14-20 (34)			

Bottom of borehole at 50.0 feet.

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BORING NUMBER BH-204

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake
DATE STARTED 10/30/12 **COMPLETED** 10/30/12
GROUND ELEVATION 330 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING 31.80 ft / Elev 298.20 ft
LOGGED BY FW **CHECKED BY** MP
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0	removed SANDY GRAVEL from roadbed					
	(CL) SILTY CLAY, low plasticity, some sand, tan and gray, mottled, dry, hard	SH 1	67		4.25	
	(CL) LEAN CLAY, low plasticity, some silt, sand, and sand veins, red and gray, dry, very stiff	SH 2	50		3.0	
5	(SC) CLAYEY SAND, low plasticity, some silt and black sandy gravel veins, tan and gray, dry	SH 3	33		5.0	
	(CL) SANDY CLAY, low plasticity, little silt, tan and gray, dry, stiff	SH 4	58		2.0	
10	(SC) CLAYEY SAND, non-plastic to low plasticity, little silty clay seam, tan, brown, with little gray, dry	SH 5	44		2.5	
15	(CL) LEAN CLAY, low to medium plasticity, some silt, trace fine sand, tan, brown, and gray, mottled, dry, stiff	SH 6	67		2.0	
20	some sand, little silt	SH 7	67		1.5	
25	(CL) SANDY CLAY, low plasticity, little silt, tan and gray, moist, very stiff	SH 8	46		3.0	
30	(ML) SANDY SILT, low plasticity to non-plastic, fine, subangular, some clay, tan and gray, moist, soft	SS 9	100	2-1-3 (4)		
35	(SM) SILTY SAND, low plasticity to non-plastic, fine, subangular, gray with little brown, dense	SS 10	94	11-14-18 (32)		

▲ SPT N VALUE ▲ 20 40 60 80
PL MC LL 20 40 60 80
□ FINES CONTENT (%) □ 20 40 60 80

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BORING NUMBER BH-204

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / □ FINES CONTENT (%) □ 20 40 60 80
35								
		(SC) CLAYEY SAND, fine, subangular, interbedded with gray, silty sand, some clay, tan, wet, compact	SS 11	94	4-5-6 (11)			
40								
		(CH) CLAY, medium plasticity, little silt, trace fine sand, gray, wet, stiff	SS 12	100	3-5-7 (12)			
45								
			SH 13	75		2.0		
50								

Bottom of borehole at 50.0 feet.

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BORING NUMBER BH-205

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake
DATE STARTED 10/30/12 **COMPLETED** 10/30/12
GROUND ELEVATION 330.5 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING 29.40 ft / Elev 301.10 ft
LOGGED BY FW **CHECKED BY** MP
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
0		(CL) LEAN CLAY, medium plasticity, some silt, trace sand, tan and gray, mottled, dry, hard	SH 1	50		4.0		
		with silty sand seams, very stiff at 2.0'	SH 2	60		3.5		
5		stiff at 4.0'	SH 3	40		1.25		
		very stiff at 6.0'	SH 4	58		3.75		
			SH 5	44		3.5		
10								
		some to little silt at 13.0'	SH 6	42		3.0		
15								
		some clayey sand seams, stiff at 18.0'	SH 7	40		1.5		
20								
		(CL) SILTY CLAY, low plasticity, some sand, dark gray, moist, stiff	SH 8	67		1.75		
25								
		(CL) SANDY SILTY CLAY, low plasticity, little clay, light gray with little brown, moist, stiff	SS 9	67	2-5-7 (12)			
30								
		(CL) SANDY CLAY, low plasticity, some silt, tan and gray, moist, very stiff	SH 10	60		3.0		
35								

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BORING NUMBER BH-205

CLIENT Luminant **PROJECT NAME** Pond Slope Stability

PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
35								
		(SC) CLAYEY SAND, interbedded with gray silty SAND, fine, subangular, little clay, compact, wet	SS 11	100	3-6-8 (14)			
40								
		(SP) SAND, fine, subangular, non-plastic, some clay, little silt, tan and brown, wet, compact	SS 12	100	4-9-12 (21)			
45								
		medium to fine, tan at 48.0'	SS 13	100	3-6-11 (17)			
50								
		very loose at 53.0'	SS 14	33				
55								
60								

Bottom of borehole at 60.0 feet.

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BORING NUMBER BH-206

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake
DATE STARTED 10/30/12 **COMPLETED** 10/30/12
GROUND ELEVATION 330.5 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
▽ **AT TIME OF DRILLING** 30.20 ft / Elev 300.30 ft
LOGGED BY FW **CHECKED BY** MP
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
0		(CL) SANDY CLAY, low plasticity, some silt, tan and gray, mottled, dry, stiff	SH 1	44		2.25		
		decreased sand content, very stiff at 2.0'	SH 2	67		3.5		
5		interbedded with silty clay layers, very stiff at 4.0'	SH 3	50		2.25		
		some silty sand veins, very stiff at 6.0'	SH 4	67		3.5		
10			SH 5	52		3.5		
15		trace organics, hard at 13.0'	SH 6	54		4.5		
20		with clayey sand veins, hard at 18.0'	SH 7	50		5.0		
25		some red, moist at 23.0'	SH 8	50		4.5		
30		(CH) SANDY CLAY, medium to high plasticity, some silt, tan and gray, very stiff	SH 9	52		3.25		
35		increased sand and silt content, dark gray, stiff at 33.0'	SH 10	56		1.5		

(Continued Next Page)

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BORING NUMBER BH-206

CLIENT Luminant **PROJECT NAME** Pond Slope Stability
PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
35								
		(SC) CLAYEY SAND, fine, subangular, low plasticity, some to little silt, gray, tan, and red, mottled, wet, compact	SS 11	100	5-6-6 (12)			
40								
		(SM) SILTY SAND, fine, subangular, non-plastic, some clay, wet, loose	SS 12	100	3-4-5 (9)			
45								
		(SP) SAND, medium to fine, trace coarse, poorly graded, subangular, non-plastic, some silt, tan, wet, compact	SS 13	100	2-6-12 (18)			
50								
		no coarse, trace clay at 53.0'	SS 14	100	5-8-13 (21)			
55								
		dense at 58.0'	SS 15	100	9-18-23 (41)			
60								

Bottom of borehole at 60.0 feet.

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BORING NUMBER BH-207

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake
DATE STARTED 10/31/12 **COMPLETED** 10/31/12
GROUND ELEVATION 330.5 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
▽ **AT TIME OF DRILLING** 34.40 ft / Elev 296.10 ft
LOGGED BY FW **CHECKED BY** MP
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0	remove 8" of SANDY GRAVEL from roadbed					
	(CL) SILTY CLAY, low plasticity, trace fine sand, gray, dry, hard	SH 1	33		5.0	
	(CL) SANDY CLAY, low plasticity, some silt and interbedded sand seams, tan and gray, mottled, dry, firm	SH 2	58		3.0	
5	(SP) SAND, poorly graded, non-plastic, some silt, clay, and gravel, black and tan, dry	SH 3	38		0.0	
	(CL) SANDY CLAY, low plasticity, some silt, gray and tan, dry, firm	SH 4	54		3.0	
	hard at 8.0'	SH 5	50		5.0	
10						
	decrease sand content, stiff at 13.0'	SH 6	56		3.75	
15						
	some sand seams at 18.0'	SH 7	52		2.5	
20						
	(SM) SILTY SAND, non-plastic, fine, subangular, little clay, gray, moist	SH 8	33			
25						
	(CL) SILTY CLAY, non-plastic, some sand, gray, moist, hard	SH 9	60		5.0	
30						
	(SM) SILTY SAND, non-plastic, fine, subangular, little clay, gray with little tan, moist, compact ▽	SS 10	89	6-7-7 (14)		
35						

▲ SPT N VALUE ▲ 20 40 60 80
PL MC LL 20 40 60 80
☐ FINES CONTENT (%) ☐ 20 40 60 80

(Continued Next Page)

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BORING NUMBER BH-207

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ / PL MC LL / ☐ FINES CONTENT (%) ☐ (20 40 60 80)
35								
		(SC) CLAYEY SAND, non-plastic, fine, subangular, some silt, gray and tan, wet, loose	SS 11	67	2-3-4 (7)			
40								
		compact at 43.0'	SS 12	100	3-5-5 (10)			
45								
			SS 13	100	3-5-6 (11)			
50								
		(SP) SAND, medium to fine, non-plastic, some silt and clay, gray and tan, wet, loose	SS 14	89	2-2-5 (7)			
55								
		(CL) SILTY CLAY, low plasticity, trace fine sand, gray, wet, very stiff	SS 15	100	3-7-12 (19)			
60								

Bottom of borehole at 60.0 feet.

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BORING NUMBER BH-208

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake
DATE STARTED 10/31/12 **COMPLETED** 10/31/12
GROUND ELEVATION 330.5 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
▽ **AT TIME OF DRILLING** 30.00 ft / Elev 300.50 ft
LOGGED BY FW **CHECKED BY** MP
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / □ FINES CONTENT (%) □ 20 40 60 80
0		remove 12" of SANDY GRAVEL from roadbed						
		(CL) SANDY CLAY, low plasticity, some silt, tan and gray, dry, stiff	SH 1	44		3.5		
		stiff to very stiff at 2.0'	SH 2	50		4.0		
5		hard at 4.0'	SH 3	54		5.0		
		SILTY SAND, nonplastic, some clay, dry	SH 4	31		1.5		
10		(CL) SANDY CLAY, low plasticity, some silt, tan, gray, and red, dry, soft to firm	SH 5	50		2.0		
15			SH 6	40		2.5		
20		very stiff at 18.0'	SH 7	50		3.5		
25		hard at 23.0'	SH 8	46		5.0		
30	▽	some sand seams, moist, very stiff at 28.0'	SH 9	54		3.0		
35		(SC) CLAYEY SAND, fine, subangular, some silt, tan, gray, and red, moist	SH 10	60		2.5		

(Continued Next Page)

Golder Associates
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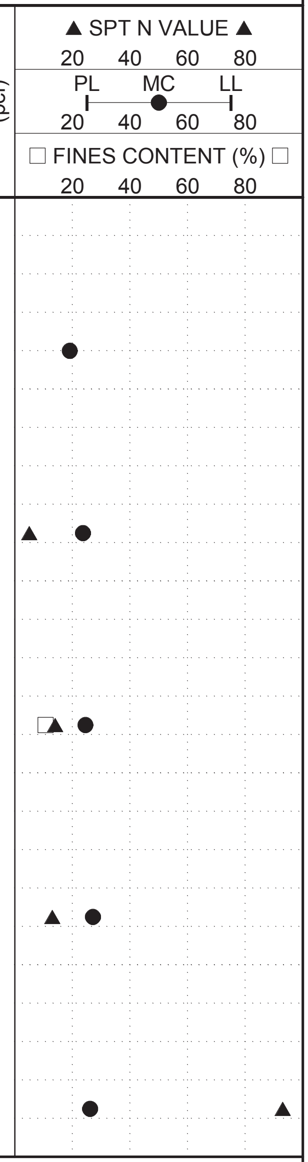
Fax: (281) 821-6870

BORING NUMBER BH-208

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
35						
	wet at 38.0'	SH 11	50			
40						
	loose at 43.0'	SS 12	100	3-2-3 (5)		
45						
	(SP) SAND, fine, little medium, non-plastic, subangular, little clay, tan, compact	SS 13	72	1-6-8 (14)		
50						
	(SC) CLAYEY SAND, medium, some silt, brown	SS 14	100	3-6-7 (13)		
55	(SM) SILTY SAND, fine, subangular, non-plastic, little clay, gray, compact					
	(CL) SILTY CLAY, low plasticity, dark gray, dense	SS 15	100	7-43-50 (93)		
60	SANDY GRAVEL, non-plastic, planar, lignite coal seam, black, hard					

Bottom of borehole at 60.0 feet.



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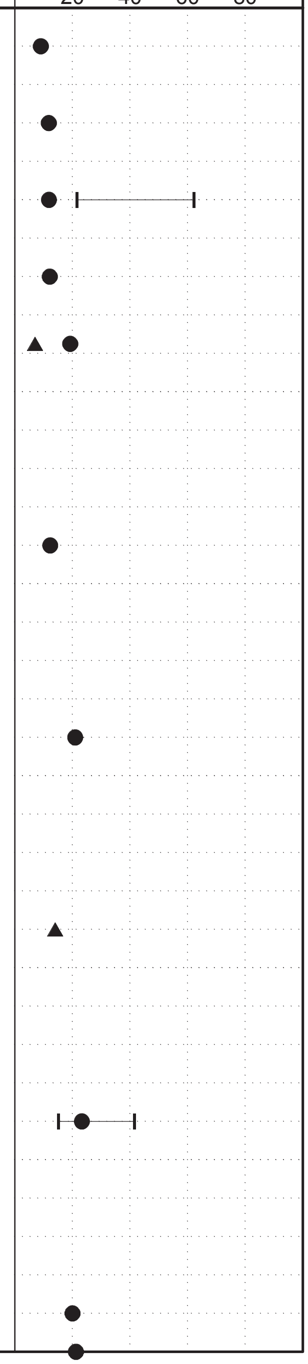
BORING NUMBER BH-209

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake
DATE STARTED 11/1/12 **COMPLETED** 11/1/12
GROUND ELEVATION 360 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
▽ **AT TIME OF DRILLING** 46.20 ft / Elev 313.80 ft no reading, cave in at 46
LOGGED BY FW **CHECKED BY** MP
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0		(SC) CLAYEY SAND, fine, subangular, medium plasticity, some fine rounded gravel, red and brown, dry	SH 1	33		5.0	
		trace fine rounded gravel, tan and gray, mottled at 2.0'	SH 2	38		5.0	
5		little silt, no gravel at 4.0'	SH 3	38		5.0	
		some silt at 6.0'	SH 4	29		4.5	
		(CL) SANDY CLAY, low plasticity, some silt, tan and gray, dry, firm	SS 5	33	2-2-5 (7)		
10							
		some red, hard at 13.0'	SH 6	21		5.0	
15							
		gray, moist, very stiff at 18.0'	SH 7	29		2.5	
20							
		(CL) LEAN CLAY, low plasticity, some silt, trace fine sand, gray and tan, moist, stiff	SS 8	67	4-6-8 (14)		
25							
		little silt, hard, gray at 28.0'	SH 9	50		5.0	
30							
		grading to clayey sand, very stiff at 33.0'	SH 10	42		3.0	
35							

▲ SPT N VALUE ▲
20 40 60 80
PL MC LL
20 40 60 80
☐ FINES CONTENT (%) ☐
20 40 60 80



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BORING NUMBER BH-209

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / □ FINES CONTENT (%) □ 20 40 60 80
35								
		some silt and sand, gray, tan, and brown, hard at 38.0'	SS 11	100	7-13-14 (27)			
40								
		(CL) SILTY CLAY, low plasticity, dark gray, moist, hard	SS 12	100	12-20-26 (46)			
45								
		(SM) SILTY SAND, fine, subangular, non-plastic, some clay, tan and gray, moist, very dense	SS 13	100	14-27-36 (63)			
50								

Bottom of borehole at 50.0 feet.

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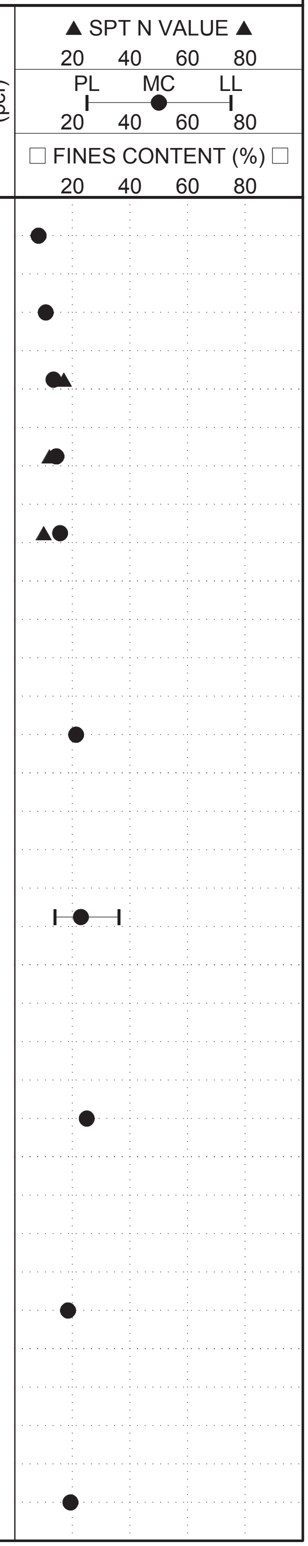
BORING NUMBER BH-210

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake
DATE STARTED 11/1/12 **COMPLETED** 11/1/12
GROUND ELEVATION 360 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING 47.00 ft / Elev 313.00 ft no reading, cave in at 47
LOGGED BY FW **CHECKED BY** MP
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0		(SC) CLAYEY SAND, fine, subangular, some silt, little fine rounded gravel, red, dry trace roots at 1.0'	SH 1	25		5.0	
		tan, gray, and red, mottled at 2.0'	SH 2	21		5.0	
5		compact at 4.0'	SS 3	67	4-7-10 (17)		
			SS 4	39	3-6-6 (12)		
10			SS 5	33	3-4-6 (10)		
15		(CL) SANDY CLAY, low to medium plasticity, little silt, red and gray, dry, very stiff	SH 6	21		3.0	
20		some silt and sand seams, gray and tan, moist, very stiff at 18.0'	SH 7	89		3.5	
25		little red, hard at 23.0'	SH 8	50		4.5	
30		trace subrounded fine gravels and coarse sand at 28.0'	SH 9	29		4.0	
35		(SC) CLAYEY SAND, fine, subangular, some silt, brown and tan, moist	SH 10	35		4.0	



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BORING NUMBER BH-210

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
35								
38		(SM) SILTY SAND, fine, subangular, non-plastic, little clay, dark gray, moist, compact	SS 11	50	4-5-5 (10)			
40								
43		(CL) SILTY CLAY, low plasticity, little fine sand, gray, moist, stiff	SS 12	94	2-4-5 (9)			
45		▽						
48		(SM) SILTY SAND, fine, subangular, non-plastic, some clay, gray and tan, mottled, wet, compact	SS 13	100	4-7-8 (15)			
50								
53			SS 14	89	5-9-9 (18)			
55								
58		little tan, dense at 58.0'	SS 15	100	7-14-17 (31)			
60								
63			SS 16	100	11-15-19 (34)			
65								
68		some dark brown clay seams at 68.0'	SS 17	100	10-15-25 (40)			
70								

Bottom of borehole at 70.0 feet.

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BORING NUMBER BH-211

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake
DATE STARTED 11/2/12 **COMPLETED** 11/2/12
GROUND ELEVATION 360 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING 60.20 ft / Elev 299.80 ft no reading, cave in at 60
LOGGED BY FW **CHECKED BY** MP
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0	(SC) CLAYEY SAND, some silt and fine rounded gravel, red, dry	SH 1	29		5.0	
	fine, subangular, gray, tan, and red at 2.0'	SH 2	29		3.5	
5	trace fine gravels and coarse sand, loose at 4.0'	SS 3	50	2-3-6 (9)		
	some sandy clay seams, compact at 6.0'	SS 4	39	4-5-8 (13)		
	increase clay and silt content at 8.0'	SS 5	72	4-8-8 (16)		
10						
15	(CL-CH) SANDY CLAY, low to medium plasticity, little silt, gray, tan, and red, dry, stiff	SS 6	33	2-5-6 (11)		
20	some silt at 18.0'	SH 7	50		3.25	
25	brown and tan at 23.0'	SH 8	44		5.0	
30	(ML) SANDY SILT, little clay, tan, moist	SH 9	25			
35	(SM) SILTY SAND, fine, subangular, some clay, tan and gray, dense	SS 10	67	7-15-19 (34)		

SPT N VALUE ▲ 20 40 60 80
PL MC LL 20 40 60 80
☐ FINES CONTENT (%) ☐ 20 40 60 80

(Continued Next Page)

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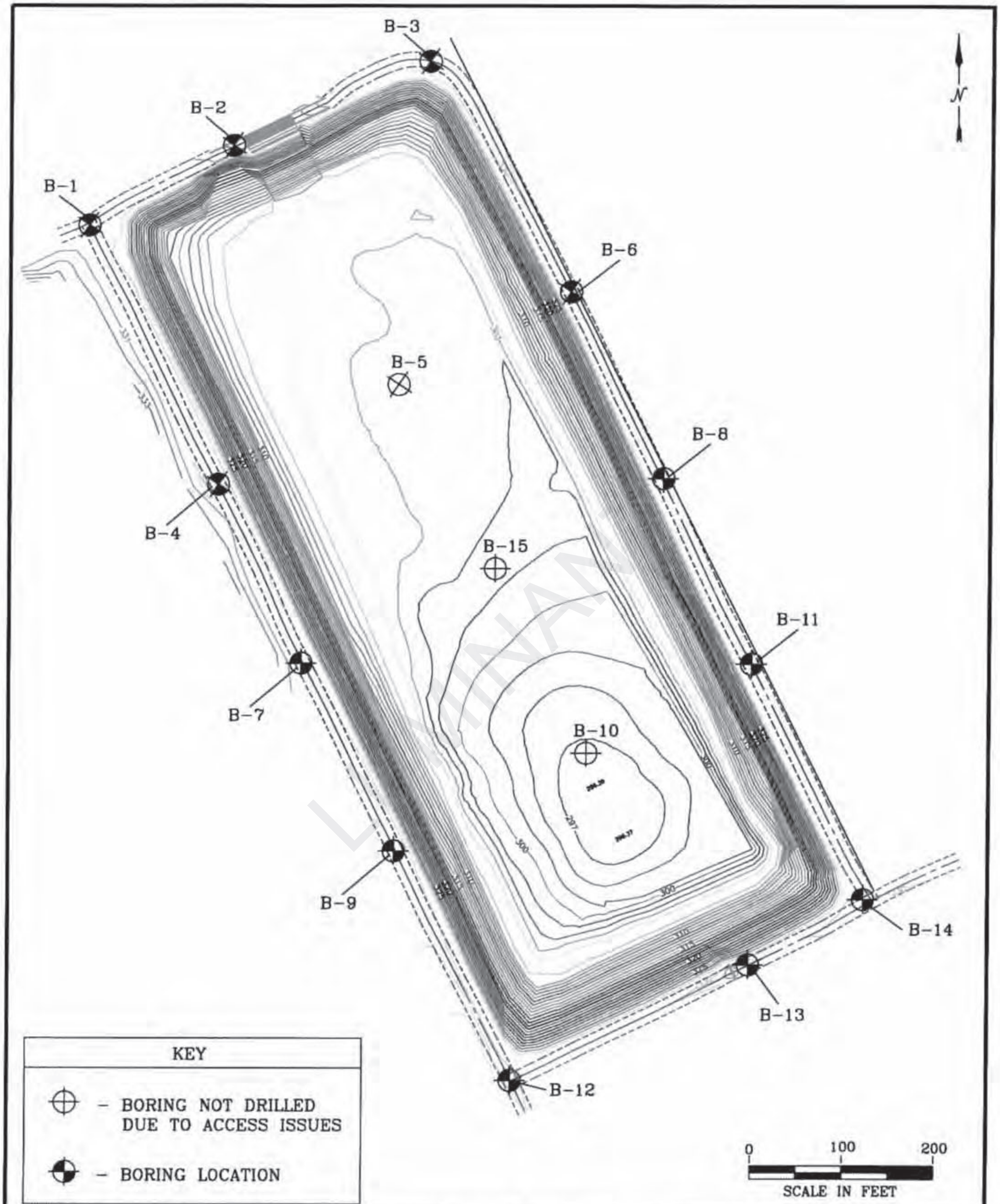
Fax: (281) 821-6870

BORING NUMBER BH-211

CLIENT Luminant **PROJECT NAME** Pond Slope Stability
PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
35								
40			SS 11	89	9-17-25 (42)			
45			SS 12	100	10-14-18 (32)			
50		(SC) CLAYEY SAND, low plasticity, fine, subangular, some silt and lean clay, gray and tan, wet, dense	SS 13	89	9-14-18 (32)			
55		(SP) SAND, fine, subangular, non-plastic, some silt, little to trace clay, tan, wet, very dense	SS 14	100	17-29-38 (67)			
60		little medium at 58.0'	SS 15	78	14-28-33 (61)			
65			SS 16	100	17-29-34 (63)			
70		(SM) SILTY SAND, fine, subangular, non-plastic, little to trace clay, gray and tan, wet, very dense	SS 17	72	18-27-37 (64)			

Bottom of borehole at 70.0 feet.



ETTL ENGINEERS & CONSULTANTS MAIN OFFICE 1717 East Erwin Tyler, Texas 75702 (903) 595-4421	MARTIN LAKE LUMINANT EAST ASH DISPOSAL POND RUSK COUNTY, TEXAS	PLATE 1 - PLAN OF BORINGS JOB NO.: G 2972-08 DATE: NOV. 2008 / SCALE: AS SHOWN	APPROVED BY: DRAWN BY: K.C.R.

LOG OF BORING B-1

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

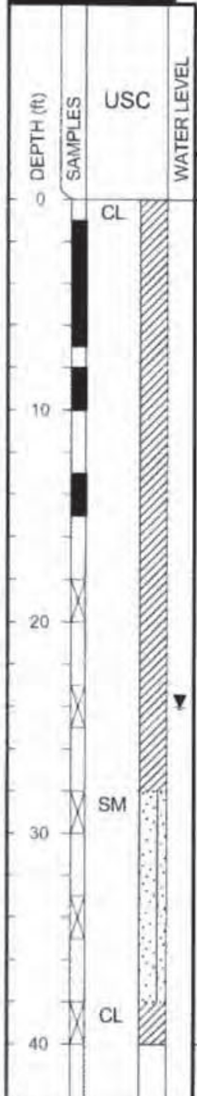
PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

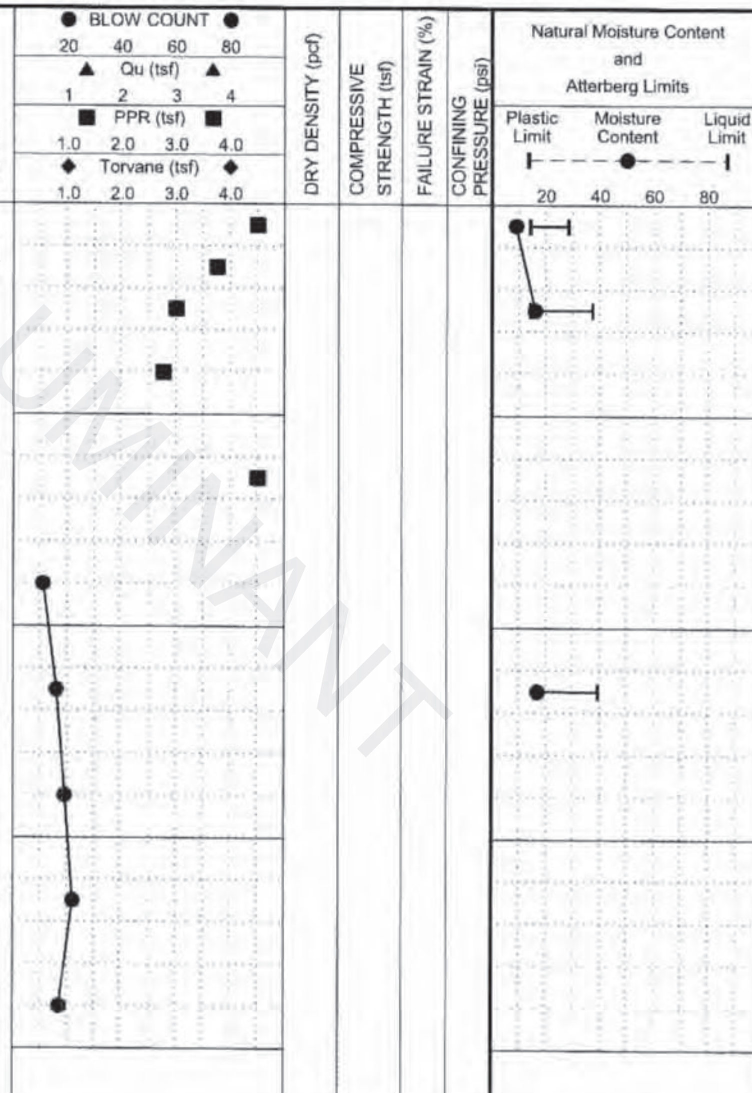
PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

DATE 10/8/08

SURFACE ELEVATION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) hard; red, tan, and gray; mottled	P=4.5+	9	28	14	14	55	+40 Sieve =0%, +4 Sieve =0%
	–very stiff	P=3.75						
	–with trace lignite	P=3.0	16	37	14	23	66	+40 Sieve =1%, +4 Sieve =0%
		P=2.75						
	–hard	P=4.5+						
		N=11						
		N=16	17	39	16	23	70	+40 Sieve =1%, +4 Sieve =0%
SM	SILTY SAND(SM) medium dense; red, tan, and gray	N=19						
	–with gravel	N=22						
CL	LEAN CLAY WITH SAND(CL) very stiff; red, tan, and gray; interbedded; laminated	N=17						
	Bottom of Boring @ 40'							





Water Level Est: Measured: Perched:

Water Observations: Seepage @ 28' while drilling. Water level @ 26' and open to 33' upon completion. Water level @ 24' and open to 27' on 10/9/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes: GPS Coordinates: N 32°15.850', W 94°33.910'

LOG OF BORING B-11

ETTL ENGINEERS & CONSULTANTS
MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

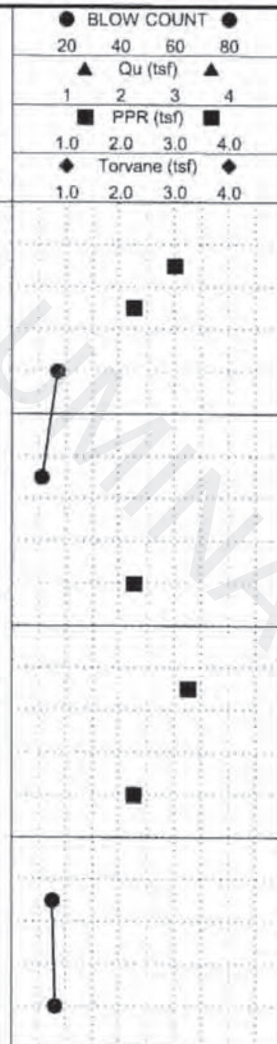
PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

DATE 10/7/08

SURFACE ELEVATION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SC	CLAYEY SAND(SC) tan, gray, and red; mottled; with gravel		6	28	12	16	33	+40 Sieve =28%, +4 Sieve =24%
		P=3.0						
		P=2.25						
CL	SANDY LEAN CLAY(CL) very stiff; tan, gray, and red; mottled	N=17	13	32	13	19	56	+40 Sieve =1%, +4 Sieve =0%
	--stiff	N=11						
		P=2.25						
		P=3.25	16	38	14	24	68	+40 Sieve =1%, +4 Sieve =0%
	--red and gray; mottled	P=2.25						
	--tan, red, and gray; mottled	N=15						
SM	SILTY SAND(SM) medium dense; gray	N=16						
	Bottom of Boring @ 40'							

Columns also printed (no values): DEPTH (ft) 0, 10, 20, 30, 40; SAMPLES; WATER LEVEL; DRY DENSITY (pcf); COMPRESSIVE STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi).



Water Level Est.: Measured: Perched:

Water Observations: Seepage @ 38' while drilling. Water level @ 36' and open to 37' upon completion. Water level @ 21' and open to 22' on 10/8/08.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.773', W 94°33.782'

LOG OF BORING B-12

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

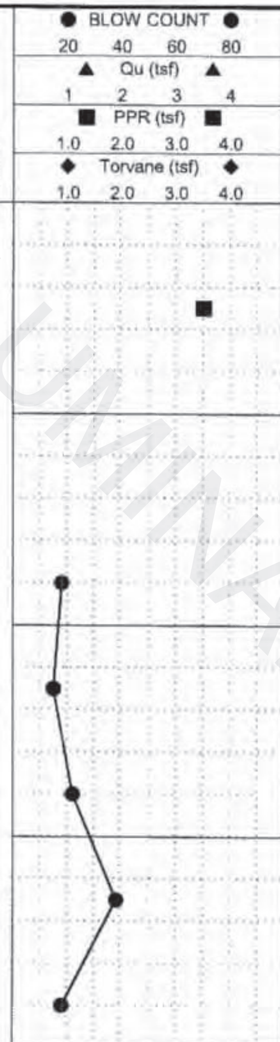
PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

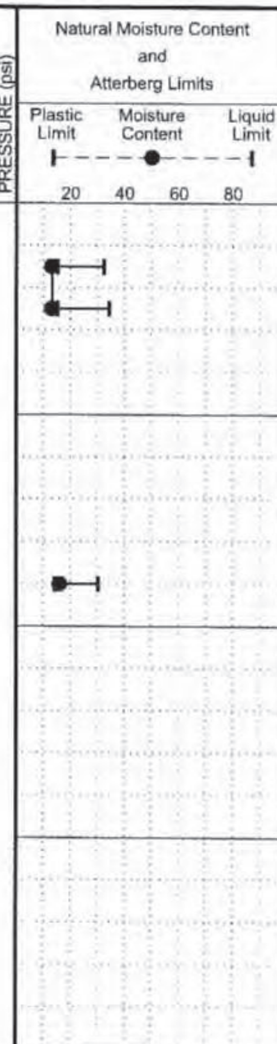
DATE 10/9/08

SURFACE ELEVATION

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) brown; with gravel		13	32	15	17	54	+40 Sieve =1%, +4 Sieve =0%
		–mottled; tan, red, and gray; with sand seams	P=3.5	13	34	15	19	57	+40 Sieve =0%, +4 Sieve =0%
10		–with silty sand							
20	CL	LEAN CLAY WITH SAND(CL) very stiff; tan, red, and gray; mottled	N=18	16	30	14	16	75	+40 Sieve =1%, +4 Sieve =0%
			N=15						
30		–with sand seams	N=22						
	SM	SILTY SAND(SM) dense; gray and red; mottled	N=38						
40	CL	SANDY LEAN CLAY(CL) very stiff; gray, red, and tan; mottled	N=18						
		Bottom of Boring @ 40'							

Other columns: DRY DENSITY (pcf); COMPRESSIVE STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi)





Water Level Est: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 33' while drilling. Water level @ 34' and open to 35' upon completion. Water level @ 23' and open to 31' on 10/10/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes: GPS Coordinates: N 32°15.696', W 94°33.830'

LOG OF BORING B-13

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

DATE 10/7/08

SURFACE ELEVATION

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) very stiff; tan, gray, and red; mottled	P=3.25						
	CL	LEAN CLAY WITH SAND(CL) very stiff; tan, gray, and red; mottled	P=3.0	15	39	16	23	70	+40 Sieve =6%
		–tan and brown	P=3.75						
10	SC	CLAYEY SAND(SC) dense; tan, brown, and red; with gravel	P=3.25	10	40	16	24	47	+40 Sieve =36%, +4 Sieve =33%
	CL	LEAN CLAY WITH SAND(CL) very stiff; tan, brown, and red; with lignite	P=2.75						
20		–red and tan	P=2.0	17	38	16	22	74	+40 Sieve =3%, +4 Sieve =0%
			P=2.25						
30		–tan, red, and gray; mottled	N=18						
	SC	CLAYEY SAND(SC) loose; tan, red, and gray; with trace gravel and ferric material	N=9	18	36	17	19	43	+40 Sieve =36%, +4 Sieve =25%
40		–medium dense	N=18						
		Bottom of Boring @ 40'							

Other columns: BLOW COUNT (20, 40, 60, 80); Qu (tsf) (1, 2, 3, 4); PPR (tsf) (1.0, 2.0, 3.0, 4.0); Torvane (tsf) (1.0, 2.0, 3.0, 4.0); DRY DENSITY (pcf); COMPRESSIVE STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi); Natural Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 20, 40, 60, 80)

Water Level Est: Measured: Perched:

Water Observations: Seepage @ 37' while drilling. Water level @ 36' and open to 38' upon completion. Water level @ 25' and open to 26' on 10/8/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.713', W 94°33.777'

LOG OF BORING B-14

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

DATE 10/6/08

SURFACE ELEVATION

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) hard; tan, gray, and red; mottled; with gravel	P=4.5+						
			P=4.5+	14	40	16	24	53	+40 Sieve =50%, +4 Sieve =49%
			P=4.5+						
			P=4.5+						
		--stiff	N=12	13	29	13	16	63	+40 Sieve =1%, +4 Sieve =0%
10	CL	SANDY LEAN CLAY(CL) very stiff; tan, gray, and red; mottled	N=16						
		--stiff; interbedded	N=14	16	31	16	15	58	+40 Sieve =2%, +4 Sieve =0%
20			N=15						
		--hard; brown, tan, and red	P=4.5+	12	40	14	26	77	+40 Sieve =1%, +4 Sieve =0%
30			N=19						
		--hard; with gray and brown silty sand	P=4.25						
40	SM	SILTY SAND(SM) medium dense; red and gray; saturated							

Graph columns: BLOW COUNT (20, 40, 60, 80); Qu (tsf) (1, 2, 3, 4); PPR (tsf) (1.0, 2.0, 3.0, 4.0); Torvane (tsf) (1.0, 2.0, 3.0, 4.0); DRY DENSITY (pcf); COMPRESSIVE STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi); Natural Moisture Content and Atterberg Limits — Plastic Limit, Moisture Content, Liquid Limit (20, 40, 60, 80)

Water Level Est.: Measured: Perched:

Water Observations: Water level @ 22' and open to 89' upon completion. Water level @ 26' and open to 27' on 10/9/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.723', W 94°33.756'

LOG OF BORING B-14

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

PROJECT NO.: G 2972-08

BORING TYPE: Flight Auger

DATE 10/6/08

SURFACE ELEVATION

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
			N=18						
50			N=16	22				25	+40 Sieve =1%, +4 Sieve =0%
		–red and tan	N=23						
60	CL	LEAN CLAY WITH SAND(CL) hard; red and tan; interbedded; laminated; with ferric material seams	N=32	22	53	29	24	77	+40 Sieve =3%, +4 Sieve =0%
		–with black lignite seams	N=50/3"						
70	SM	SILTY SAND(SM) very dense; gray; with fat clay partings	N=50/5.5"						
		–gray	N=50/5"						
80			N=50/6"	24	24	21	3	41	+40 Sieve =0%, +4 Sieve =0%
	CL	LEAN CLAY(CL) hard; gray	N=50/6"						

Chart columns: BLOW COUNT (20 40 60 80); Qu (tsf) (1 2 3 4); PPR (tsf) (1.0 2.0 3.0 4.0); Torvane (tsf) (1.0 2.0 3.0 4.0); DRY DENSITY (pcf); COMPRESSIVE STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi); Natural Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80)

Water Level Est: ▽ Measured: ▼ Perched: ▼

Water Observations: Water level @ 22' and open to 89' upon completion. Water level @ 26' and open to 27' on 10/9/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.723', W 94°33.756'

LOG OF BORING B-14

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

DATE 10/6/08

SURFACE ELEVATION

DEPTH (ft)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	BLOW COUNT (20 40 60 80) / Qu (tsf) (1 2 3 4) / PPR (tsf) (1.0 2.0 3.0 4.0) / Torvane (tsf) (1.0 2.0 3.0 4.0)	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	Natural Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
90				–with black lignite	N=50/3.5"												
				–dark brown; with silt seams; with lignite seam	N=50/6"												
100					N=88												
				Bottom of Boring @ 100'													

Water Level Est: ∇ Measured: ▼ Perched: ▼

Water Observations: Water level @ 22' and open to 89' upon completion. Water level @ 26' and open to 27' on 10/9/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.723', W 94°33.756'

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ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING B-2

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

DATE 10/8/08

SURFACE ELEVATION

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) very stiff; tan, red, and gray	N=19	8	32	14	18	50	+40 Sieve =0%, +4 Sieve =0%
		–hard; red, tan, and gray; mottled	P=4.25						
			P=3.75						
10			P=4.0						
		–with some gravel	P=4.5+						
20		–tan, red, and gray; mottled	N=1	17	28	15	13	63	+40 Sieve =1%, +4 Sieve =0%
		–gray, red, and tan; mottled	N=22	13	39	15	24	54	+40 Sieve =0%, +4 Sieve =0%
30	SM	SILTY SAND(SM) medium dense; red and gray; saturated	N=15						
			N=13						
40		Bottom of Boring @ 40'							

Chart columns: BLOW COUNT (20, 40, 60, 80); Qu (tsf) (1, 2, 3, 4); PPR (tsf) (1.0, 2.0, 3.0, 4.0); Torvane (tsf) (1.0, 2.0, 3.0, 4.0); DRY DENSITY (pcf); COMPRESSIVE STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi); Natural Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 20, 40, 60, 80).

Water Level Est: Measured: Perched:

Water Observations: Seepage @ 32' while drilling. Water level @ 29' and open to 32' upon completion. Water level @ 25' and open to 25' on 10/9/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.860', W 94°33.890'

LOG OF BORING B-3

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

DATE 10/8/08

SURFACE ELEVATION

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) very stiff; tan, red, and gray; mottled	P=3.5										
			P=2.5					18	33	13	20	68	+40 Sieve =1%, +4 Sieve =0%
			P=3.0										
10			P=3.5										
		--stiff	P=1.5										
20	SC	CLAYEY SAND(SC) medium dense; red	N=15					10	37	15	22	19	+40 Sieve =15%, +4 Sieve =7%
		--gray	N=4										
30	CL	LEAN CLAY WITH SAND(CL) stiff; red, tan, and gray; mottled	N=15					18	34	16	18	71	+40 Sieve =5%, +4 Sieve =0%
		--with sand seams	N=13										
40	SC	CLAYEY SAND(SC) medium dense; gray and red; mottled; with clay seams	N=13										
		Bottom of Boring @ 40'											

BLOW COUNT 20 40 60 80; Qu (tsf) 1 2 3 4; PPR (tsf) 1.0 2.0 3.0 4.0; Torvane (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

Water Level Est: Measured: Perched:

Water Observations: Seepage @ 29' while drilling. Water level @ 28' and open to 34' upon completion. Water level @ 25' and open to 32' on 10/9/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.876', W 94°33.842'

LOG OF BORING B-4

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

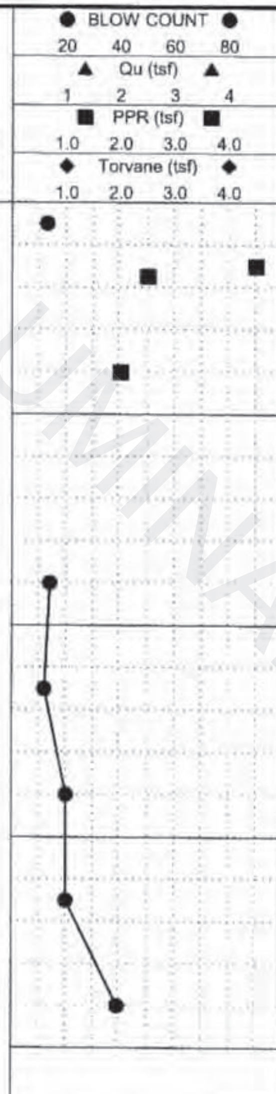
PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

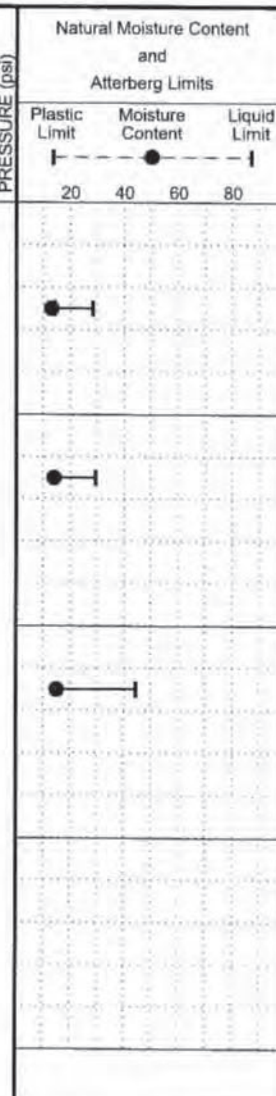
PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

DATE 10/8/08

SURFACE ELEVATION

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) stiff; tan, red, and gray; mottled	N=13										
			P=2.5 P=4.5+					13	28	14	14	60	+40 Sieve =1%, +4 Sieve =0%
			P=2.0										
10													
	SC	CLAYEY SAND(SC) red, tan, and gray; mottled						14	29	14	15	36	+40 Sieve =0%, +4 Sieve =0%
	CL	SANDY LEAN CLAY(CL) stiff; tan, red, and gray; mottled; with sand seams	N=14										
20		–red and tan	N=12					15	44	15	29	67	+40 Sieve =0%, +4 Sieve =0%
		–with sand seams	N=20										
30	SM	SILTY SAND(SM) medium dense; red; saturated	N=20										
		–red and tan; with gravel	N=39										
40		Bottom of Boring @ 40'											





Water Level Est: Measured: Perched:

Water Observations: Seepage @ 28' while drilling. Water level @ 27' and open to 30' upon completion. Water level @ 23' and open to 28' on 10/9/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.804', W 94°33.891'

LOG OF BORING B-6

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

DATE 10/7/08

SURFACE ELEVATION

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) very stiff; tan, red, and gray; mottled	P=3.5										
			P=4.5+										
	SC	CLAYEY SAND(SC) medium dense; tan, red, and gray; mottled	N=17					11	31	16	15	43	+40 Sieve =1%, +4 Sieve =0%
10			N=24										
	CL	LEAN CLAY(CL) stiff; tan, red, and gray; mottled	P=1.75					19	45	16	29	88	+40 Sieve =0%, +4 Sieve =0%
20		–very stiff; brown, gray, and red; with sand; trace ferric material and lignite	P=3.25					14	46	17	29	74	+40 Sieve =0%, +4 Sieve =0%
		–with sand seams	N=19										
30		–tan, red, and gray; mottled	N=25					18	46	17	29	84	+40 Sieve =8%, +4 Sieve =3%
		–tan and gray; mottled	N=18										
	SM	SILTY SAND(SM) tan and gray	N=18										
40	CL	SANDY LEAN CLAY(CL) very stiff; tan and gray											
		Bottom of Boring @ 40'											

Chart legend: BLOW COUNT 20 40 60 80; Qu (tsf) 1 2 3 4; PPR (tsf) 1.0 2.0 3.0 4.0; Torvane (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

Water Level Est: Measured: Perched:

Water Observations: Seepage @ 28' while drilling. Water level @ 26' and open to 34' upon completion. Water level @ 25' and open to 27' on 10/8/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.833', W 94°33.814'

ETTL
ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING B-7

DATE 10/8/08

SURFACE ELEVATION

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) hard; tan, red, and gray; mottled	P=4.0						
CL ML	SANDY SILTY CLAY(CL-ML) very stiff; tan, red, and gray; mottled	P=3.0	16	21	14	7	63	+40 Sieve =0%, +4 Sieve =0%
		P=3.0						
CL	LEAN CLAY WITH SAND(CL) very stiff; tan, red, and gray; mottled	P=3.25	15	34	16	18	74	+40 Sieve =1%, +4 Sieve =0%
	–stiff	P=1.5						
		P=1.5	15	36	15	21	72	+40 Sieve =0%, +4 Sieve =0%
CH	FAT CLAY(CH) stiff; gray, red, and tan; mottled	N=11	25	55	19	36	88	+40 Sieve =1%, +4 Sieve =0%
SM	SILTY SAND(SM) medium dense; tan, red, gray, mottled	N=10						
CL	SANDY LEAN CLAY(CL) very stiff; red, tan, and gray; mottled	N=20						

Bottom of Boring @ 40'

Water Level Est: Measured: Perched:

Water Observations: Seepage @ 33' while drilling. Water level @ 32' and open to 35' upon completion. Water level @ 23' and open to 27' on 10/9/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.775', W 94°33.875'

ETTL
ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING B-8

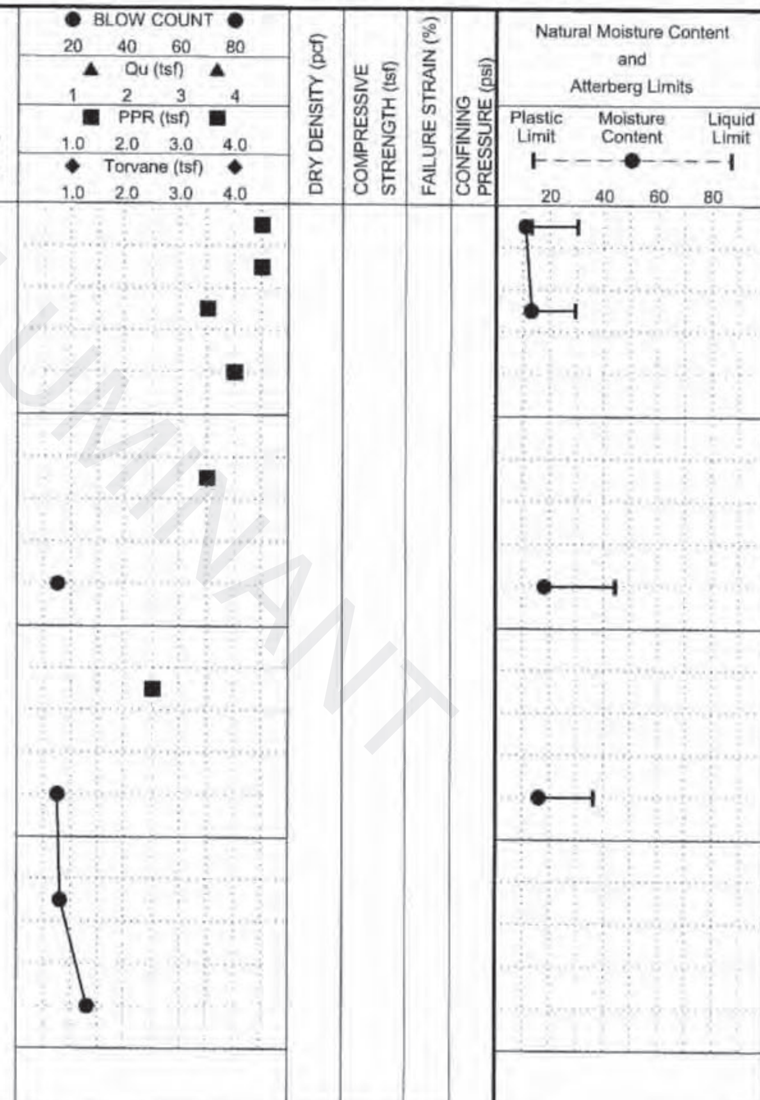
PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

DATE 10/7/08

SURFACE ELEVATION

Depth (ft)	USC	Material Description	Field Strength Data	Moisture Content (%)	LL	PL	PI	Minus #200 Sieve (%)	Other Tests Performed (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) hard; tan, red, and gray; mottled	P=4.5+	11	30	13	17	67	+40 Sieve =2%, +4 Sieve =0%
			P=4.5+						
			P=3.5	13	29	13	16	67	+40 Sieve =0%, +4 Sieve =0%
			P=4.0						
10			P=3.5						
		–very stiff	N=15	18	44	18	26	70	+40 Sieve =3%, +4 Sieve =0%
20			P=2.5						
			N=15	16	36	16	20	63	+40 Sieve =9%, +4 Sieve =3%
30		–red and gray; mottled	N=16						
	SM	SILTY SAND(SM) dense; red, tan, and reddish gray; mottled; saturated	N=26						
40		Bottom of Boring @ 40'							



Water Level Est: Measured: Perched:

Water Observations: Seepage @ 38' while drilling. Water level @ 35' and open to 36' upon completion. Water level @ 23' and open to 27' on 10/8/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.803', W 94°33.798'

LOG OF BORING B-9

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

DATE 10/9/08

SURFACE ELEVATION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) hard; tan, red, and gray; mottled	P=4.5+						
		P=4.5						
		P=2.5	14	29	14	15	59	+40 Sieve =2%, +4 Sieve =0%
		P=3.25						
	--sand content increasing	SF	14	36	15	21	58	+40 Sieve =1%, +4 Sieve =0%
	--with bluish green sandy clay	P=2.5	13	38	14	24	56	+40 Sieve =1%, +4 Sieve =0%
SM	SILTY SAND(SM) medium dense; gray, tan, and red; mottled	N=16						
CL	SANDY LEAN CLAY(CL) very stiff; gray, tan, and red; mottled							
SM	SILTY SAND(SM) medium dense; tan, red, and gray	N=23						
	--with clay seams	N=14						
	--saturated	N=23						
	Bottom of Boring @ 40'							

Column headings also printed: DEPTH (ft) 0, 10, 20, 30, 40; SAMPLES; WATER LEVEL; BLOW COUNT 20 40 60 80; Qu (tsf) 1 2 3 4; PPR (tsf) 1.0 2.0 3.0 4.0; Torvane (tsf) 1.0 2.0 3.0 4.0; DRY DENSITY (pcf); COMPRESSIVE STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi); Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit, 20 40 60 80; ATTERBERG LIMITS(%): LIQUID LIMIT, PLASTIC LIMIT, PLASTICITY INDEX.

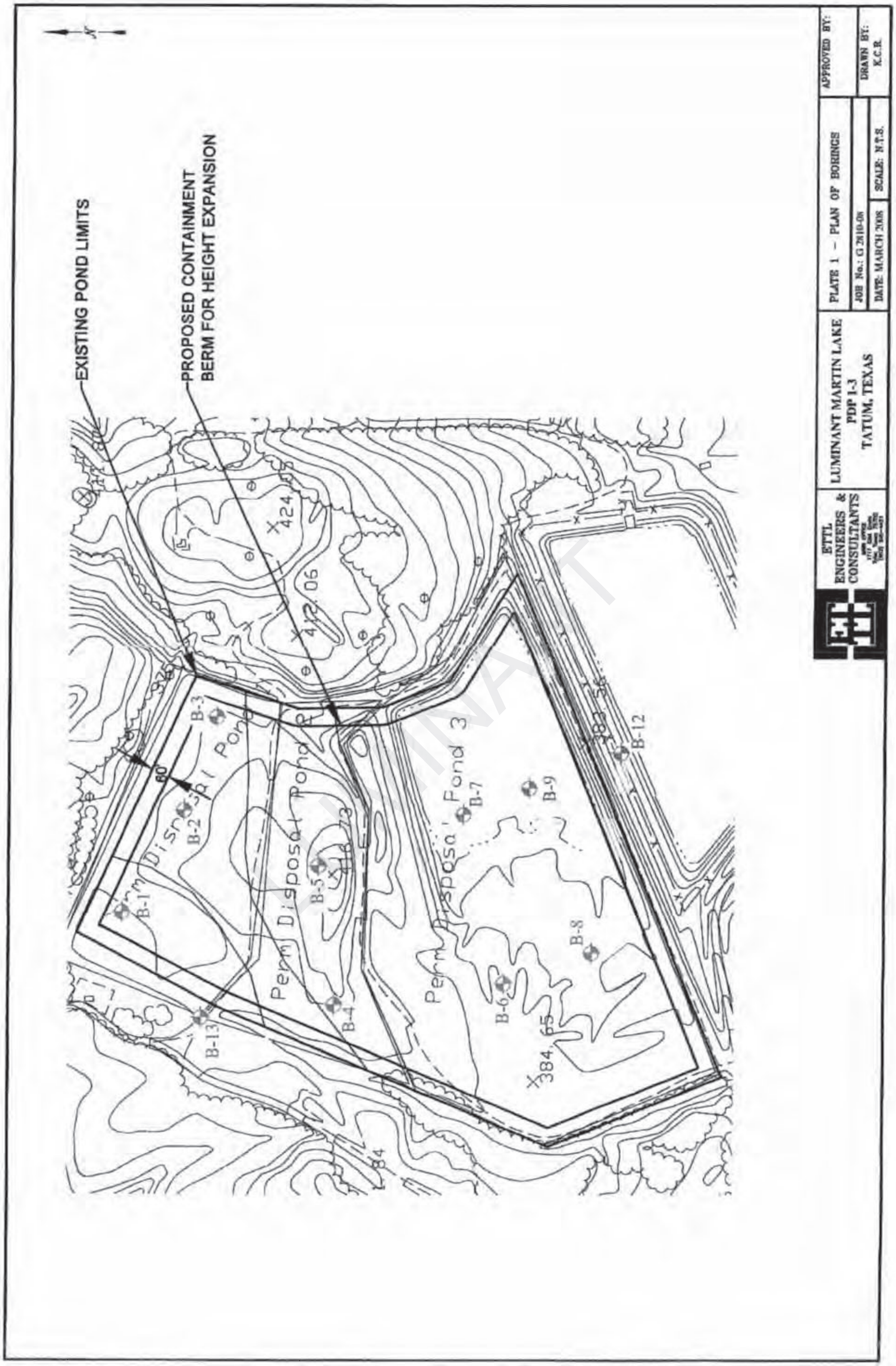
Water Level Est: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 28' while drilling. Water level @ 23' and open to 31' upon completion. Water level @ 23' and open to 29' on 10/10/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.745', W 94°33.857'

PERMANENT DISPOSAL POND - 5


EXISTING POND LIMITS
PROPOSED CONTAINMENT BERM FOR HEIGHT EXPANSION
B-1
B-2
B-3
B-4
B-5
B-6
B-7
B-8
B-9
B-12
B-13
Perm Disposal Pond 3
424.05
412.06
416.73
383.56
384.65
ETTL ENGINEERS & CONSULTANTS
LUMINANT MARTIN LAKE
PDP 1-3
TATUM, TEXAS
PLATE 1 – PLAN OF BORINGS
JOB No.: G 2810-08
DATE: MARCH 2008
SCALE: N.T.S.
APPROVED BY:
DRAWN BY:
K.C.R.

LOG OF BORING B-1

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

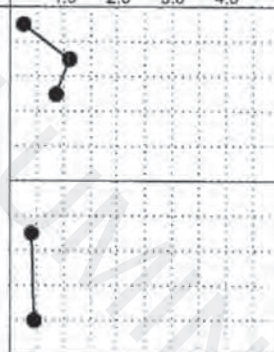
PROJECT NO.: G 2810-08 **BORING TYPE:** Flight Auger

DATE 2/22/08

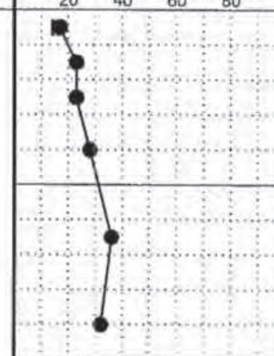
SURFACE ELEVATION 390'

DEPTH (ft)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0		SM	▼	SILTY SAND(SM) loose; tan; moist; with ferric oxide; with organics	N=5					17	16	14	2	34	+40 Sieve =8%, +4 Sieve =3%
				ASH SEDIMENT medium dense; black and gray; coarse to very fine-grained sand	N=22	101				23					
					N=17					23					
				–black		82				28				23	+40 Sieve =55%, +4 Sieve =26%
10															
				–loose; black and gray; coarse to very fine-grained sand	N=8					36					
20					N=9					32				53	
				Bottom of Boring @ 20'											

BLOW COUNT 20 40 60 80 / Qu (tsf) 1 2 3 4 / PPR (tsf) 1.0 2.0 3.0 4.0 / Torvane (tsf) 1.0 2.0 3.0 4.0



Natural Moisture Content and Atterberg Limits — Plastic Limit, Moisture Content, Liquid Limit — 20 40 60 80



Water Level: Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 7' while drilling. Water level @ 1' and caved to 6' on 2/29/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.790', W 94°34.996'. Minus #200 Sieve (53%) @ 18' (Hydrometer - Specific Gravity 2.608). Dry Density (82) @ 8' (Hydraulic Conductivity K=2.79E-04 cm/sec).

LOG OF BORING B-12

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

PROJECT NO.: G 2810-08 **BORING TYPE:** Rotary Wash

DATE 2/27/08

SURFACE ELEVATION 380'

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SC	CLAYEY SAND(SC) medium dense; red and orange	N=25					16	35	15	20	37	+40 Sieve =10%, +4 Sieve =3%
	–loose; gray, red, and orange	N=9										
CL	LEAN CLAY WITH SAND(CL) stiff; red, orange, and tan	N=10										
	–gray and red	N=13					24	47	19	28	79	+40 Sieve =3%, +4 Sieve =0%
	–red and orange											
SC	CLAYEY SAND(SC) medium dense; red and orange	N=11										
	–with iron oxide cemented sandstone gravel	N=12					17	36	15	21	44	+40 Sieve =21%, +4 Sieve =18%
SM	SILTY SAND(SM) medium dense; gray, red, and orange	N=17										
CL	SANDY LEAN CLAY(CL) medium dense; red, orange, and gray	N=20					20	40	16	24	61	+40 Sieve =5%, +4 Sieve =3%
		N=17										
	–red and orange; with iron oxide cemented sandstone seam @ 45'											
SM	SILTY SAND(SM) medium dense; gray, orange, and tan	N=23										

DEPTH (ft): 0, 10, 20, 30, 40, 50

BLOW COUNT: 20 40 60 80; Qu (tsf): 1 2 3 4; PPR (tsf): 1.0 2.0 3.0 4.0; Torvane (tsf): 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

Water Level: Est. Measured: Perched:

Water Observations: Dry and open to 25' on 2/29/08.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.513', W 94°34.904'.

LOG OF BORING B-12

ETTL
ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

PROJECT NO.: G 2810-08 **BORING TYPE:** Rotary Wash

DATE 2/27/08

SURFACE ELEVATION 380'

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
		-gray, red, brown	N=26										
60		-gray and brown	N=28										
	ML	SILT(ML) dense; brown and gray	N=46	99				26				96	+40 Sieve =2%, +4 Sieve =0%
70		-very dense	N=66										
	CL	LEAN CLAY WITH SAND(CL) hard; gray	N=50/3"										
80			N=50/4"	102				22	45	24	21	73	+40 Sieve =24%, +4 Sieve =23%
	ML	SILT(ML) very dense; gray	N=71										
90			N=50/5"	107				23				94	+40 Sieve =2%, +4 Sieve =0%
			N=70										
100			N=80										
		Bottom of Boring @ 100'											

Graph scales: BLOW COUNT 20, 40, 60, 80; Qu (tsf) 1, 2, 3, 4; PPR (tsf) 1.0, 2.0, 3.0, 4.0; Torvane (tsf) 1.0, 2.0, 3.0, 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20, 40, 60, 80

Water Level: Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Dry and open to 25' on 2/29/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.513', W 94°34.904'.

LOG OF BORING B-13

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

PROJECT NO.: G 2810-08 **BORING TYPE:** Rotary Wash

DATE 2/19/08

SURFACE ELEVATION 380'

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SC	CLAYEY SAND(SC) medium dense; red	N=11						
		N=16	14	24	14	10	46	+40 Sieve =3%, +4 Sieve =1%
	–brown and gray	N=38						
	–dense; red and tan	N=47						
	–tan, red, and gray	N=37						
CH	FAT CLAY(CH) stiff; red, gray, and tan	P=1.5	23	51	20	31	89	+40 Sieve =7%, +4 Sieve =1%
	–with iron laminations	P=1.5 P=1.5						
CL	LEAN CLAY(CL) very stiff; gray	N=26	23	48	21	27	94	+40 Sieve =2%, +4 Sieve =0%
	–hard	P=4.5+						
	–gray and brown; with iron oxide cemented sandstone seams	P=4.5+						
ML	SANDY SILT(ML) very dense; gray; with clay seams	N=63	26				66	+40 Sieve =2%, +4 Sieve =0%
		N=63						

Water Level Est: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 29' while drilling. Water level @ 28' and open upon completion. Water level @ 12' and caved to 14' on 2/29/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.752', W 94°35.072'.

LOG OF BORING B-13

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

PROJECT NO.: G 2810-08 **BORING TYPE:** Rotary Wash

DATE 2/19/08

SURFACE ELEVATION 380'

BLOW COUNT ● 20 40 60 80 ●; ▲ Qu (tsf) ▲ 1 2 3 4; ■ PPR (tsf) ■ 1.0 2.0 3.0 4.0; ◆ Torvane (tsf) ◆ 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit ├ - - - ● Moisture Content - - - ┤ Liquid Limit; 20 40 60 80

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
		–hard; laminated with sand seams	P=4.5+										
60		–very stiff; gray and green; with sand seams	P=2.5										
	CL	LEAN CLAY(CL) hard; gray; laminated with sand seams	N=76					26	47	24	23	96	+40 Sieve =2%, +4 Sieve =0%
70	SM	SILTY SAND(SM) very dense; gray	N=75										
			N=50/3.5"										
80	ML	SILT(ML) very dense; gray	N=78										
		–with clay seams	P=SF										
90			N=50/5"										
			N=50/3"										
100			N=50/4"										
		Bottom of Boring @ 100'											

Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 29' while drilling. Water level @ 28' and open upon completion. Water level @ 12' and caved to 14' on 2/29/08.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.752', W 94°35.072'.

LOG OF BORING B-2

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

PROJECT NO.: G 2810-08 **BORING TYPE:** Flight Auger

DATE 2/22/08

SURFACE ELEVATION 390'

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CH	SANDY FAT CLAY(CH) stiff; red and orange	N=11	22	51	18	33	65	+40 Sieve =9%, +4 Sieve =6%
		N=11	23					
	–with sand	N=12	28	57	17	40	78	+40 Sieve =2%, +4 Sieve =0%
	ASH SEDIMENT medium dense; black	N=11	29				16	+40 Sieve =63%, +4 Sieve =40%
	–very loose; with organic odor	N=3	30				39	+40 Sieve =36%, +4 Sieve =12%
	–light gray		42				93	
	Bottom of Boring @ 25'							

Chart column headings: BLOW COUNT (20, 40, 60, 80); Qu (tsf) (1, 2, 3, 4); PPR (tsf) (1.0, 2.0, 3.0, 4.0); Torvane (tsf) (1.0, 2.0, 3.0, 4.0); DRY DENSITY (pcf); COMPRESSIVE STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi); Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20, 40, 60, 80)

Depth (ft): 0, 10, 20

Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 13' while drilling. Water level @ 1' and caved to 8' on 2/29/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.764', W 94°34.903'. Minus #200 Sieve (93%) @ 23' (Hydrometer - Specific Gravity 2.675).

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING B-3

PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

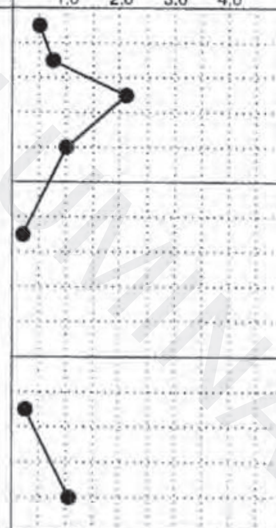
PROJECT NO.: G 2810-08 **BORING TYPE:** Flight Auger

DATE 2/22/08

SURFACE ELEVATION 390'

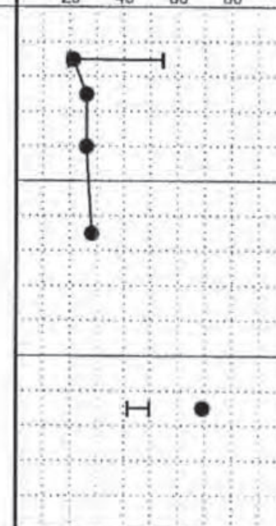
USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CH	SANDY FAT CLAY(CH) medium stiff; red and orange	N=10						
	–stiff	N=15	21	54	19	35	69	+40 Sieve =5%, +4 Sieve =1%
	ASH SEDIMENT dense; black	N=42	26				42	
	–medium dense; black and gray; coarse-grained sand	N=20	26				10	+40 Sieve =60%, +4 Sieve =10%
	–very loose; black; coarse to fine-grained sand	N=4	28				9	+40 Sieve =67%, +4 Sieve =35%
	–no recovery							
	–loose; light gray	N=5	69	49	41	8	100	+40 Sieve =0%, +4 Sieve =0%
	–medium dense; black; with organic odor	N=21						
	Bottom of Boring @ 30'							

BLOW COUNT (20, 40, 60, 80); Qu (tsf) (1, 2, 3, 4); PPR (tsf) (1.0, 2.0, 3.0, 4.0); Torvane (tsf) (1.0, 2.0, 3.0, 4.0)



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)

Natural Moisture Content and Atterberg Limits — Plastic Limit, Moisture Content, Liquid Limit (20, 40, 60, 80)



Water Level — Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 8' while drilling. Water level @ 2' and caved to 8' on 2/29/08..

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes: GPS Coordinates: N 32°15.746', W 94°34.855'. Minus #200 Sieve (42%) @ 5' (Hydrometer - Specific Gravity 2.561).

LOG OF BORING B-4

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

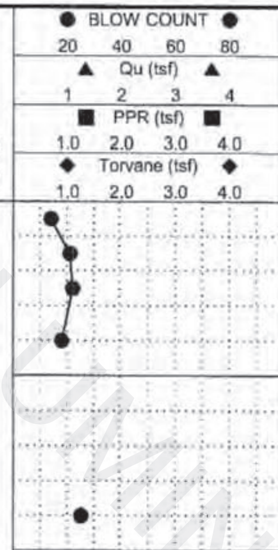
PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

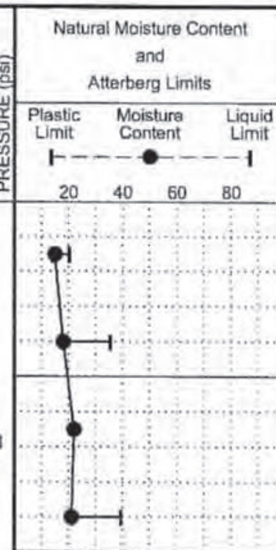
PROJECT NO.: G 2810-08 **BORING TYPE:** Flight Auger

DATE 2/22/08

SURFACE ELEVATION 385'

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	SC SM	SILTY CLAYEY SAND(SC-SM) medium dense; red and brown	N=14										
		–very stiff; red and orange	N=21					15	20	14	6	42	+40 Sieve =1%, +4 Sieve =0%
	SM	SILTY SAND(SM) medium dense; red and tan	N=22										
10	CL	LEAN CLAY(CL) very stiff; red, orange, and tan	N=18					18	35	18	17	85	+40 Sieve =5%, +4 Sieve =1%
		–red, tan, and gray	P=3.5	99	2.40	10	13	22					
20			N=25					21	39	21	18	81	+40 Sieve =0%, +4 Sieve =0%
		Bottom of Boring @ 20'											





Water Level Est: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 3' while drilling. Water level @ Surface and caved to 15' on 2/29/08.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.675', W 94°35.083'.

LOG OF BORING B-5

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

PROJECT NO.: G 2810-08 **BORING TYPE:** Flight Auger

DATE 2/22/08

SURFACE ELEVATION 415'

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CH	FAT CLAY WITH SAND(CH) medium stiff; red, orange, and gray	N=6					23	51	16	35	77	+40 Sieve =4%, +4 Sieve =1%
	–soft	N=4										
CL	SANDY LEAN CLAY(CL) medium stiff; red and orange	N=6					17	28	14	14	60	+40 Sieve =6%, +4 Sieve =1%
CH	FAT CLAY WITH SAND(CH) very stiff; red and orange	N=23					23	52	17	35	77	+40 Sieve =4%, +4 Sieve =1%
	ASH SEDIMENT medium dense; gray and black	N=23					25				16	+40 Sieve =54%, +4 Sieve =24%
	–loose	N=7										
	–medium dense	N=15	62				34				32	+40 Sieve =37%, +4 Sieve =16%
	–loose	N=8										
	–gray	N=5	62				57				99	+40 Sieve =1%, +4 Sieve =0%
	–very loose	N=4										
	–loose	N=7										
	Bottom of Boring @ 45'											

Depth (ft): 0, 10, 20, 30, 40

BLOW COUNT: 20 40 60 80
Qu (tsf): 1 2 3 4
PPR (tsf): 1.0 2.0 3.0 4.0
Torvane (tsf): 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit — 20 40 60 80

Water Level — Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Water level @ 23' and caved to 26' on 2/29/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes: GPS Coordinates: N 32°15.667', W 94°34.936'.

LOG OF BORING B-6

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

PROJECT NO.: G 2810-08 **BORING TYPE:** Flight Auger

DATE 2/22/08

SURFACE ELEVATION 385'

Scales: BLOW COUNT 20 40 60 80; Qu (tsf) 1 2 3 4; PPR (tsf) 1.0 2.0 3.0 4.0; Torvane (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0		ASH SEDIMENT medium dense; black and tan	N=19					26				44	+40 Sieve =30%, +4 Sieve =13%
			P=SF										
	CL	SANDY LEAN CLAY(CL) stiff; red and tan	N=10					22	35	19	16	61	+40 Sieve =7%, +4 Sieve =4%
		–very stiff	P=2.5										
10													
		ASH SEDIMENT loose; black	N=9					40				61	+40 Sieve =5%, +4 Sieve =2%
		–medium dense	N=12					68				84	
20		Bottom of Boring @ 20'											

Water Level Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 4' while drilling. Water level @ 4' and caved to 7' upon completion. Water level @ 1' and caved to 8' on 2/29/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.591', W 94°35.088', Minus #200 Sieve (84) @ 18' (Hydrometer - Specific Gravity 2.732).

LOG OF BORING B-7

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

PROJECT NO.: G 2810-08 **BORING TYPE:** Rotary Wash

DATE 2/28/08

SURFACE ELEVATION 390'

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0		ASH SEDIMENT medium dense; black	N=13					37				16	+40 Sieve =49%, +4 Sieve =10%
		–dense; black	N=40										
			P=4.5	98	2.30	2	6	23					
10		–loose	N=7										
		–very loose	N=4					38				11	
20	CL	LEAN CLAY WITH SAND(CL) medium stiff; orange and black	N=7					27	42	17	25	75	+40 Sieve =4%, +4 Sieve =0%
		–tan and red		104	0.50	13	22	21					
30		–medium dense; red and orange	N=22										
	CH	SANDY FAT CLAY(CH) medium dense; red and orange	N=23					27	53	20	33	69	+40 Sieve =27%, +4 Sieve =22%
40			N=22										
		Bottom of Boring @ 40'											

Blow count / Qu (tsf) / PPR (tsf) / Torvane (tsf) scale: BLOW COUNT 20 40 60 80; Qu (tsf) 1 2 3 4; PPR (tsf) 1.0 2.0 3.0 4.0; Torvane (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

Water Level — Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Water level @ 3' and caved to 24' on 2/29/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.646', W 94°34.870'. Minus #200 Sieve (11%) @ 13' (Hydrometer - Specific Gravity 2.655).

LOG OF BORING B-8

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

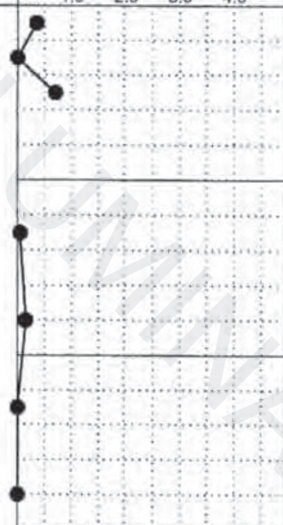
PROJECT NO.: G 2810-08 **BORING TYPE:** Flight Auger

DATE 2/20/08

SURFACE ELEVATION 390'

DEPTH (ft)	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	ASH SEDIMENT loose; gray	N=7										
	-very loose; gray and black	N=0					73				95	+40 Sieve =3%, +4 Sieve =0%
	-medium dense; brown	N=14										
10												
	-very loose; black	N=1										
20		N=3					72				95	+40 Sieve =1%, +4 Sieve =0%
		N=0										
30	-strong odor	N=0					85				99	+40 Sieve =0%, +4 Sieve =0%
	Bottom of Boring @ 30'											

USC: ASH (symbol); ATTERBERG LIMITS(%)

● BLOW COUNT ● 20 40 60 80
▲ Qu (tsf) ▲ 1 2 3 4
■ PPR (tsf) ■ 1.0 2.0 3.0 4.0
◆ Torvane (tsf) ◆ 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits
Plastic Limit — Moisture Content — Liquid Limit
20 40 60 80

Water Level Est: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 4' while drilling. Water level @ 6' and caved to 17' upon completion. Dry and caved to 3' and on 2/29/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.548', W 94°34.570'.

LOG OF BORING B-9

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

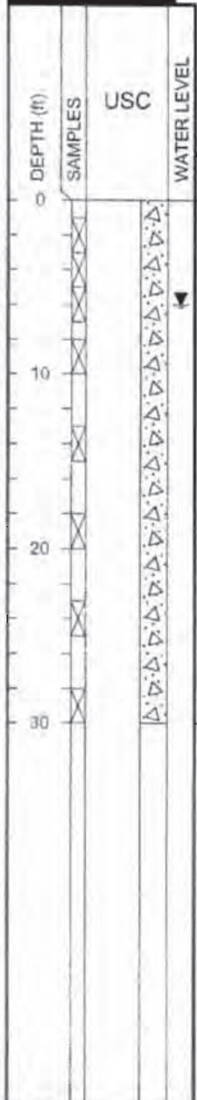
PROJECT: Luminant Martin Lake PDP 1-3, Tatum, Texas

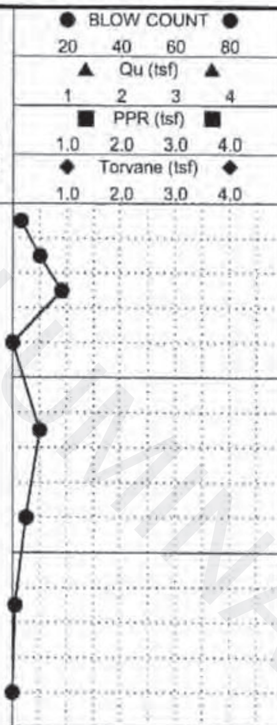
PROJECT NO.: G 2810-08 **BORING TYPE:** Flight Auger

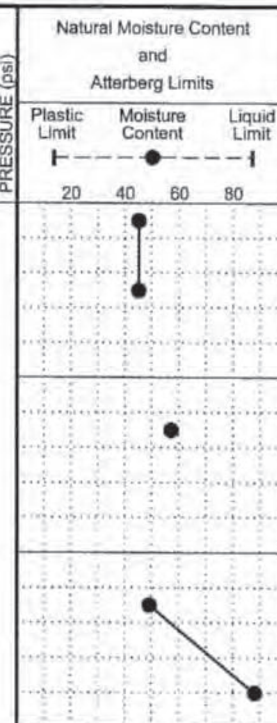
DATE 2/20/08

SURFACE ELEVATION 390'

MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
ASH SEDIMENT very loose; gray	N=3					45				89	
–loose; black and gray	N=10										
–medium dense	N=18					45				77	+40 Sieve =4%, +4 Sieve =0%
–very loose; black	N=0										
–loose	N=10					57				94	+40 Sieve =3%, +4 Sieve =0%
	N=5										
–very loose	N=1					49				68	+40 Sieve =4%, +4 Sieve =0%
–gray and black; strong odor	N=0					88				97	+40 Sieve =2%, +4 Sieve =0%
Bottom of Boring @ 30'											







Water Level Est.: ▽ Measured: ▼ Perched: ▽

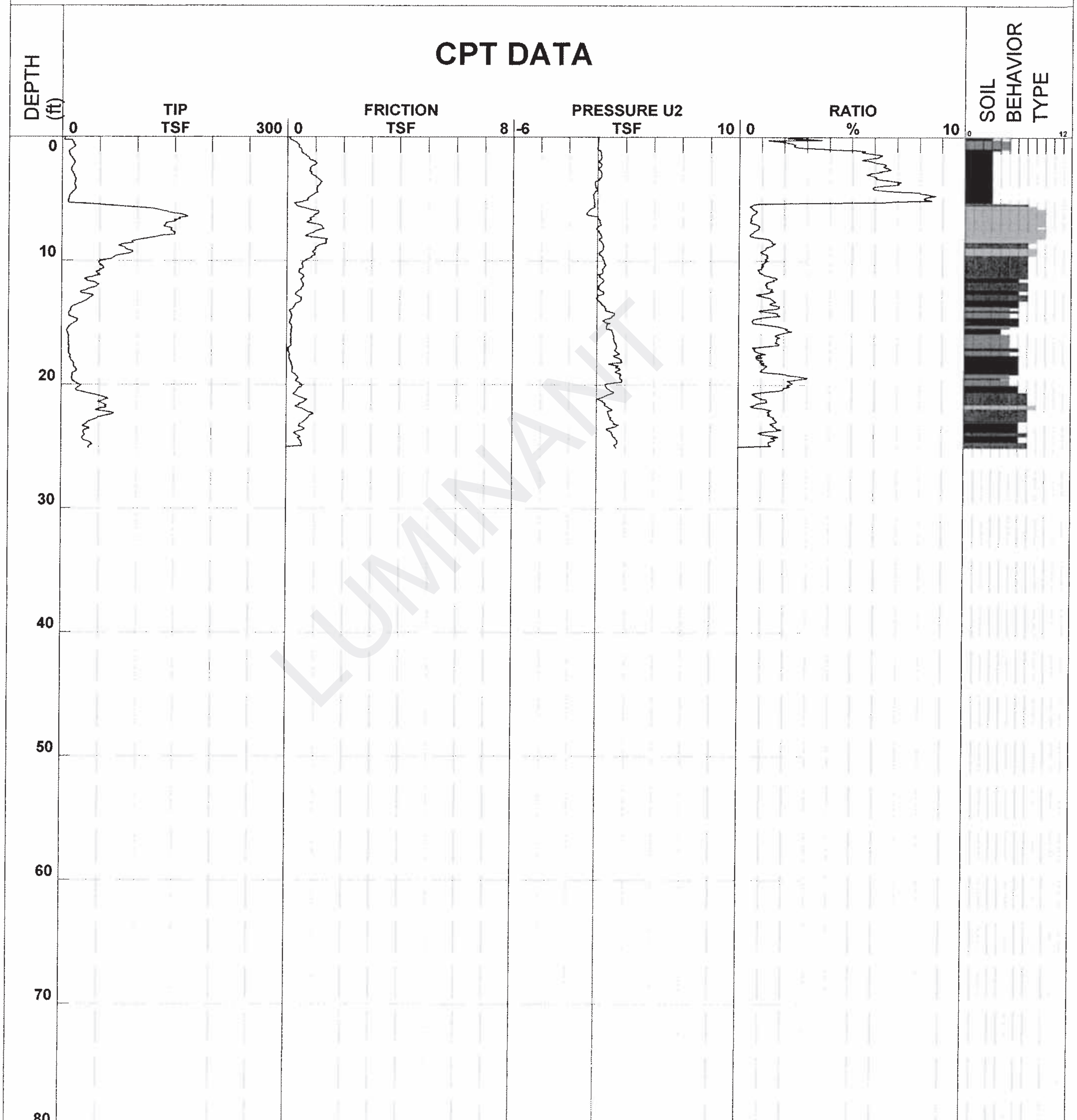
Water Observations: Seepage @ 4' while drilling. Water level @ 6' and caved to 18' upon completion. Dry and caved to 4' on 2/29/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes: GPS Coordinates: N 32°15.556', W 94°34.913'. Minus #200 Sieve (89%) @ 1' (Hydrometer - Specific Gravity 2.761).

CPT Data

Job Number	04.1908-0020	CPT Number	B-02	Location	Tatum-Tx
Operator	GLENN JOHNSON	Date and T	16-Apr-2008 13:47:38	Cone Number	F7.5CKEW2/B 1866
Client		Elevation		Water Table	



1 - sensitive fine grained
2 - organic material
3 - clay
4 - silty clay to clay
5 - clayey silt to silty clay
6 - sandy silt to clayey silt
7 - silty sand to sandy silt
8 - sand to silty sand
9 - sand
10 - gravelly sand to sand
11 - very stiff fine grained (*)
12 - sand to clayey sand (*)

(*) Overconsolidated or Cemented

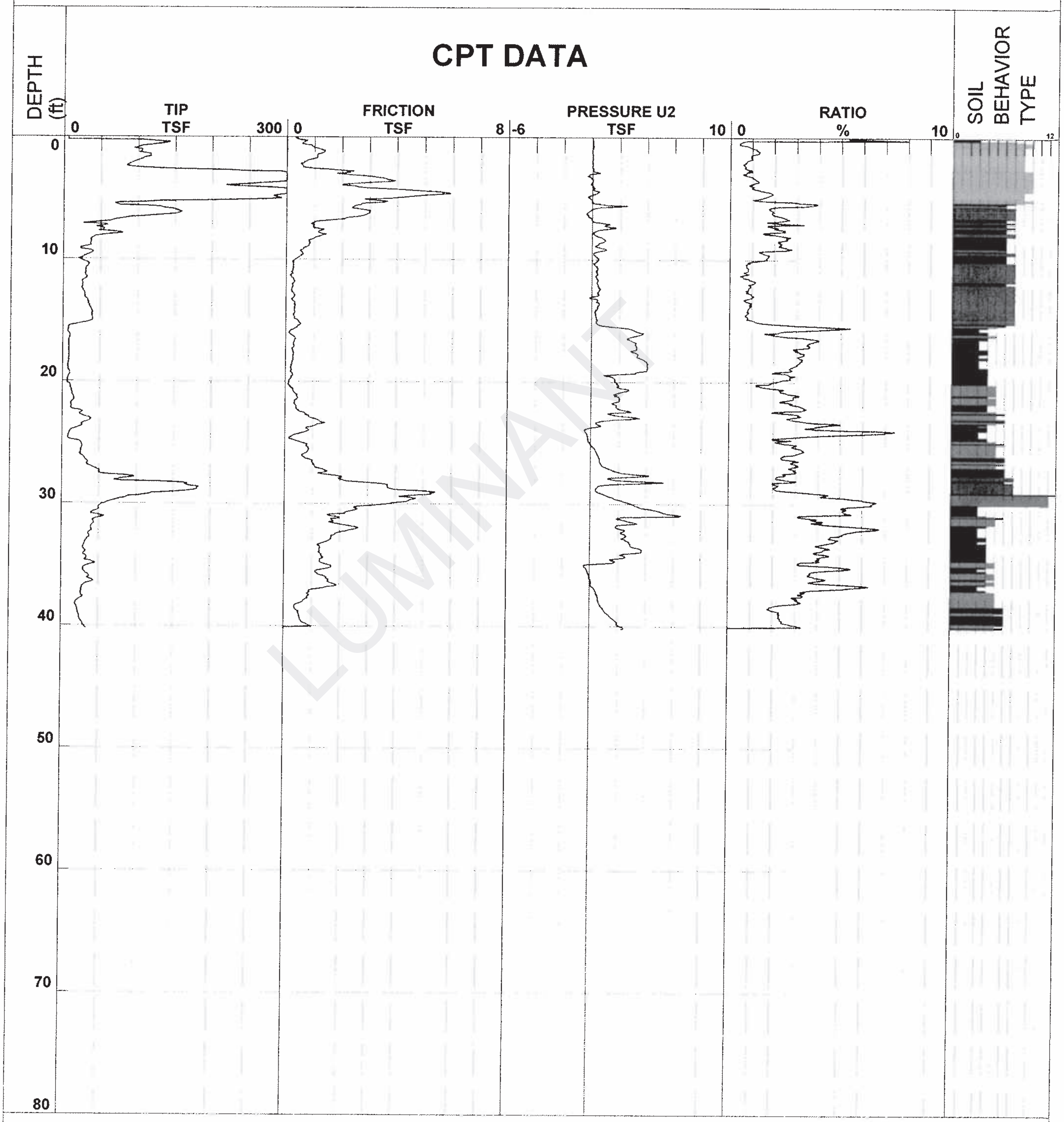
CPT Data

FUGRO

Job Number 04.1908-0020 | CPT Number B-07 | Location Tatum-Tx

Operator GLENN JOHNSON | Date and T 16-Apr-2008 12:40:51 | Cone Number F7.5CKEW2/B 1866

Client | Elevation | Water Table



1 - sensitive fine grained | 4 - silty clay to clay | 7 - silty sand to sandy silt | 10 - gravelly sand to sand

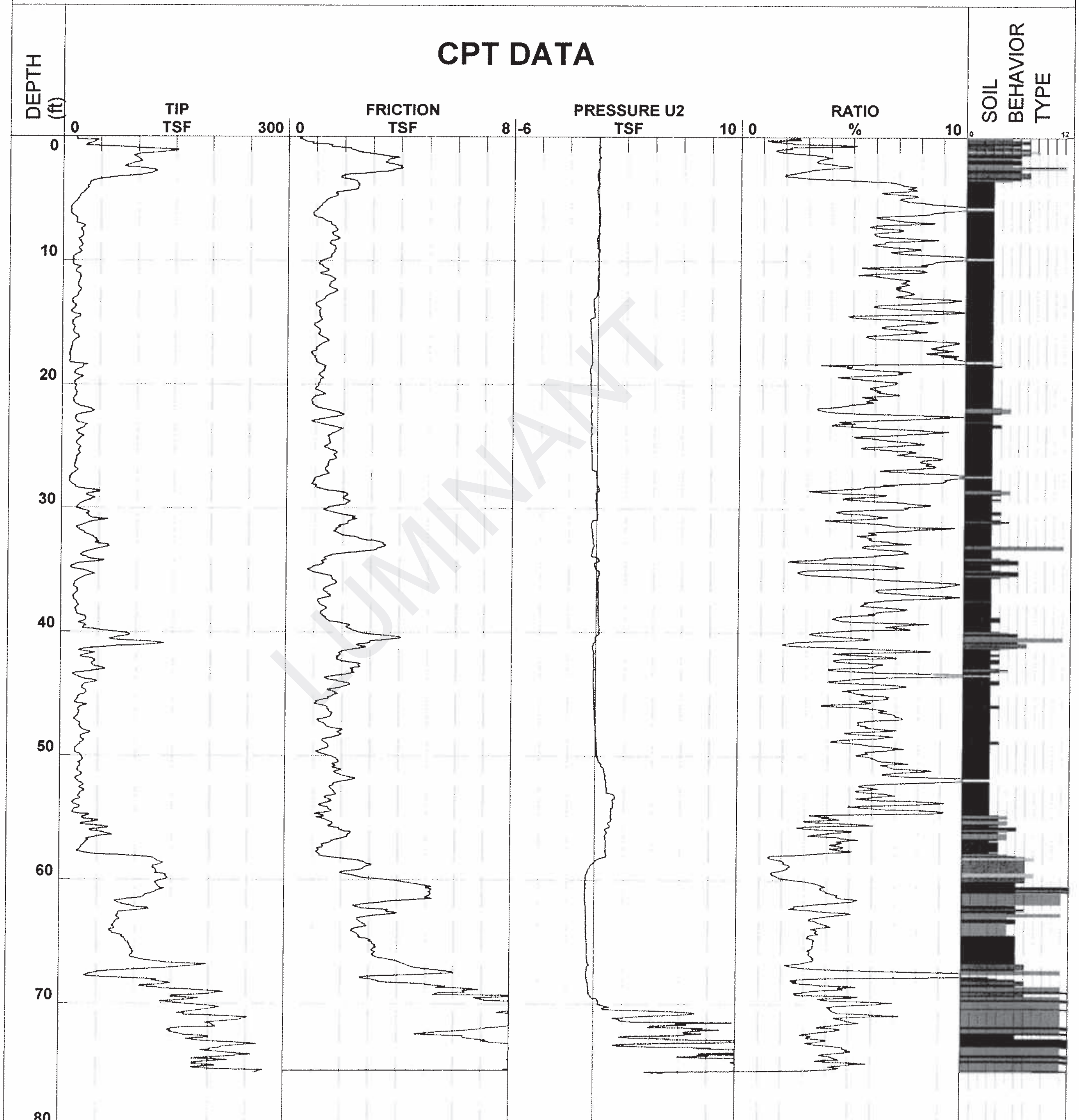
2 - organic material | 5 - clayey silt to silty clay | 8 - sand to silty sand | 11 - very stiff fine grained (*)

3 - clay | 6 - sandy silt to clayey silt | 9 - sand | 12 - sand to clayey sand (*)

Robertson et al 1986 * Overconsolidated or Cemented

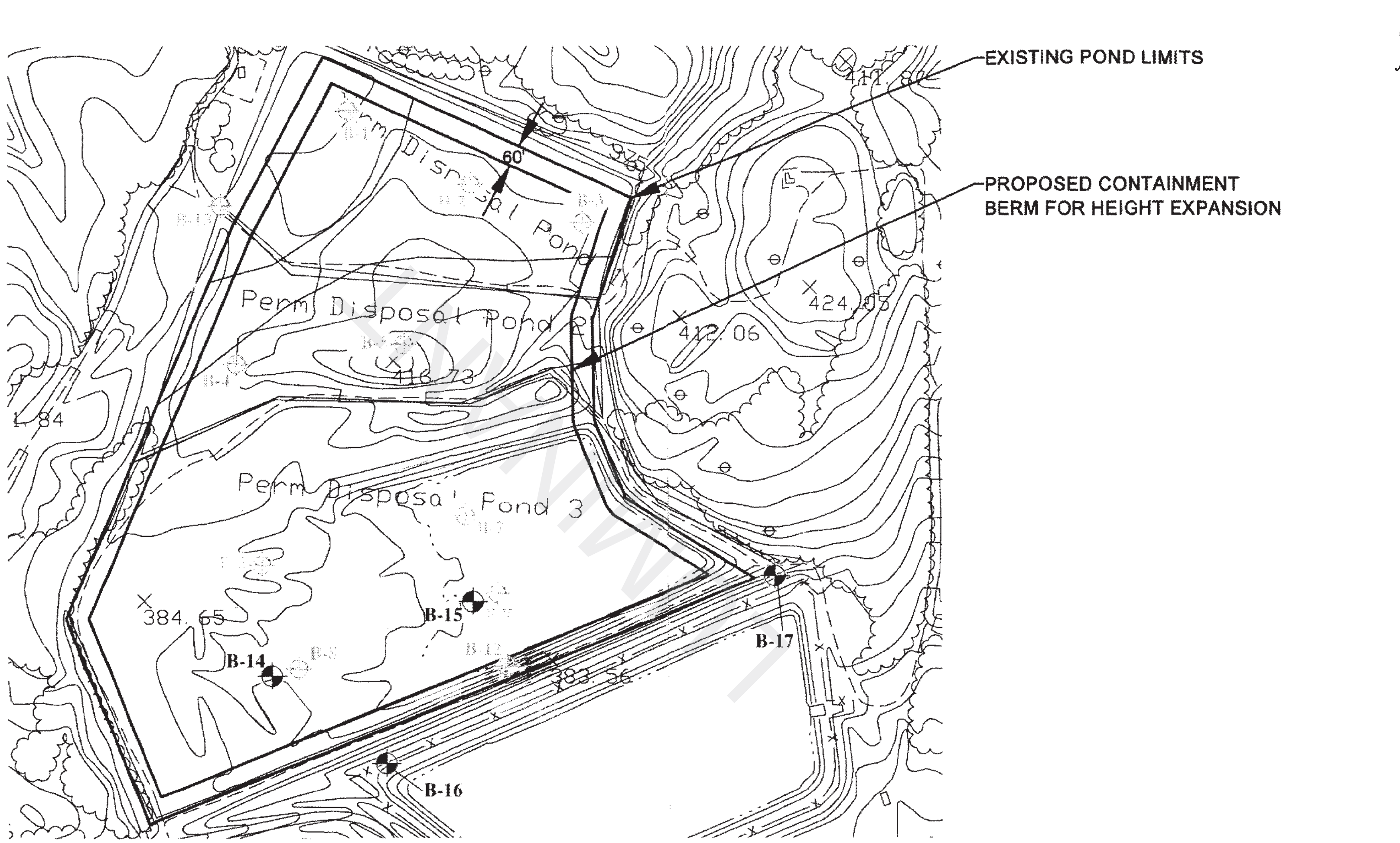
CPT Data

Job Number 04.1908-0020	CPT Number B-12	Location Tatum-Tx
Operator GLENN JOHNSON	Date and T 16-Apr-2008 10:58:47	Cone Number F7.5CKEW2/B 1866
Client	Elevation	Water Table



1 - sensitive fine grained	4 - silty clay to clay	7 - silty sand to sandy silt	10 - gravelly sand to sand
2 - organic material	5 - clayey silt to silty clay	8 - sand to silty sand	11 - very stiff fine grained (*)
3 - clay	6 - sandy silt to clayey silt	9 - sand	12 - sand to clayey sand (*)

(*) Overconsolidated or Cemented



ETTL ENGINEERS & CONSULTANTS MAIN OFFICE 1717 East Erwin Tyler, Texas 75702 (903) 595-4421	LUMINANT MARTIN LAKE PDP 1-3 TATUM, TEXAS	PLATE 1 – PLAN OF BORINGS JOB No.: G 3219-09 DATE: MARCH 2008 SCALE: N.T.S.	APPROVED BY: DRAWN BY: K.C.R.

LOG OF BORING B-14

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3 Supplemental
Tatum, Texas

PROJECT NO.: G3219-09 **BORING TYPE:** Rotary Wash

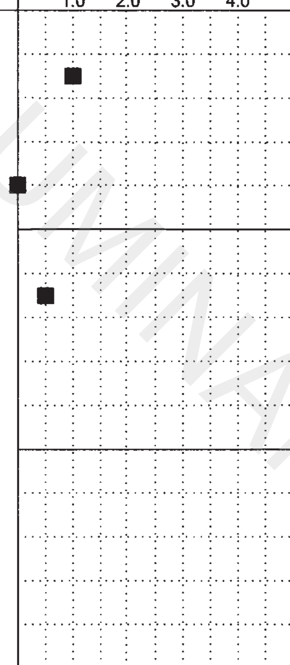
DATE 8/18/09

SURFACE ELEVATION

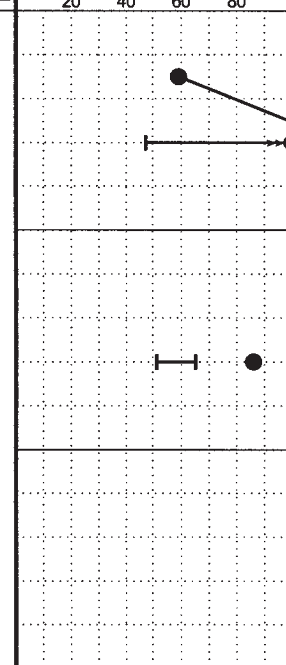
DEPTH (ft)	MATERIAL DESCRIPTION	MOISTURE CONTENT (%)	LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	ASH SEDIMENT black;						
	--dark gray; with silty clay	59				83	+40 Sieve=3%, +4 Sieve=0%
	--black; with sand	119	111	47	64	89	+40 Sieve=1%, +4 Sieve=0%
	--gray						
10							
	--black; with silt						
		86	65	51	14	95	+40 Sieve=1%, +4 Sieve=0%
20							
30	Bottom of Boring @ 30'						

Column headings: DEPTH (ft), SAMPLES, USC, GEOLOGIC UNIT, WATER LEVEL, MATERIAL DESCRIPTION, FIELD STRENGTH DATA, DRY DENSITY (pcf), COMPRESSIVE STRENGTH (tsf), FAILURE STRAIN (%), CONFINING PRESSURE (psi), MOISTURE CONTENT (%), ATTERBERG LIMITS(%): LIQUID LIMIT (LL), PLASTIC LIMIT (PL), PLASTICITY INDEX (PI), MINUS #200 SIEVE (%), OTHER TESTS PERFORMED (Page Ref. #)

● BLOW COUNT ● 20 40 60 80
▲ Qu (tsf) ▲ 1 2 3 4
■ PPR (tsf) ■ 1.0 2.0 3.0 4.0
◆ Torvane (tsf) ◆ 1.0 2.0 3.0 4.0



Natural Moisture Content and Atterberg Limits
Plastic Limit — Moisture Content — Liquid Limit
20 40 60 80



Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 5' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32° 15.549', W 94°34.971'

LOG OF BORING B-15

ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3 Supplemental
Tatum, Texas

PROJECT NO.: G3219-09 **BORING TYPE:** Rotary Wash

DATE 8/18/09

SURFACE ELEVATION

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	LEAN CLAY(CL) tan, gray, and red											
		ASH SEDIMENT gray	N=16										
		--no recovery	N=10										
		--black; with clay and silt	N=22										
		ASH SEDIMENT gray; with sand; laminated						42				47	+40 Sieve=9%, +4 Sieve=1%
		--with silt	N=2										
10													
		--with sand	N=1					79				95	+40 Sieve=2%, +4 Sieve=0%
		--full recovery											
20													
		--no recovery											
		--black	N=9										
		--black and gray	N=1					54				85	+40 Sieve=7%, +4 Sieve=3%
30		Bottom of Boring @ 30'											

BLOW COUNT: 20 40 60 80
Qu (tsf): 1 2 3 4
PPR (tsf): 1.0 2.0 3.0 4.0
Torvane (tsf): 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits
Plastic Limit — Moisture Content — Liquid Limit
20 40 60 80

ATTERBERG LIMITS(%): LIQUID LIMIT (LL), PLASTIC LIMIT (PL), PLASTICITY INDEX (PI)

Water Level Est.: ▽ Measured: ▼ Perched: ▼
Water Observations: Seepage @ 5' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32° 15.556', W 94°34.913'

LOG OF BORING B-16

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

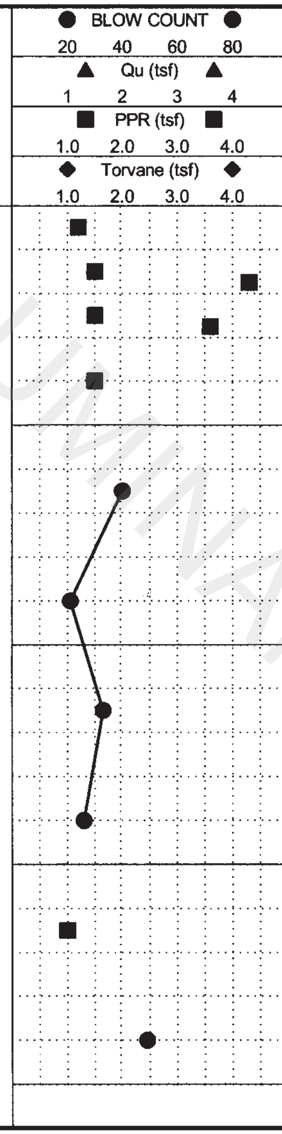
PROJECT: Luminant Martin Lake PDP 1-3 Supplemental
Tatum, Texas

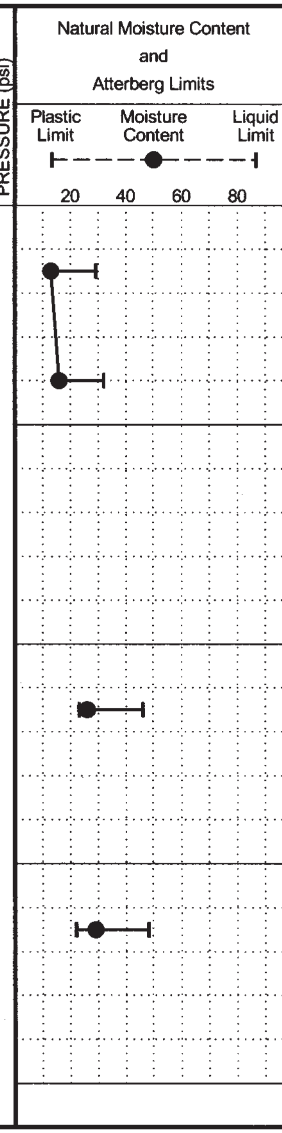
PROJECT NO.: G3219-09 **BORING TYPE:** Rotary Wash

DATE 8/18/09

SURFACE ELEVATION

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) orange and tan	P=1.2										
		--tan and gray	P=1.5 P=4.3					13	29	14	15	34	+40 Sieve=1%, +4 Sieve=0%
		--orange and tan	P=1.25 P=3.6										
	SC	CLAYEY SAND(SC) gray and orange	P=1.5					16	32	16	16	37	+40 Sieve=0%, +4 Sieve=0%
10													
			N=40										
	ML	SANDY CLAYEY SILT(ML) orange and light gray	N=21										
20	CL	LEAN CLAY(CL) gray and reddish tan											
			N=33					26	46	23	23	82	+40 Sieve=4%, +4 Sieve=1%
		--orange and tan; with trace of lignite	N=26										
30													
	SC	CLAYEY SAND(SC) tan and brown	P=1.0					29	48	22	26	85	+40 Sieve=5%, +4 Sieve=0%
	SP	SAND(SP) gray	N=49										
40		Bottom of Boring @ 40'											





Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations:

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32° 15.484', W 94°34.965'

LOG OF BORING B-17

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

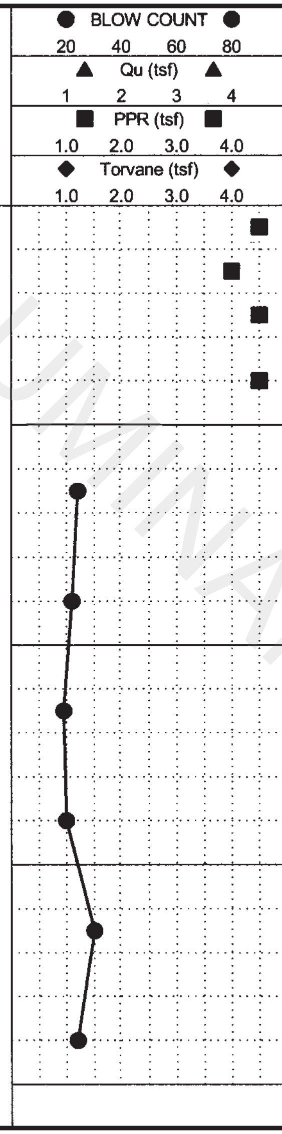
PROJECT: Luminant Martin Lake PDP 1-3 Supplemental
Tatum, Texas

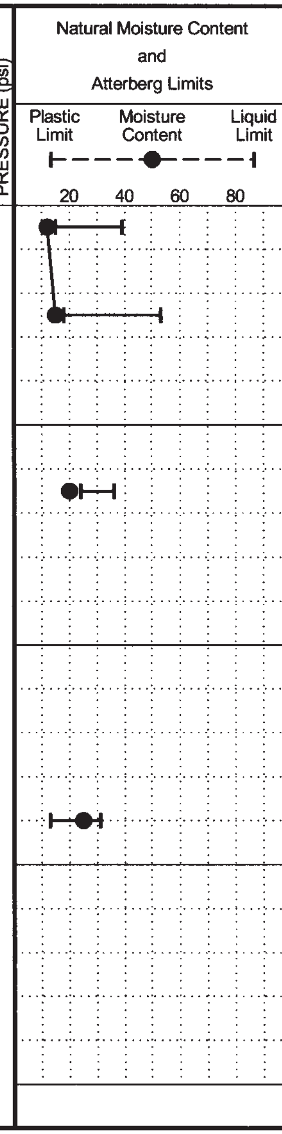
PROJECT NO.: G3219-09 **BORING TYPE:** Rotary Wash

DATE 8/18/09

SURFACE ELEVATION

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) orange and tan	P=4.5+					12	39	15	24	60	+40 Sieve=7%, +4 Sieve=4%
		--orange and brown	P=4.0										
		--red, tan, and yellow	P=4.5					15	53	18	35	51	+40 Sieve=7%, +4 Sieve=1%
		--tan and gray	P=4.5+										
10	SC	CLAYEY SAND(SC) tan	N=40					20	36	24	12	52	+40 Sieve=0%, +4 Sieve=0%
		--tan and brown	N=22										
20		--tan and gray; laminated	N=19										
		--gray and orange	N=20					25	31	13	18	39	+40 Sieve=0%, +4 Sieve=0%
30		--tan	N=30										
		--tan and orange	N=24										
40		Bottom of Boring @ 40'											





Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Bailed to 20' and open upon completion.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32° 15.566', W 94°34.736'

APPENDIX B

LABORATORY TEST RESULTS

BOTTOM ASH PONDS AND SCRUBBER POND

Golder Associates
500 Century Plaza Drive, Suite 190
Houston, Texas 77073
Telephone: (281) 821-6868
Fax: (281) 821-6870

SUMMARY OF LABORATORY RESULTS

CLIENT Luminant **PROJECT NAME** Pond Slope Stability

PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
BH-201	0.0							19.2			
BH-201	2.0							13.7			
BH-201	6.0	26	14	12				9.4			
BH-201	8.0							15.1			
BH-201	13.0							16.3			
BH-201	18.0							20.8			
BH-201	23.0	36	14	22				19.9			
BH-201	28.0							18.2			
BH-201	33.0							15.0			
BH-201	38.0				0.85	40		14.9			
BH-201	43.0							21.4			
BH-201	48.0							23.5			
BH-202	0.0							20.8			
BH-202	2.0	55	19	36				17.1			
BH-202	4.0							20.5			
BH-202	6.0							26.7			
BH-202	8.0							15.3			
BH-202	13.0							14.9			
BH-202	18.0	29	13	16				17.1			
BH-202	23.0							17.6			
BH-202	28.0				0.85	49		18.1			
BH-202	33.0							17.0			
BH-202	38.0							20.8			
BH-202	43.0							23.0			
BH-202	48.0							26.2			
BH-203	0.0							12.6			
BH-203	2.0							14.6			
BH-203	4.0							16.1			
BH-203	6.0	50	19	31				21.5			
BH-203	8.0							22.3			
BH-203	13.0							18.0			
BH-203	18.0							14.6			
BH-203	23.0							17.3			
BH-203	25.0							19.9			
BH-203	28.0				2	17		23.6			
BH-203	30.0							27.7			
BH-203	33.0							29.1			
BH-203	38.0							29.4			
BH-204	0.0							13.9			
BH-204	2.0							21.1			
BH-204	4.0							15.0			
BH-204	6.0							16.6			
BH-204	8.0							13.5			

Golder Associates
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Houston, Texas 77073
Telephone: (281) 821-6868
Fax: (281) 821-6870

SUMMARY OF LABORATORY RESULTS

CLIENT Luminant **PROJECT NAME** Pond Slope Stability

PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
BH-204	28.0				4.75	58		19.1			
BH-204	33.0							13.8			
BH-204	38.0							21.0			
BH-204	43.0	51	20	31				26.6			
BH-204	48.0							23.8			
BH-205	0.0							17.5			
BH-205	2.0							15.6			
BH-205	4.0							15.5			
BH-205	6.0							20.7			
BH-205	8.0							17.4			
BH-205	13.0	47	15	32				23.0			
BH-205	18.0							22.9			
BH-205	23.0	28	17	11				16.3			
BH-205	28.0				4.75	69		16.4			
BH-205	33.0							14.7			
BH-205	38.0							25.4			
BH-205	43.0							26.7			
BH-205	48.0							25.0			
BH-205	53.0				9.5	11		25.9			
BH-206	0.0							17.1			
BH-206	2.0	44	15	29				15.6			
BH-206	4.0							14.0			
BH-206	6.0							16.2			
BH-206	8.0							21.7			
BH-206	13.0							18.1			
BH-206	18.0							12.2			
BH-206	23.0							15.9			
BH-206	28.0	59	17	42				20.3			
BH-206	33.0							19.8			
BH-206	38.0							18.2			
BH-206	43.0							22.1			
BH-206	48.0							23.3			
BH-206	53.0							23.0			
BH-206	58.0							22.1			
BH-207	0.0							15.6			
BH-207	2.0							15.3			
BH-207	4.0							14.9			
BH-207	6.0							18.2			
BH-207	13.0							18.9			
BH-207	18.0							13.0			
BH-207	23.0							16.9			
BH-207	28.0	31	16	15				16.7			
BH-207	33.0							17.4			

Golder Associates
500 Century Plaza Drive, Suite 190
Houston, Texas 77073
Telephone: (281) 821-6868
Fax: (281) 821-6870

SUMMARY OF LABORATORY RESULTS

CLIENT Luminant **PROJECT NAME** Pond Slope Stability
PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
BH-207	38.0							19.0			
BH-207	43.0							21.8			
BH-207	48.0							22.2			
BH-207	53.0							25.2			
BH-207	58.0							29.8			
BH-208	0.0							20.2			
BH-208	2.0							16.2			
BH-208	4.0							12.9			
BH-208	6.0							11.5			
BH-208	8.0	28	15	13				15.2			
BH-208	13.0							15.9			
BH-208	18.0							20.2			
BH-208	23.0							18.0			
BH-208	28.0							21.3			
BH-208	33.0							18.1			
BH-208	38.0							19.1			
BH-208	43.0							23.7			
BH-208	48.0				4.75	11		24.5			
BH-208	53.0							27.1			
BH-208	58.0							26.1			
BH-209	0.0							9.0			
BH-209	2.0							11.8			
BH-209	4.0	62	21	41				11.8			
BH-209	6.0							12.1			
BH-209	8.0							19.2			
BH-209	13.0							12.3			
BH-209	18.0							21.0			
BH-209	28.0	41	15	26				23.3			
BH-209	33.0							20.0			
BH-209	35.0							21.2			
BH-209	38.0							17.9			
BH-209	43.0							24.0			
BH-209	48.0							21.2			
BH-210	0.0							8.2			
BH-210	2.0							10.7			
BH-210	4.0							13.4			
BH-210	6.0							14.4			
BH-210	8.0							15.7			
BH-210	13.0							21.3			
BH-210	18.0	36	14	22				22.9			
BH-210	23.0							25.0			
BH-210	28.0							18.5			
BH-210	33.0							19.3			

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Telephone: (281) 821-6868
Fax: (281) 821-6870

SUMMARY OF LABORATORY RESULTS

CLIENT Luminant **PROJECT NAME** Pond Slope Stability

PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
BH-210	38.0							17.2			
BH-210	43.0							25.6			
BH-210	48.0				9.5	33		33.4			
BH-210	53.0							29.3			
BH-210	58.0							29.3			
BH-210	63.0							26.6			
BH-210	68.0							31.1			
BH-211	0.0							8.7			
BH-211	2.0							13.3			
BH-211	4.0							15.0			
BH-211	6.0							14.5			
BH-211	8.0							13.2			
BH-211	13.0							17.6			
BH-211	18.0	50	17	33				15.0			
BH-211	23.0							11.6			
BH-211	28.0				9.5	52		11.6			
BH-211	33.0							22.5			
BH-211	38.0							21.1			
BH-211	43.0							24.3			
BH-211	48.0							24.3			
BH-211	53.0							24.9			
BH-211	58.0							22.9			
BH-211	63.0							29.5			
BH-211	68.0							26.6			

Golder Associates
500 Century Plaza Drive, Suite 190
Houston, Texas 77073
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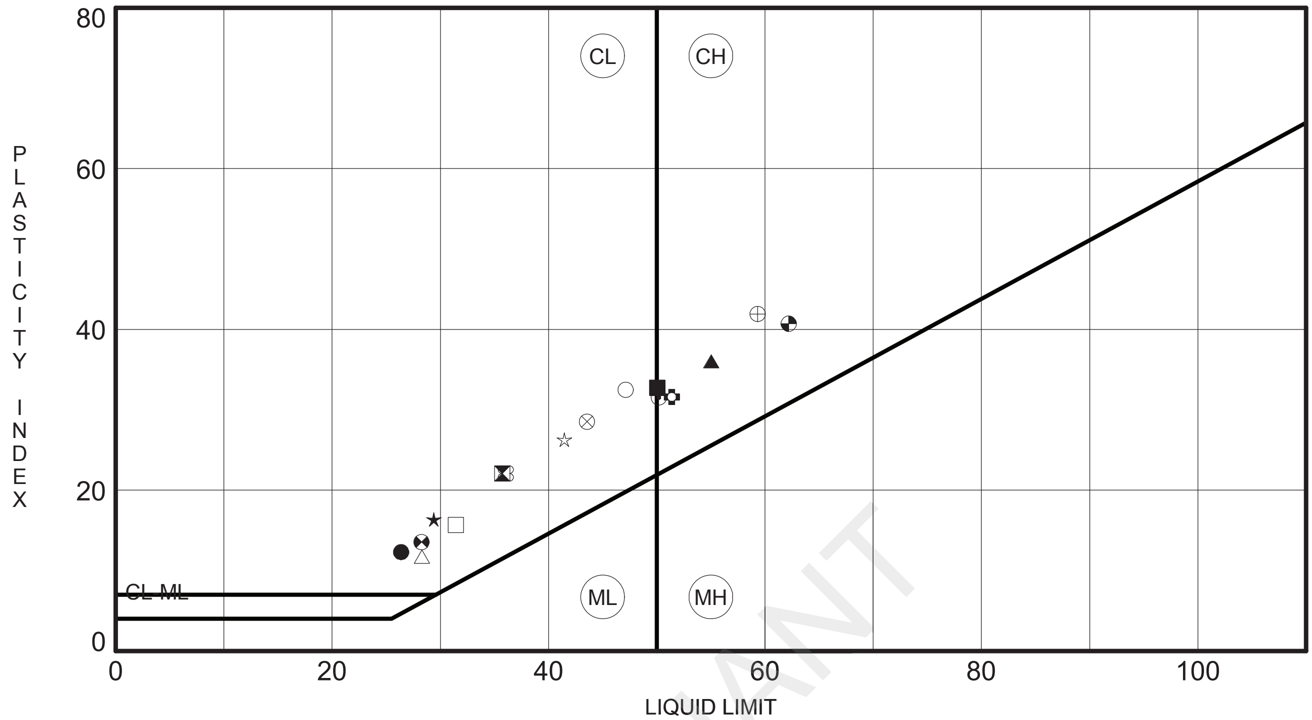
Fax: (281) 821-6870

ATTERBERG LIMITS' RESULTS

CLIENT Luminant **PROJECT NAME** Pond Slope Stability

PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**BH-201**	**6.0**	**26**	**14**	**12**		
⧗	**BH-201**	**23.0**	**36**	**14**	**22**		
▲	**BH-202**	**2.0**	**55**	**19**	**36**		
★	**BH-202**	**18.0**	**29**	**13**	**16**		
⊙	**BH-203**	**6.0**	**50**	**19**	**31**		
✿	**BH-204**	**43.0**	**51**	**20**	**31**		
○	**BH-205**	**13.0**	**47**	**15**	**32**		
△	**BH-205**	**23.0**	**28**	**17**	**11**		
⊗	**BH-206**	**2.0**	**44**	**15**	**29**		
⊕	**BH-206**	**28.0**	**59**	**17**	**42**		
□	**BH-207**	**28.0**	**31**	**16**	**15**		
⊗	**BH-208**	**8.0**	**28**	**15**	**13**		
◕	**BH-209**	**4.0**	**62**	**21**	**41**		
☆	**BH-209**	**28.0**	**41**	**15**	**26**		
⌘	**BH-210**	**18.0**	**36**	**14**	**22**		
■	**BH-211**	**18.0**	**50**	**17**	**33**		

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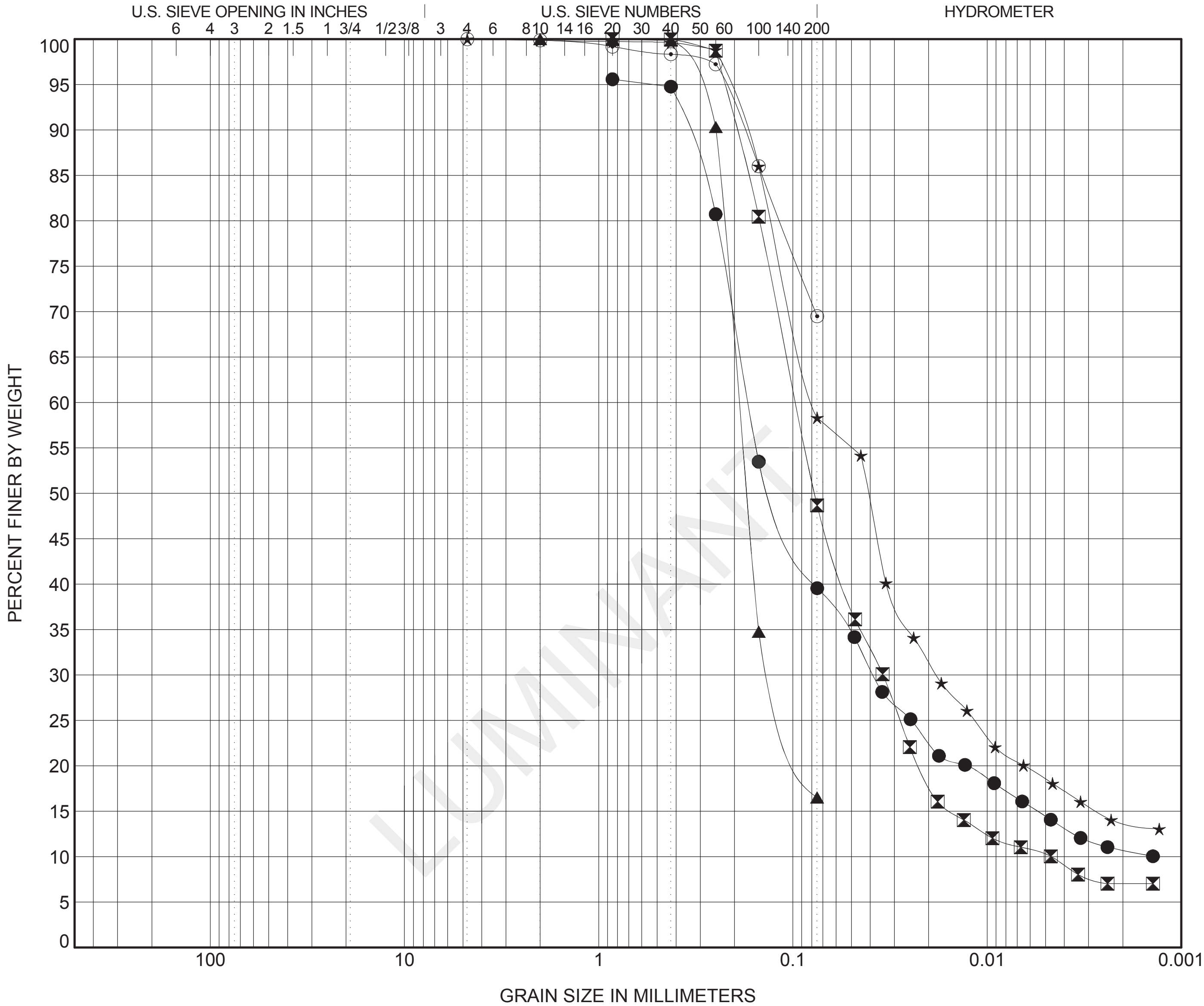
GRAIN SIZE DISTRIBUTION

CLIENT Luminant **PROJECT NAME** Pond Slope Stability

PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**BH-201**	**38**						
⧗	**BH-202**	**28**					**2.63**	**20.54**
▲	**BH-203**	**28**						
★	**BH-204**	**28**						
⊙	**BH-205**	**28**						

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH-201**	**38**	**0.85**	**0.169**	**0.038**			**56.0**	**25.1**	**14.4**
⧗	**BH-202**	**28**	**0.85**	**0.096**	**0.034**	**0.005**	**0.0**	**51.3**	**38.4**	**10.2**
▲	**BH-203**	**28**	**2**	**0.189**	**0.125**		**0.0**	**83.5**	**16.5**	
★	**BH-204**	**28**	**4.75**	**0.078**	**0.018**		**0.0**	**41.7**	**39.8**	**18.5**
⊙	**BH-205**	**28**	**4.75**				**0.0**	**30.5**	**69.5**	

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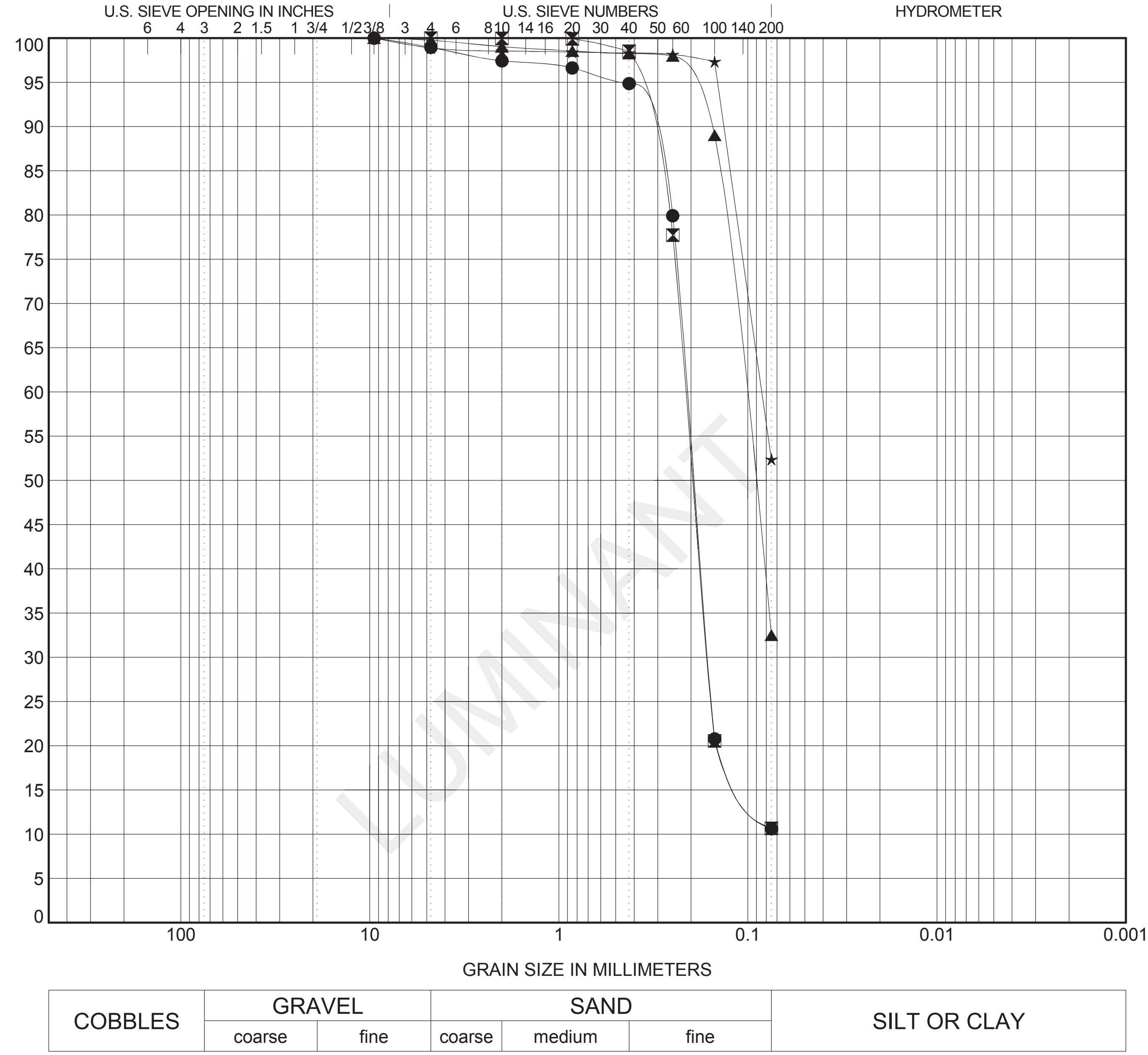
GRAIN SIZE DISTRIBUTION

CLIENT Luminant **PROJECT NAME** Pond Slope Stability

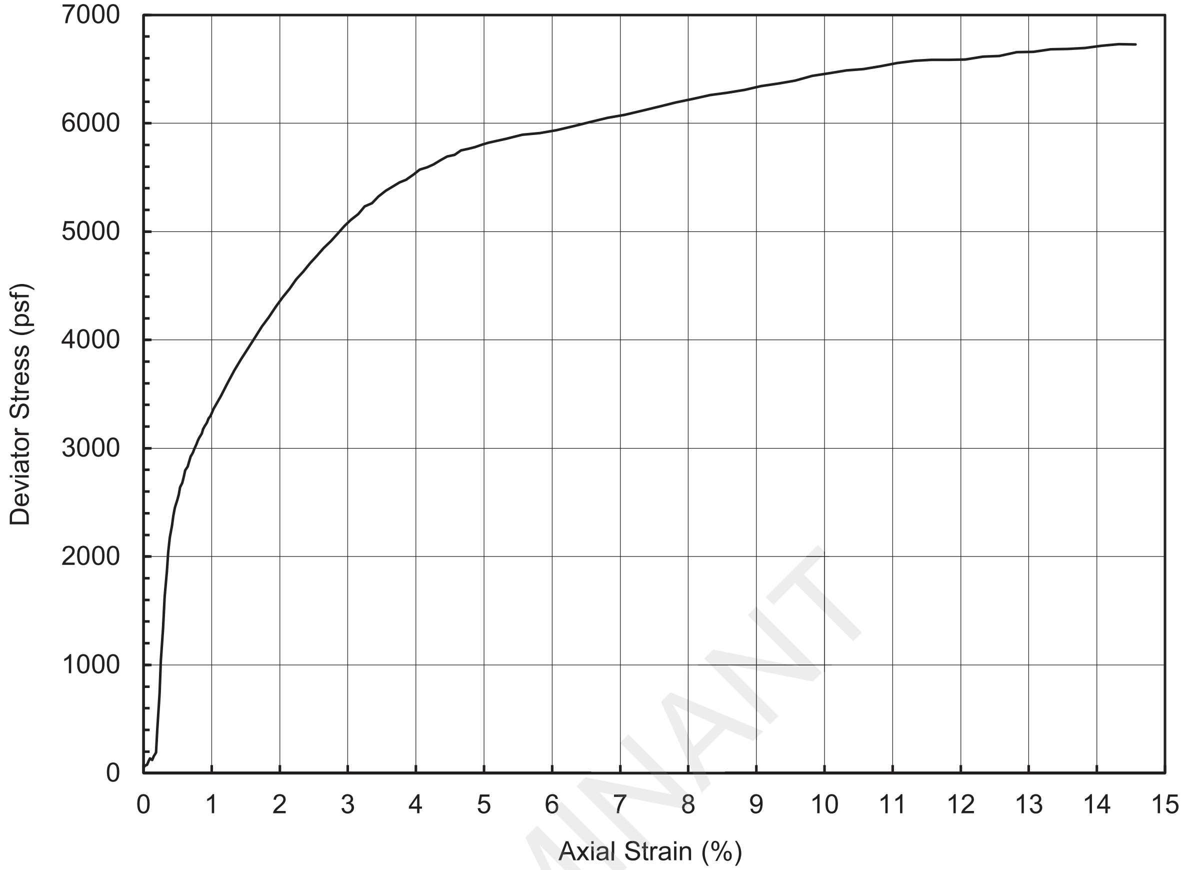
PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake



BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
● BH-205	53					1.74	2.93
⧗ BH-208	48					1.75	2.98
▲ BH-210	48						
★ BH-211	28						

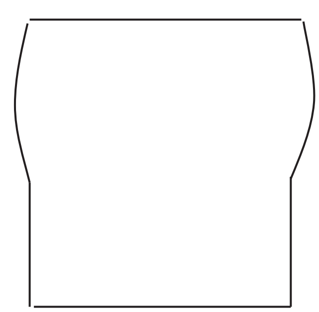
BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● BH-205	53	9.5	0.21	0.162		1.1	88.3	10.6	
⧗ BH-208	48	4.75	0.213	0.163		0.0	89.3	10.7	
▲ BH-210	48	9.5	0.105			0.2	67.2	32.5	
★ BH-211	28	9.5	0.084			1.1	46.5	52.4	

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Reddish Yellow Clay (visual classification)						
LL		PI		LI		USCS	

Depth (ft)	4.0	Confining Pressure (psf)	617
Specimen Height (inch)	6.0	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	6732
Initial Specimen Weight (g)	1263.7	Axial Strain at Peak Stress (%)	14.3
Moist Unit Weight (pcf)	131.9		
Initial Water Content (%)	15		
Initial Dry Unit Weight (pcf)	114.6		



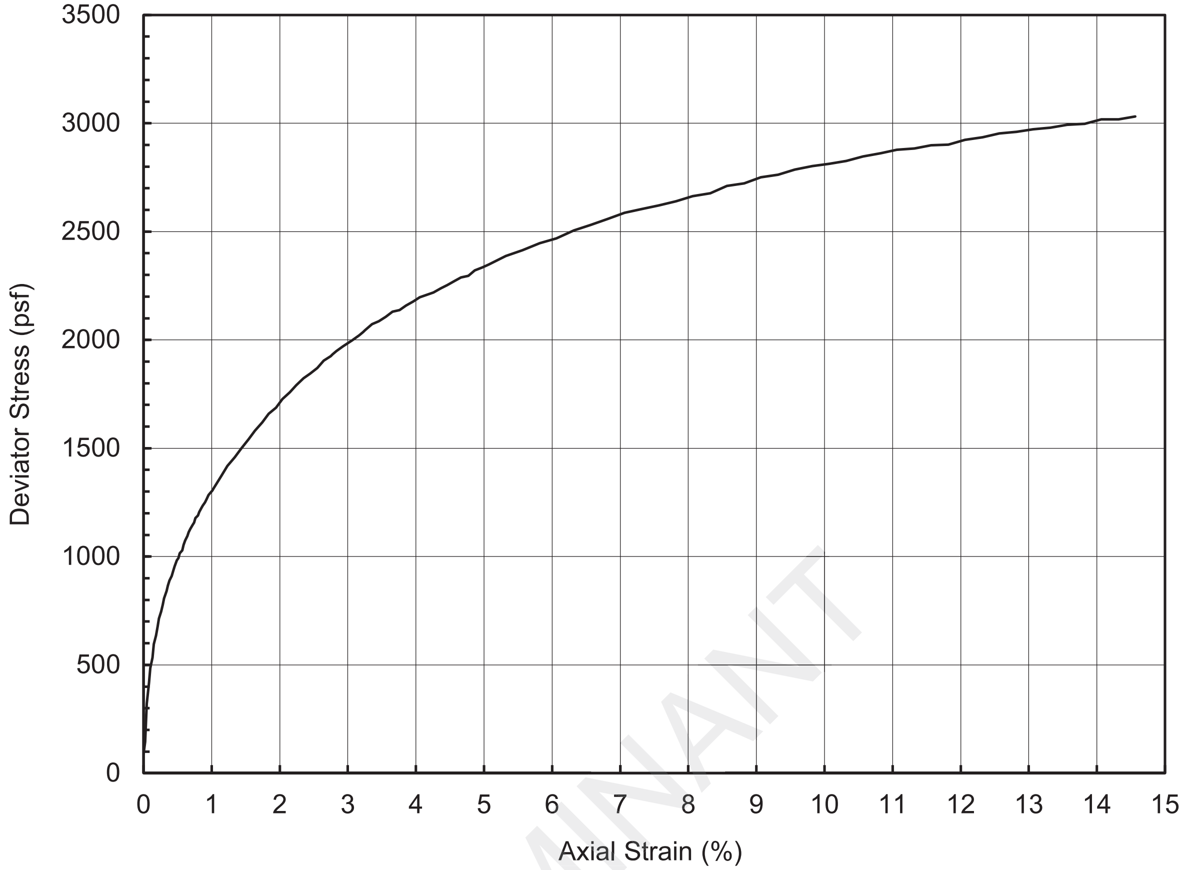
Failure Sketch

Project Title	Luminant - Martin Lake Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-201 TO-3
Comments	

Golder Associates

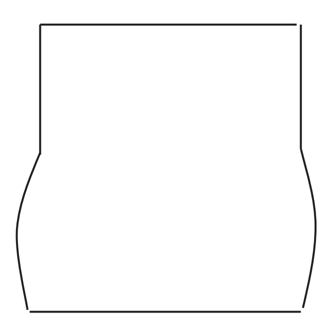
Performed by	PN
Date	12-Nov-12
Check	HR
Review	SBK

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Reddish Yellow Clay (visual classification)						
LL		PI		LI		USCS	

Depth (ft)	18.0	Confining Pressure (psf)	2371
Specimen Height (inch)	5.9	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	3035
Initial Specimen Weight (g)	1232.8	Axial Strain at Peak Stress (%)	14.8
Moist Unit Weight (pcf)	132.4		
Initial Water Content (%)	19		
Initial Dry Unit Weight (pcf)	111.7		



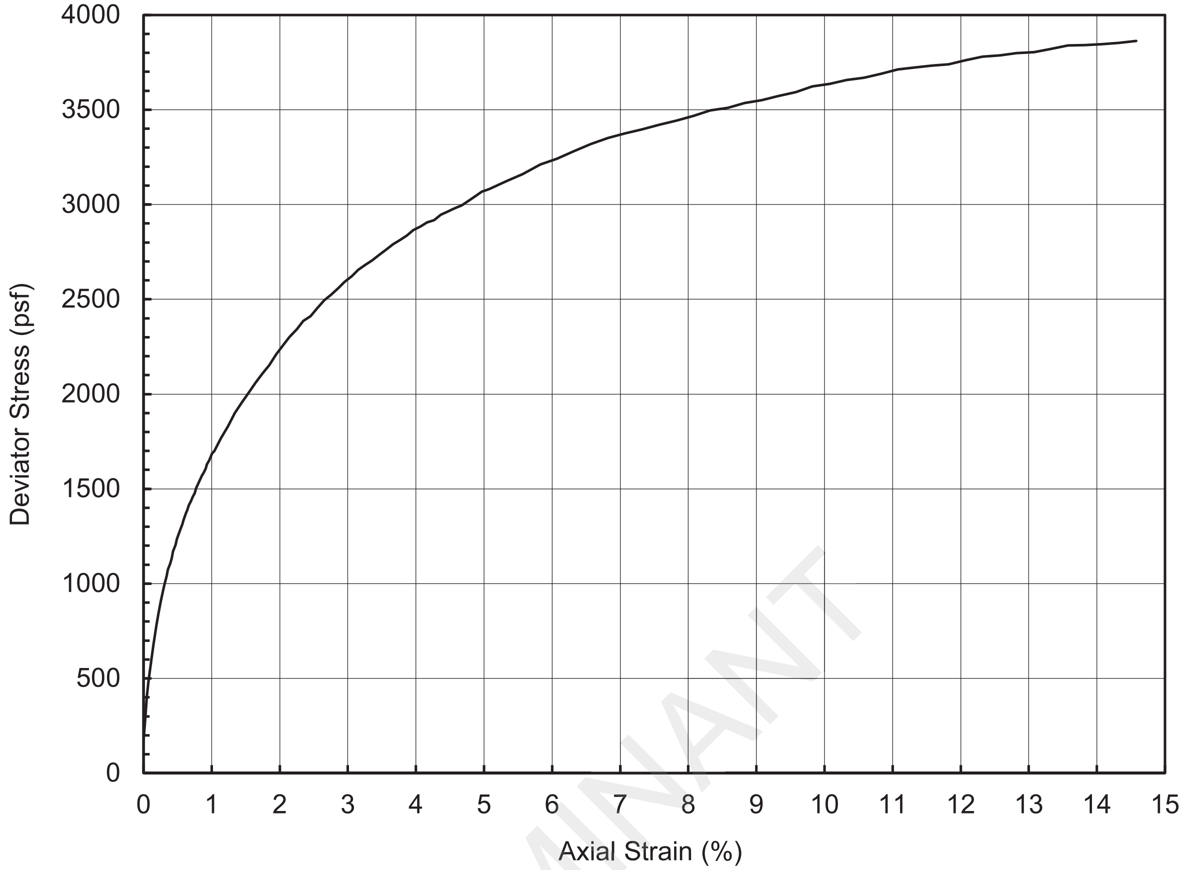
Failure Sketch

Project Title	Luminant - Martin Lake Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-202 TO-7
Comments	

Golder Associates

Performed by	**PN**
Date	**13-Nov-12**
Check	**HR**
Review	**SBK**

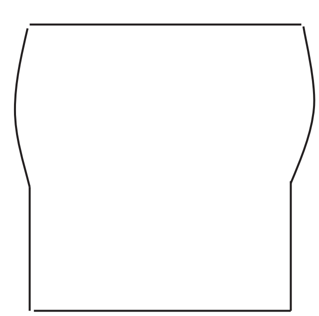
UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Reddish Gray Clay (visual classification)						
LL		PI		LI		USCS	

Depth (ft)	6.0	Confining Pressure (psf)	858
Specimen Height (inch)	6.0	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	3877
Initial Specimen Weight (g)	1199.6	Axial Strain at Peak Stress (%)	14.8
Moist Unit Weight (pcf)	124.7		
Initial Water Content (%)	21		
Initial Dry Unit Weight (pcf)	102.7		

Project Title	Luminant - Martin Lake Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-203 TO-4
Comments	

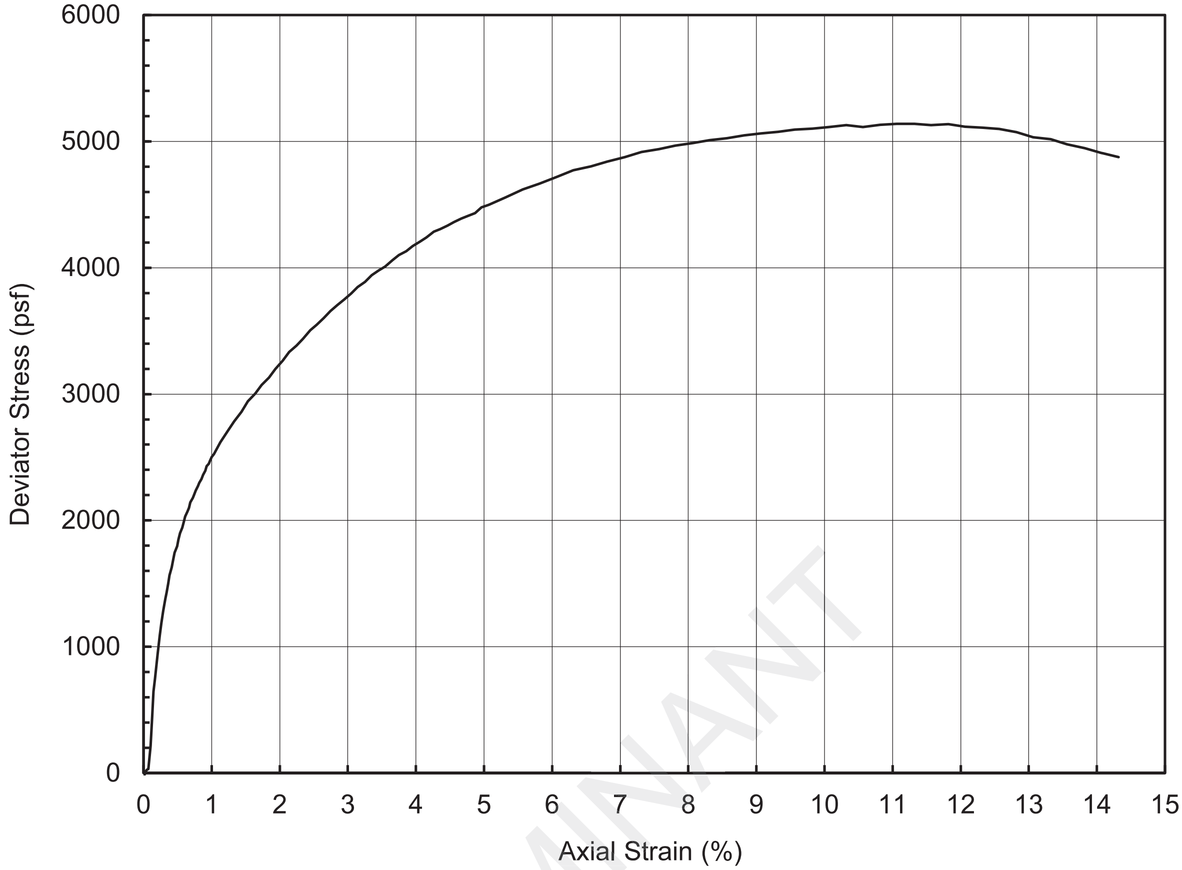


Failure Sketch

Golder Associates

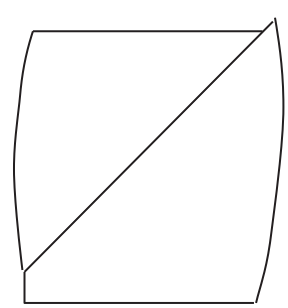
Performed by	**PN**
Date	**13-Nov-12**
Check	**HR**
Review	**SBK**

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Reddish Gray Clay (visual classification)						
LL		PI		LI		USCS	

Depth (ft)	23.0	Confining Pressure (psf)	3008
Specimen Height (inch)	6.0	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	5139
Initial Specimen Weight (g)	1192.8	Axial Strain at Peak Stress (%)	11.3
Moist Unit Weight (pcf)	126.6		
Initial Water Content (%)	26		
Initial Dry Unit Weight (pcf)	100.9		



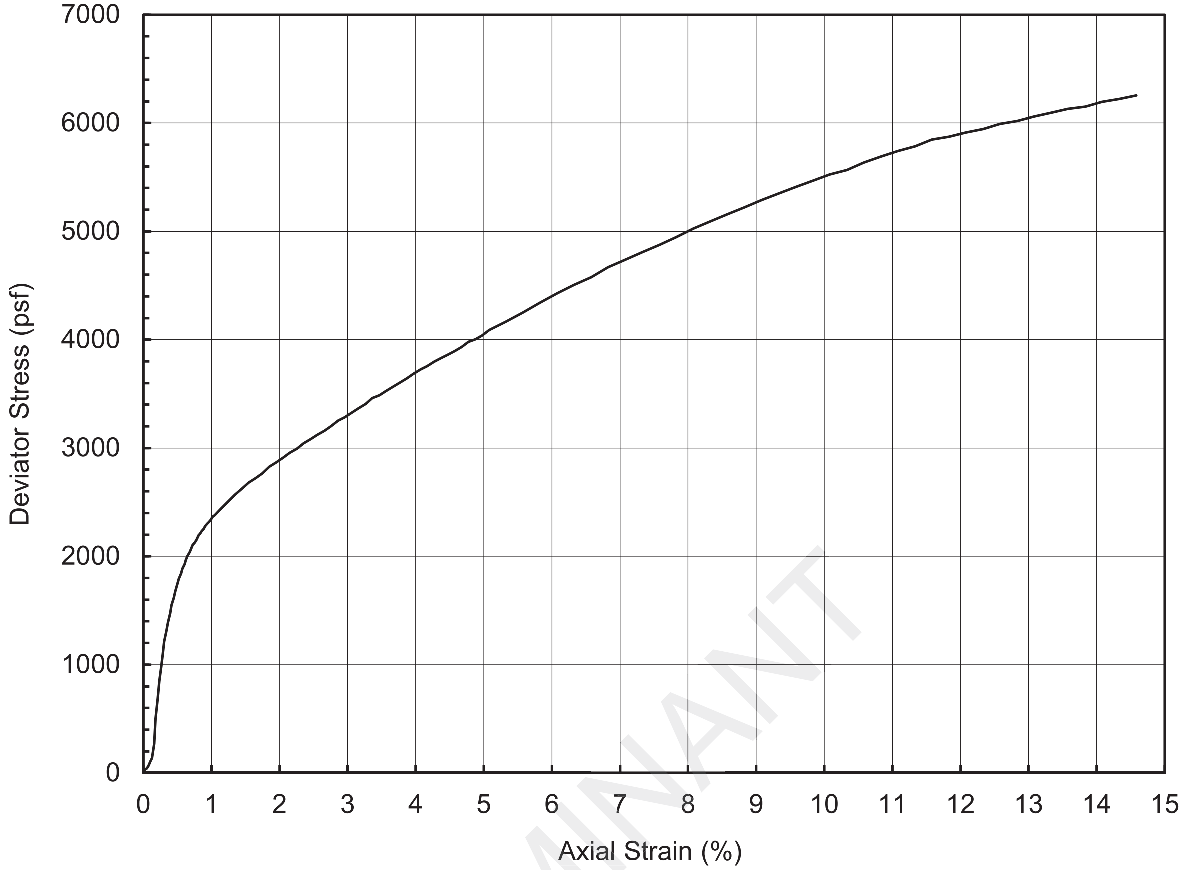
Failure Sketch

Project Title	Luminant - Martin Lake Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-204 TO-8
Comments	

Golder Associates

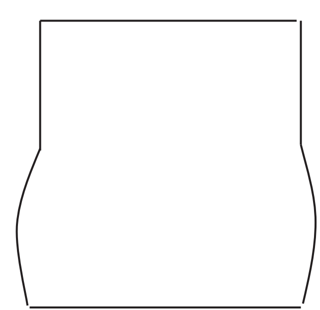
Performed by	**PN**
Date	**13-Nov-12**
Check	**HR**
Review	**SBK**

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Reddish Yellow Clay (visual classification)						
LL		PI		LI		USCS	

Depth (ft)	13.0	Confining Pressure (psf)	1760
Specimen Height (inch)	5.9	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	6270
Initial Specimen Weight (g)	1252.5	Axial Strain at Peak Stress (%)	14.8
Moist Unit Weight (pcf)	131.9		
Initial Water Content (%)	27		
Initial Dry Unit Weight (pcf)	104.1		



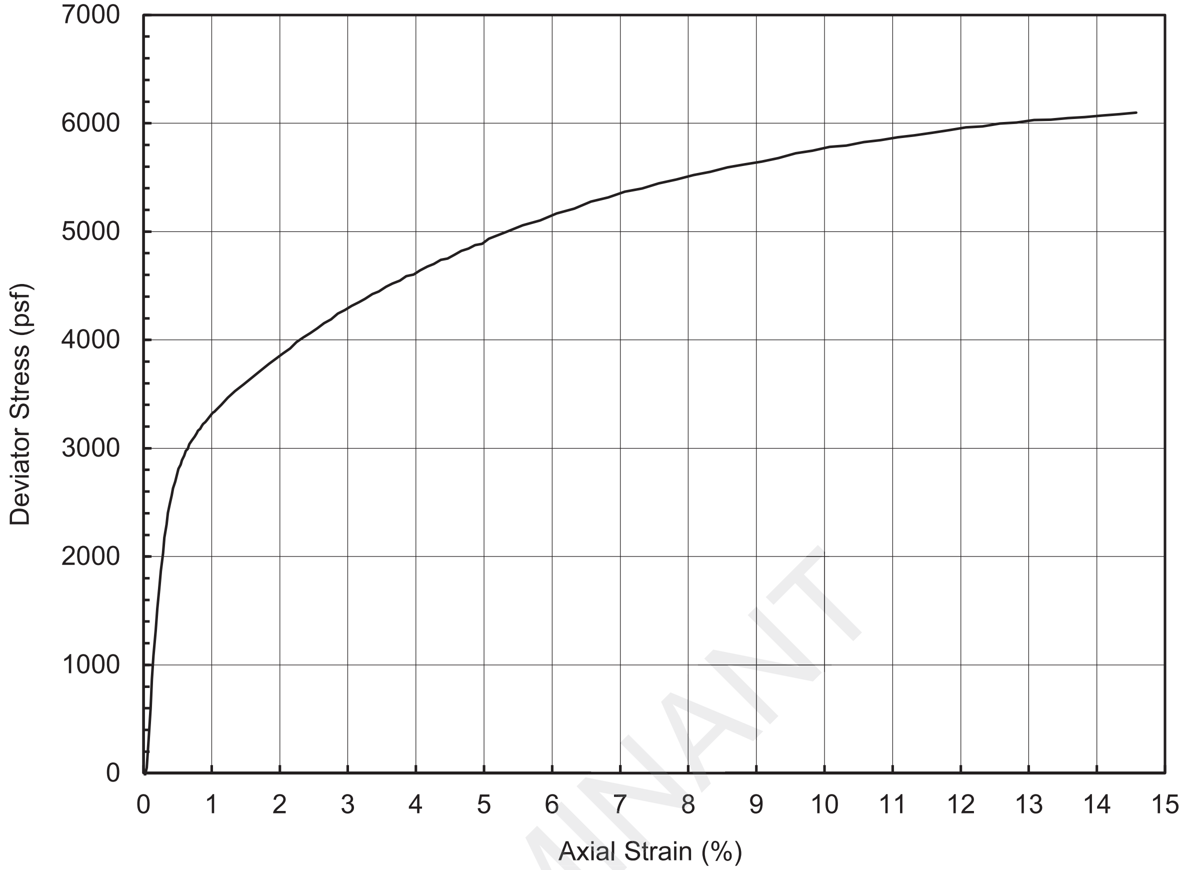
Failure Sketch

Project Title	Luminant - Martin Lake Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-205 TO-6
Comments	

Golder Associates

Performed by	**PN**
Date	**13-Nov-12**
Check	**HR**
Review	**SBK**

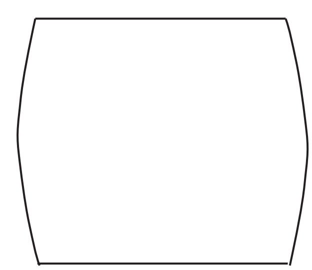
UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Grayish Brown Fat Clay						
LL	59	PI	42	LI	0.1	USCS	CH

Depth (ft)	28.0	Confining Pressure (psf)	3627
Specimen Height (inch)	5.9	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	6110
Initial Specimen Weight (g)	1219.7	Axial Strain at Peak Stress (%)	14.8
Moist Unit Weight (pcf)	127.5		
Initial Water Content (%)	20		
Initial Dry Unit Weight (pcf)	106.6		

Project Title	Luminant - Martin Lake Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-206 TO-9
Comments	

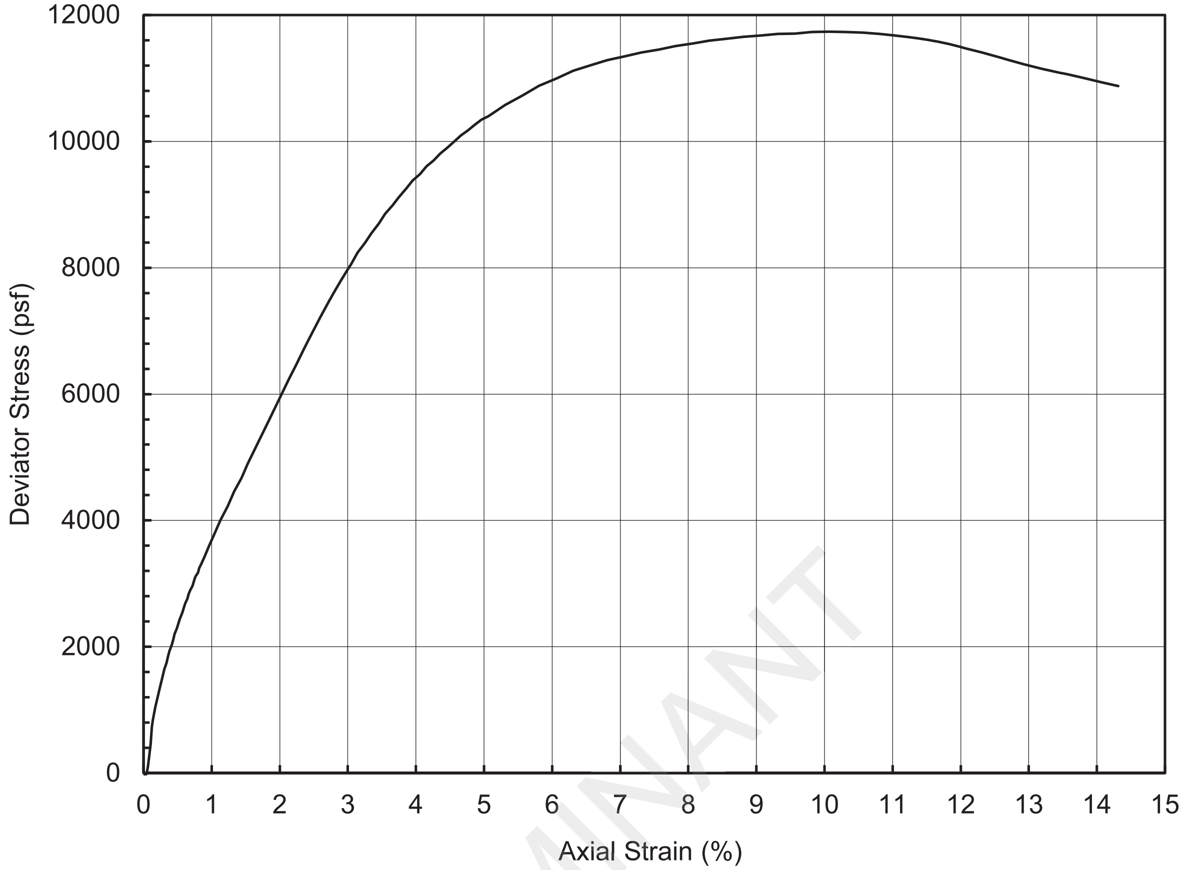


Failure Sketch

Golder Associates

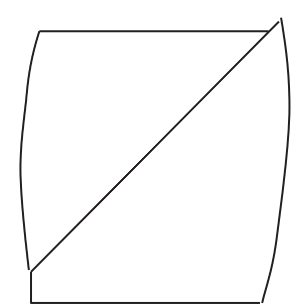
Performed by	**PN**
Date	**15-Nov-12**
Check	**HR**
Review	**JF**

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Grayish Brown Lean Clay						
LL	31	PI	15	LI	0.0	USCS	CL

Depth (ft)	28.0	Confining Pressure (psf)	3620
Specimen Height (inch)	5.9	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	11735
Initial Specimen Weight (g)	1251.9	Axial Strain at Peak Stress (%)	10.1
Moist Unit Weight (pcf)	127.7		
Initial Water Content (%)	16		
Initial Dry Unit Weight (pcf)	109.9		



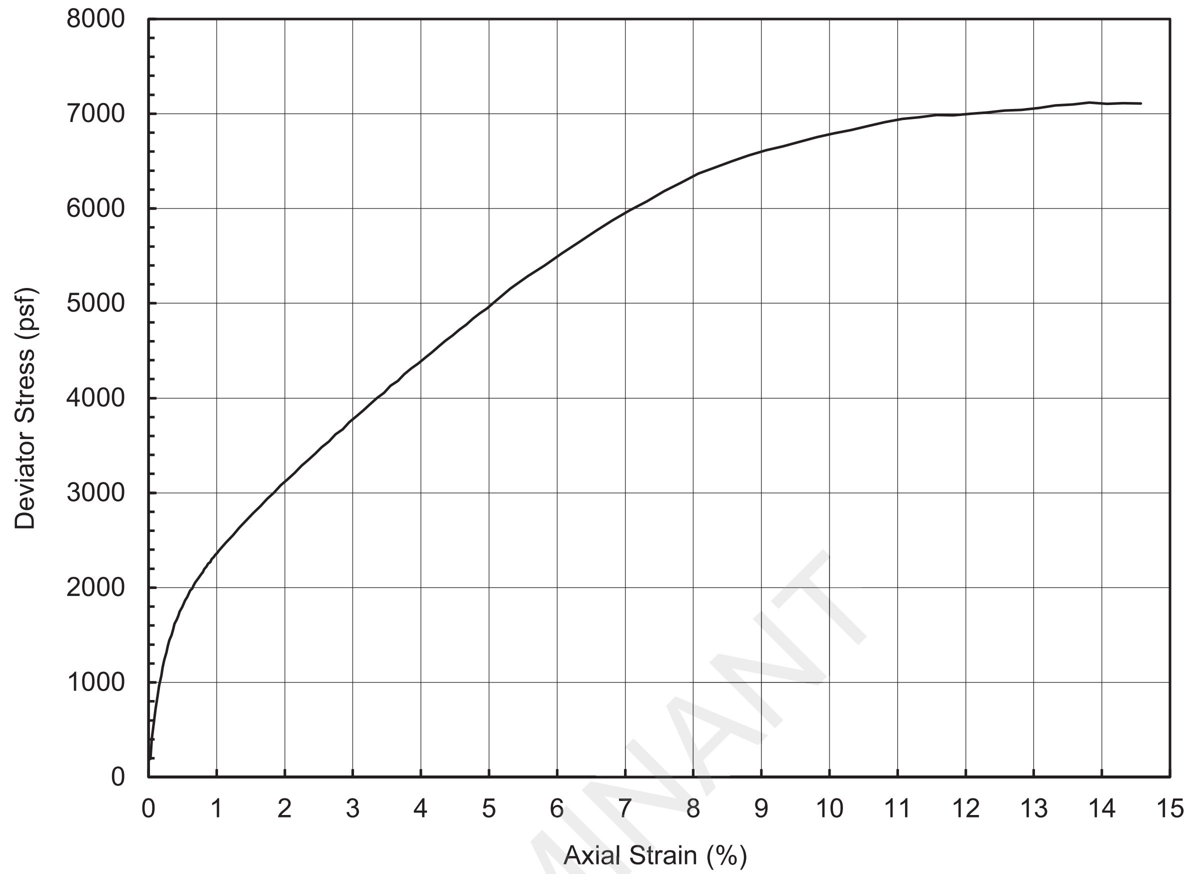
Failure Sketch

Project Title	Luminant - Martin Lake Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-207 TO-9
Comments	

Golder Associates

Performed by	PN
Date	15-Nov-12
Check	HR
Review	JF

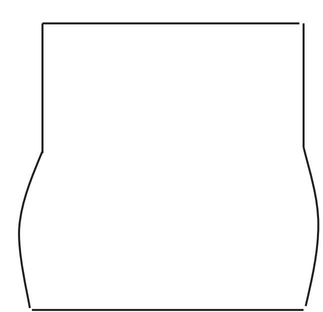
UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Reddish Yellow Lean Clay						
LL	28	PI	13	LI	0.0	USCS	CL

Depth (ft)	8.0	Confining Pressure (psf)	1046
Specimen Height (inch)	5.9	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	7118
Initial Specimen Weight (g)	1287.7	Axial Strain at Peak Stress (%)	13.8
Moist Unit Weight (pcf)	138.1		
Initial Water Content (%)	14		
Initial Dry Unit Weight (pcf)	120.7		

Project Title	Luminant - Martin Lake Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-208 TO-5
Comments	



Failure Sketch

Performed by	PN
Date	16-Nov-12
Check	HR
Review	JF

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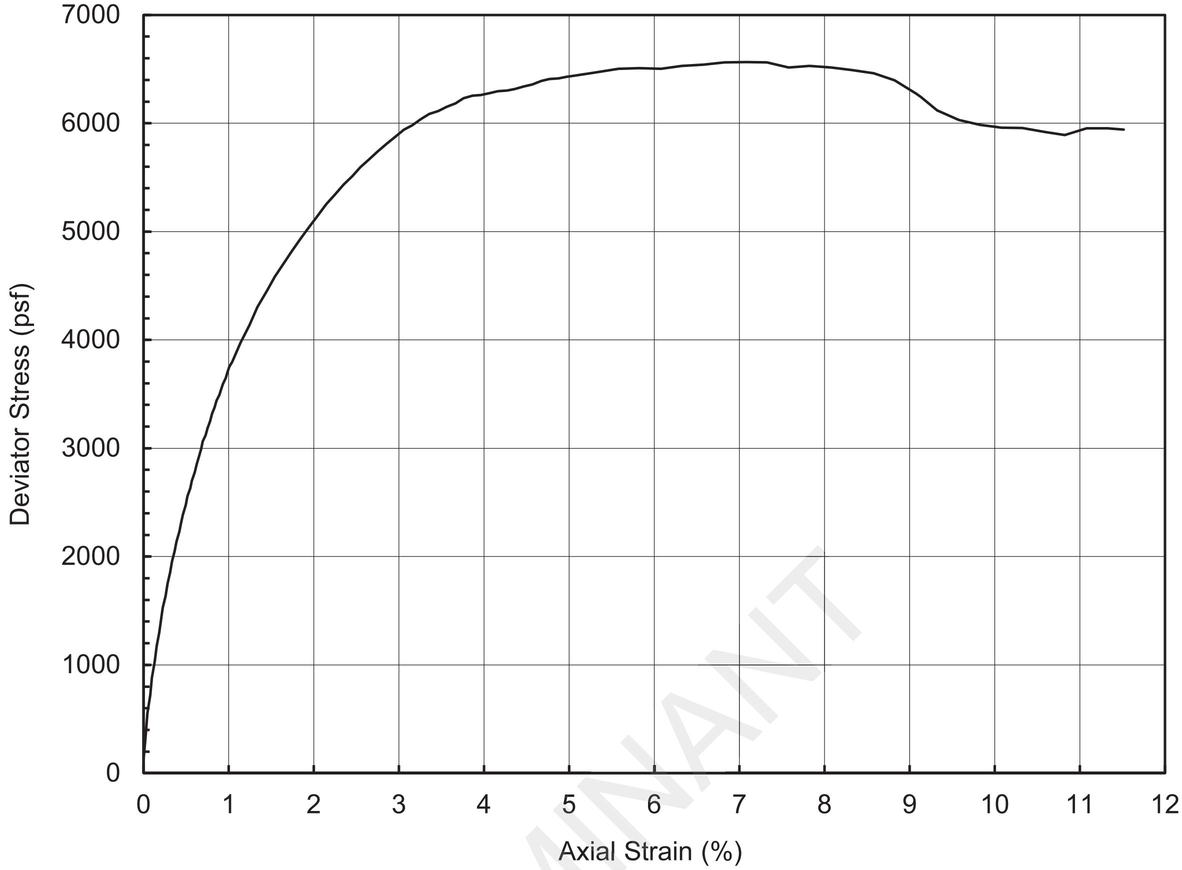
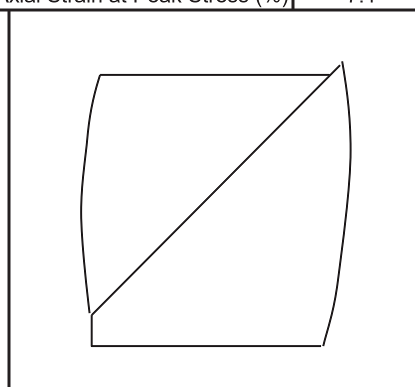
UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Grayish Brown Lean Clay						
LL	41	PI	26	LI	0.3	USCS	CL

Depth (ft)	28.0	Confining Pressure (psf)	3624
Specimen Height (inch)	6.0	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	6566
Initial Specimen Weight (g)	1202.8	Axial Strain at Peak Stress (%)	7.1
Moist Unit Weight (pcf)	128.0		
Initial Water Content (%)	22		
Initial Dry Unit Weight (pcf)	104.7		



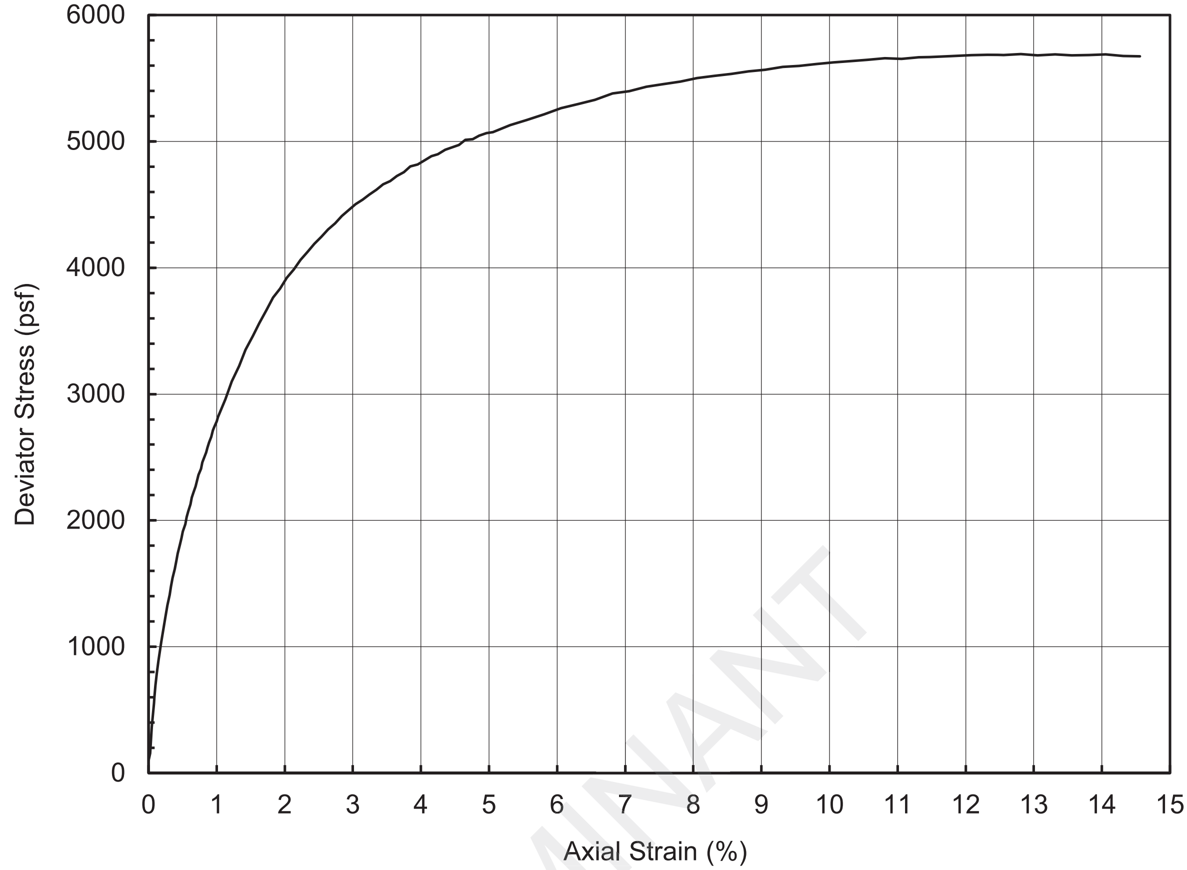
Failure Sketch

Project Title	Luminant - Martin Lake Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-209 TO-9
Comments	

Golder Associates

Performed by	**PN**
Date	**16-Nov-12**
Check	**HR**
Review	**JF**

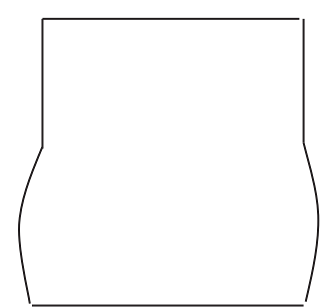
UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Reddish Gray Lean Clay						
LL	36	PI	22	LI	0.5	USCS	CL

Depth (ft)	18.0	Confining Pressure (psf)	2375
Specimen Height (inch)	6.0	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	5691
Initial Specimen Weight (g)	1192.0	Axial Strain at Peak Stress (%)	12.8
Moist Unit Weight (pcf)	126.7		
Initial Water Content (%)	24		
Initial Dry Unit Weight (pcf)	102.2		

Project Title	Luminant - Martin Lake Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-210 TO-7
Comments	



Failure Sketch

Performed by	**PN**
Date	**16-Nov-12**
Check	**HR**
Review	**JF**

Golder Associates

PROJECT INFORMATION

PROJECT: Luminant East Ash Disposal
LOCATION: Rusk County, Texas
PROJECT NO: G 2972 - 08
CLIENT:
Movember 2008

TRIAXIAL TEST PROGRAM BY GARRY H. GREGORY, P.E.

VERSION 1.0 - AUGUST 1998 - REVISED MARCH 24, 1999

THIS COPY LICENSED TO:
ETTL ENGINEERS AND CONSULTANTS, INC.
1717 East Erwin
Tyler, TX 75702

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Possible Fill Sample
DESCRIPTION: Tan, Brown & Red Sandy Lean Clay
Sampled on Site, B-13 3' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Both Ends & Diameter Trimmed + # 4 Sieve

PLATE: B.1

PLATE: B.2

PLATE: B.3

Number of Specimens = 3

SPECIMEN DATA

SPECIMEN NO. 1

	initial		final		Diameter			Height		
Moist soil & Tare :	522.40	g	621.30	g	top	2.04	in	Ht 1	4.44	in
Dry soil and Tare :	468.70	g	544.40	g	mid	2.04	in	Ht 2	4.44	in
Tare :	129.80	g	119.40	g	bot	2.04	in	Ht 3	4.44	in
Moisture content :	[redacted]	%	[redacted]	%	Avg	[redacted]	in	Ht4	4.44	in
Weight:	496.1	g						Avg Ht	[redacted]	in

Change in Ht due to saturation :	-0.02	in	Initial specimen vol :	[redacted]	cc
Change in Ht due to consolidation :	-0.018	in	At test specimen vol :	[redacted]	cc
Change in pipet vol due to consolidation :	2.0	cc	Initial dry density :	[redacted]	pcf
Saturation Parameter " B " = 0.95			At test dry density:	[redacted]	pcf

Strain Rate (in/min) =	0.0005	Failure Strain % =	2.7	Effective Cell Pressure (psi) =	[redacted]
σ_1' Failure (psi) =	20.41	σ_1 Failure (psi) =	[redacted]	Estimated ν =	0.35
σ_3' Failure (psi) =	5.41	σ_3 Failure (psi) =	[redacted]	Back Pressure (psi) =	50.0
ΔU =	[redacted]	Total Pore Pressure =	54.6	Cell Pressure (psi) =	60.0

SPECIMEN NO. 2

	initial		final		Diameter			Height		
Moist soil & Tare :	549.80	g	636.40	g	top	2.01	in	Ht 1	4.44	in
Dry soil and Tare :	469.20	g	560.20	g	mid	2.01	in	Ht 2	4.44	in
Tare :	123.20	g	139.10	g	bot	2.01	in	Ht 3	4.44	in
Moisture content :	[redacted]	%	[redacted]	%	Avg	[redacted]	in	Ht4	4.44	in
Weight:	496.0	g						Avg Ht	[redacted]	in

Change in Ht due to saturation :	-0.006	in	Initial specimen vol :	[redacted]	cc
Change in Ht due to consolidation :	-0.034	in	At test specimen vol :	[redacted]	cc
Change in pipet vol due to consolidation :	3.9	cc	Initial dry density :	[redacted]	pcf
Saturation Parameter " B " = 0.97			At test dry density:	[redacted]	pcf

Strain Rate (in/min) =	0.0005	Failure Strain % =	3.9	Effective Cell Pressure (psi) =	[redacted]
σ_1' Failure (psi) =	37.62	σ_1 Failure (psi) =	[redacted]	Estimated ν =	0.35
σ_3' Failure (psi) =	12.02	σ_3 Failure (psi) =	[redacted]	Back Pressure (psi) =	50.0
ΔU =	[redacted]	Total Pore Pressure =	58.0	Cell Pressure (psi) =	70.0

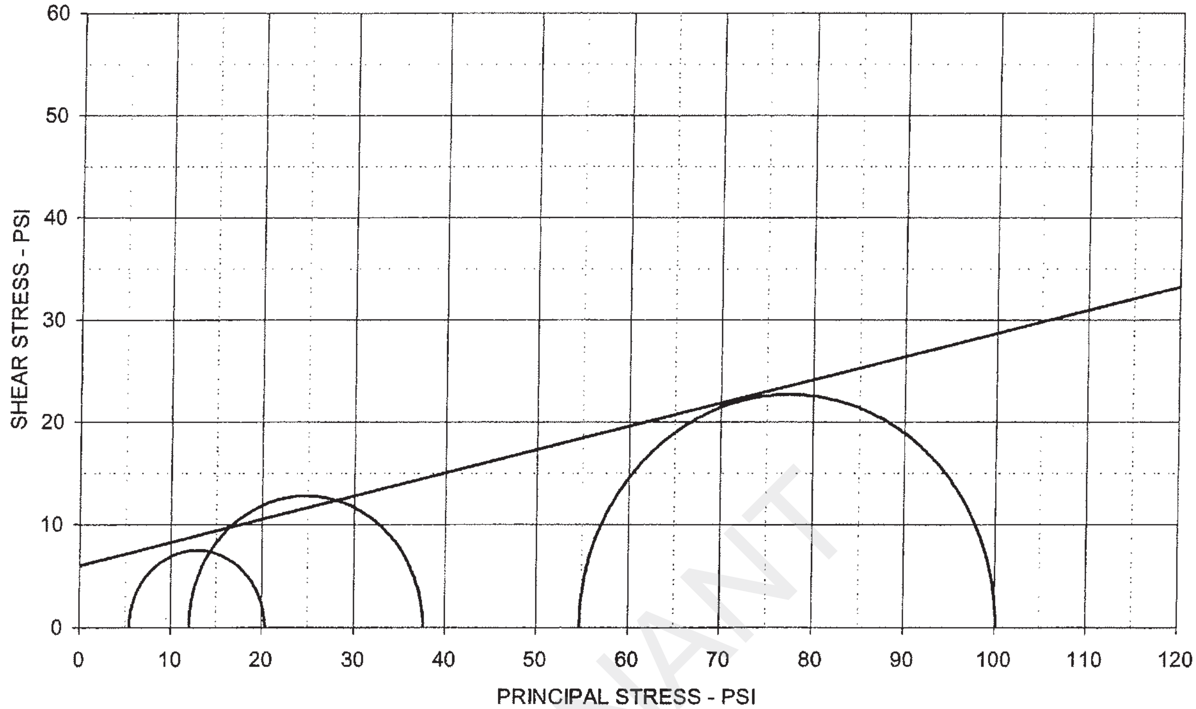
SPECIMEN NO. 3

	initial		final		Diameter			Height		
Moist soil & Tare :	594.50	g	656.50	g	top	2.06	in	Ht 1	4.54	in
Dry soil and Tare :	530.10	g	579.20	g	mid	2.06	in	Ht 2	4.54	in
Tare :	126.30	g	139.30	g	bot	2.06	in	Ht 3	4.54	in
Moisture content :	[redacted]	%	[redacted]	%	Avg	[redacted]	in	Ht4	4.54	in
Weight:	518.0	g						Avg Ht	[redacted]	in

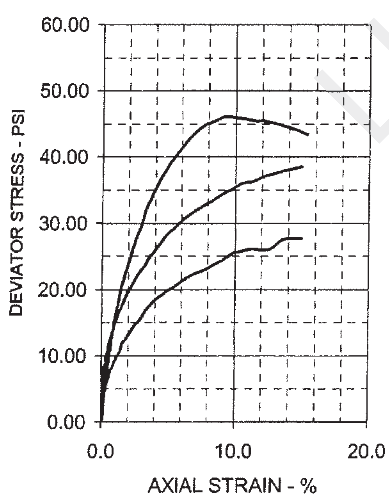
Change in Ht due to saturation :	-0.001	in	Initial specimen vol :	[redacted]	cc
Change in Ht due to consolidation :	-0.052	in	At test specimen vol :	[redacted]	cc
Change in pipet vol due to consolidation :	5.6	cc	Initial dry density :	[redacted]	pcf
Saturation Parameter " B " = 0.97			At test dry density:	[redacted]	pcf

Strain Rate (in/min) =	0.0005	Failure Strain % =	8.5	Effective Cell Pressure (psi) =	[redacted]
σ_1' Failure (psi) =	100.17	σ_1 Failure (psi) =	[redacted]	Estimated ν =	0.35
σ_3' Failure (psi) =	54.77	σ_3 Failure (psi) =	[redacted]	Back Pressure (psi) =	50.0
ΔU =	[redacted]	Total Pore Pressure =	35.2	Cell Pressure (psi) =	90.0

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	φ ' = 12.8 deg	c' = 6.0 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	15.8	16.6	15.9	
Dry Density - pcf	113.0	115.0	112.5	
Diameter - inches	2.04	2.01	2.06	
Height - inches	4.44	4.44	4.54	
AT TEST				
Final Moisture - %	18.1	18.1	17.6	
Dry Density - pcf	114.0	116.9	115.1	
Calculated Diameter (in.)	2.02	2.00	2.04	
Height - inches	4.40	4.40	4.49	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.00	25.60	45.40	
Total Pore Pressure - psi	54.6	58.0	35.2	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.7	3.9	8.5	
σ_1' Failure - psi	20.41	37.62	100.17	
σ_3' Failure - psi	5.41	12.02	54.77	

TEST DESCRIPTION

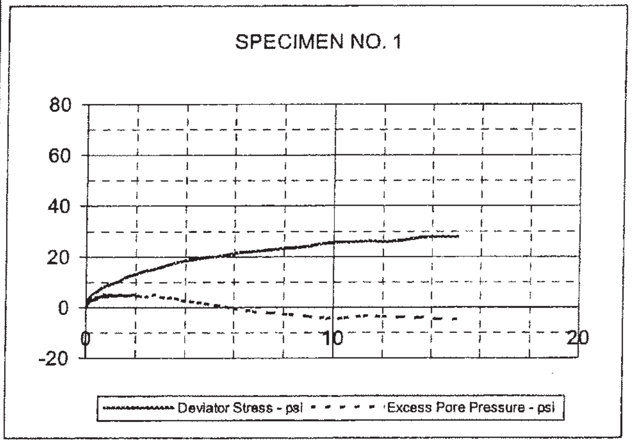
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Possible Fill Sample
DESCRIPTION: Tan, Brown & Red Sandy Lean Clay
Sampled on Site, B-13 3' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Both Ends & Diameter Trimmed + # 4 Sieve

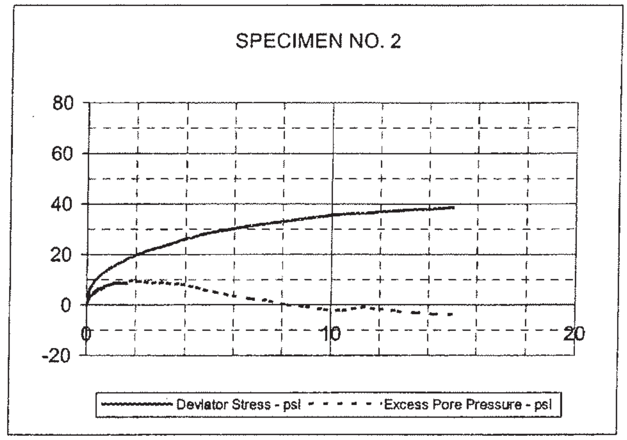
PROJECT INFORMATION

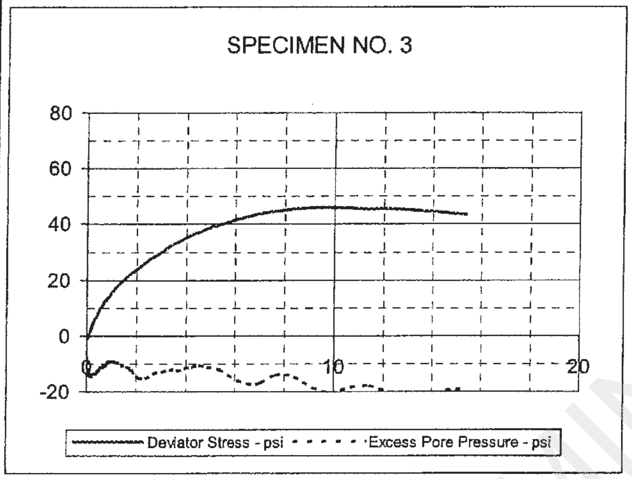
PROJECT: Luminant East Ash Disposal
LOCATION: Rusk County, Texas
PROJECT NO: G 2972 - 08
CLIENT:
Movember 2008

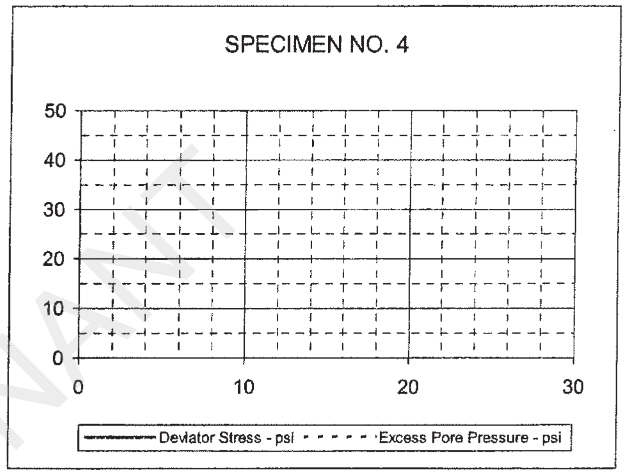
ETTL ENGINEERS & CONSULTANTS PLATE: B.1

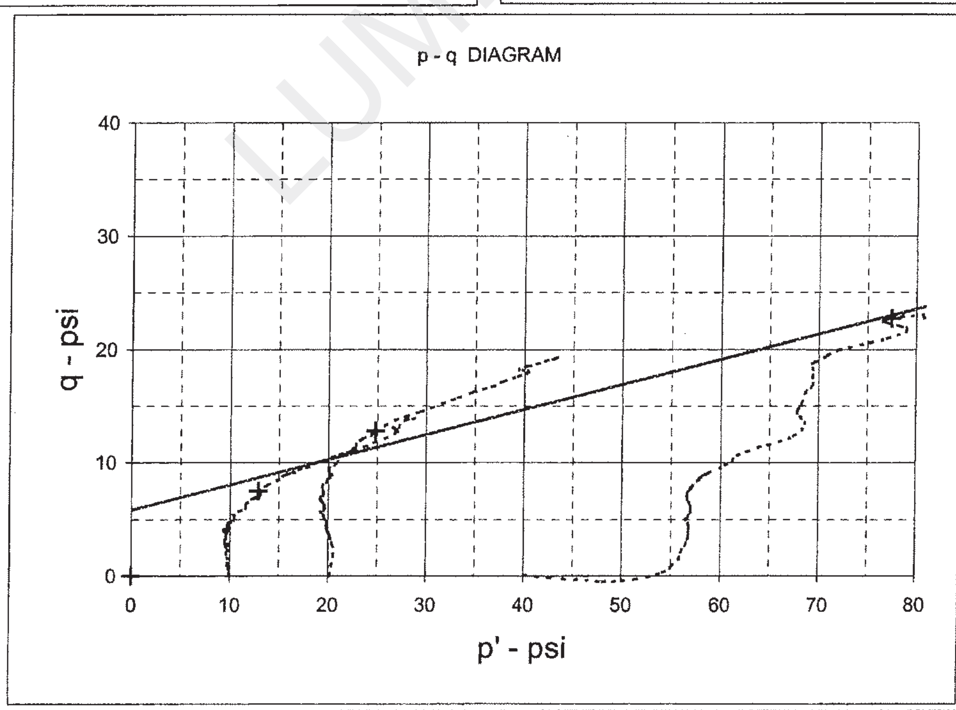
~~G 2972-08, B-13, 3'-10' Fill~~







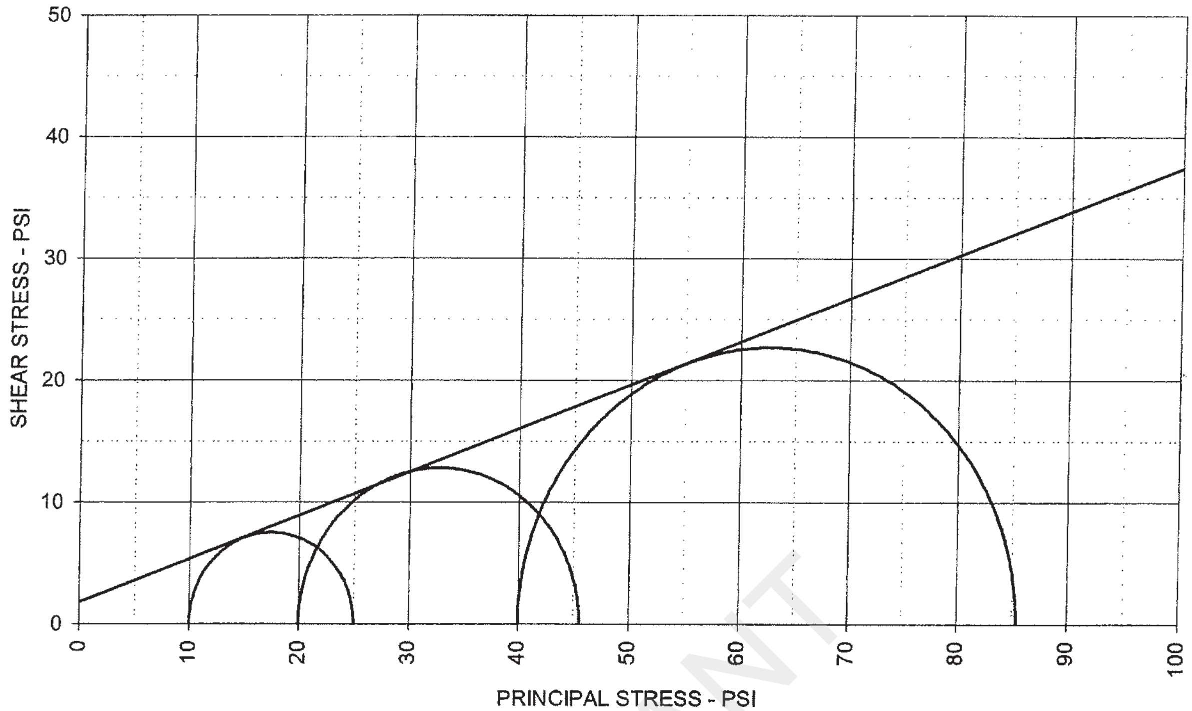




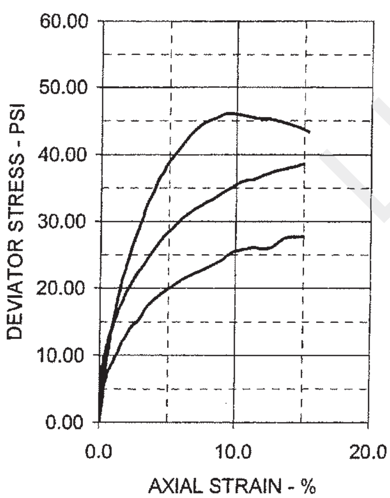
EFFECTIVE STRESS PARAMETERS	R^2 = 0.97	α (deg) = 12.5	a (psi) = 5.8
PROJECT: Luminant East Ash Disposal		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 2972 - 08		ETTL ENGINEERS & CONSULTANTS	PLATE: B.2
DESCRIPTION: Tan, Brown & Red Sandy Lean Clay			

G 2972-08, B-13, 3'-10' Fill

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	ϕ = 19.6 deg	c = 1.8 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	15.8	16.6	15.9	
Dry Density - pcf	113.0	115.0	112.5	
Diameter - inches	2.04	2.01	2.06	
Height - inches	4.44	4.44	4.54	
AT TEST				
Final Moisture - %	18.1	18.1	17.6	
Dry Density - pcf	114.0	116.9	115.1	
Calculated Diameter (in.)	2.02	2.00	2.04	
Height - inches	4.40	4.40	4.49	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.00	25.60	45.40	
Total Pore Pressure - psi	54.6	58.0	35.2	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.7	3.9	8.5	
σ_1 Failure - psi	25.00	45.60	85.40	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Possible Fill Sample
DESCRIPTION: Tan, Brown & Red Sandy Lean Clay
Sampled on Site, B-13 3' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Both Ends & Diameter Trimmed + # 4 Sieve

PROJECT INFORMATION

PROJECT: Luminant East Ash Disposal
LOCATION: Rusk County, Texas
PROJECT NO: G 2972 - 08
CLIENT:
Movember 2008

ETTL ENGINEERS & CONSULTANTS

PLATE: B.3

PROJECT INFORMATION

PROJECT: Luminant East Ash Disposal
LOCATION: Rusk County, Texas
PROJECT NO: G 2972 - 08
CLIENT:
Movember 2008

TRIAXIAL TEST PROGRAM BY GARRY H. GREGORY, P.E.

VERSION 1.0 - AUGUST 1998 - REVISED MARCH 24, 1999

THIS COPY LICENSED TO:
ETTL ENGINEERS AND CONSULTANTS, INC.
1717 East Erwin
Tyler, TX 75702

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Sample
DESCRIPTION: Gray, Tan & Redd. Br Sandy Clay w/ some Gravel
Sampled on Site, B-2 8' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Both Ends & Diameter Trimmed + # 4 Sieve

PLATE: B.1

PLATE: B.2

PLATE: B.3

Number of Specimens = 3

SPECIMEN DATA

SPECIMEN NO. 1

	initial		final		Diameter			Height		
Moist soil & Tare :	479.30	g	630.20	g	top	2.08	in	Ht 1	4.25	in
Dry soil and Tare :	429.60	g	548.70	g	mid	2.08	in	Ht 2	4.25	in
Tare :	129.70	g	128.00	g	bot	2.08	in	Ht 3	4.25	in
Moisture content :	[illegible]	%	[illegible]	%	Avg	[illegible]	in	Ht4	4.25	in
Weight:	496.8	g						Avg Ht	[illegible]	in

Change in Ht due to saturation :	-0.014	in	Initial specimen vol :	[illegible]	cc
Change in Ht due to consolidation :	0.005	in	At test specimen vol :	[illegible]	cc
Change in pipet vol due to consolidation :	0.6	cc	Initial dry density :	[illegible]	pcf
Saturation Parameter " B " =	0.96		At test dry density:	[illegible]	pcf

Strain Rate (in/min) =	0.0005	Failure Strain % =	2.4	Effective Cell Pressure (psi) =	[illegible]
σ_1' Failure (psi) =	36.26	σ_1 Failure (psi) =	[illegible]	Estimated ν =	0.35
σ_3' Failure (psi) =	8.24	σ_3 Failure (psi) =	[illegible]	Back Pressure (psi) =	50.0
ΔU =	[illegible]	Total Pore Pressure =	51.8	Cell Pressure (psi) =	60.0

SPECIMEN NO. 2

	initial		final		Diameter			Height		
Moist soil & Tare :	505.50	g	618.20	g	top	2.08	in	Ht 1	4.40	in
Dry soil and Tare :	451.40	g	537.60	g	mid	2.08	in	Ht 2	4.40	in
Tare :	114.00	g	102.60	g	bot	2.08	in	Ht 3	4.40	in
Moisture content :	[illegible]	%	[illegible]	%	Avg	[illegible]	in	Ht4	4.40	in
Weight:	611.6	g						Avg Ht	[illegible]	in

Change in Ht due to saturation :	0.01	in	Initial specimen vol :	[illegible]	cc
Change in Ht due to consolidation :	-0.048	in	At test specimen vol :	[illegible]	cc
Change in pipet vol due to consolidation :	7.0	cc	Initial dry density :	[illegible]	pcf
Saturation Parameter " B " =	0.98		At test dry density:	[illegible]	pcf

Strain Rate (in/min) =	0.0005	Failure Strain % =	3.4	Effective Cell Pressure (psi) =	[illegible]
σ_1' Failure (psi) =	48.53	σ_1 Failure (psi) =	[illegible]	Estimated ν =	0.35
σ_3' Failure (psi) =	13.88	σ_3 Failure (psi) =	[illegible]	Back Pressure (psi) =	50.0
ΔU =	[illegible]	Total Pore Pressure =	56.1	Cell Pressure (psi) =	70.0

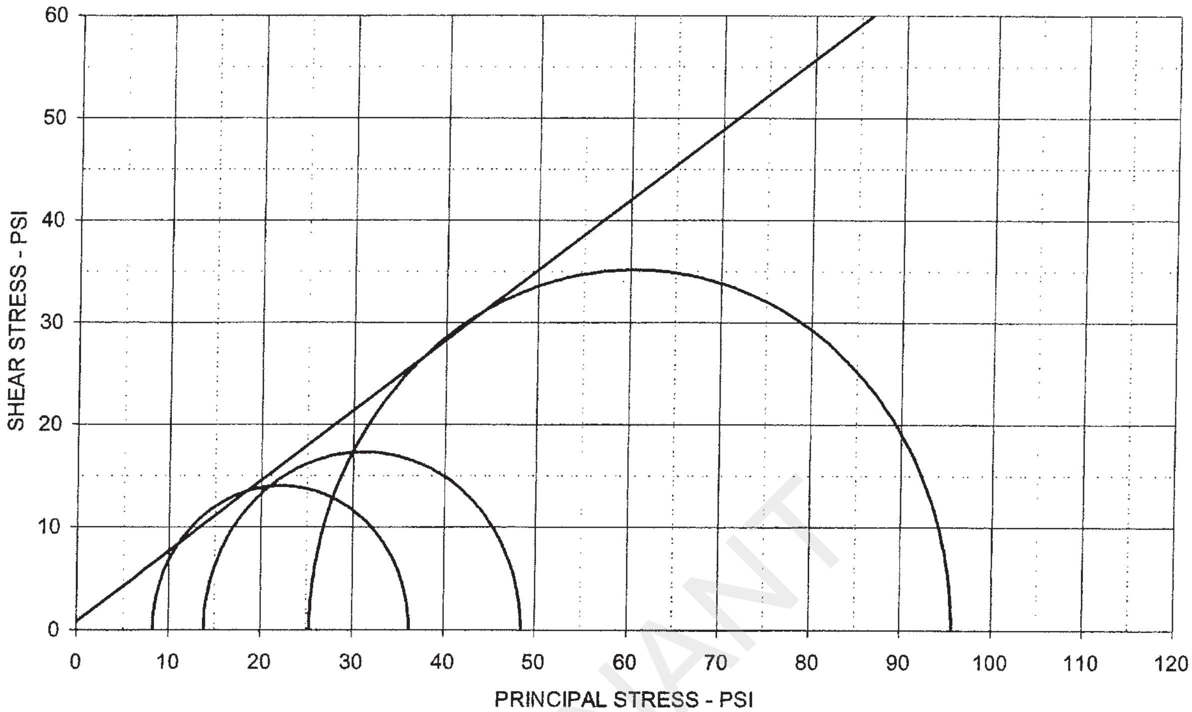
SPECIMEN NO. 3

	initial		final		Diameter			Height		
Moist soil & Tare :	414.70	g	721.60	g	top	2.11	in	Ht 1	4.62	in
Dry soil and Tare :	381.70	g	652.20	g	mid	2.11	in	Ht 2	4.62	in
Tare :	102.50	g	139.10	g	bot	2.11	in	Ht 3	4.62	in
Moisture content :	[illegible]	%	[illegible]	%	Avg	[illegible]	in	Ht4	4.62	in
Weight:	579.6	g						Avg Ht	[illegible]	in

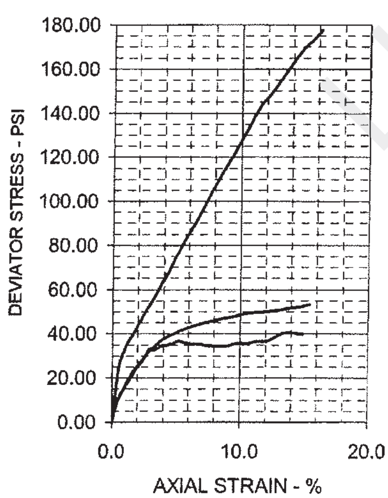
Change in Ht due to saturation :	-0.021	in	Initial specimen vol :	[illegible]	cc
Change in Ht due to consolidation :	-0.018	in	At test specimen vol :	[illegible]	cc
Change in pipet vol due to consolidation :	5.4	cc	Initial dry density :	[illegible]	pcf
Saturation Parameter " B " =	0.99		At test dry density:	[illegible]	pcf

Strain Rate (in/min) =	0.0005	Failure Strain % =	4.6	Effective Cell Pressure (psi) =	[illegible]
σ_1' Failure (psi) =	95.68	σ_1 Failure (psi) =	[illegible]	Estimated ν =	0.35
σ_3' Failure (psi) =	25.40	σ_3 Failure (psi) =	[illegible]	Back Pressure (psi) =	50.0
ΔU =	[illegible]	Total Pore Pressure =	64.6	Cell Pressure (psi) =	90.0

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	φ ' =	34.4 deg	c' =	0.8 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	16.6	16.0	11.8	
Dry Density - pcf	112.3	112.1	122.3	
Diameter - inches	2.08	2.08	2.11	
Height - inches	4.25	4.40	4.62	
AT TEST				
Final Moisture - %	19.4	18.1	13.5	
Dry Density - pcf	112.6	115.3	124.9	
Calculated Diameter (in.)	2.08	2.07	2.10	
Height - inches	4.24	4.37	4.58	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	28.02	34.65	70.28	
Total Pore Pressure - psi	51.8	56.1	64.6	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.4	3.4	4.6	
σ_1' Failure - psi	36.26	48.53	95.68	
σ_3' Failure - psi	8.24	13.88	25.40	

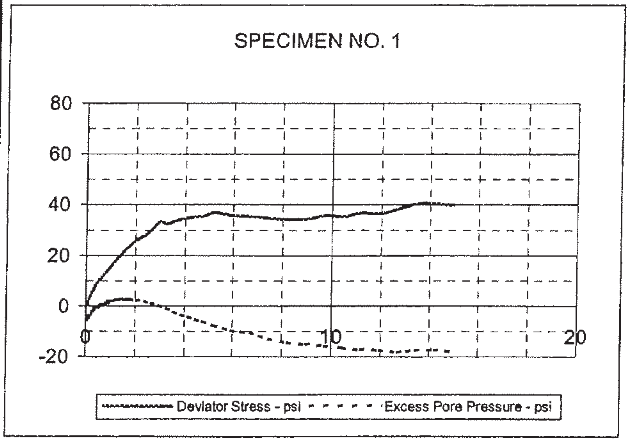
TEST DESCRIPTION

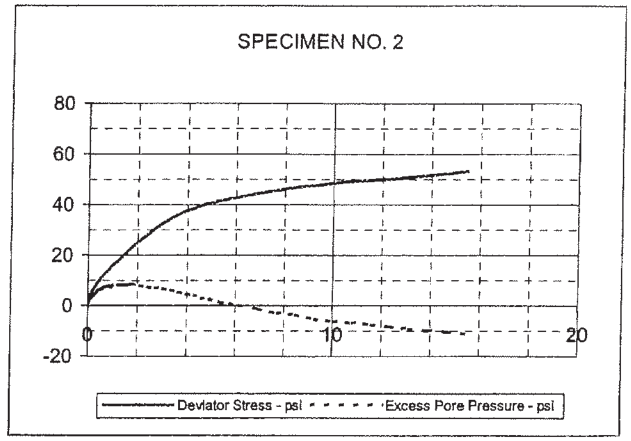
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Sample
DESCRIPTION: Gray, Tan & Redd. Br Sandy Clay w/ some Gravel
Sampled on Site, B-2 8' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Both Ends & Diameter Trimmed + # 4 Sieve
G 2972-08, B-2, 8'-20' Native

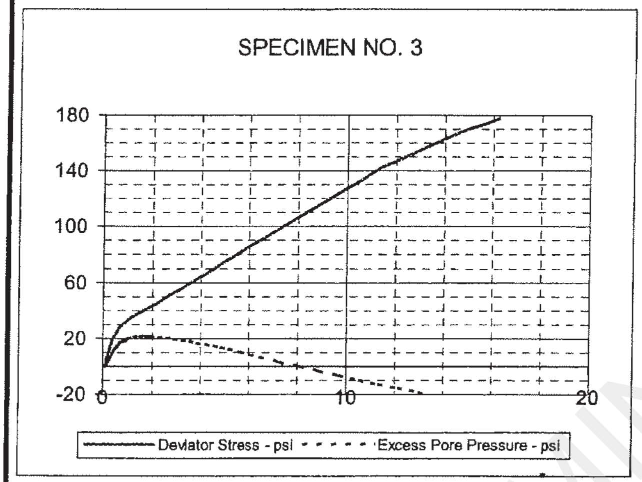
PROJECT INFORMATION

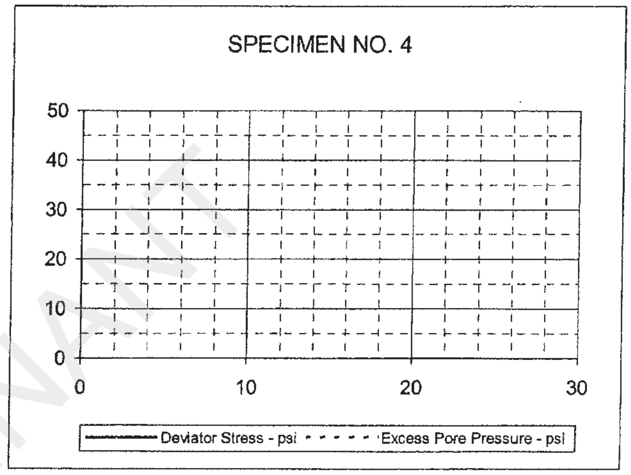
PROJECT: Luminant East Ash Disposal
LOCATION: Rusk County, Texas
PROJECT NO: G 2972 - 08
CLIENT:
Movember 2008

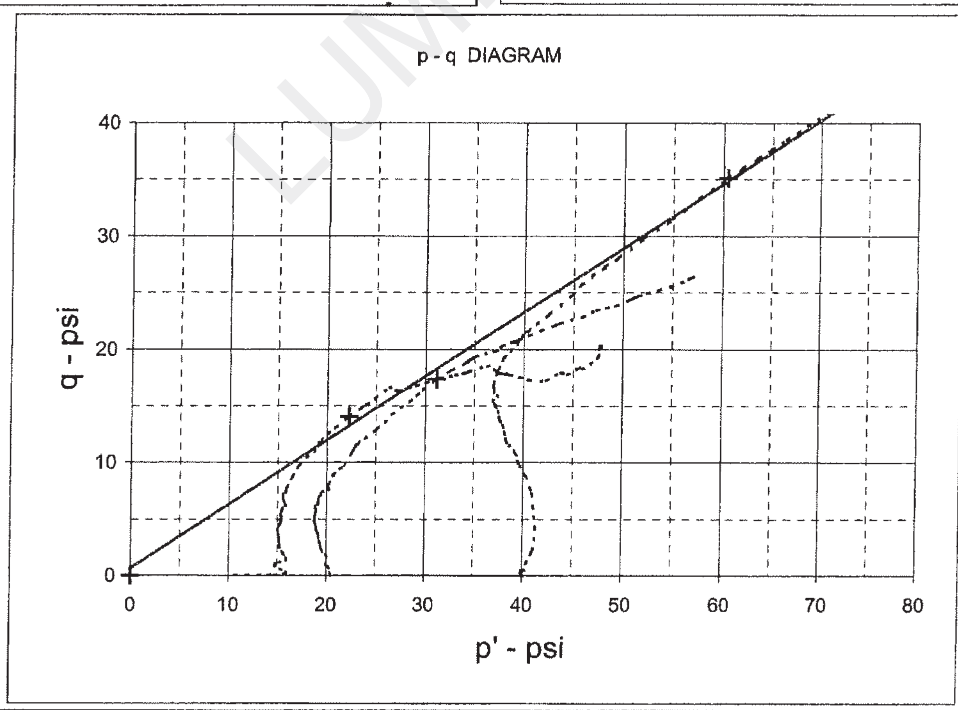
ETTL ENGINEERS & CONSULTANTS	PLATE: B.1







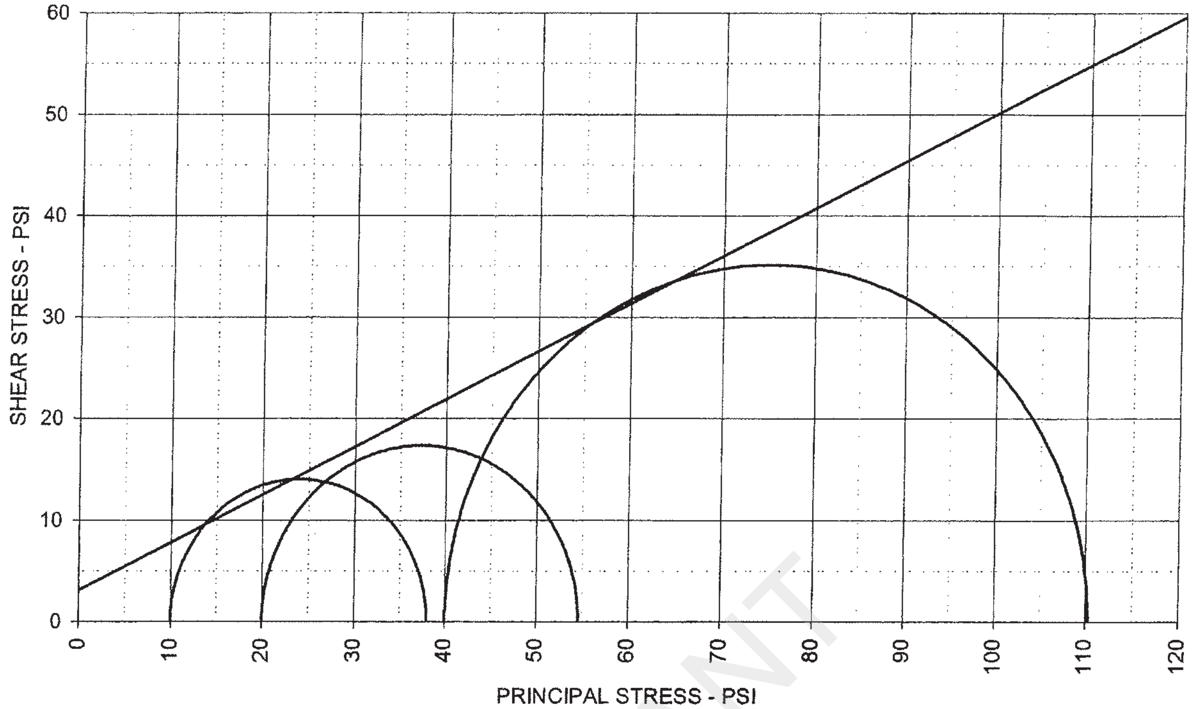




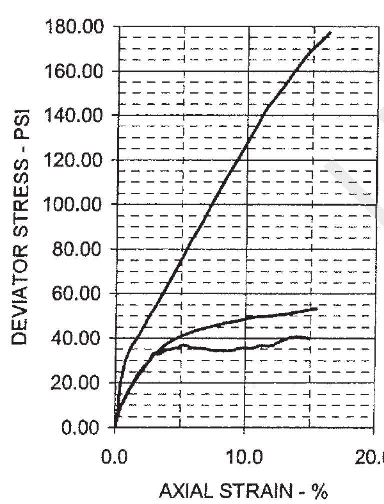
EFFECTIVE STRESS PARAMETERS	R^2 = 0.99	α (deg) = 29.5	a (psi) = 0.7
PROJECT: Luminant East Ash Disposal		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 2972 - 08		ETTL ENGINEERS & CONSULTANTS	PLATE: B.2
DESCRIPTION: Gray, Tan & Redd. Br Sandy Clay w/ some Gravel			

G 2972-08, B-2, 8'-20' Native

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	ϕ = 25.2 deg	c = 3.1 psi		
SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	16.6	16.0	11.8	
Dry Density - pcf	112.3	112.1	122.3	
Diameter - inches	2.08	2.08	2.11	
Height - inches	4.25	4.40	4.62	
AT TEST				
Final Moisture - %	19.4	18.1	13.5	
Dry Density - pcf	112.6	115.3	124.9	
Calculated Diameter (in.)	2.08	2.07	2.10	
Height - inches	4.24	4.37	4.58	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	28.02	34.65	70.28	
Total Pore Pressure - psi	51.8	56.1	64.6	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.4	3.4	4.6	
σ_1 Failure - psi	38.02	54.65	110.28	
σ_3 Failure - psi	10.00	20.00	40.00	



TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Sample
DESCRIPTION: Gray, Tan & Redd. Br Sandy Clay w/ some Gravel
Sampled on Site, B-2 8' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Both Ends & Diameter Trimmed + # 4 Sieve

PROJECT INFORMATION

PROJECT: Luminant East Ash Disposal
LOCATION: Rusk County, Texas
PROJECT NO: G 2972 - 08
CLIENT:
Movember 2008

ETTL ENGINEERS & CONSULTANTS PLATE: B.3

PROJECT INFORMATION

PROJECT: Luminant East Ash Disposal
LOCATION: Rusk County, Texas
PROJECT NO: G 2972 - 08
CLIENT:
November, 2008

TRIAXIAL TEST PROGRAM BY GARRY H. GREGORY, P.E.

VERSION 1.0 - AUGUST 1998 - REVISED MARCH 24, 1999

THIS COPY LICENSED TO:
ETTL ENGINEERS AND CONSULTANTS, INC.
1717 East Erwin
Tyler, TX 75702

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Possible Fill Sample
DESCRIPTION: Tan & Red Sandy Lean Clay w/ Roots
Sampled on Site, B-1, 3' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Both Ends & Diameter Trimmed + # 4 Sieve

PLATE: B.1

PLATE: B.2

PLATE: B.3

Number of Specimens = 3

SPECIMEN DATA

SPECIMEN NO. 1

	initial		final		Diameter			Height		
Moist soil & Tare :	539.30	g	625.10	g	top	2.07	in	Ht 1	4.23	in
Dry soil and Tare :	482.00	g	546.00	g	mid	2.07	in	Ht 2	4.23	in
Tare :	127.40	g	126.90	g	bot	2.07	in	Ht 3	4.23	in
Moisture content :	[illegible]	%	[illegible]	%	Avg	2.07	in	Ht4	4.23	in
Weight:	493.2	g						Avg Ht	[illegible]	in

Change in Ht due to saturation :	0.02	in	Initial specimen vol :	[illegible]	cc
Change in Ht due to consolidation :	-0.006	in	At test specimen vol :	[illegible]	cc
Change in pipet vol due to consolidation :	3.2	cc	Initial dry density :	[illegible]	pcf
Saturation Parameter " B " = 0.97			At test dry density:	[illegible]	pcf

Strain Rate (in/min) =	0.0005	Failure Strain % =	1.4	Effective Cell Pressure (psi) =	[illegible]
σ_1' Failure (psi) =	29.29	σ_1 Failure (psi) =	[illegible]	Estimated ν =	0.35
σ_3' Failure (psi) =	6.35	σ_3 Failure (psi) =	[illegible]	Back Pressure (psi) =	50.0
ΔU =	[illegible]	Total Pore Pressure =	53.7	Cell Pressure (psi) =	60.0

SPECIMEN NO. 2

	initial		final		Diameter			Height		
Moist soil & Tare :	548.00	g	591.00	g	top	2.01	in	Ht 1	4.25	in
Dry soil and Tare :	492.70	g	519.10	g	mid	2.01	in	Ht 2	4.25	in
Tare :	136.60	g	124.60	g	bot	2.01	in	Ht 3	4.25	in
Moisture content :	[illegible]	%	[illegible]	%	Avg	[illegible]	in	Ht4	4.25	in
Weight:	462.2	g						Avg Ht	[illegible]	in

Change in Ht due to saturation :	-0.009	in	Initial specimen vol :	[illegible]	cc
Change in Ht due to consolidation :	-0.033	in	At test specimen vol :	[illegible]	cc
Change in pipet vol due to consolidation :	4.2	cc	Initial dry density :	[illegible]	pcf
Saturation Parameter " B " = 0.99			At test dry density:	[illegible]	pcf

Strain Rate (in/min) =	0.0005	Failure Strain % =	3.0	Effective Cell Pressure (psi) =	[illegible]
σ_1' Failure (psi) =	40.52	σ_1 Failure (psi) =	[illegible]	Estimated ν =	0.35
σ_3' Failure (psi) =	14.53	σ_3 Failure (psi) =	[illegible]	Back Pressure (psi) =	50.0
ΔU =	[illegible]	Total Pore Pressure =	55.5	Cell Pressure (psi) =	70.0

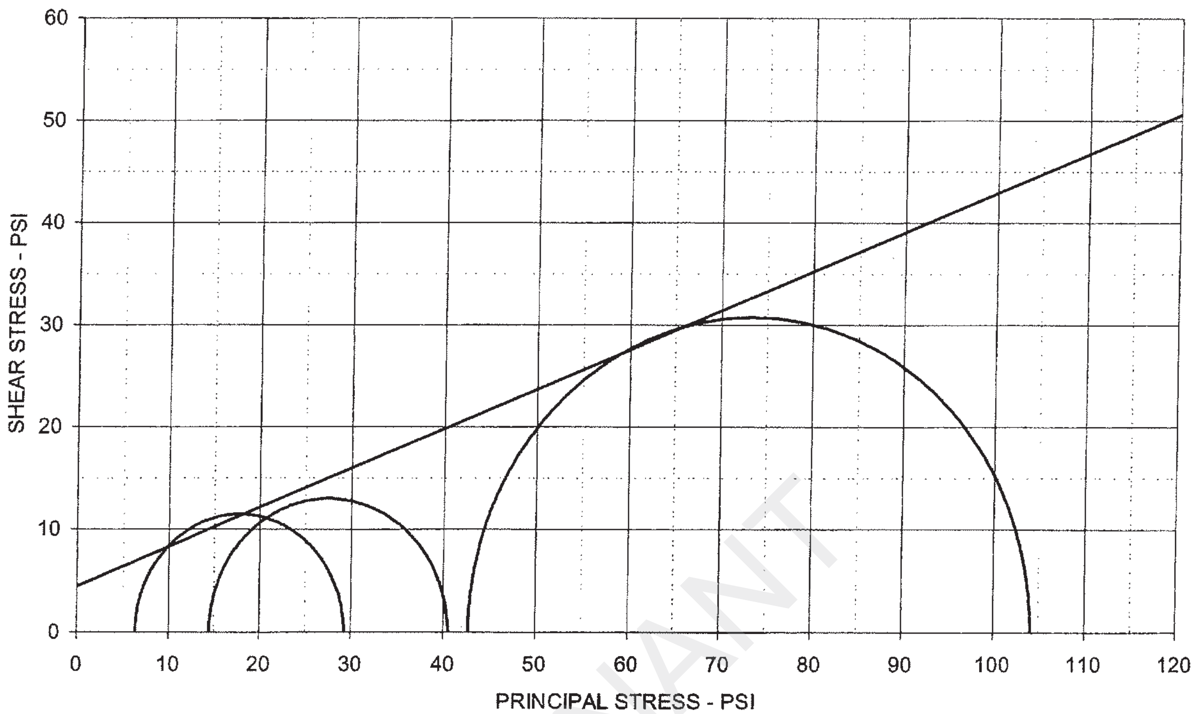
SPECIMEN NO. 3

	initial		final		Diameter			Height		
Moist soil & Tare :	431.00	g	628.40	g	top	2.10	in	Ht 1	4.28	in
Dry soil and Tare :	385.90	g	558.80	g	mid	2.10	in	Ht 2	4.28	in
Tare :	105.00	g	119.40	g	bot	2.10	in	Ht 3	4.28	in
Moisture content :	[illegible]	%	[illegible]	%	Avg	[illegible]	in	Ht4	4.28	in
Weight:	510.5	g						Avg Ht	[illegible]	in

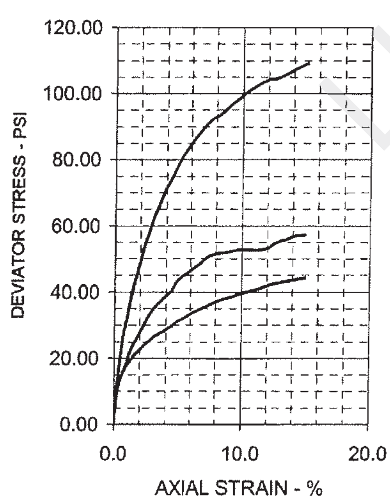
Change in Ht due to saturation :	-0.017	in	Initial specimen vol :	[illegible]	cc
Change in Ht due to consolidation :	-0.039	in	At test specimen vol :	[illegible]	cc
Change in pipet vol due to consolidation :	4.6	cc	Initial dry density :	[illegible]	pcf
Saturation Parameter " B " = 0.97			At test dry density:	[illegible]	pcf

Strain Rate (in/min) =	0.0005	Failure Strain % =	3.0	Effective Cell Pressure (psi) =	[illegible]
σ_1' Failure (psi) =	104.13	σ_1 Failure (psi) =	[illegible]	Estimated ν =	0.35
σ_3' Failure (psi) =	42.71	σ_3 Failure (psi) =	[illegible]	Back Pressure (psi) =	50.0
ΔU =	[illegible]	Total Pore Pressure =	47.3	Cell Pressure (psi) =	90.0

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	φ ' = 21.0 deg	c' = 4.5 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	16.2	15.5	16.1	
Dry Density - pcf	113.6	113.1	113.3	
Diameter - inches	2.07	2.01	2.10	
Height - inches	4.23	4.25	4.28	
AT TEST				
Final Moisture - %	18.3	18.2	15.8	
Dry Density - pcf	115.2	115.3	115.5	
Calculated Diameter (in.)	2.08	1.99	2.08	
Height - inches	4.24	4.21	4.22	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	22.94	25.99	61.42	
Total Pore Pressure - psi	53.7	55.5	47.3	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.4	3.0	3.0	
σ_1' Failure - psi	29.29	40.52	104.13	
σ_3' Failure - psi	6.35	14.53	42.71	

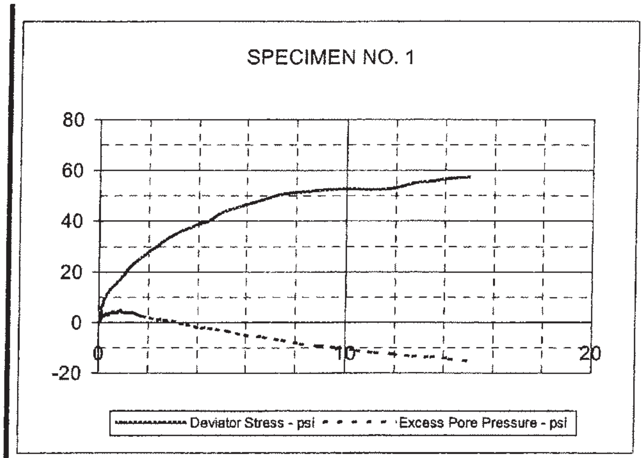
TEST DESCRIPTION

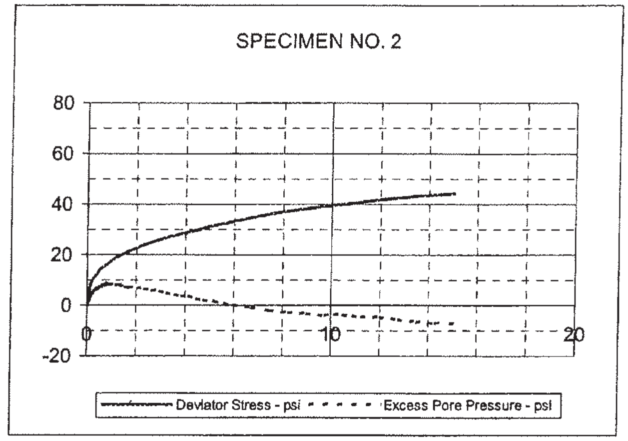
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Possible Fill Sample
DESCRIPTION: Tan & Red Sandy Lean Clay w/ Roots
Sampled on Site, B-1 3' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Both Ends & Diameter Trimmed + # 4 Sieve
G 2972-08, B-1, 3'-10' Fill

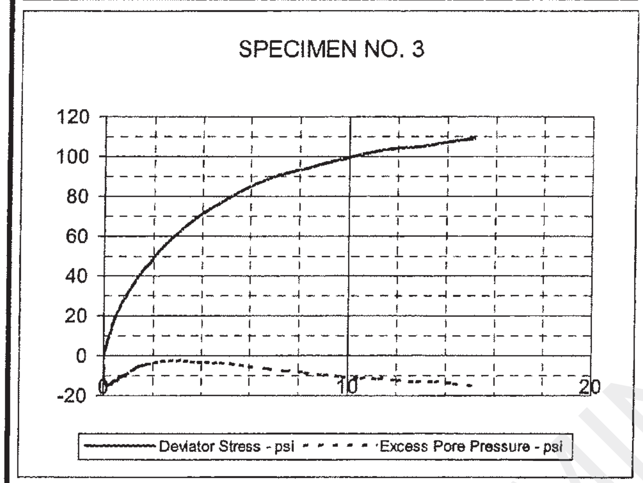
PROJECT INFORMATION

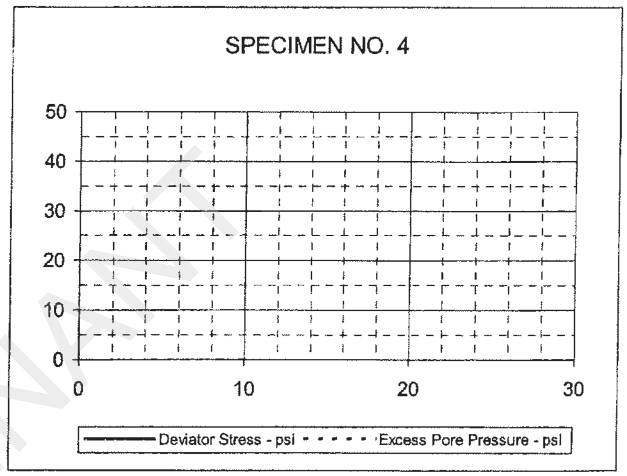
PROJECT: Luminant East Ash Disposal
LOCATION: Rusk County, Texas
PROJECT NO: G 2972 - 08
CLIENT:
Movember 2008

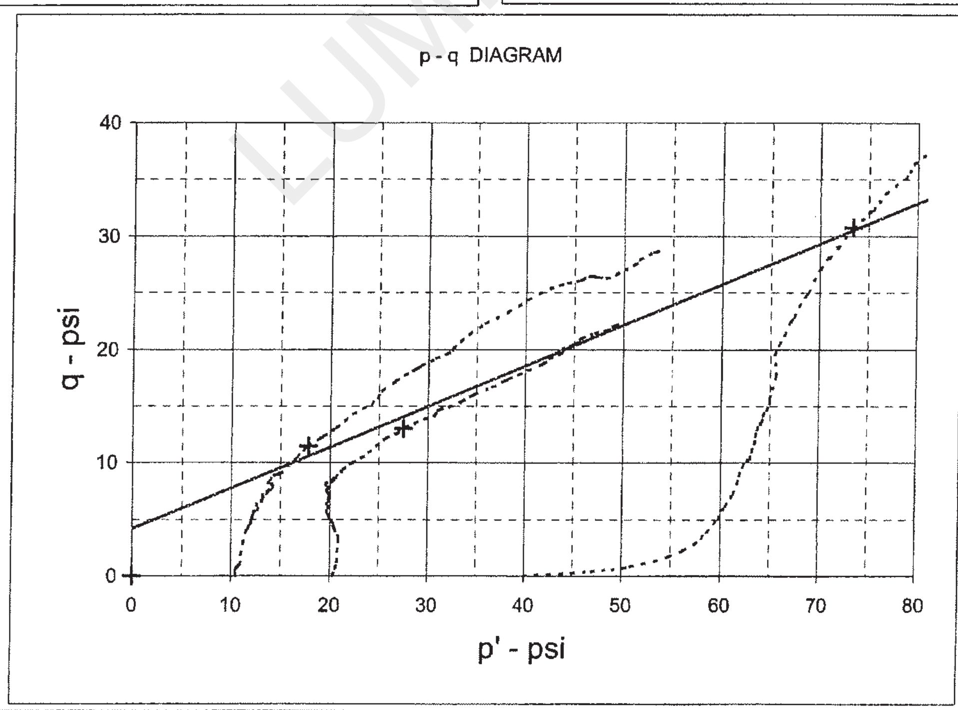
ETTL ENGINEERS & CONSULTANTS | PLATE: B.1







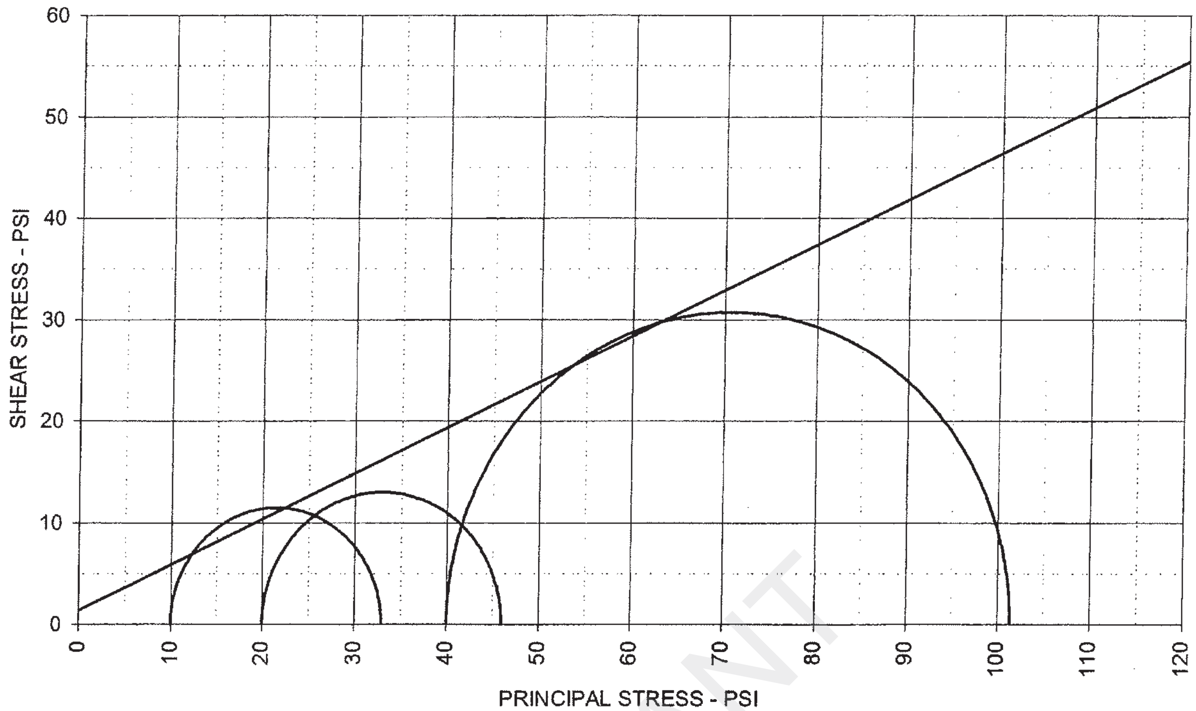




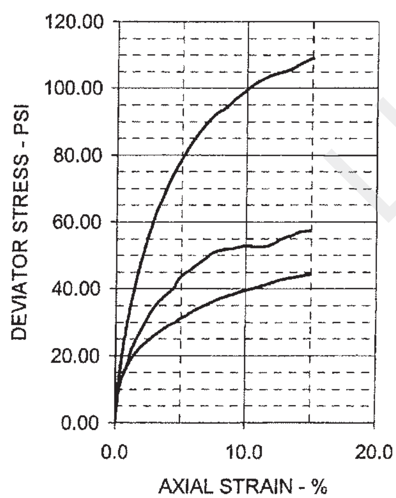
EFFECTIVE STRESS PARAMETERS	R^2 = 0.99	α (deg) = 19.7	a (psi) = 4.2
PROJECT: Luminant East Ash Disposal		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 2972 - 08		ETTL ENGINEERS & CONSULTANTS	PLATE: B.2
DESCRIPTION: Tan & Red Sandy Lean Clay w/ Roots			

G 2972-08, B-1, 3'-10' Fill

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	ϕ = 24.2 deg	c = 1.4 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	16.2	15.5	16.1	
Dry Density - pcf	113.6	113.1	113.3	
Diameter - inches	2.07	2.01	2.10	
Height - inches	4.23	4.25	4.28	
AT TEST				
Final Moisture - %	18.3	18.2	15.8	
Dry Density - pcf	115.2	115.3	115.5	
Calculated Diameter (in.)	2.08	1.99	2.08	
Height - inches	4.24	4.21	4.22	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	22.94	25.99	61.42	
Total Pore Pressure - psi	53.7	55.5	47.3	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.4	3.0	3.0	
σ_1 Failure - psi	32.94	45.99	101.42	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Possible Fill Sample
DESCRIPTION: Tan & Red Sandy Lean Clay w/ Roots
Sampled on Site, B-1 3' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Both Ends & Diameter Trimmed + # 4 Sieve

PROJECT INFORMATION

PROJECT: Luminant East Ash Disposal
LOCATION: Rusk County, Texas
PROJECT NO: G 2972 - 08
CLIENT:
Movember 2008

ETTL ENGINEERS & CONSULTANTS PLATE: B.3

PERMANENT DISPOSAL POND - 5

HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

PROJECT: Luminant Martin Lake, PDP 1-3
CLIENT: TXU
CONTRACTOR: not given
JOB No. : **G 2810 - 08**

REPORT No.:
DATE SAMPLED: February 2008
SAMPLED BY: ETTL Drill Crew
LOCATION: MLSES
SAMPLE No. :
DESCRIPTION: Gray & Dark Gray Bottom Ash
TECHNICIAN: M. Thompson
DATE: 04/15/08

RESULTS

	Grain Diameter	
% Retain	+2.0 mm	**47.69**
% Retain	+0.05 mm	**99.26**
% Passing	0.05 to 2.0 mm	**51.57**
% Passing	0.002 to 0.05 mm	**0.72**
% Passing	> 0.002 mm	**0.02**

WEIGHT OF SAMPLE (AIR DRY)	100.00
WEIGHT OF SAMPLE (OVEN DRY)	99.90
PERCENT RETAINED ON # 10	47.69
SPECIFIC GRAVITY	2.563

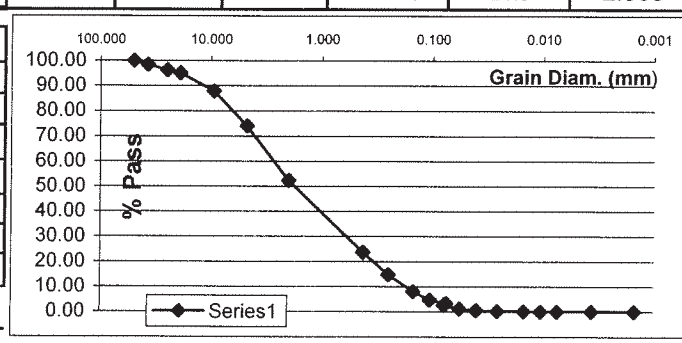
Mc Hydrom	
Tare Wt	29.89
Wet Wt.	68.94
Dry Wt	68.90
MC	0.1025%

SIEVE	WEIGHT	%RETAIN	GRAIN DIA	%PASSING
40	54.66	76.31	0.425	23.69
60	71.63	85.20	0.250	14.80
100	84.45	91.91	0.150	8.09
140	90.93	95.30	0.105	4.70
200	93.54	96.67	0.075	3.33

TEMP (C)	HYDROMETER CORRECTION	HYDROMETER READING	CORRECTED READING	L.Hydrom FACTOR	K. Diam. FACTOR	a. SP.GR. FACTOR	TIME (MIN)	GRAIN DIA (MM)	% SOIL PASSING
21.5	5.7	11.0	5.3	15.5	0.0141	1.02	0.5	0.0787	2.82
21.5	5.7	8.0	2.3	16	0.0141	1.02	1	0.0566	1.21
21.5	5.7	6.8	1.1	16.1	0.0141	1.02	2	0.0401	0.57
21.5	5.7	6.2	0.5	16.3	0.0141	1.02	5	0.0255	0.25
21.5	5.7	6.0	0.3	16.3	0.0141	1.02	15	0.0147	0.15
21.5	5.7	5.8	0.1	16.3	0.0141	1.02	30	0.0104	0.04
21.5	5.7	5.8	0.1	16.3	0.0141	1.02	60	0.0074	0.04
21.5	5.7	5.8	0.1	16.3	0.0141	1.02	250	0.0036	0.04
22.0	5.6	5.6	0.0	16.3	0.0140	1.02	1440	0.0015	0.02

SPECIFIC GRAVITY		BOTTLE #	Bottle Wt	Bott & Water	WaterTemp	Corr.Soil	Bott, S & Water	WaterTemp	Specif. Grav
Air dry Sample(gr)	100	10	188.06	686.13	22.5	99.90	747.18	21.5	**2.563**

	Sieve Size	Grams Retain	% Pass
Sieve % Pass	2"	0.00	100.00
	1-1/2"	89.00	98.47
Air Dry Start Wt.:	1"	215.04	96.31
5836.8	3/4"	288.14	95.06
Dry Start Wt.:	3/8"	709.78	87.83
5830.82	No 4	1510.97	74.09
	No 10	2780.46	52.31



Remarks:

HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

PROJECT: Luminant Martin Lake, PDP 1-3
CLIENT: TXU
CONTRACTOR: not given
JOB No. : **G 2810 - 08**

REPORT No.:
DATE SAMPLED: February 2008
SAMPLED BY: ETTL Drill Crew
LOCATION: B-9, 1'-3'
SAMPLE No. :
DESCRIPTION: Gray Ash (Cementing)
TECHNICIAN: H. Walka
DATE: 03/14/08

RESULTS

	Grain Diameter	
% Retain	+2.0 mm	**0.08**
% Retain	+0.05 mm	**41.35**
% Passing	0.05 to 2.0 mm	**41.27**
% Passing	0.002 to 0.05 mm	**56.63**
% Passing	> 0.002 mm	**2.02**

WEIGHT OF SAMPLE (AIR DRY)	100.00
WEIGHT OF SAMPLE (OVEN DRY)	99.73
PERCENT RETAINED ON # 10	0.08
SPECIFIC GRAVITY	2.761

Mc Hydrom	
Tare Wt	29.50
Wet Wt.	62.41
Dry Wt	62.32
MC	0.2742%

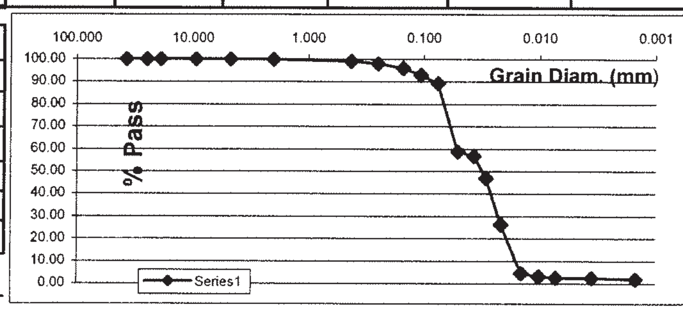
SIEVE	WEIGHT	%RETAIN	GRAIN DIA	%PASSING
40	0.92	1.00	0.425	99.00
60	1.92	2.00	0.250	98.00
100	3.90	3.99	0.150	96.01
140	7.07	7.16	0.105	92.84
200	10.67	10.77	0.075	89.23

TEMP (C)	HYDROMETER CORRECTION	HYDROMETER READING	CORRECTED READING	L.Hydrom FACTOR	K. Diam. FACTOR	a. SP.GR. FACTOR	TIME (MIN)	GRAIN DIA (MM)	% SOIL PASSING
23.0	5.2	65.0	59.8	6.6	0.0138	0.98	0.5	0.0502	58.67
23.0	5.2	63.0	57.8	7	0.0138	0.98	1	0.0365	56.71
23.0	5.2	53.0	47.8	8.6	0.0138	0.98	2	0.0286	46.89
23.0	5.2	32.0	26.8	12	0.0138	0.98	5	0.0214	26.27
22.5	5.4	10.0	4.6	15.6	0.0140	0.98	15	0.0142	4.51
22.5	5.4	8.5	3.1	15.8	0.0140	0.98	30	0.0101	3.04
22.5	5.4	8.0	2.6	16	0.0140	0.98	60	0.0072	2.55
22.0	5.6	8.0	2.4	16	0.0140	0.98	250	0.0035	2.39
22.0	5.6	7.5	1.9	16.1	0.0140	0.98	1440	0.0015	1.90

SPECIFIC GRAVITY		BOTTLE #	Bottle Wt	Bott & Water	WaterTemp	Corr.Soil	Bott, S & Water	WaterTemp	Specif. Grav
Air dry Sample(gr)	50	7	179.97	678.12	22.5	49.86	709.93	22.5	**2.761**

	Sieve Size	Grams Retain	% Pass
Sieve % Pass	1-1/2"	0.00	100.00
Air Dry Start Wt.:	1"	0.00	100.00
334.9	3/4"	0.00	100.00
Dry Start Wt.:	3/8"	0.00	100.00
333.98	No 4	0.00	100.00
	No 10	0.26	99.92

Remarks:



HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

PROJECT:	Luminant Martin Lake, PDP 1-3
CLIENT:	TXU
CONTRACTOR:	not given
JOB No. :	**G 2810 - 08**
REPORT No.:	
DATE SAMPLED:	February 2008
SAMPLED BY:	ETTL Drill Crew
LOCATION:	B-7, 13'-15'
SAMPLE No. :	
DESCRIPTION:	Gray Ash
TECHNICIAN:	H. Walka
DATE:	03/14/08

RESULTS

	Grain Diameter	
% Retain	+2.0 mm	**59.89**
% Retain	+0.05 mm	**92.28**
% Passing	0.05 to 2.0 mm	**32.39**
% Passing	0.002 to 0.05 mm	**4.63**
% Passing	> 0.002 mm	**3.09**

WEIGHT OF SAMPLE (AIR DRY)	50.00
WEIGHT OF SAMPLE (OVEN DRY)	49.81
PERCENT RETAINED ON # 10	59.89
SPECIFIC GRAVITY	2.655

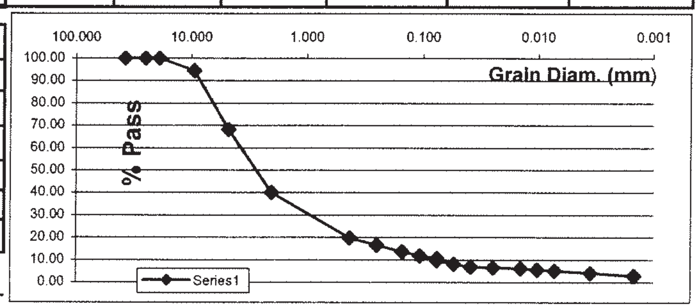
Mc Hydrom	
Tare Wt	30.03
Wet Wt.	45.86
Dry Wt	45.80
MC	0.3805%

SIEVE	WEIGHT	%RETAIN	GRAIN DIA	%PASSING
40	25.25	80.22	0.425	19.78
60	29.25	83.44	0.250	16.56
100	32.74	86.25	0.150	13.75
140	35.11	88.16	0.105	11.84
200	36.67	89.42	0.075	10.58

TEMP (C)	HYDROMETER CORRECTION	HYDROMETER READING	CORRECTED READING	L.Hydrom FACTOR	K. Diam. FACTOR	a. SP.GR. FACTOR	TIME (MIN)	GRAIN DIA (MM)	% SOIL PASSING
22.0	5.6	17.5	11.9	14.5	0.0140	1.00	0.5	0.0752	9.61
22.0	5.6	15.5	9.9	14.8	0.0140	1.00	1	0.0537	8.00
22.0	5.6	14.0	8.4	15	0.0140	1.00	2	0.0383	6.79
22.0	5.6	13.5	7.9	15.2	0.0140	1.00	5	0.0244	6.39
22.0	5.6	13.0	7.4	15.2	0.0140	1.00	15	0.0141	5.99
21.5	5.7	12.5	6.8	15.3	0.0141	1.00	30	0.0101	5.46
21.5	5.7	12.0	6.3	15.3	0.0141	1.00	60	0.0071	5.05
22.0	5.6	10.5	4.9	15.6	0.0140	1.00	250	0.0035	3.97
22.0	5.6	9.0	3.4	15.8	0.0140	1.00	1440	0.0015	2.77

SPECIFIC GRAVITY		BOTTLE #	Bottle Wt	Bott & Water	WaterTemp	Corr.Soil	Bott, S & Water	WaterTemp	Specif. Grav
Air dry Sample(gr)	25	4	179.25	677.26	22.5	24.91	692.79	22.5	**2.655**

	Sieve Size	Grams Retain	% Pass
Sieve % Pass	1-1/2"	0.00	100.00
Air Dry Start Wt.:	1"	0.00	100.00
243.3	3/4"	0.00	100.00
Dry Start Wt.:	3/8"	13.45	94.47
242.38	No 4	77.42	68.18
	No 10	145.71	40.11



Remarks:

LUMINANT

HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

PROJECT: Luminant Martin Lake, PDP 1-3
CLIENT: TXU
CONTRACTOR: not given
JOB No. : **G 2810 - 08**

REPORT No.:
DATE SAMPLED: February 2008
SAMPLED BY: ETTL Drill Crew
LOCATION: B-6, 18'-20'
SAMPLE No. :
DESCRIPTION: Tan Ash
TECHNICIAN: H. Walka
DATE: 03/14/08

RESULTS

	Grain Diameter	
% Retain	+2.0 mm	**10.97**
% Retain	+0.05 mm	**18.74**
% Passing	0.05 to 2.0 mm	**7.77**
% Passing	0.002 to 0.05 mm	**77.39**
% Passing	> 0.002 mm	**3.87**

			Mc Hydrom
WEIGHT OF SAMPLE (AIR DRY)	50.00	Tare Wt	29.86
WEIGHT OF SAMPLE (OVEN DRY)	49.81	Wet Wt.	51.33
PERCENT RETAINED ON # 10	10.97	Dry Wt	51.25
SPECIFIC GRAVITY	2.732	MC	0.3740%

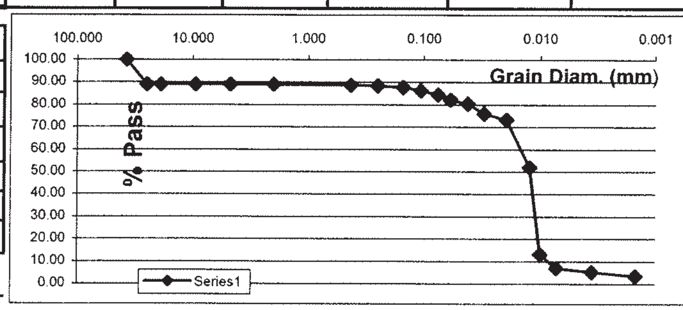
SIEVE	WEIGHT	%RETAIN	GRAIN DIA	%PASSING
40	0.26	11.44	0.425	88.56
60	0.42	11.72	0.250	88.28
100	0.78	12.36	0.150	87.64
140	1.61	13.85	0.105	86.15
200	2.62	15.65	0.075	84.35

TEMP (C)	HYDROMETER CORRECTION	HYDROMETER READING	CORRECTED READING	L.Hydrom FACTOR	K. Diam. FACTOR	a. SP.GR. FACTOR	TIME (MIN)	GRAIN DIA (MM)	% SOIL PASSING
22.0	5.6	52.0	46.4	8.8	0.0140	0.99	0.5	0.0586	82.16
22.0	5.6	51.0	45.4	8.9	0.0140	0.99	1	0.0417	80.39
22.0	5.6	48.5	42.9	9.4	0.0140	0.99	2	0.0303	75.97
22.0	5.6	47.0	41.4	9.6	0.0140	0.99	5	0.0194	73.31
22.0	5.6	35.0	29.4	11.5	0.0140	0.99	15	0.0122	52.08
22.0	5.6	13.0	7.4	15.2	0.0140	0.99	30	0.0099	13.15
22.0	5.6	9.5	3.9	15.8	0.0140	0.99	60	0.0072	6.96
22.0	5.6	8.5	2.9	16	0.0140	0.99	250	0.0035	5.19
22.0	5.6	7.5	1.9	16.1	0.0140	0.99	1440	0.0015	3.42

SPECIFIC GRAVITY		BOTTLE #	Bottle Wt	Bott & Water	WaterTemp	Corr.Soil	Bott, S & Water	WaterTemp	Specif. Grav
Air dry Sample(gr)	50	3	179.93	678.11	22.5	49.81	709.70	22.5	**2.732**

	Sieve Size	Grams Retain	% Pass
Sieve % Pass	1-1/2"	0.00	100.00
Air Dry Start Wt.:	1"	28.83	89.03
262.8	3/4"	28.83	89.03
Dry Start Wt.:	3/8"	28.83	89.03
261.82	No 4	28.83	89.03
	No 10	28.83	89.03

Remarks:



HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

PROJECT: Luminant Martin Lake, PDP 1-3
CLIENT: TXU
CONTRACTOR: not given
JOB No. : **G 2810 - 08**

REPORT No.:
DATE SAMPLED: February 2008
SAMPLED BY: ETTL Drill Crew
LOCATION: B-3, 5'-7'
SAMPLE No. :
DESCRIPTION: Black Ash
TECHNICIAN: H. Walka
DATE: 03/06/08

RESULTS

	Grain Diameter	
% Retain	+2.0 mm	**11.60**
% Retain	+0.05 mm	**76.50**
% Passing	0.05 to 2.0 mm	**64.91**
% Passing	0.002 to 0.05 mm	**21.88**
% Passing	> 0.002 mm	**1.62**

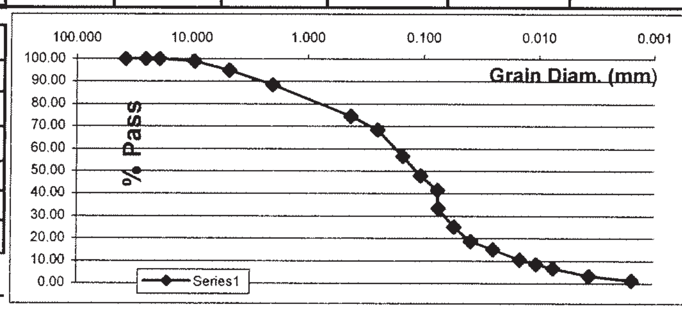
			Mc Hydrom
WEIGHT OF SAMPLE (AIR DRY)	50.00	Tare Wt	29.43
WEIGHT OF SAMPLE (OVEN DRY)	49.53	Wet Wt.	65.41
PERCENT RETAINED ON # 10	11.60	Dry Wt	65.07
SPECIFIC GRAVITY	2.561	MC	0.9540%

SIEVE	WEIGHT	%RETAIN	GRAIN DIA	%PASSING
40	7.81	25.54	0.425	74.46
60	11.21	31.61	0.250	68.39
100	17.82	43.41	0.150	56.59
140	22.64	52.01	0.105	47.99
200	26.25	58.45	0.075	41.55

TEMP (C)	HYDROMETER CORRECTION	HYDROMETER READING	CORRECTED READING	L.Hydrom FACTOR	K. Diam. FACTOR	a. SP.GR. FACTOR	TIME (MIN)	GRAIN DIA (MM)	% SOIL PASSING
20.0	6.2	24.5	18.3	13.3	0.0143	1.02	0.5	0.0738	33.31
20.0	6.2	20.0	13.8	14.2	0.0143	1.02	1	0.0539	25.11
20.0	6.2	16.5	10.3	14.7	0.0143	1.02	2	0.0388	18.74
20.0	6.2	14.5	8.3	15	0.0143	1.02	5	0.0248	15.10
20.0	6.2	12.0	5.8	15.5	0.0143	1.02	15	0.0145	10.55
19.5	6.4	11.0	4.6	15.6	0.0145	1.02	30	0.0104	8.44
19.5	6.4	10.0	3.6	15.8	0.0145	1.02	60	0.0074	6.62
20.0	6.2	8.0	1.8	16.1	0.0143	1.02	250	0.0036	3.27
19.5	6.4	7.0	0.6	16.3	0.0145	1.02	1440	0.0015	1.15

SPECIFIC GRAVITY		BOTTLE #	Bottle Wt	Bott & Water	WaterTemp	Corr.Soil	Bott, S & Water	WaterTemp	Specif. Grav
Air dry Sample(gr)	100	7	179.97	678.12	22.5	99.06	738.67	21.0	**2.561**

	Sieve Size	Grams Retain	% Pass
Sieve % Pass	1-1/2"	0.00	100.00
Air Dry Start Wt.:	1"	0.00	100.00
335.3	3/4"	0.00	100.00
Dry Start Wt.:	3/8"	3.42	98.98
332.13	No 4	17.17	94.88
	No 10	38.89	88.40



Remarks:

HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

PROJECT:	Luminant Martin Lake, PDP 1-3
CLIENT:	TXU
CONTRACTOR:	not given
JOB No. :	**G 2810 - 08**

REPORT No.:	
DATE SAMPLED:	February 2008
SAMPLED BY:	ETTL Drill Crew
LOCATION:	B-2, 23'-25'
SAMPLE No. :	
DESCRIPTION:	Light Gray & Black Ash
TECHNICIAN:	H. Walka
DATE:	03/06/08

RESULTS

	Grain Diameter	
% Retain	+2.0 mm	**0.76**
% Retain	+0.05 mm	**16.00**
% Passing	0.05 to 2.0 mm	**15.24**
% Passing	0.002 to 0.05 mm	**83.90**
% Passing	> 0.002 mm	**0.09**

WEIGHT OF SAMPLE (AIR DRY)	50.00
WEIGHT OF SAMPLE (OVEN DRY)	49.16
PERCENT RETAINED ON # 10	0.76
SPECIFIC GRAVITY	2.675

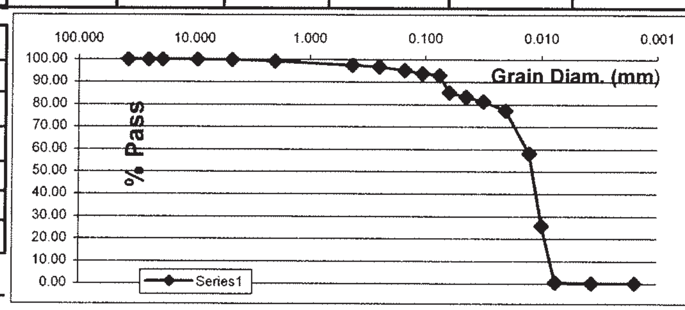
Mc Hydrom	
Tare Wt	29.91
Wet Wt.	55.02
Dry Wt	54.60
MC	1.7011%

SIEVE	WEIGHT	%RETAIN	GRAIN DIA	%PASSING
40	0.89	2.56	0.425	97.44
60	1.22	3.22	0.250	96.78
100	2.01	4.82	0.150	95.18
140	2.67	6.15	0.105	93.85
200	3.07	6.96	0.075	93.04

TEMP (C)	HYDROMETER CORRECTION	HYDROMETER READING	CORRECTED READING	L.Hydrom FACTOR	K. Diam. FACTOR	a. SP.GR. FACTOR	TIME (MIN)	GRAIN DIA (MM)	% SOIL PASSING
20.0	6.2	48.5	42.3	9.4	0.0143	1.00	0.5	0.0620	85.37
20.0	6.2	47.5	41.3	9.6	0.0143	1.00	1	0.0443	83.35
20.0	6.2	46.5	40.3	9.7	0.0143	1.00	2	0.0315	81.33
20.0	6.2	44.5	38.3	10.1	0.0143	1.00	5	0.0203	77.30
20.0	6.2	35.0	28.8	11.7	0.0143	1.00	15	0.0126	58.12
20.0	6.2	19.0	12.8	14.3	0.0143	1.00	30	0.0099	25.83
20.0	6.2	6.5	0.3	16.3	0.0143	1.00	60	0.0075	0.59
20.0	6.2	6.3	0.1	16.3	0.0143	1.00	250	0.0037	0.19
19.5	6.4	6.4	0.0	16.3	0.0145	1.00	1440	0.0015	0.07

SPECIFIC GRAVITY		BOTTLE #	Bottle Wt	Bott & Water	WaterTemp	Corr.Soil	Bott, S & Water	WaterTemp	Specif. Grav
Air dry Sample(gr)	50	4	179.25	677.26	22.5	49.16	708.22	21.0	**2.675**

	Sieve Size	Grams Retain	% Pass
Sieve % Pass	1-1/2"	0.00	100.00
Air Dry Start Wt.:	1"	0.00	100.00
144.3	3/4"	0.00	100.00
Dry Start Wt.:	3/8"	0.00	100.00
141.89	No 4	0.10	99.93
	No 10	1.10	99.24



Remarks:

HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

PROJECT:	Luminant Martin Lake, PDP 1-3
CLIENT:	TXU
CONTRACTOR:	not given
JOB No. :	**G 2810 - 08**
REPORT No.:	
DATE SAMPLED:	February 2008
SAMPLED BY:	ETTL Drill Crew
LOCATION:	B-1, 18'-20'
SAMPLE No. :	
DESCRIPTION:	Black, Tan & Gray Ash
TECHNICIAN:	H. Walka
DATE:	03/06/08

RESULTS

	Grain Diameter	
% Retain	+2.0 mm	**14.96**
% Retain	+0.05 mm	**64.42**
% Passing	0.05 to 2.0 mm	**49.46**
% Passing	0.002 to 0.05 mm	**35.29**
% Passing	> 0.002 mm	**0.29**

WEIGHT OF SAMPLE (AIR DRY)	50.00
WEIGHT OF SAMPLE (OVEN DRY)	49.29
PERCENT RETAINED ON # 10	14.96
SPECIFIC GRAVITY	2.608

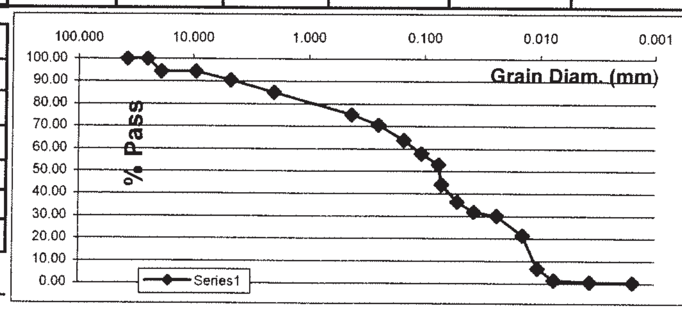
	Mc Hydrom
Tare Wt	29.29
Wet Wt.	59.40
Dry Wt	58.97
MC	1.4488%

SIEVE	WEIGHT	%RETAIN	GRAIN DIA	%PASSING
40	5.76	24.90	0.425	75.10
60	8.38	29.42	0.250	70.58
100	12.31	36.20	0.150	63.80
140	15.78	42.19	0.105	57.81
200	18.60	47.05	0.075	52.95

TEMP (C)	HYDROMETER CORRECTION	HYDROMETER READING	CORRECTED READING	L.Hydrom FACTOR	K. Diam. FACTOR	a. SP.GR. FACTOR	TIME (MIN)	GRAIN DIA (MM)	% SOIL PASSING
20.0	6.2	31.5	25.3	12.2	0.0143	1.01	0.5	0.0707	44.08
20.0	6.2	27.0	20.8	13	0.0143	1.01	1	0.0516	36.24
20.0	6.2	24.5	18.3	13.3	0.0143	1.01	2	0.0369	31.88
20.0	6.2	23.5	17.3	13.5	0.0143	1.01	5	0.0235	30.14
20.0	6.2	18.5	12.3	14.3	0.0143	1.01	15	0.0140	21.43
20.0	6.2	10.0	3.8	15.8	0.0143	1.01	30	0.0104	6.61
20.0	6.2	7.0	0.8	16.3	0.0143	1.01	60	0.0075	1.38
20.0	6.2	6.5	0.3	16.3	0.0143	1.01	250	0.0037	0.51
19.5	6.4	6.5	0.1	16.3	0.0145	1.01	1440	0.0015	0.23

SPECIFIC GRAVITY		BOTTLE #	Bottle Wt	Bott & Water	WaterTemp	Corr.Soil	Bott, S & Water	WaterTemp	Specif. Grav
Air dry Sample(gr)	100	3	179.93	678.11	22.5	98.57	739.11	20.5	**2.608**

	Sieve Size	Grams Retain	% Pass
Sieve % Pass	1-1/2"	0.00	100.00
Air Dry Start Wt.:	1"	0.00	100.00
268.4	3/4"	15.10	94.37
Dry Start Wt.:	3/8"	15.10	94.37
264.57	No 4	25.58	90.47
	No 10	40.15	85.04



Remarks:

HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

PROJECT: Luminant Martin Lake, PDP 1-3
CLIENT: TXU
CONTRACTOR: not given
JOB No. : **G 2810 - 08**

REPORT No.:
DATE SAMPLED: February 2008
SAMPLED BY: ETTL Drill Crew
LOCATION: MLSES
SAMPLE No. :
DESCRIPTION: Tan & Gray Econimizet Ash
TECHNICIAN: M. Thompson
DATE: 04/15/08

RESULTS

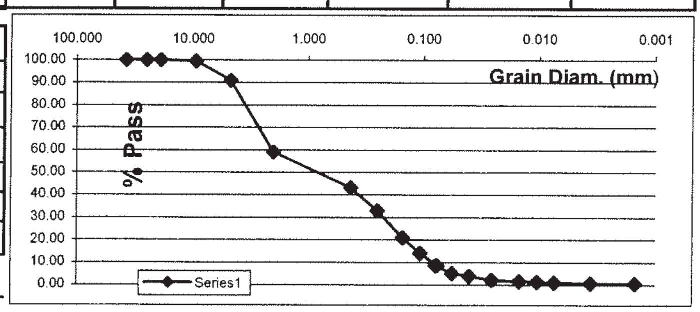
	Grain Diameter	
% Retain	+2.0 mm	**41.02**
% Retain	+0.05 mm	**95.89**
% Passing	0.05 to 2.0 mm	**54.87**
% Passing	0.002 to 0.05 mm	**3.55**
% Passing	> 0.002 mm	**0.55**

				SIEVE	**WEIGHT**	**%RETAIN**	**GRAIN DIA**	**%PASSING**
		Mc Hydrom		40	13.34	56.76	0.425	43.24
WEIGHT OF SAMPLE (AIR DRY)	50.00	Tare Wt	30.27	60	22.12	67.12	0.250	32.88
WEIGHT OF SAMPLE (OVEN DRY)	49.98	Wet Wt.	62.43	100	32.26	79.09	0.150	20.91
PERCENT RETAINED ON # 10	41.02	Dry Wt	62.42	140	38.01	85.87	0.105	14.13
SPECIFIC GRAVITY	2.670	MC	0.0311%	200	42.66	91.36	0.075	8.64

TEMP (C)	HYDROMETER CORRECTION	HYDROMETER READING	CORRECTED READING	L.Hydrom FACTOR	K. Diam. FACTOR	a. SP.GR. FACTOR	TIME (MIN)	GRAIN DIA (MM)	% SOIL PASSING
21.5	5.7	13.0	7.3	15.2	0.0141	1.00	0.5	0.0780	8.58
21.5	5.7	10.0	4.3	15.6	0.0141	1.00	1	0.0558	5.04
21.5	5.7	9.0	3.3	15.8	0.0141	1.00	2	0.0397	3.86
21.5	5.7	7.5	1.8	16.1	0.0141	1.00	5	0.0254	2.09
21.5	5.7	7.0	1.3	16.1	0.0141	1.00	15	0.0146	1.50
21.5	5.7	6.8	1.1	16.1	0.0141	1.00	30	0.0104	1.27
21.5	5.7	6.5	0.8	16.3	0.0141	1.00	60	0.0074	0.91
21.5	5.7	6.3	0.6	16.3	0.0141	1.00	250	0.0036	0.68
22.0	5.6	6.0	0.4	16.3	0.0140	1.00	1440	0.0015	0.51

SPECIFIC GRAVITY		BOTTLE #	Bottle Wt	Bott & Water	WaterTemp	Corr.Soil	Bott, S & Water	WaterTemp	Specif. Grav
Air dry Sample(gr)	100	7	179.97	678.12	22.5	99.97	740.78	21.5	**2.670**

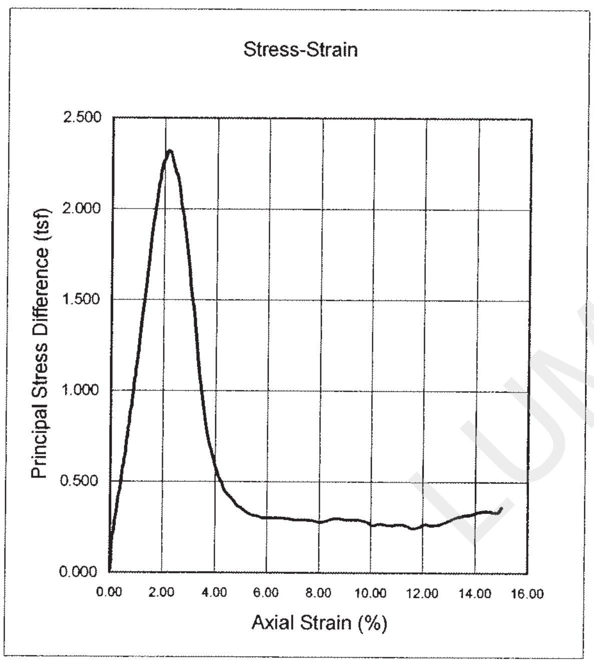
	Sieve Size	Grams Retain	% Pass
Sieve % Pass	1-1/2"	0.00	100.00
Air Dry Start Wt.:	1"	0.00	100.00
2182.9	3/4"	0.00	100.00
Dry Start Wt.:	3/8"	12.53	99.43
2182.22	No 4	200.01	90.83
	No 10	895.12	58.98



Remarks:

ASTM D 2850 Confined Compressive Strength of Cohesive Soil

Project: Luminant Martin Lake: PDP 1-3



Project No.:	G 2810-08	
Boring No.:	B-7	
Depth, ft.:	5'-7'	
Material:	Black Ash with Gravel	
Initial Height	5.706	Inches
Initial Diameter	2.767	Inches
Moisture Content:	22.9%	%
Dry Density:	97.5	lbs/cu ft
Specific Gravity (Assumed)	2.670	
Volume of Solids:	0.585	
Volume of Voids	0.415	
Void Ratio:	0.709	
Confining Pressure:	6.1	PSI
Pocket Penetr. Reading:	4.5	
Torvane (T)		
Rate of Strain: (%/ min)	1.0%	
Peak Strain:	**2.1**	%
Max Stress:	**2.32**	**TSF**
Date:	3/11/2008	

1/2 Stress (KSF) 2.321

Strain at 1/2 Stress (%) 0.99

Type of Specimen: Native

Remarks:

Secant Modulus (KSF) @ 1/2 Peak Stress 234

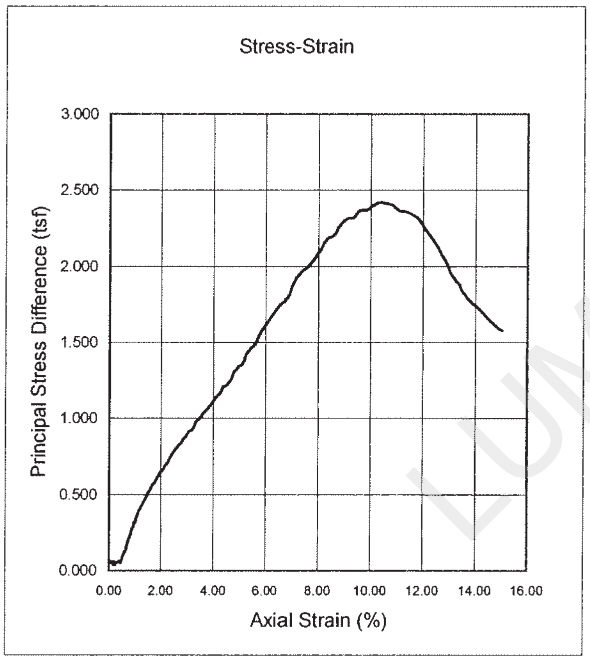
RQD Value: 100%

Angle of Fracture in Degrees: 65

Sketch of Fracture:

ASTM D 2850 Confined Compressive Strength of Cohesive Soil

Project: TXU PDP: Martin Lake, TX



Project No.:	G 2810-08	
Boring No.:	B-4	
Depth, ft.:	13'-15'	
Material:	Red & Gray Laminated Lean Clay	
Initial Height	3.613	Inches
Initial Diameter	2.667	Inches
Moisture Content:	22.3%	%
Dry Density:	99.4	lbs/cu ft
Specific Gravity (Assumed)	2.670	
Volume of Solids:	0.596	
Volume of Voids	0.404	
Void Ratio:	0.677	
Confining Pressure:	13	PSI
Pocket Penetr. Reading:	3.5	
Torvane (T)		
Rate of Strain: (%/ min)	1.0%	
Peak Strain:	**10.3**	%
Max Stress:	**2.42**	**TSF**
Date:	5/12/2008	

1/2 Stress (KSF) 2.416

Secant Modulus (KSF) @ 1/2 Peak Stress 61

Strain at 1/2 Stress (%) 3.94

RQD Value: 100%

Type of Specimen: Native

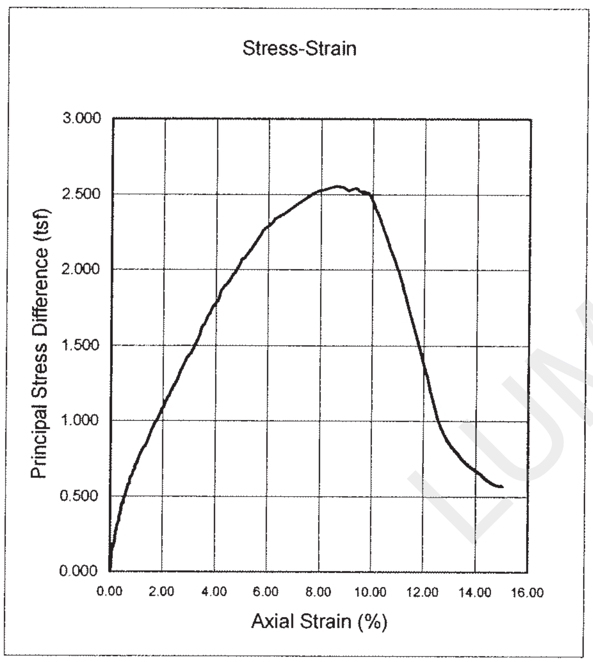
Angle of Fracture in Degrees: N/A

Remarks: undefined fracture

Sketch of Fracture:

ASTM D 2850 Confined Compressive Strength of Cohesive Soil

Project: Luminant Martin Lake: PDP 1-3



Project No.:	G 2810-08	
Boring No.:	B-4	
Depth, ft.:	13'-15'	
Material:	Light Gray & Red Slity Clayey Sand w/ Ferric seams	
Initial Height	5.688	Inches
Initial Diameter	2.75	Inches
Moisture Content:	21.5%	%
Dry Density:	104.6	lbs/cu ft
Specific Gravity (Assumed)	2.670	
Volume of Solids:	0.628	
Volume of Voids	0.372	
Void Ratio:	0.593	
Confining Pressure:	13	PSI
Pocket Penetr. Reading:	3.9	
Torvane (T)	1.138	
Rate of Strain: (%/ min)	1.0%	
Peak Strain:	**8.6**	%
Max Stress:	**2.55**	**TSF**
Date:	4/11/2008	

1/2 Stress (KSF) 2.552

Strain at 1/2 Stress (%) 2.54

Type of Specimen: Native

Remarks:

Secant Modulus (KSF) @ 1/2 Peak Stress 100

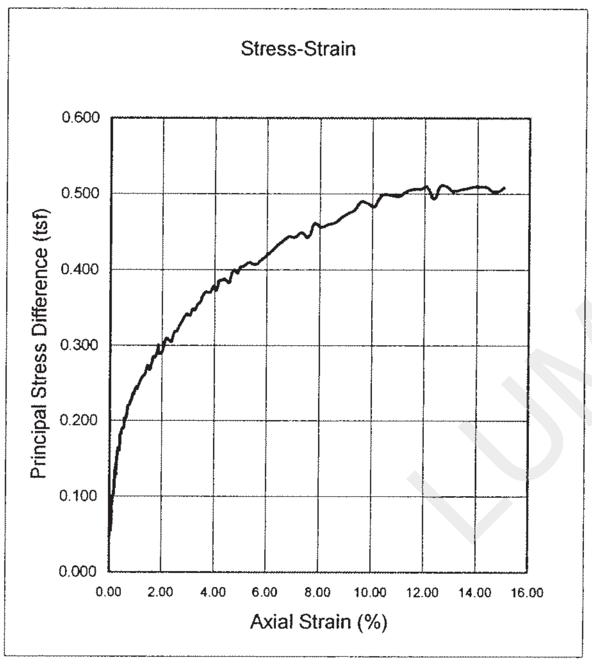
RQD Value: 100%

Angle of Break in Degrees: 60

Sketch of Fracture:

ASTM D 2850 Confined Compressive Strength of Cohesive Soil

Project: Luminant Martin Lake: PDP 1-3



Project No.:	G 2810-08	
Boring No.:	B-7	
Depth, ft.:	23'-25'	
Material:	Black, Red, Tan, & Gray Clay w/ gravel	
Initial Height	5.686	Inches
Initial Diameter	2.717	Inches
Moisture Content:	21.0%	%
Dry Density:	103.9	lbs/cu ft
Specific Gravity (Assumed)	2.670	
Volume of Solids:	0.624	
Volume of Voids	0.376	
Void Ratio:	0.603	
Confining Pressure:	21.7	PSI
Pocket Penetr. Reading:		
Torvane (T)		
Rate of Strain: (%/ min)	1.0%	
Peak Strain:	**12.8**	%
Max Stress:	**0.51**	**TSF**
Date:	3/11/2008	

1/2 Stress (KSF) 0.510

Secant Modulus (KSF) @ 1/2 Peak Stress 43

Strain at 1/2 Stress (%) 1.20

RQD Value: 100%

Type of Specimen: Native

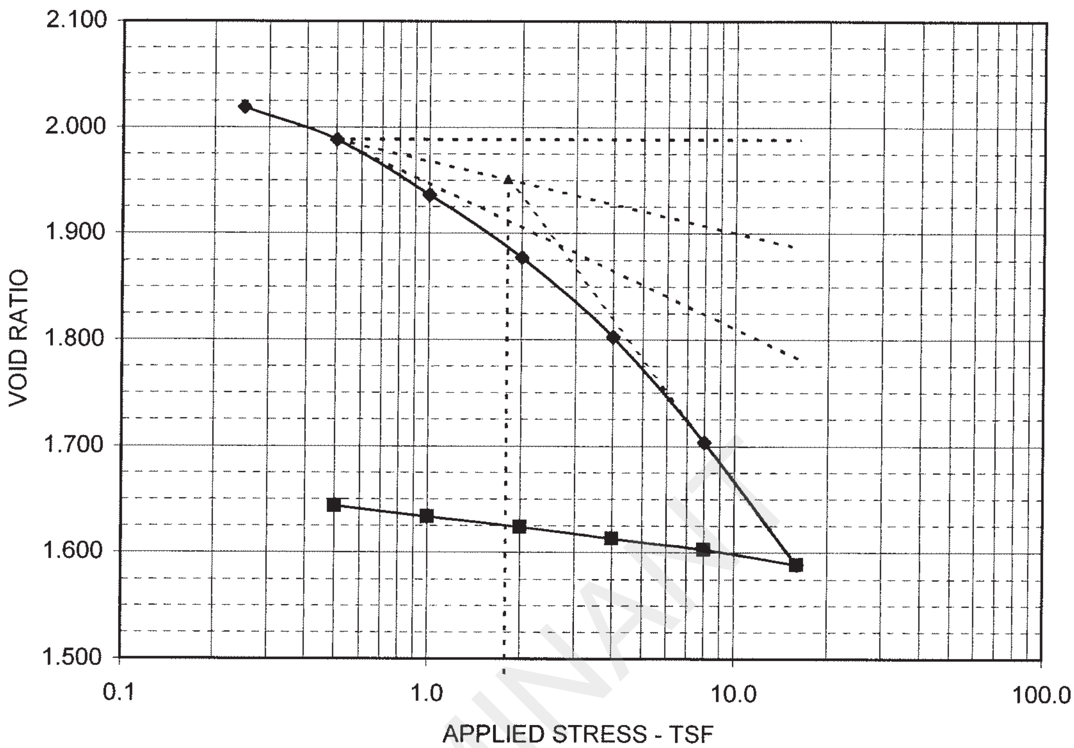
Angle of Break in Degrees: 53

Remarks: Not able to find a well defined fracture

Sketch of Fracture:

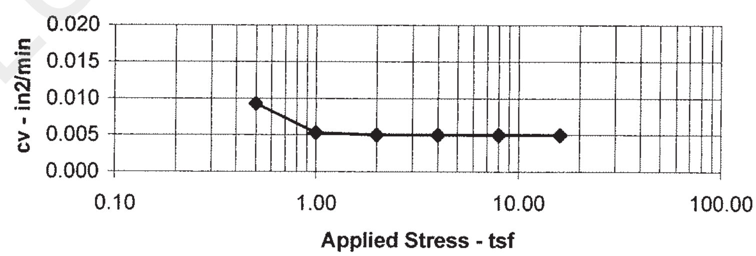
CONSOLIDATION TEST REPORT

ASTM D 2435



C_c = 0.381	C_r = 0.033	e_0 = 2.0191	Pc (tsf) = 1.79	OCR = 10.2

LOAD tsf	c_v in^2/min	k in/min
Seating	NA	NA
0.50	9.34E-03	9.85E-07
1.00	5.36E-03	4.89E-07
2.00	5.03E-03	2.65E-07
4.00	5.04E-03	1.73E-07
8.00	5.03E-03	1.18E-07
16.00	5.03E-03	7.08E-08



c_v values calculated by Sivaram and Swamee's Method

SAMPLE AND TEST DATA

SAMPLE LOCATION: B-6, 3-5'
DESCRIPTION: Ash, black and dark gray

LL: NA PL: NA PI: NA -200:NA
ASSUMED SPECIFIC GRAVITY: 2.70
MC Initial: 58.1% MC Final: 47.2%
Dia. (in.) : 2.50 Height (in.) : 1.000
Initial Sat %: 70.2 Final Sat %: 100.0
DRY DENSITY (pcf): 55.8

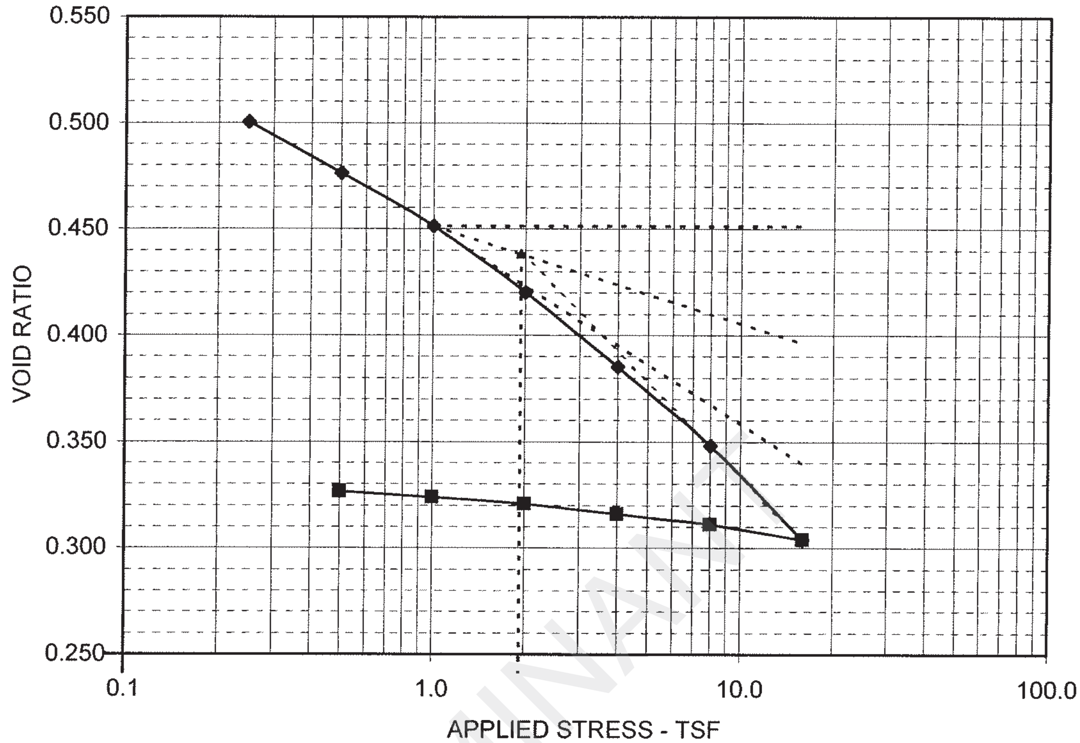
PROJECT INFORMATION

PROJECT:	Luminant Martin Lake PDP 1-3
LOCATION:	Rusk, TX.
PROJECT NO.:	ETT08002-07
CLIENT:	ETTL Engineers & Consultants, Inc.
CLIENT NO.:	G2810-08
DATE:	4/24/2008

REMARKS: OCR calculated based on Pc and vertical overburden

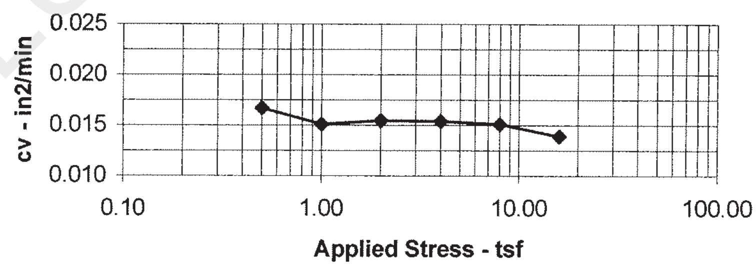
GREGORY GEOTECHNICAL PLATE B-CN.1

CONSOLIDATION TEST REPORT
ASTM D 2435



C_c = 0.146	C_r = 0.012	e_0 = 0.5597	Pc (tsf) = 1.93	OCR = 3.5

LOAD tsf	c_v in^2/min	k in/min
Seating	NA	NA
0.50	1.67E-02	2.82E-06
1.00	1.51E-02	1.33E-06
2.00	1.55E-02	8.75E-07
4.00	1.54E-02	5.00E-07
8.00	1.51E-02	2.67E-07
16.00	1.39E-02	1.50E-07



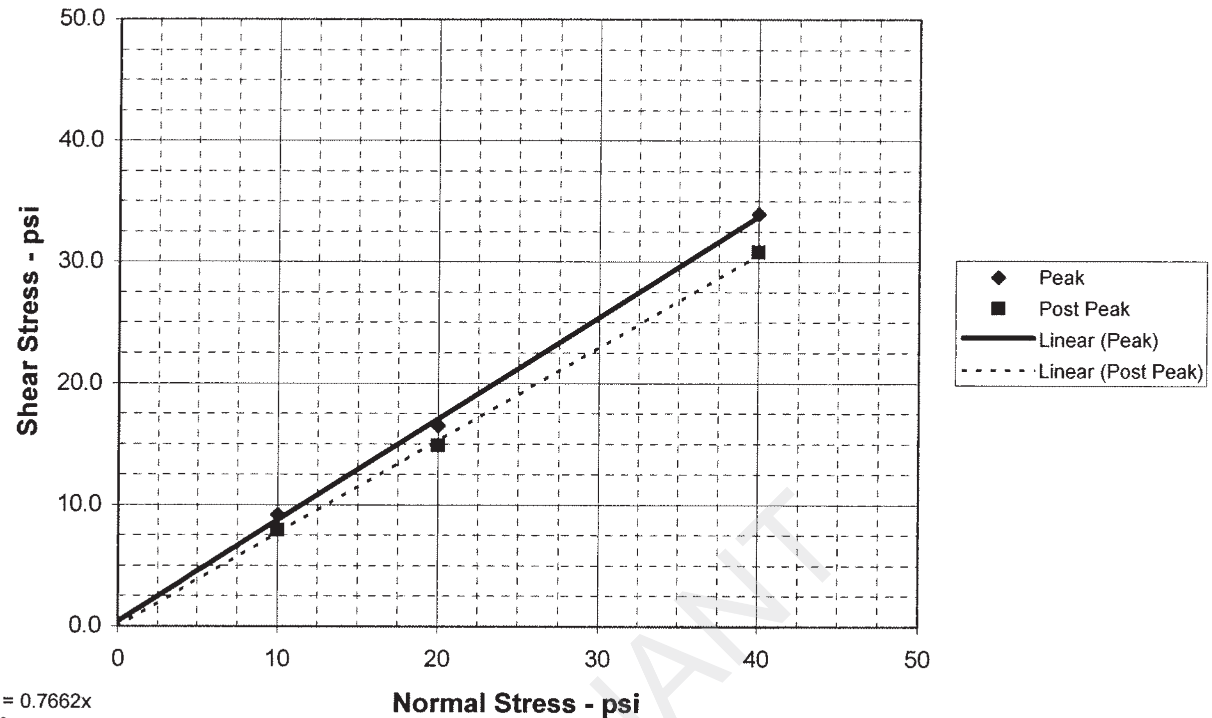
c_v values calculated by Sivaram and Swamee's Method

SAMPLE AND TEST DATA			
SAMPLE LOCATION: B-4, 8-10'			
DESCRIPTION: Clayey Sand , reddish brown with gray			
LL: NA	PL: NA	PI: NA	-200: NA
ASSUMED SPECIFIC GRAVITY:			2.70
MC Initial:	13.0%	MC Final:	19.6%
Dia. (in.) :	2.50	Height (in.) :	1.000
Initial Sat %:	70.2	Final Sat %:	100.0
DRY DENSITY (pcf):		108.0	

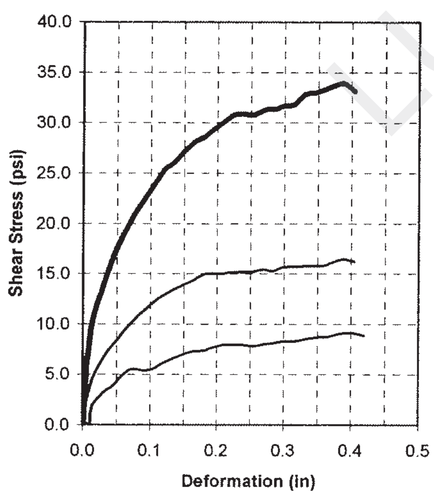
PROJECT INFORMATION	
PROJECT:	Luminant Martin Lake PDP 1-3
LOCATION:	Rusk, TX.
PROJECT NO.:	ETT08002-07
CLIENT:	ETTL Engineers & Consultants, Inc.
CLIENT NO.:	G2810-08
DATE:	4/24/2008
REMARKS: OCR calculated based on Pc and vertical overburden	

GREGORY GEOTECHNICAL | PLATE B-CN.2

DIRECT SHEAR TEST REPORT



PEAK STRENGTH PARAMETERS	ϕ =	39.8 deg	c =	0.5 psi
POST PEAK STRENGTH PARAMETERS	ϕ =	37.5 deg	c =	0.0 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	52.1	29.3	21.2	
Dry Density - pcf	50.2	71.7	95.2	
Diameter - inches	2.50	2.50	2.50	
Height - inches	1.13	1.13	1.13	
AT TEST				
Final Moisture - %	64.3	25.0	31.6	
Dry Density - pcf	55.8	79.1	117.3	
Height-End of Consol. (in.)	1.02	1.03	0.92	
Height-End of Shear (in.)	0.97	0.99	0.89	
Normal Stress - psi	10.0	20.0	40.0	
Peak Failure Stress-psi	9.2	16.5	34.0	
Post Peak Failure Stress-psi	7.9	14.9	30.8	
Strain Rate - inches/min.	0.00300	0.00300	0.00300	
Peak Failure Strain - %	16.2	15.6	15.6	
Post Peak Failure Strain %	8.4	7.2	9.6	

Dry Density at test based on initial moisture and height at end of consolidation.

TEST DESCRIPTION

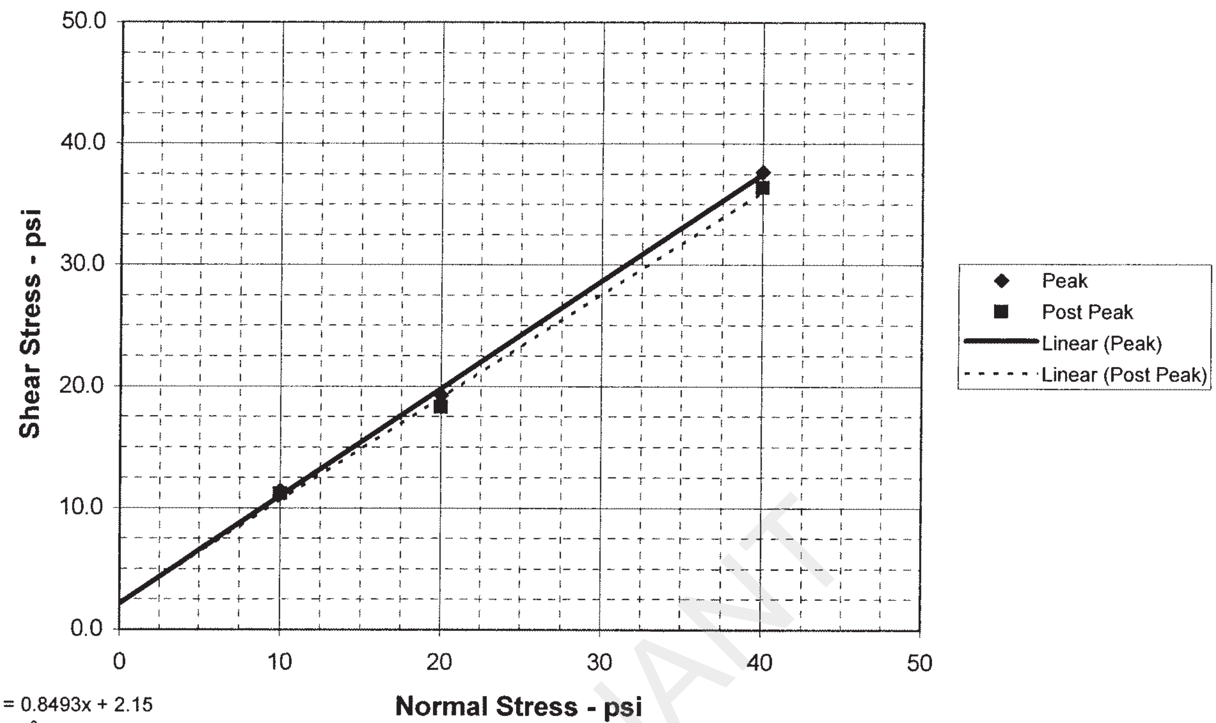
TYPE OF TEST & NO: CD-DS-1
SAMPLE TYPE: Shelby Tube
DESCRIPTION: Ash, black and gray
SAMPLE LOCATION: B-6, 3-5 ft
ASSUMED SPECIFIC GRAVITY: 2.65
LL: 35 PL: 19 PI: 16 Percent -200: 61
REMARKS: Multi-Specimen

PROJECT INFORMATION

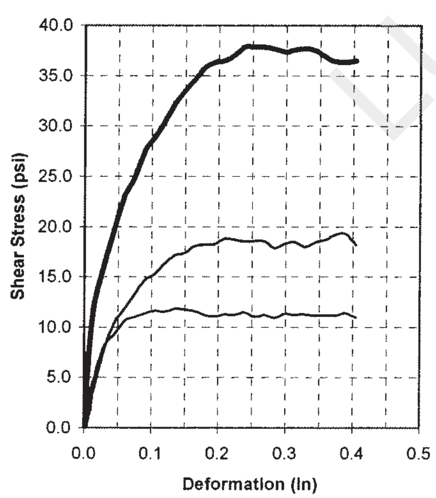
PROJECT: Luminant Martin Lake PDP 1-3
LOCATION: Rusk , TX
PROJECT NO: ETT08002-07 (G2810-08)
CLIENT : ETTL Engineers & Consultants, Inc
DATE:4/25/08

GREGORY GEOTECHNICAL PLATE: B-DS.1

DIRECT SHEAR TEST REPORT



PEAK STRENGTH PARAMETERS	ϕ =	41.4 deg	c =	2.2 psi
POST PEAK STRENGTH PARAMETERS	ϕ =	40.3 deg	c =	2.2 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	13.1	13.1	13.1	
Dry Density - pcf	71.8	71.7	71.7	
Diameter - inches	2.50	2.50	2.50	
Height - inches	1.00	1.00	1.00	
AT TEST				
Final Moisture - %	38.5	37.4	31.6	
Dry Density - pcf	73.6	73.7	75.8	
Height-End of Consol. (in.)	0.98	0.97	0.95	
Height-End of Shear (in.)	1.00	0.96	0.92	
Normal Stress - psi	10.0	20.0	40.0	
Peak Failure Stress-psi	11.4	19.3	37.7	
Post Peak Failure Stress-psi	11.2	18.3	36.4	
Strain Rate - inches/min.	0.00300	0.00300	0.00300	
Peak Failure Strain - %	15.6	15.6	13.2	
Post Peak Failure Strain %	13.8	12.0	15.0	

Dry Density at test based on initial moisture and height at end of consolidation.

TEST DESCRIPTION

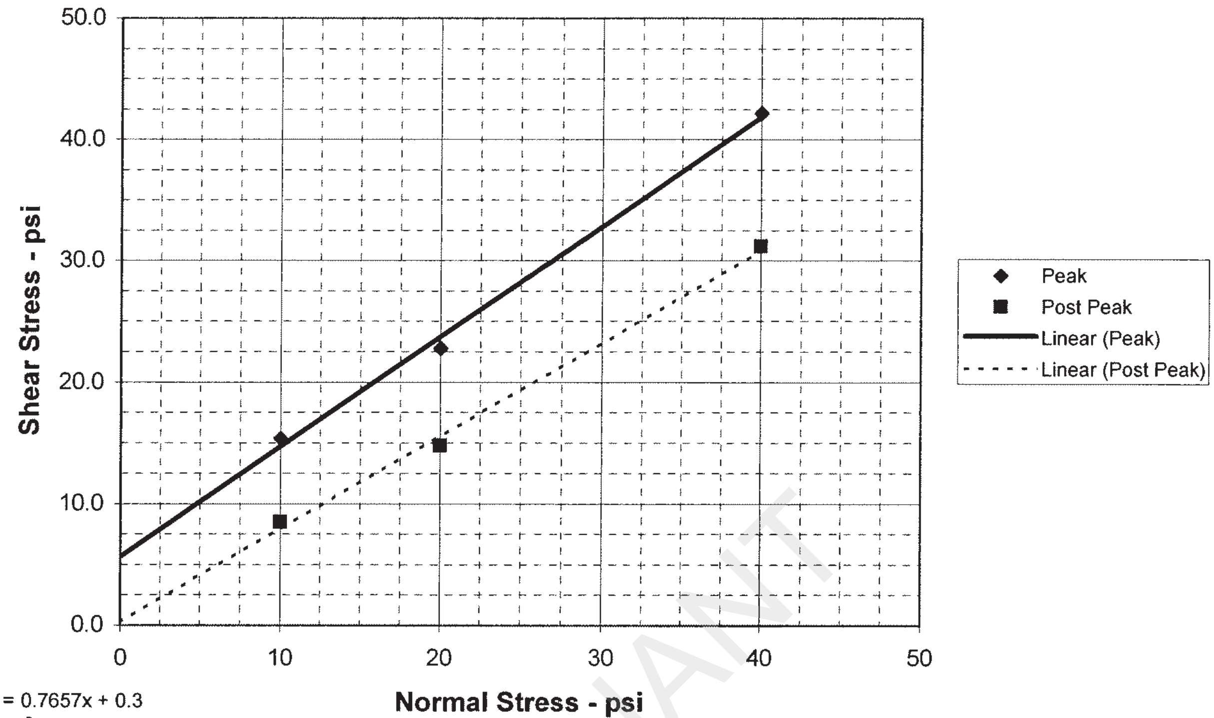
TYPE OF TEST & NO: CD-DS-2
SAMPLE TYPE: Re-Compacted
DESCRIPTION: Ash, black and dark gray
SAMPLE LOCATION: MLSES (Bulk)
SPECIFIC GRAVITY: 2.56
LL: NP PL: NP PI: NP Percent -200: 3.33
REMARKS: Multi-Specimen

PROJECT INFORMATION

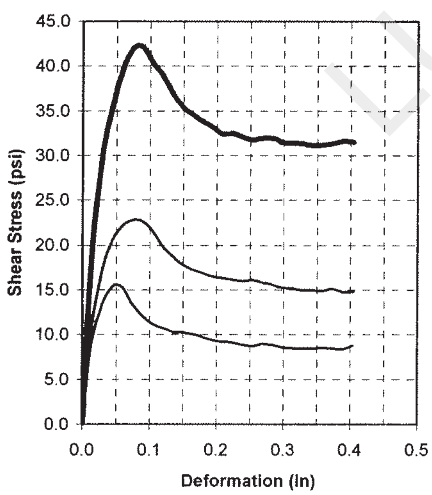
PROJECT: Luminant Martin Lake PDP 1-3
LOCATION: Rusk , TX
PROJECT NO: ETT08002-07 (G2810-08)
CLIENT : ETTL Engineers & Consultants, Inc
DATE:5/6/08

GREGORY GEOTECHNICAL | PLATE: B-DS.2

DIRECT SHEAR TEST REPORT



PEAK STRENGTH PARAMETERS	ϕ =	42.1 deg	c =	5.7 psi
POST PEAK STRENGTH PARAMETERS	ϕ =	37.4 deg	c =	0.3 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	0.1	0.1	0.1	
Dry Density - pcf	71.7	71.7	71.7	
Diameter - inches	2.50	2.50	2.50	
Height - inches	1.00	1.00	1.00	
AT TEST				
Final Moisture - %	50.3	37.4	31.6	
Dry Density - pcf	73.4	73.1	73.1	
Height-End of Consol. (in.)	0.98	0.98	0.98	
Height-End of Shear (in.)	1.01	1.01	0.99	
Normal Stress - psi	10.0	20.0	40.0	
Peak Failure Stress-psi	15.4	22.8	42.2	
Post Peak Failure Stress-psi	8.5	14.8	31.2	
Strain Rate - inches/min.	0.00300	0.00300	0.00300	
Peak Failure Strain - %	17.6	3.0	3.6	
Post Peak Failure Strain %	15.0	15.6	13.8	

Dry Density at test based on initial moisture and height at end of consolidation.

TEST DESCRIPTION

TYPE OF TEST & NO: CD-DS-2
SAMPLE TYPE: Re-Compacted
DESCRIPTION: Economized Ash, tan and gray
SAMPLE LOCATION: MLSES (Bulk)
SPECIFIC GRAVITY: 2.67
LL: NP PL: NP PI: NP Percent -200: 8.64
REMARKS: Multi-Specimen

PROJECT INFORMATION

PROJECT: Luminant Martin Lake PDP 1-3
LOCATION: Rusk , TX
PROJECT NO: ETT08002-07 (G2810-08)
CLIENT : ETTL Engineers & Consultants, Inc
DATE:5/20/08

GREGORY GEOTECHNICAL PLATE: B-DS.3

PROJECT INFORMATION

PROJECT: Martin Lake PDP 1 - 3 Supplemental
LOCATION:
PROJECT NO: G 3219 - 09
CLIENT: HDR
September 2009

TRIAXIAL TEST PROGRAM BY GARRY H. GREGORY, P.E.

VERSION 1.0 - AUGUST 1998 - REVISED MARCH 24, 1999

THIS COPY LICENSED TO:
ETTL ENGINEERS AND CONSULTANTS, INC.
1717 East Erwin
Tyler, TX 75702

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Shelby Tube Sample
DESCRIPTION: Tan w/ Red & Gray Clayey Sand
Sampled on Site, B-16 8' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

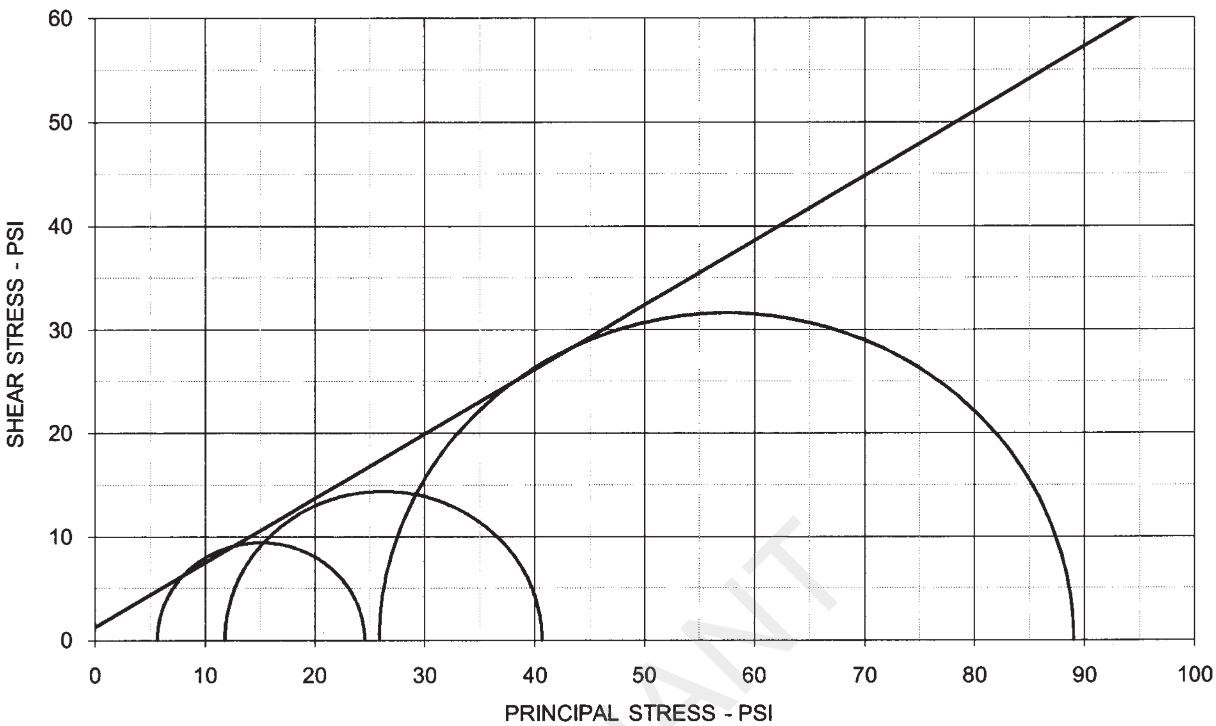
PLATE: B.1

PLATE: B.2

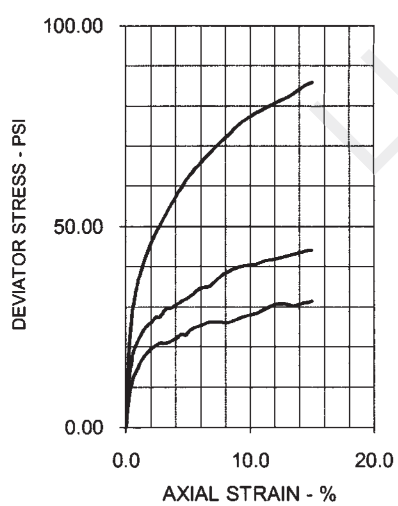
PLATE: B.3

Number of Specimens = 3

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	φ ' = 31.9 deg	c' = 1.3 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	17.2	16.8	16.3	
Dry Density - pcf	112.6	114.4	115.0	
Diameter - inches	2.47	2.46	2.48	
Height - inches	4.98	4.97	5.00	
AT TEST				
Final Moisture - %	18.4	16.5	16.0	
Dry Density - pcf	113.1	115.3	116.9	
Calculated Diameter (in.)	2.47	2.46	2.50	
Height - inches	5.00	4.97	5.06	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	18.88	28.83	63.14	
Total Pore Pressure - psi	54.3	58.2	64.1	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.8	3.0	5.2	
σ_1' Failure - psi	24.54	40.64	89.01	
σ_3' Failure - psi	5.66	11.81	25.87	

TEST DESCRIPTION

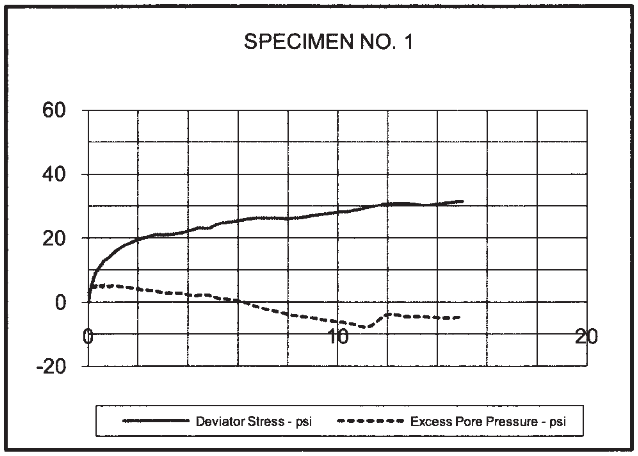
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Shelby Tube Sample
DESCRIPTION: Tan w/ Red & Gray Clayey Sand
Sampled on Site, B-16 8' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

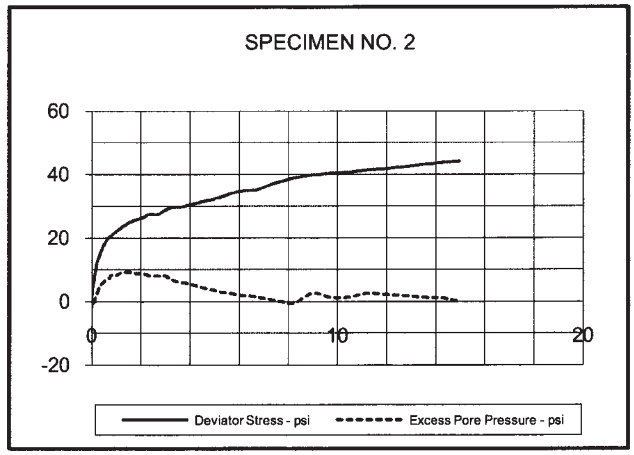
PROJECT INFORMATION

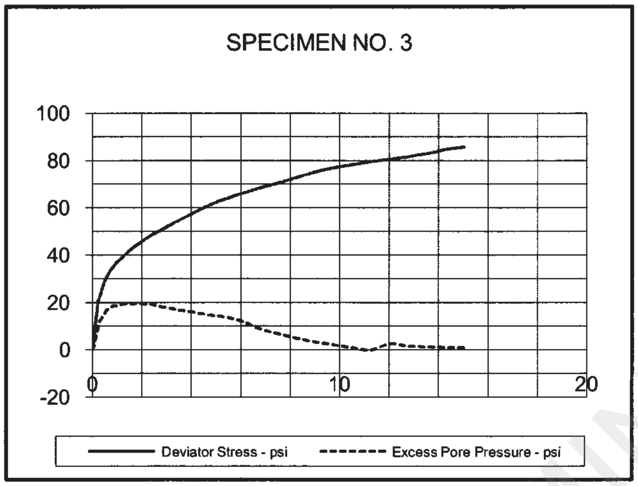
PROJECT: Martin Lake PDP 1 - 3 Supplemental
LOCATION:
PROJECT NO: G 3219 - 09
CLIENT: HDR
September 2009

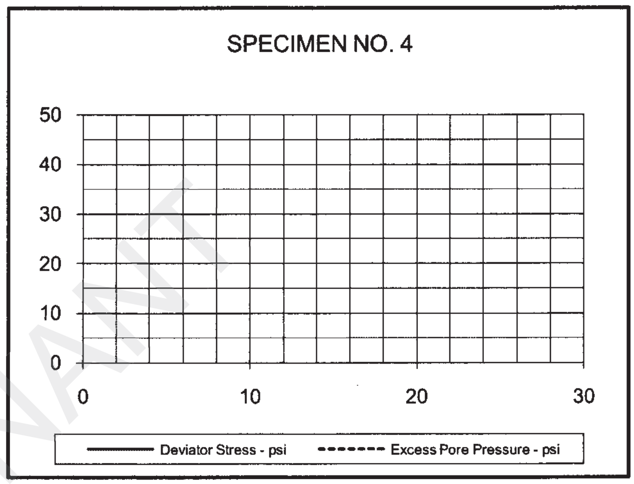
ETTL ENGINEERS & CONSULTANTS | PLATE: B.1

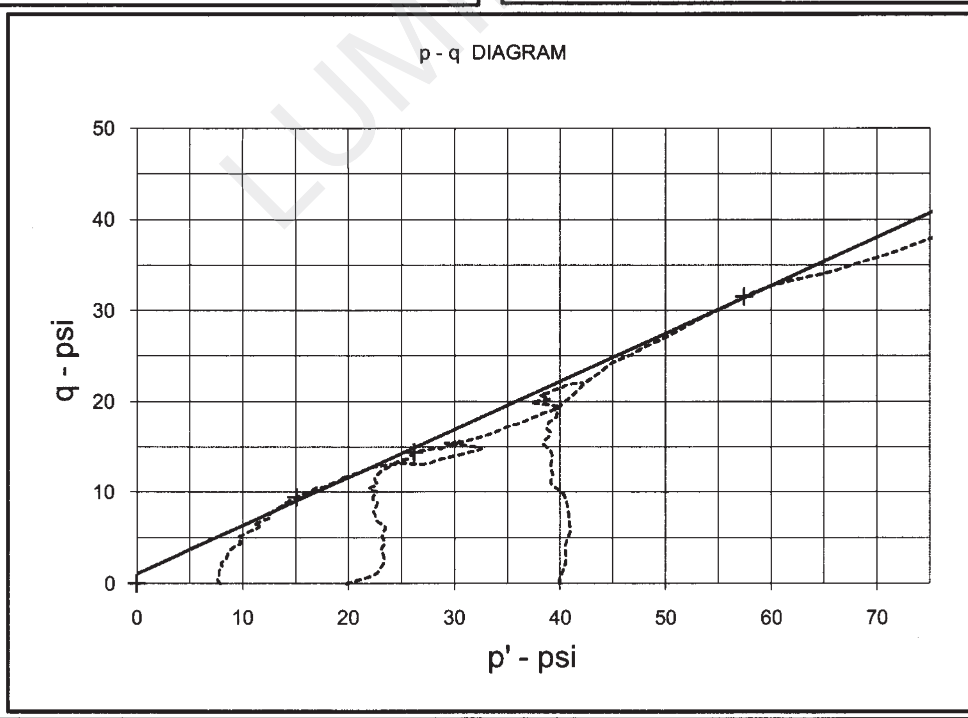
G 3219-09, B-16 8'-10' Native







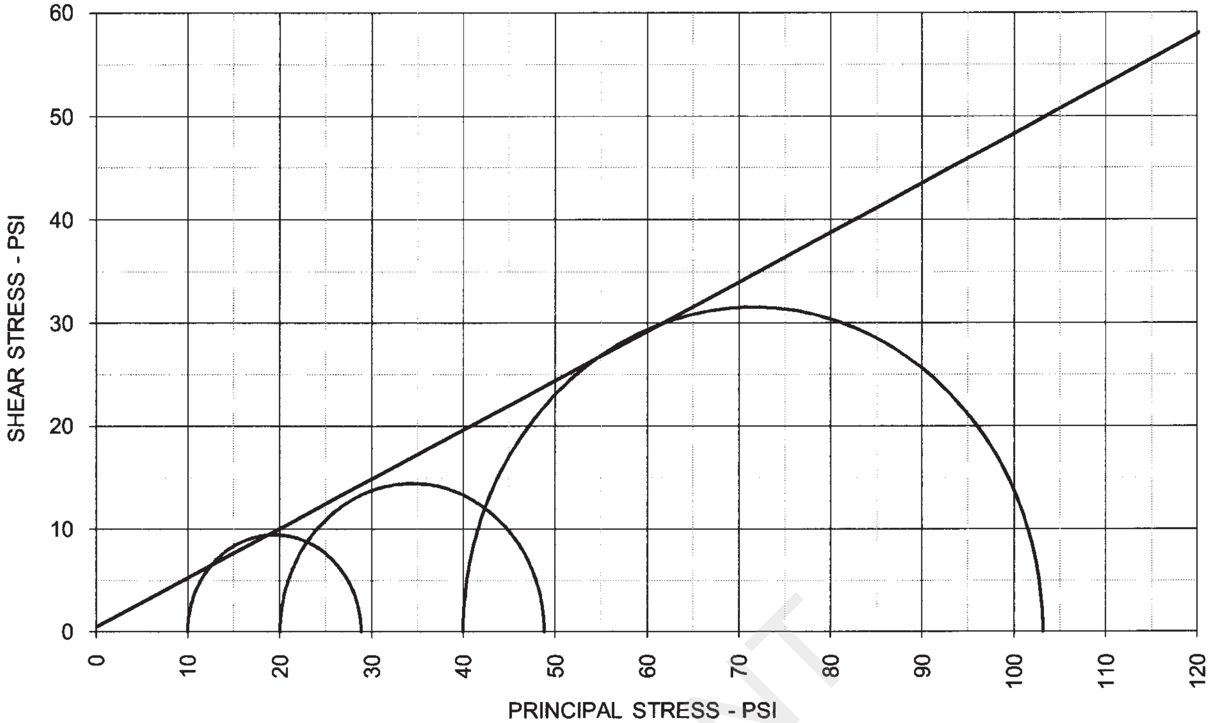




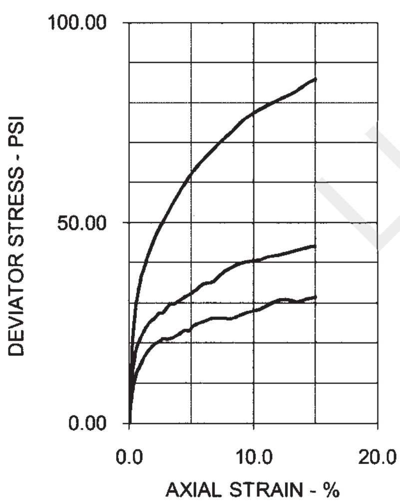
EFFECTIVE STRESS PARAMETERS	R^2 = 1.00	α (deg) = 27.9	a (psi) = 1.1
PROJECT: Martin Lake PDP 1 - 3 Supplemental		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3219 - 09		ETTL ENGINEERS & CONSULTANTS	PLATE: B.2
DESCRIPTION: Tan w/ Red & Gray Clayey Sand			

G 3219-09, B-16 8'-10' Native

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	ϕ =	25.6 deg	c =	0.5 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	17.2	16.8	16.3	
Dry Density - pcf	112.6	114.4	115.0	
Diameter - inches	2.47	2.46	2.48	
Height - inches	4.98	4.97	5.00	
AT TEST				
Final Moisture - %	18.4	16.5	16.0	
Dry Density - pcf	113.1	115.3	116.9	
Calculated Diameter (in.)	2.47	2.46	2.50	
Height - inches	5.00	4.97	5.06	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	18.88	28.83	63.14	
Total Pore Pressure - psi	54.3	58.2	64.1	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.8	3.0	5.2	
σ_1 Failure - psi	28.88	48.83	103.14	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Shelby Tube Sample
DESCRIPTION: Tan w/ Red & Gray Clayey Sand
Sampled on Site, B-16 8' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

PROJECT INFORMATION

PROJECT: Martin Lake PDP 1 - 3 Supplemental
LOCATION:
PROJECT NO: G 3219 - 09
CLIENT: HDR
September 2009

ETTL ENGINEERS & CONSULTANTS PLATE: B.3

PROJECT INFORMATION

PROJECT: Martin Lake PDP 1 - 3 Supplemental
LOCATION:
PROJECT NO: G 3219 - 09
CLIENT: HDR
September 2009

TRIAXIAL TEST PROGRAM BY GARRY H. GREGORY, P.E.

VERSION 1.0 - AUGUST 1998 - REVISED MARCH 24, 1999

THIS COPY LICENSED TO:
ETTL ENGINEERS AND CONSULTANTS, INC.
1717 East Erwin
Tyler, TX 75702

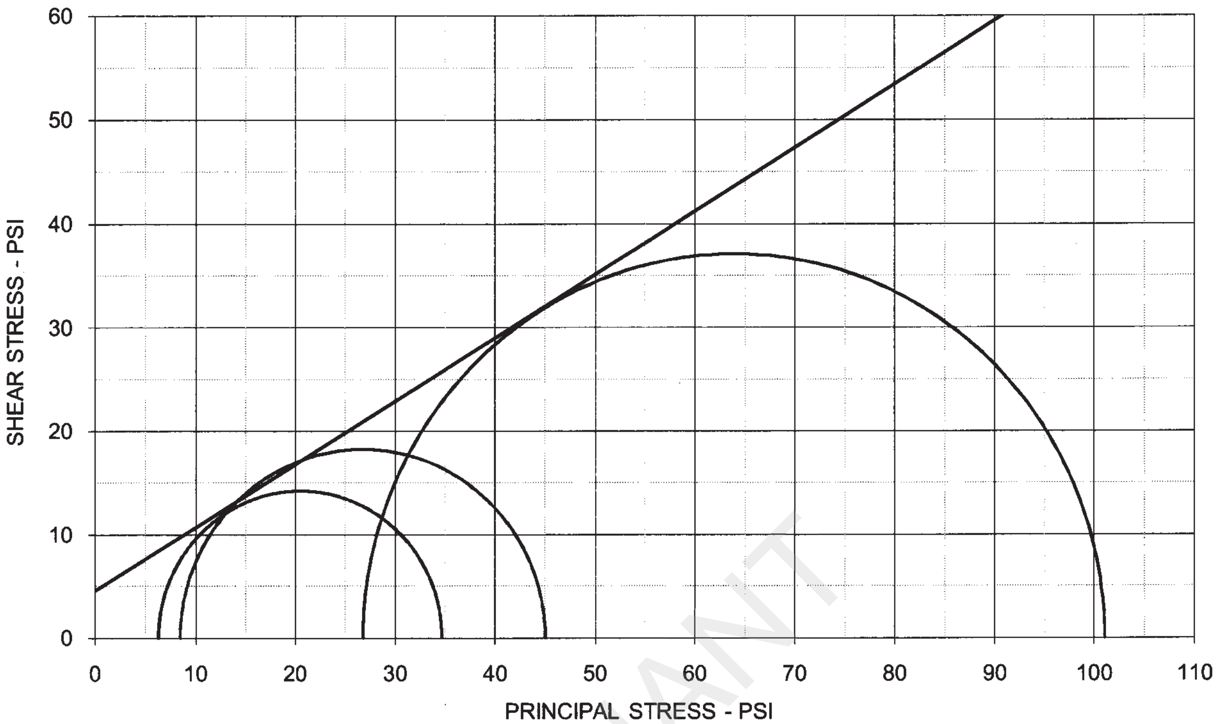
TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Shelby Tube Sample
DESCRIPTION: Tan & Red Sandy Lean Clay
Sampled on Site, B-17 3' to 7' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

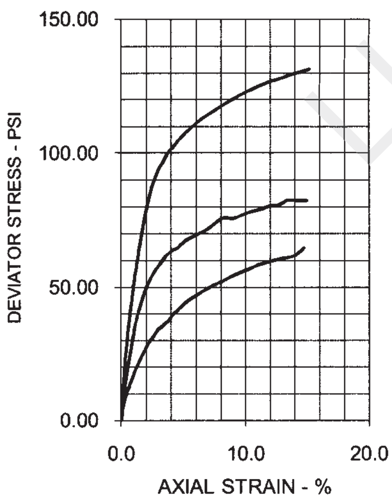
PLATE: B.1
PLATE: B.2
PLATE: B.3

Number of Specimens = 3

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	φ ' = 31.4 deg	c' = 4.6 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	16.2	13.3	13.9	
Dry Density - pcf	113.5	121.6	115.5	
Diameter - inches	2.49	2.49	2.50	
Height - inches	5.08	5.00	5.16	
AT TEST				
Final Moisture - %	18.1	14.7	16.3	
Dry Density - pcf	114.1	123.3	117.2	
Calculated Diameter (in.)	2.50	2.50	2.52	
Height - inches	5.10	5.04	5.22	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	28.40	36.54	74.24	
Total Pore Pressure - psi	53.7	61.5	63.2	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	0.8	3.5	1.8	
σ_1' Failure - psi	34.71	45.04	101.03	
σ_3' Failure - psi	6.31	8.50	26.79	

TEST DESCRIPTION

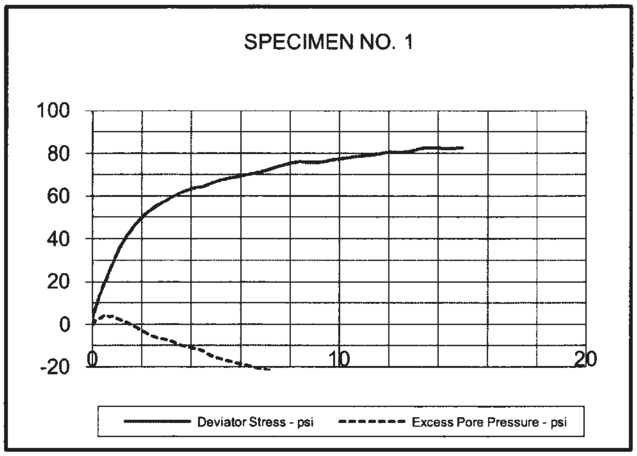
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Shelby Tube Sample
DESCRIPTION: Tan & Red Sandy Lean Clay
Sampled on Site, B-17 3' to 7' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

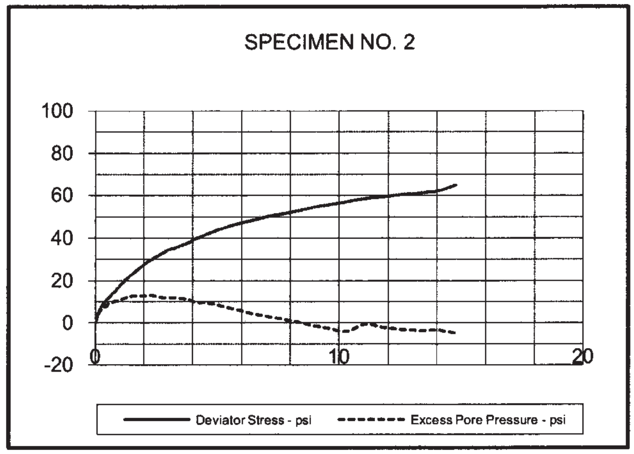
PROJECT INFORMATION

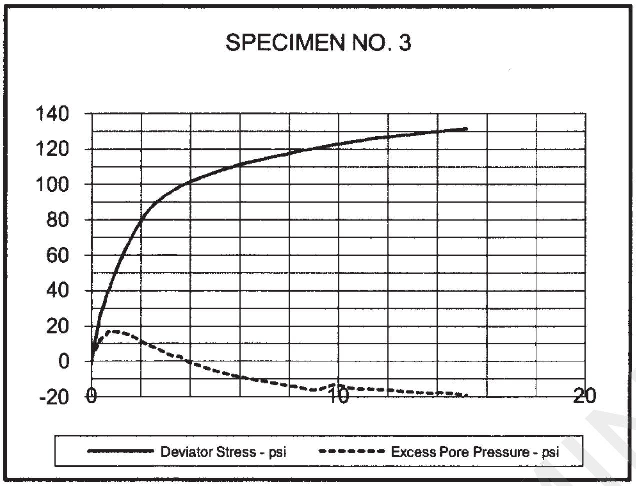
PROJECT: Martin Lake PDP 1 - 3 Supplemental
LOCATION:
PROJECT NO: G 3219 - 09
CLIENT: HDR
September 2009

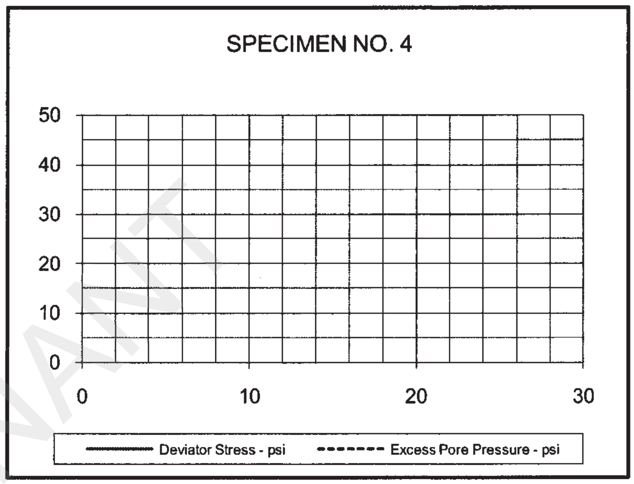
ETTL ENGINEERS & CONSULTANTS PLATE: B.1

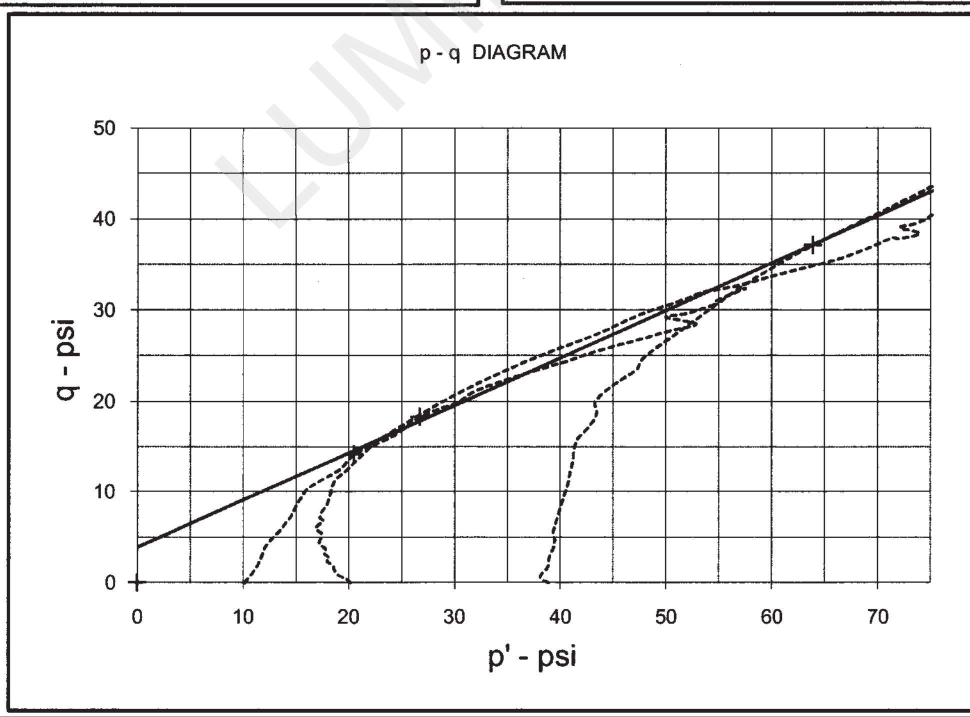
G 3219-09, B-17 3'-7' Native







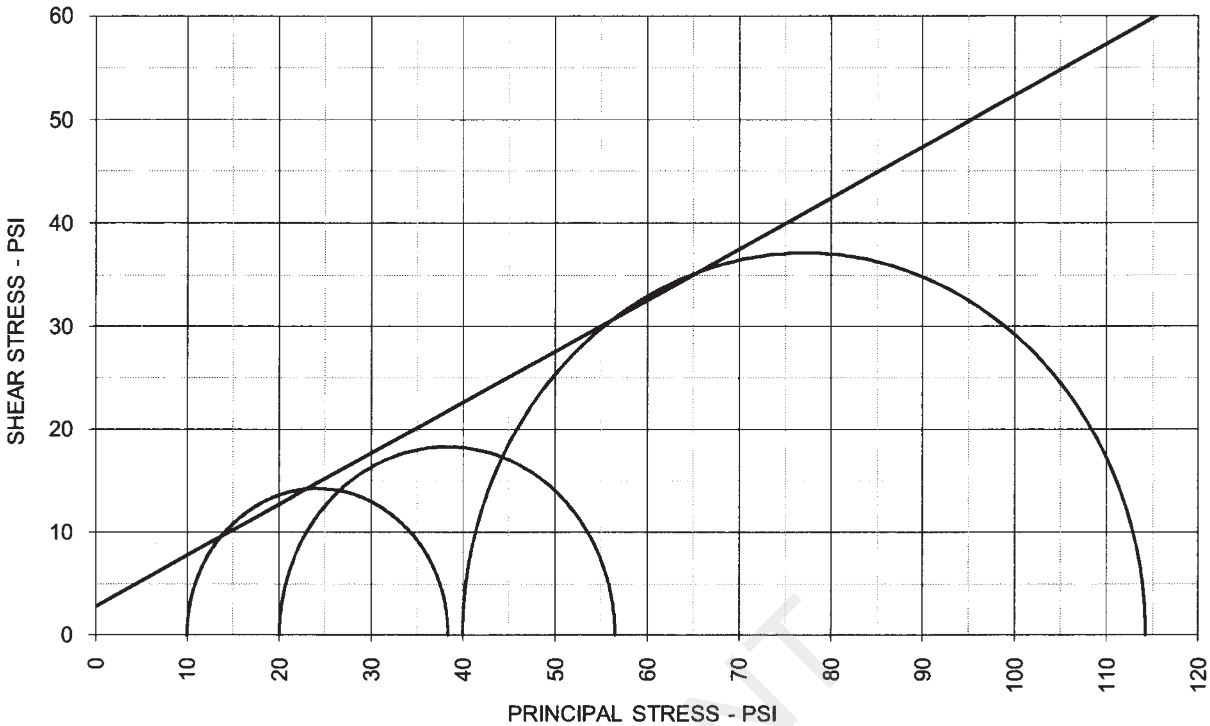




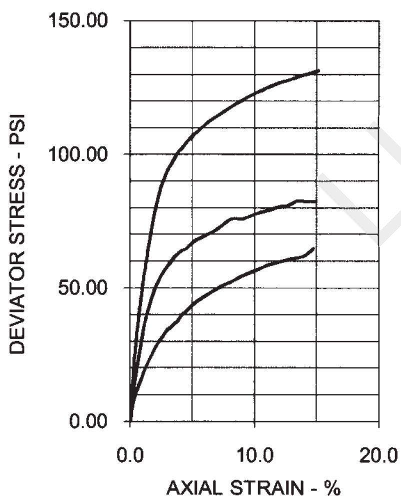
EFFECTIVE STRESS PARAMETERS	R^2 = 1.00	α (deg) = 27.5	a (psi) = 3.9
PROJECT: Martin Lake PDP 1 - 3 Supplemental		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3219 - 09		ETTL ENGINEERS & CONSULTANTS	PLATE: B.2
DESCRIPTION: Tan & Red Sandy Lean Clay			

G 3219-09, B-17 3'-7' Native

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	ϕ = 26.4 deg	c = 2.8 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	16.2	13.3	13.9	
Dry Density - pcf	113.5	121.6	115.5	
Diameter - inches	2.49	2.49	2.50	
Height - inches	5.08	5.00	5.16	
AT TEST				
Final Moisture - %	18.1	14.7	16.3	
Dry Density - pcf	114.1	123.3	117.2	
Calculated Diameter (in.)	2.50	2.50	2.52	
Height - inches	5.10	5.04	5.22	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	28.40	36.54	74.24	
Total Pore Pressure - psi	53.7	61.5	63.2	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	0.8	3.5	1.8	
σ_1 Failure - psi	38.40	56.54	114.24	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Shelby Tube Sample
DESCRIPTION: Tan & Red Sandy Lean Clay
Sampled on Site, B-17 3' to 7' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

PROJECT INFORMATION

PROJECT: Martin Lake PDP 1 - 3 Supplemental
LOCATION:
PROJECT NO: G 3219 - 09
CLIENT: HDR
September 2009

ETTL ENGINEERS & CONSULTANTS PLATE: B.3

PROJECT INFORMATION

PROJECT: Martin Lake PDP 1 - 3 Supplemental
LOCATION:
PROJECT NO: G 3219 - 09
CLIENT: HDR
September 2009

TRIAXIAL TEST PROGRAM BY GARRY H. GREGORY, P.E.

VERSION 1.0 - AUGUST 1998 - REVISED MARCH 24, 1999

THIS COPY LICENSED TO:
ETTL ENGINEERS AND CONSULTANTS, INC.
1717 East Erwin
Tyler, TX 75702

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Lab Molded
DESCRIPTION: Tan & Reddish Tan Silty Sand
Sampled on Site, TP- 31 0' to 5' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 2%
LL: 20 PL: 17 PI: 3 Percent -200: 27%
REMARKS: Both Ends Trimmed + # 4 Sieve 1%

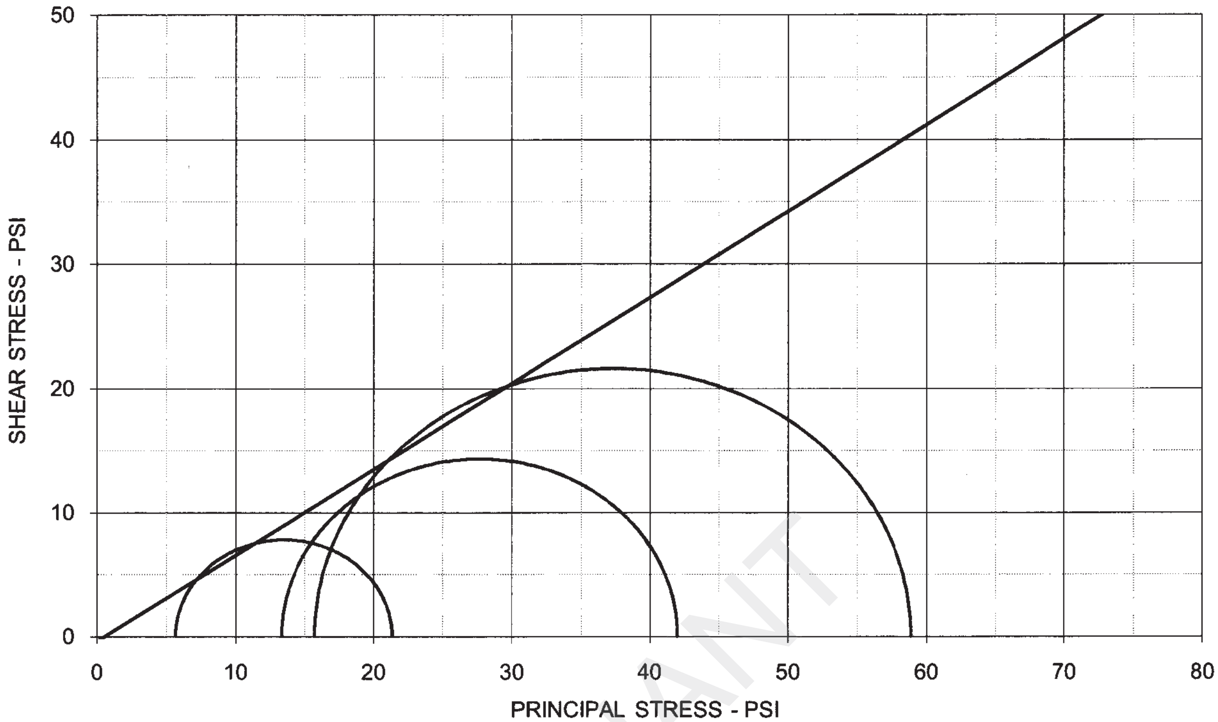
PLATE: B.1

PLATE: B.2

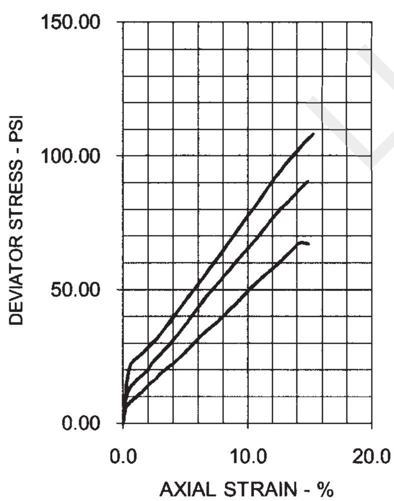
PLATE: B.3

Number of Specimens = 3

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	φ ' = 34.7 deg	c' = -0.4 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	17.3	17.2	17.4	
Dry Density - pcf	110.3	110.5	110.4	
Diameter - inches	2.87	2.87	2.85	
Height - inches	5.57	5.59	5.61	
AT TEST				
Final Moisture - %	17.2	16.7	16.5	
Dry Density - pcf	110.6	111.6	112.0	
Calculated Diameter (in.)	2.87	2.88	2.87	
Height - inches	5.58	5.62	5.66	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.65	28.63	43.17	
Total Pore Pressure - psi	54.3	56.7	74.3	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.4	3.5	4.6	
σ_1' Failure - psi	21.35	41.97	58.90	
σ_3' Failure - psi	5.70	13.34	15.73	

TEST DESCRIPTION

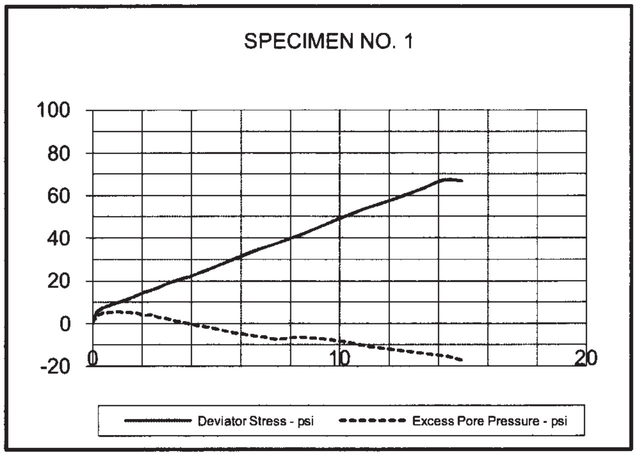
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Lab Molded
DESCRIPTION: Tan & Reddish Tan Silty Sand
Sampled on Site, TP- 31 0' to 5' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 2%
LL: 20 PL: 17 PI: 3 Percent -200: 27%
REMARKS: Both Ends Trimmed + # 4 Sieve 1%

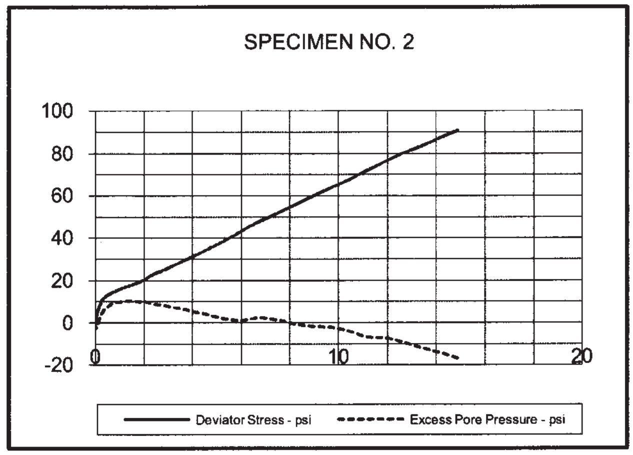
PROJECT INFORMATION

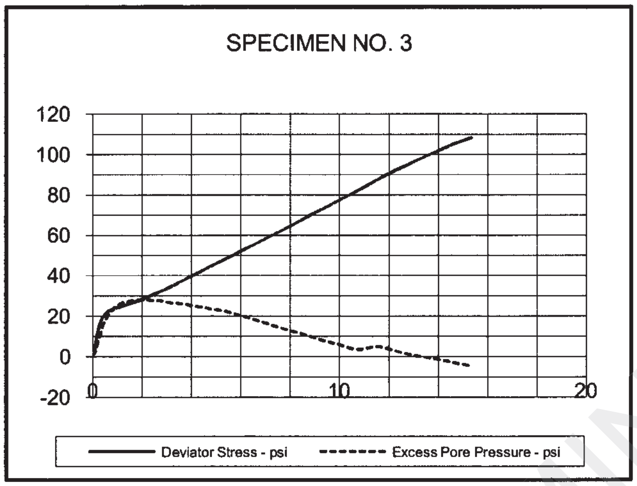
PROJECT: Martin Lake PDP 1 - 3 Supplemental
LOCATION:
PROJECT NO: G 3219 - 09
CLIENT: HDR
September 2009

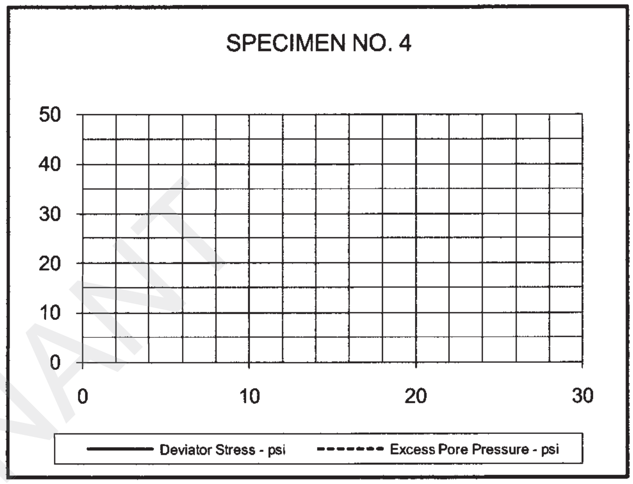
ETTL ENGINEERS & CONSULTANTS PLATE: B.1

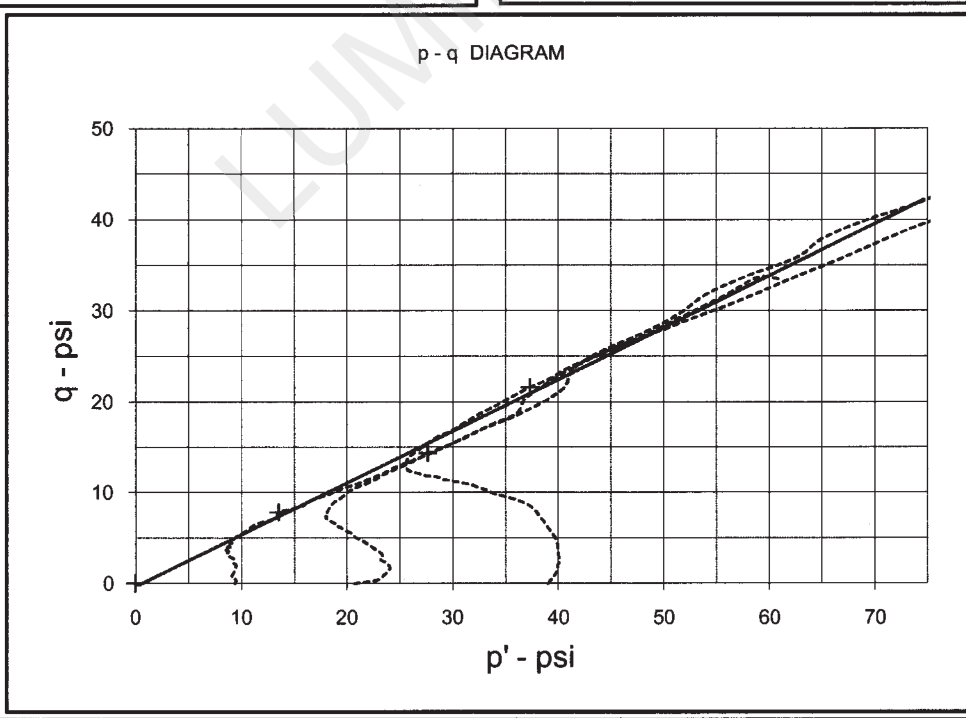
G 3219-09, TP-31 0'-5' Lab Molded







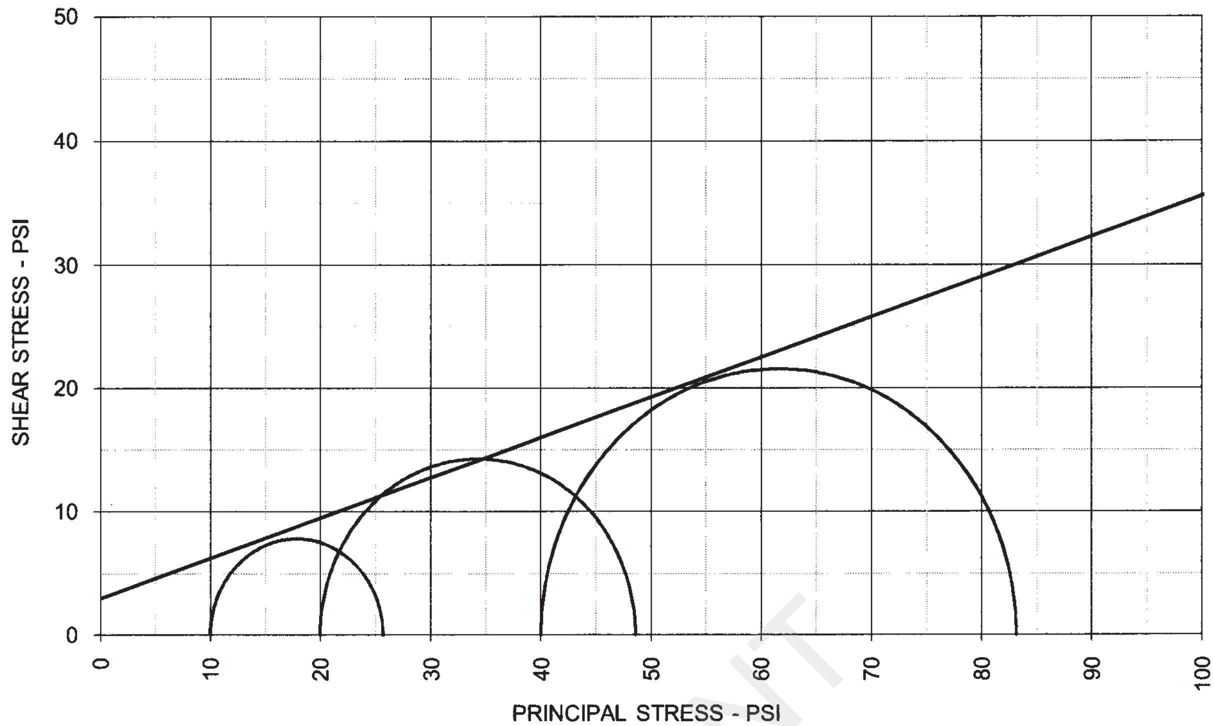




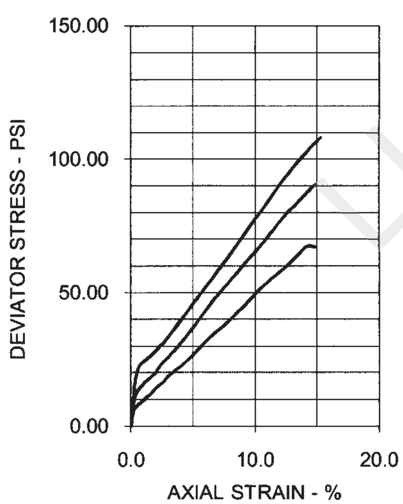
EFFECTIVE STRESS PARAMETERS	R^2 = 0.98	α (deg) = 29.7	a (psi) = -0.3
PROJECT: Martin Lake PDP 1 - 3 Supplemental		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3219 - 09		ETTL ENGINEERS & CONSULTANTS	PLATE: B.2
DESCRIPTION: Tan & Reddish Tan Silty Sand			

G 3219-09, TP-31 0'-5' Lab Molded

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	φ = 18.0 deg	c = 3.0 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	17.3	17.2	17.4	
Dry Density - pcf	110.3	110.5	110.4	
Diameter - inches	2.87	2.87	2.85	
Height - inches	5.57	5.59	5.61	
AT TEST				
Final Moisture - %	17.2	16.7	16.5	
Dry Density - pcf	110.6	111.6	112.0	
Calculated Diameter (in.)	2.87	2.88	2.87	
Height - inches	5.58	5.62	5.66	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.65	28.63	43.17	
Total Pore Pressure - psi	54.3	56.7	74.3	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.4	3.5	4.6	
σ_1 Failure - psi	25.65	48.63	83.17	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

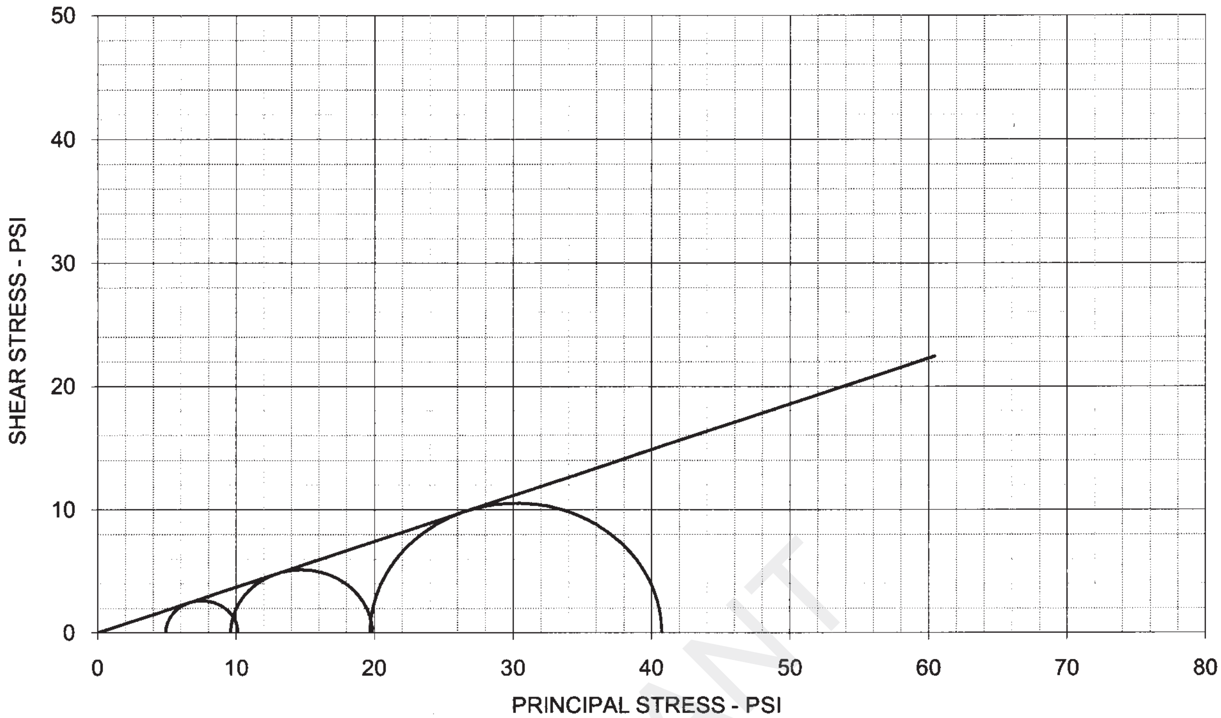
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Lab Molded
DESCRIPTION: Tan & Reddish Tan Silty Sand
Sampled on Site, TP- 31 0' to 5' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 2%
LL: 20 PL: 17 PI: 3 Percent -200: 27%
REMARKS: Both Ends Trimmed + # 4 Sieve 1%

PROJECT INFORMATION

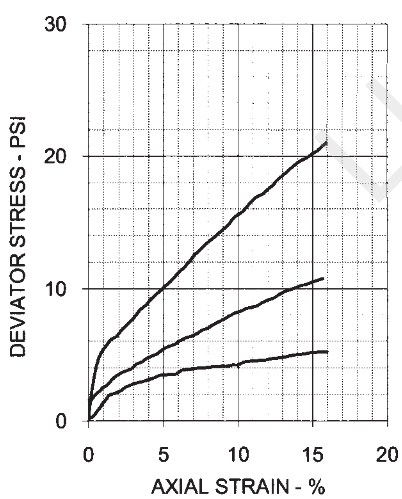
PROJECT: Martin Lake PDP 1 - 3 Supplemental
LOCATION:
PROJECT NO: G 3219 - 09
CLIENT: HDR
September 2009

ETTL ENGINEERS & CONSULTANTS PLATE: B.3

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	φ ' = 20.4 deg	c' = 0.0 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	26.1	24.6	21.3	
Dry Density - pcf	94.3	95.8	101.6	
Diameter - inches	1.40	1.40	1.40	
Height - inches	2.81	2.85	3.20	
AT TEST				
Final Moisture - %	26.1	24.6	21.3	
Dry Density - pcf	94.3	97.0	101.6	
Calculated Diameter (in.)	1.40	1.40	1.40	
Height - inches	2.81	2.85	3.20	
Effect. Cell Pressure - psi	5.0	10.0	20.0	
Failure Stress - psi	5.21	10.25	21.03	
Total Pore Pressure - psi	20.0	20.0	20.0	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	15.6	14.2	15.9	
σ_1' Failure - psi	10.11	19.85	40.73	
σ_3' Failure - psi	4.90	9.60	19.70	

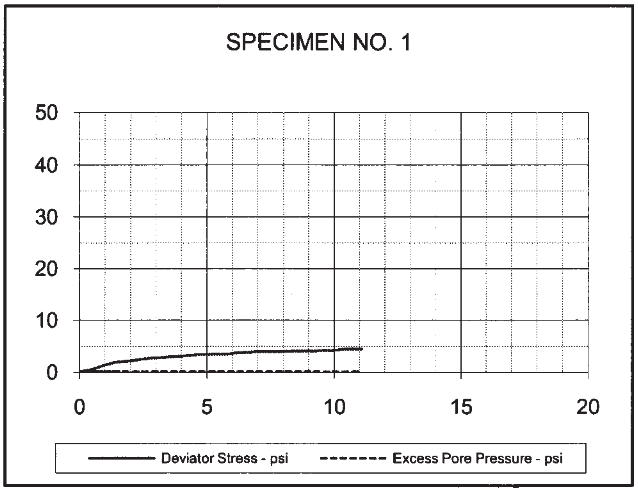
TEST DESCRIPTION

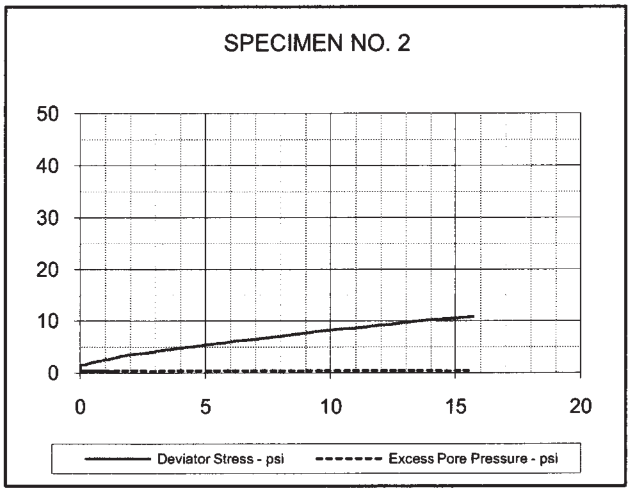
TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: SHELBY TUBE
DESCRIPTION:SANDY LEAN CLAY(CL), tan br w/ red br and gray
SAMPLE LOCATION: B-16, 3-5'
ASSUMED SPECIFIC GRAVITY: 2.70
LL: 43 PL: 14 PI: 29 Percent -200: 56
REMARKS: Tested in a fully softened remolded state

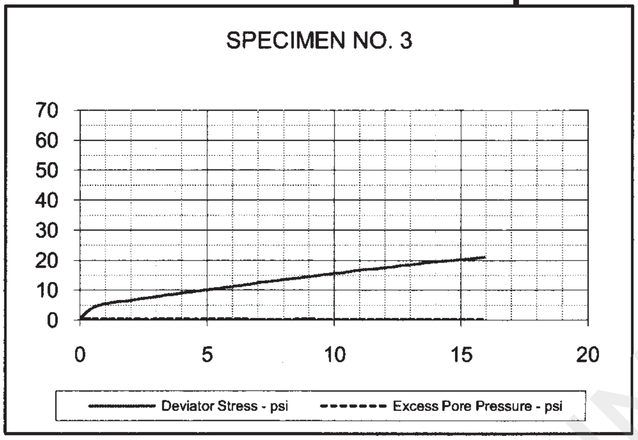
PROJECT INFORMATION

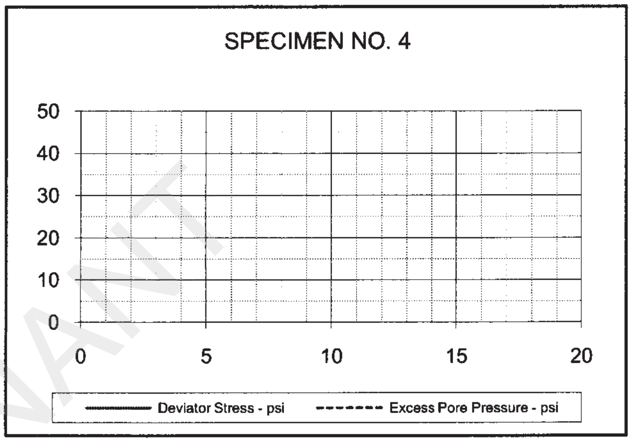
PROJECT: Luminant Martin Lake PDP 1-3 Vertical Expansion
LOCATION: Tatum, TX
PROJECT NO: ETT08002-11
CLIENT: ETTL Engineers & Consultants, Inc.
DATE: 9/15/09

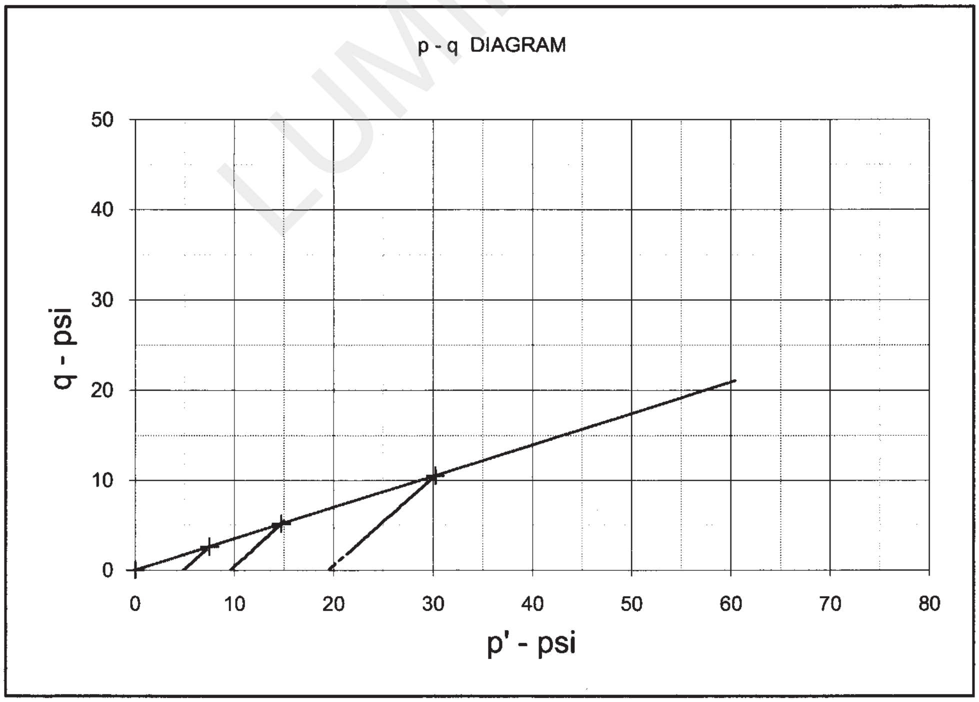
GREGORY GEOTECHNICAL PLATE: B-CD.1







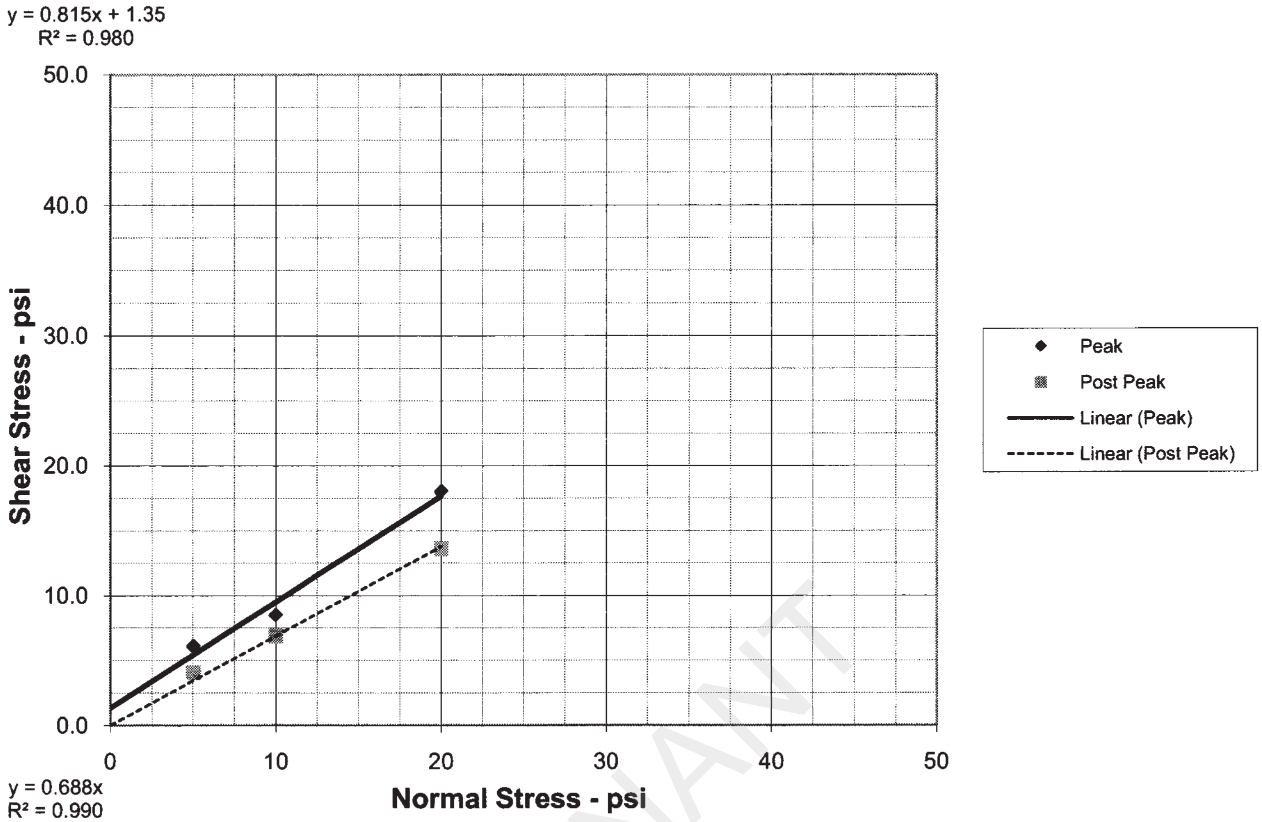




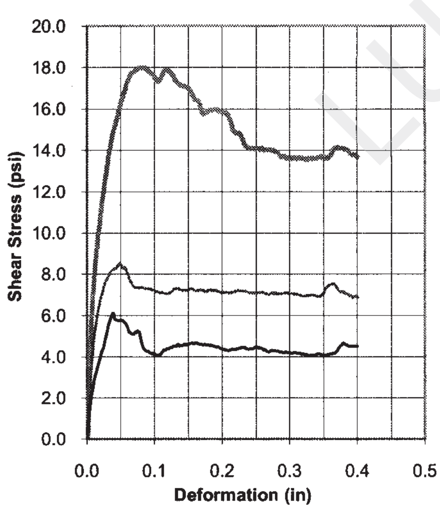
EFFECTIVE STRESS PARAMETERS	R^2 = 1.000	α (deg) = 19.2	a (psi) = 0.0
PROJECT: Luminant Martin Lake PDP 1-3 Vertical Expansion		TYPE OF TEST & NO: CD Triaxial - CD-1	
PROJECT NO: ETT08002-11		***GREGORY GEOTECHNICAL***	PLATE: B-CD.2
DESCRIPTION:SANDY LEAN CLAY(CL), tan br w/ red br and gray			

CD-08002-11-01.xls

DIRECT SHEAR TEST REPORT



PEAK STRENGTH PARAMETERS	φ =	39.2 deg	c =	1.4 psi
POST PEAK STRENGTH PARAMETERS	φ =	34.6 deg	c =	0.0 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	41.3	42.3	48.4	
Dry Density - pcf	78.9	72.5	72.9	
Diameter - inches	2.50	2.50	2.50	
Height - inches	1.00	1.00	1.00	
AT TEST				
Final Moisture - %	46.6	59.5	31.6	
Dry Density - pcf	81.0	74.2	73.0	
Height-End of Consol. (in.)	1.03	1.02	1.00	
Height-End of Shear (in.)	1.03	1.03	1.01	
Normal Stress - psi	5.0	10.0	20.0	
Peak Failure Stress-psi	6.1	8.5	18.0	
Post Peak Failure Stress-psi	4.1	6.9	13.6	
Strain Rate - inches/min.	0.00030	0.00030	0.00030	
Peak Failure Strain - %	1.6	1.9	3.1	
Post Peak Failure Strain %	4.3	12.7	11.8	

Dry Density at test based on initial moisture and height at end of consolidation.

TEST DESCRIPTION

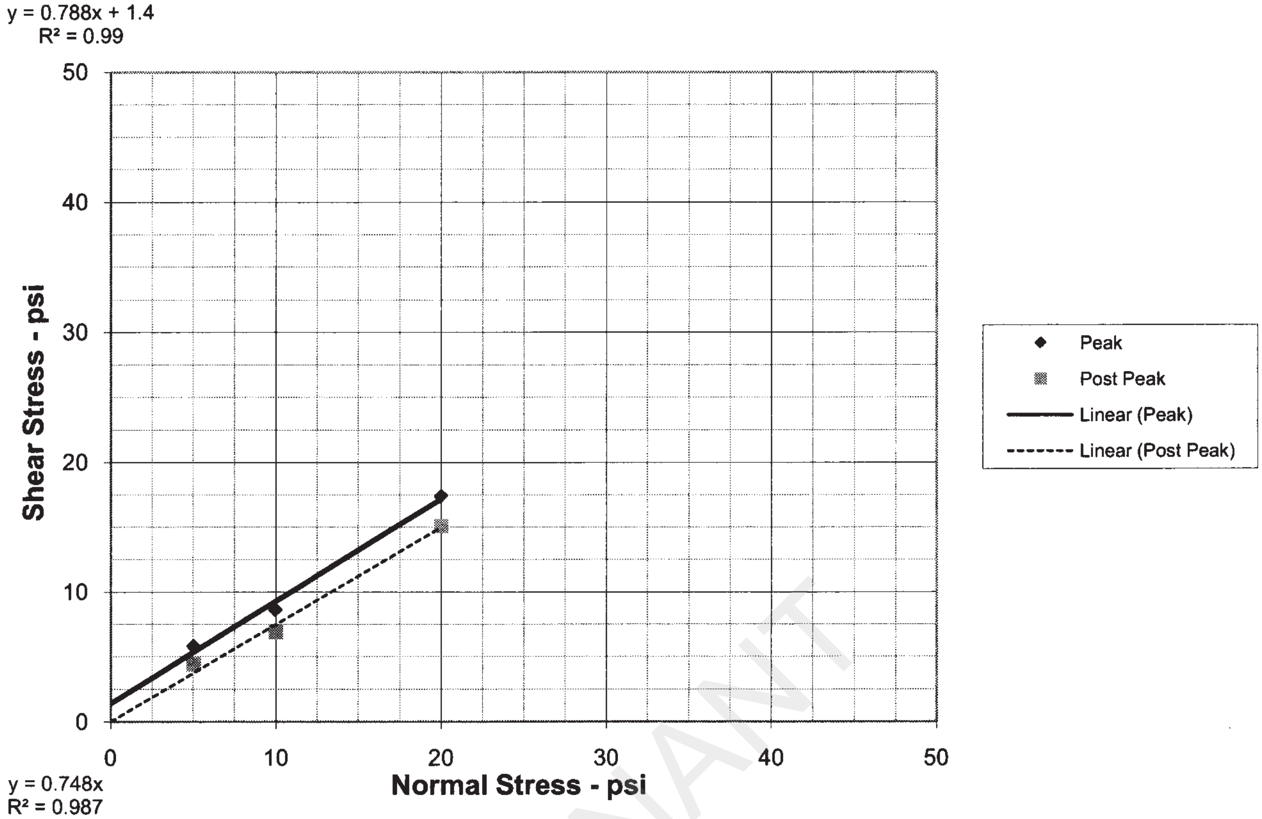
TYPE OF TEST & NO: CD-DS-1
SAMPLE TYPE: Shelby Tube
DESCRIPTION: SILT(MH), black (classification tests from 13-15 ft)
SAMPLE LOCATION: B-15, 18-20 ft
ASSUMED SPECIFIC GRAVITY: 2.65
LL: NP PL: NP PI: NP Percent -200: 95
REMARKS: Tested at natural MC

PROJECT INFORMATION

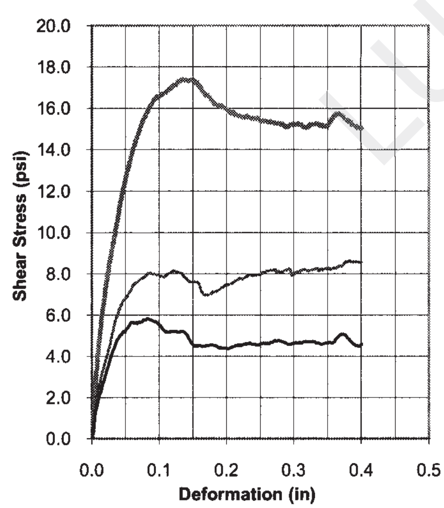
PROJECT: Luminant Martin Lake PDP 1-3 Vertical Expansion
LOCATION: Tatum, TX
PROJECT NO: ETT08002-11 (G3219-09)
CLIENT : ETTL Engineers & Consultants, Inc
DATE: 9/25/09

GREGORY GEOTECHNICAL PLATE: B-DS. 1

DIRECT SHEAR TEST REPORT



PEAK STRENGTH PARAMETERS	φ =	38.3 deg	c =	1.4 psi
POST PEAK STRENGTH PARAMETERS	φ =	36.8 deg	c =	0.0 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	47.2	47.5	46.5	
Dry Density - pcf	77.0	73.3	72.6	
Diameter - inches	2.50	2.50	2.50	
Height - inches	1.00	1.00	1.00	
AT TEST				
Final Moisture - %	47.2	47.5	31.6	
Dry Density - pcf	77.0	73.3	72.6	
Height-End of Consol. (in.)	1.00	1.00	1.00	
Height-End of Shear (in.)	0.98	0.98	0.99	
Normal Stress - psi	5.0	10.0	20.0	
Peak Failure Stress-psi	5.8	8.6	17.4	
Post Peak Failure Stress-psi	4.4	6.9	15.1	
Strain Rate - inches/min.	0.00030	0.00030	0.00030	
Peak Failure Strain - %	3.1	15.0	3.1	
Post Peak Failure Strain %	7.8	6.8	12.8	

Dry Density at test based on initial moisture and height at end of consolidation.

TEST DESCRIPTION

TYPE OF TEST & NO: CD-DS-2
SAMPLE TYPE: Shelby Tube
DESCRIPTION: SILT(MH), black (classification tests from 13-15 ft)
SAMPLE LOCATION: B-15, 18-20 ft
ASSUMED SPECIFIC GRAVITY: 2.65
LL: NP PL: NP PI: NP Percent -200: 95
REMARKS: Tested in a fully softened remolded state

PROJECT INFORMATION

PROJECT: Luminant Martin Lake PDP 1-3 Vertical Expansion
LOCATION: Tatum, TX
PROJECT NO: ETT08002-11 (G3219-09)
CLIENT : ETTL Engineers & Consultants, Inc
DATE: 9/23/09

GREGORY GEOTECHNICAL PLATE: B-DS. 2

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✱ MATERIALS ✱ ENVIRONMENTAL ✱ DRILLING ✱ LANDFILLS

HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project : Martin Lake PDP 1 - 3 Supplemental, Tatum, Texas

Date: 8/26/2009 Panel Number : P 1 ; ASTM D 5084

Project No. : G 3219-09 Permometer Data

Boring No.:	B - 14	ap =	0.031416 cm2	Set Mercury to Pipet Rp at		Equilibrium	1.8 cm3
Sample:		aa =	0.767120 cm2			Pipet Rp	**6.7** cm3
Depth (ft):	3' to 5'	M1 =	0.030180	C =	0.000414194	Annulus Ra	1.5 cm3
Other Location:		M2 =	1.040953	T =	0.203859738		

Material Description : Dark Gray Ash

SAMPLE DATA

Wet Wt. sample + ring or tare :			502.16	g	
Tare or ring Wt. :			0.0	g	
Wet Wt: of Sample :			502.16	g	
Diameter :	2.85	in	7.24	cm2	
Length :	2.80	in	7.12	cm	
Area:	6.38	in^2	41.16	cm2	
Volume :	17.88	in^3	292.92	cm3	
Unit Wt.(wet):	**106.97**	pcf	**1.71**	g/cm^3	
Unit Wt.(dry):	**68.77**	pcf	**1.10**	g/cm^3	

	Before Test		After Test
Tare No.:	T 20	Tare No.:	T 22
Wet Wt.+tare:	522.84	Wet Wt.+tare:	625.95
Dry Wt.+tare:	393.34	Dry Wt.+tare:	480.79
Tare Wt:	160.27	Tare Wt:	140.47
Dry Wt.:	233.07	Dry Wt.:	340.32
Water Wt.:	129.5	Water Wt.:	145.16
% moist.:	**55.6**	% moist.:	**42.7**

Specific Gravity: **2.60** Max Dry Density(pcf) = 68.7952 OMC = 55.5627065

% of max = 100.0 +/- OMC = 0.00

Calculated % saturation: 81.52 Void ratio (e) = **1.36** Porosity (n)= **0.58**

TEST READINGS

Z1(Mercury Height Difference @ t1): 5.1 cm Hydraulic Gradient = 9.04

Date	elapsed t (seconds)	Z (pipet @ t)	$\Delta Z\pi$ (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
8/26/2009	8	4.5	2.1553335	25	0.889	2.66E-05	7.55E-02	
8/26/2009	10	4.05	2.6053335	25	0.889	2.79E-05	7.91E-02	
8/26/2009	12	3.6	3.0553335	25	0.889	2.99E-05	8.48E-02	
8/26/2009	14	3.25	3.4053335	25	0.889	3.12E-05	8.84E-02	

SUMMARY

ka = 2.89E-05 cm/sec Acceptance criteria = 25 %

ki			Vm	
k1 =	2.66E-05	cm/sec	7.8	%
k2 =	2.79E-05	cm/sec	3.5	%
k3 =	2.99E-05	cm/sec	3.5	%
k4 =	3.12E-05	cm/sec	7.8	%

$$Vm = \frac{|ka-ki|}{ka} \times 100$$

Hydraulic conductivity	k =	**2.89E-05**	cm/sec	**8.19E-02**	ft/day
Void Ratio	e =	**1.36**			
Porosity	n =	**0.58**			
Bulk Density	γ =	**1.71**	g/cm3	**107.0**	pcf
Water Content	W =	**0.61**	cm3/cm3	(at 20 deg C)	
Intrinsic Permeability	kint =	**2.96E-10**	cm2	(at 20 deg C)	

Liquid Limit LL		
Plastic Limit PL		
Plasticity Index PI		
- 200 Sieve		%
+ No 40 Sieve		%
+ No 4 Sieve		%

Respectfully Submitted

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ETTL Engineers & Consultants Inc.

GEOTECHNICAL * MATERIALS * ENVIRONMENTAL * DRILLING * LANDFILLS

HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project : Martin Lake PDP 1 - 3 Supplemental, Tatum, Texas

Date: 8/26/2009 Panel Number : P 2 ; ASTM D 5084

Project No. : G 3219-09 Permometer Data

Boring No.:	B - 14	ap =	0.031416 cm2		Set Mercury to Pipet Rp at	Equilibrium	1.8	cm3
Sample:		aa =	0.767120 cm2			Pipet Rp	**6.7**	cm3
Depth (ft):	16' to 17'	M1 =	0.030180	C =	0.000414194	Annulus Ra	1.5	cm3
Other Location:		M2 =	1.040953	T =	0.203859738			

Material Description : Dark Gray Ash

SAMPLE DATA

Wet Wt. sample + ring or tare :			457.47	g
Tare or ring Wt. :			0.0	g
Wet Wt: of Sample :			457.47	g
Diameter :	2.85	in	7.24	cm2
Length :	2.80	in	7.12	cm
Area:	6.38	in^2	41.16	cm2
Volume :	17.88	in^3	292.92	cm3
Unit Wt.(wet):	**97.45**	pcf	**1.56**	g/cm^3
Unit Wt.(dry):	**57.36**	pcf	**0.92**	g/cm^3

Before Test		After Test	
Tare No.:	T 18	Tare No.:	T 16
Wet Wt.+tare:	711.07	Wet Wt.+tare:	569.97
Dry Wt.+tare:	478.92	Dry Wt.+tare:	412.38
Tare Wt:	146.73	Tare Wt:	151.98
Dry Wt.:	332.19	Dry Wt.:	260.4
Water Wt.:	232.15	Water Wt.:	157.59
% moist.:	**69.9**	% moist.:	**60.5**

Specific Gravity: **2.50** Max Dry Density(pcf) = 57.38916 OMC = 69.8847045

% of max = 100.0 +/- OMC = 0.00

Calculated % saturation: 87.92 Void ratio (e) = **1.72** Porosity (n)= **0.63**

TEST READINGS

Z1(Mercury Height Difference @ t1): 5.1 cm Hydraulic Gradient = 9.04

Date	elapsed t (seconds)	Z (pipet @ t)	ΔZπ (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
8/26/2009	80	4.2	2.4553335	25	0.889	3.20E-06	9.06E-03	
8/26/2009	90	4.05	2.6053335	25	0.889	3.10E-06	8.79E-03	
8/26/2009	100	3.9	2.7553335	25	0.889	3.04E-06	8.61E-03	
8/26/2009	110	3.75	2.9053335	25	0.889	3.00E-06	8.52E-03	

SUMMARY

ka = 3.08E-06 cm/sec Acceptance criteria = 25 %

ki			Vm	
k1 =	3.20E-06	cm/sec	3.6	%
k2 =	3.10E-06	cm/sec	0.5	%
k3 =	3.04E-06	cm/sec	1.5	%
k4 =	3.00E-06	cm/sec	2.6	%

$$Vm = \frac{|ka-ki|}{ka} \times 100$$

Hydraulic conductivity	k =	**3.08E-06**	cm/sec	**8.74E-03**	ft/day
Void Ratio	e =	**1.72**			
Porosity	n =	**0.63**			
Bulk Density	γ =	**1.56**	g/cm3	**97.5**	pcf
Water Content	W =	**0.64**	cm3/cm3	(at 20 deg C)	
Intrinsic Permeability	kint =	**3.16E-11**	cm2	(at 20 deg C)	

Liquid Limit	LL	
Plastic Limit	PL	
Plasticity Index	**PI**	
- 200 Sieve		%
+ No 40 Sieve		%
+ No 4 Sieve		%

Respectfully Submitted

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GEOTECHNICAL ✱ MATERIALS ✱ ENVIRONMENTAL ✱ DRILLING ✱ LANDFILLS

HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project : Luminant Martin Lake Supplemental, TP-31, Tatum, Texas
Date: 9/9/2009 Panel Number : P 1 ; ASTM D 5084
Project No. : G 3219-09 Permometer Data

Boring No.:	TP- 31	ap =	0.031416 cm2		Set Mercury to Pipet Rp at	Equilibrium	1.8	cm3
Sample:	9228	aa =	0.767120 cm2			Pipet Rp	**6.7**	cm3
Depth (ft):	0' to 5'	M1 =	0.030180	C =	0.000414162	Annulus Ra	1.5	cm3
Other Location:		M2 =	1.040953	T =	0.203870442			

Material Description : Tan & Reddish Tan Silty Sand

SAMPLE DATA

Wet Wt. sample + ring or tare :			627.20	g
Tare or ring Wt. :			0.0	g
Wet Wt: of Sample :			627.20	g
Diameter :	2.89	in	7.33	cm2
Length :	2.88	in	7.30	cm
Area:	6.55	in^2	42.23	cm2
Volume :	18.82	in^3	308.41	cm3
Unit Wt.(wet):	**126.90**	pcf	**2.03**	g/cm^3
Unit Wt.(dry):	**108.26**	pcf	**1.73**	g/cm^3

Before Test		After Test	
Tare No.:	T 6	Tare No.:	T 1
Wet Wt.+tare:	841.20	Wet Wt.+tare:	841.71
Dry Wt.+tare:	749.54	Dry Wt.+tare:	741.72
Tare Wt:	217.39	Tare Wt:	217.29
Dry Wt.:	532.15	Dry Wt.:	524.43
Water Wt.:	91.66	Water Wt.:	99.99
% moist.:	**17.2**	% moist.:	**19.1**

Specific Gravity: **2.65** Max Dry Density(pcf) = 108.3018 OMC = 17.2244668
% of max = 100.0 +/- OMC = 0.00
Calculated % saturation: 95.65 Void ratio (e) = **0.53** Porosity (n)= **0.35**

TEST READINGS

Z1(Mercury Height Difference @ t1): 5.1 cm Hydraulic Gradient = 8.81

Date	elapsed t (seconds)	Z (pipet @ t)	$\Delta Z\pi$ (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)
7/31/2009	600	5.3	1.3550759	25	0.889	1.98E-07	5.63E-04
7/31/2009	720	5.1	1.5550759	25	0.889	1.95E-07	5.53E-04
7/31/2009	840	5	1.6550759	25	0.889	1.80E-07	5.12E-04
7/31/2009	960	4.8	1.8550759	25	0.889	1.82E-07	5.17E-04

Reset = *

SUMMARY

ka = 1.89E-07 cm/sec Acceptance criteria = 25 %

ki			Vm	
k1 =	1.98E-07	cm/sec	5.0	%
k2 =	1.95E-07	cm/sec	3.2	%
k3 =	1.80E-07	cm/sec	4.5	%
k4 =	1.82E-07	cm/sec	3.6	%

$$Vm = \frac{|ka-ki|}{ka} \times 100$$

Hydraulic conductivity	k =	**1.89E-07**	cm/sec	**5.36E-04**	ft/day
Void Ratio	e =	**0.53**			
Porosity	n =	**0.35**			
Bulk Density	γ =	**2.03**	g/cm3	**126.9**	pcf
Water Content	W =	**0.30**	cm3/cm3	(at 20 deg C)	
Intrinsic Permeability	kint =	**1.94E-12**	cm2	(at 20 deg C)	

Liquid Limit	LL	20	
Plastic Limit	PL	17	
Plasticity Index	**PI**	3	
- 200 Sieve		27	%
+ No 40 Sieve		2	%
+ No 4 Sieve		1	%

Respectfully Submitted

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ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✱ MATERIALS ✱ ENVIRONMENTAL ✱ DRILLING ✱ LANDFILLS

Project:	Luminant Martin Lake Supplemental, Tatum, Texas
Client:	HDR
Contractor:	
Job No.	**G 3219 - 09**

Sample No.:	**9228**	Date Sampled:	8/26/2009
Material Origin:	TP- 31		
Sampling Info. provided By:	Jacob LeNoir		
Location Sampled:	TP- 31		
Material Description:	Tan & Reddish Tan Silty Sand		
Sampled By:	Jacob LeNoir		
Technician:	T. Sliger	Date:	8/28/2009

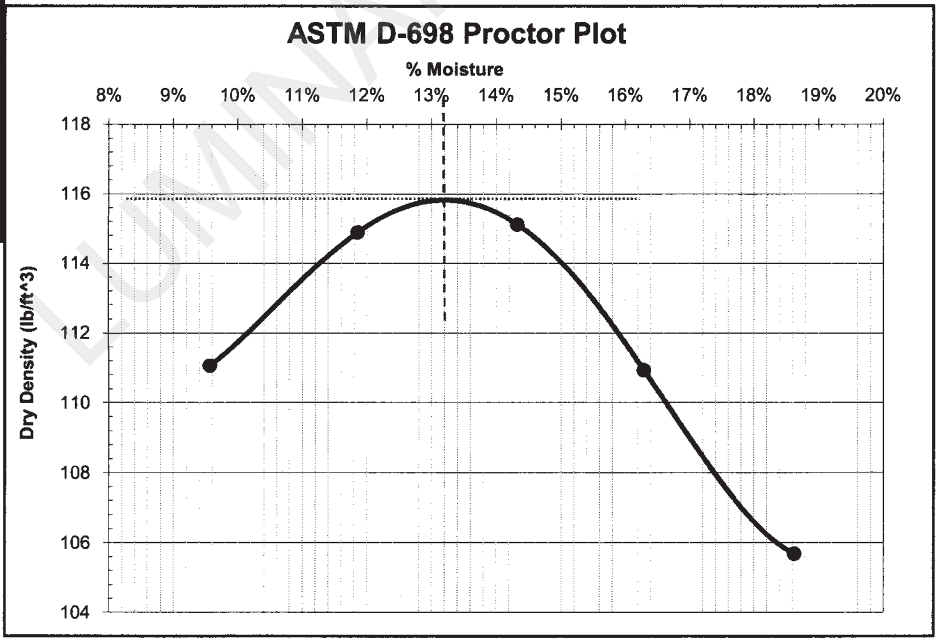
Maximum Dry Density: (ASTM D 698)	115.9	(lb/ft^3)
Optimum Moisture Content:	13.2	(%)

Classification

LL	20
PL	17
PI	3

-200 Sieve	27%
+40 Sieve	2%
+4 Sieve	1%

Proctor Points	
% Moisture	Dry Density (lb/ft^3)
9.6%	111.1
11.9%	114.9
14.3%	115.1
16.3%	110.9
18.6%	105.7



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Established in 1960, Golder Associates is a global, employee-owned organization that helps clients find sustainable solutions to the challenges of finite resources, energy and water supply and management, waste management, urbanization, and climate change. We provide a wide range of independent consulting, design, and construction services in our specialist areas of earth, environment, and energy. By building strong relationships and meeting the needs of clients, our people have created one of the most trusted professional services organizations in the world.

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Engineering Earth's Development, Preserving Earth's Integrity

APPENDIX F9 - SAFETY FACTOR ASSESSMENT

REPORT

SAFETY FACTOR ASSESSMENT REPORT

Martin Lake Steam Electric Station

Submitted To: Luminant
1601 Bryan Street
Dallas, TX 75201

Submitted By: Golder Associates Inc.
500 Century Plaza Drive, Suite 190
Houston, TX 77073 USA

10/10/16

STATE OF TEXAS
JEFFREY B. FASSETT
85675
LICENSED
PROFESSIONAL ENGINEER

Professional Engineering Firm
Registration Number F-2578

October 2016 **Project No. 164816402**

Golder Associates

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1.0 INTRODUCTION

1.1 Purpose

The "Disposal of Coal Combustion Residuals (CCR) from Electric Utilities rule" (40 Code of Federal Regulations (40 CFR) Part 257), effective October 19, 2015, requires that existing CCR surface impoundments meeting the requirements of §257.73(b) conduct initial and periodic safety factor assessments in accordance with §257.73(e). This report provides the safety factor assessments for the Martin Lake Steam Electric Station's (MLSES's) CCR Impoundments, identified as the Bottom Ash Ponds (BAPs) – the West Ash Pond (WAP) and the East Ash Pond (EAP) – the New Scrubber Pond (NSP), and the Permanent Disposal Pond-5 (PDP-5).

1.2 Site Background

The MLSES generates bottom ash, fly ash, and flue gas desulfurization (FGD) material during electricity generation. The following surface impoundments, shown on Figure 1, are in operation at the MLSES and subject to the CCR rule.

1.2.1 The Bottom Ash Ponds (BAPs)

The BAPs include the West Ash Pond (WAP) and the East Ash Pond (EAP). The WAP and EAP receive sluice water from bottom ash dewatering bins and other process wastewater sources that typically include bottom ash fines. The BAPs were originally constructed in 1977 with a 2-feet thick compacted clay liner. In 1989, the WAP was relined with a 60-mil high density polyethylene (HDPE) geomembrane over 3 feet of clay on the sideslopes, and the floor with a double 60-mil HDPE geomembrane with a geonet leak detection layer overlying an 18-inch thick clay liner. Both the sideslopes and floor are overlain with a 4-inch thick concrete revetment mat. In 2010, the sideslopes and floor of the EAP were relined with a double 60-mil HDPE geomembrane with a geonet leak detection layer overlying an 18-inch thick clay layer. A geotextile layer was placed between the lower geomembrane and the clay. The liner system on the sideslopes and floor of the EAP are overlain with a 4-inch thick concrete revetment mat.

1.2.2 New Scrubber Pond (NSP)

The NSP, abutting the southeastern portion of the WAP and the southern portion of the EAP, is used to manage FGD wastes and discharge from the sludge thickener sumps, the plant yard sumps, and stormwater management areas. Water collecting in the NSP serves as wet-well make-up water as well as emergency make-up water in the scrubber area. The NSP was originally constructed with the BAPs and lined with clay liner. In 1989, the NSP was relined with a double 60-mil HDPE geomembrane with a geonet leak detection layer. A geotextile layer was placed between the lower geomembrane and the subgrade and a 4-inch thick concrete revetment mat covers the upper geomembrane.

1.2.3 Permanent Disposal Pond-5 (PDP-5)

PDP-5 is primarily used to manage excess liquids including stormwater and excess process wastewater from both the New Scrubber Pond and Bottom Ash Ponds. Recovered CCR wastewaters are received in PDP-5 during cleaning cycles. PDP-5 was constructed in 2010/2011, above PDP-1, PDP-2, and PDP-3, which were previously closed as landfills. PDF-5 is lined with a 3-foot thick clay liner on the sideslopes and a 2-foot thick clay liner on the floor, both overlain with a 0.5-foot thick protective cover soil layer.

1.3 Previous Slope Stability Evaluations

Golder and ETTL Engineers and Consultants (ETTL) have previously performed evaluations on the BAPs, the NSP and PDP-5 as part of the following reports submitted to Luminant:

- Ash and Scrubber Ponds and Permanent Disposal Pond #4, Stability Investigation Report, Luminant Martin Lake SES, Rusk County, Texas, Golder, dated December 2012.
- Geotechnical Investigation, Luminant Martin Lake SES, Reline East Ash Disposal Pond, Tatum, Texas, ETTL, dated December 2008.

The studies found the BAPs and NSP slopes to be adequately stable.

ETTL performed stability evaluations on PDP-5 in 2009, as presented in the following report:

- Geotechnical Investigation, Luminant Martin Lake SES, Vertical Expansion of Permanent Disposal Ponds 1, 2, and 3, Tatum, Texas. ETTL Engineers and Consultants Inc. Tyler, Texas, dated July 2008.
- Geotechnical Investigation, Luminant Martin Lake SES, Vertical Expansion of Permanent Disposal Ponds 1, 2, and 3, Tatum, Texas – Supplemental Seepage and Slope Stability. ETTL Engineers and Consultants Inc., dated October 2009.

The above reports found the design slopes of PDP-5 to be stable as long as drainage is functional, preventing the embankments from saturating.

2.0 SUBSURFACE CONDITIONS

The MLSES site is located in the Martin Creek area which is situated in the Sabine River Valley and lies on the west flank of the Sabine Uplift. The formations in the region comprise sedimentary deposits of continental and marine origin, mainly the lower Wilcox Group flanked by younger beds like the Carrizo Sand. In the Martin Creek area, the Wilcox formation is estimated to be about 650- to 700-feet thick and consists of sandy clays, silty sands, clays, and lignite in varying amounts. The Rockdale formation is the major component in the area among the sediments of the Wilcox group occupying approximately the middle four-fifths of the Wilcox Section. The Wilcox Group is underlain by the Paleocene Midway Group (containing Upper Willis and Lower Kincaid), which is estimated to be 900-feet thick around the site, and is composed mainly of silty clay and clay. The Midway Group overlies a section of Cretaceous Rocks that are approximately 7000-feet thick (Rone Engineers, 1984).

2.1 Site Geology

2.1.1 Bottom Ash Ponds and New Scrubber Pond

2.1.1.1 Subsurface Investigations and Laboratory Testing

Information from previous subsurface investigations was used to characterize the subsurface site conditions. In 2008, ETTL conducted a subsurface investigation for the EAP as part of an effort to reline the pond. ETTL drilled twelve borings along the crest of the EAP embankment at approximate elevation 330 feet – mean sea level (ft-msl). All borings were 40-feet deep except one which was 100-feet deep. The boring map and boring logs are presented in Appendix A. Geotechnical laboratory testing – moisture contents, Atterberg limits, grain size distribution, and consolidated-undrained (CU) triaxial compression tests - was conducted on selected samples. The soil index testing results presented as part of the boring logs, while the CU test results from ETTL are summarized in Appendix B.

Golder conducted a subsurface investigation for the WAP and NSP in December 2012. Golder completed eight, 50- to 60-foot deep borings along the crest of the pond embankments at approximate elevation 330 ft-msl. The boring map and boring logs are presented in Appendix A. As part of the investigation, laboratory testing was performed on selected samples in accordance with commonly accepted methods and practices. Undisturbed and disturbed soil samples were tested to determine water content, Atterberg limits, grain size distribution, and shear strength. Water content determination was performed in accordance with ASTM D2216; Atterberg limits were determined in accordance with ASTM D4318; and grain size distribution was performed in accordance with ASTM D422. Shear strength testing consisted of unconsolidated-undrained (UU) triaxial compression in general accordance with ASTM D2850. Laboratory test results are presented in Appendix B.

The findings from the above subsurface investigations were reviewed for their applicability to this study, and are summarized in the following sections.

2.1.1.2 Subsurface Site Conditions

The above borings consisted of fill and native soils. The soils encountered in the borings generally consisted of stiff to hard sandy clays and firm to very dense sands. The subsurface stratigraphy generally consisted of interchanging layers of clays, sandy clays, clayey sands and non-plastic sands. The clayey sand layers ranged in thickness from 2 to 16 feet where encountered. The sandy clay and clay layers are described as firm to hard, low to high plasticity clays and vary in thickness from 2 to 38 feet. Loose to very dense, silty or poorly graded sand was typically encountered beneath or interlayered with the sandy clay/clayey sand strata. The 100-foot boring by ETTL showed deeper layers of very dense silty sand with intermittent layers of hard low plasticity clay.

Water was encountered in each of the eight borings performed by Golder, ranging between El. 296.1 to 303.3 ft-msl. The average water elevation measured in the Golder boreholes, during drilling, was at El. 300.3 ft-msl. The ETTL borings measured the water level to range between El. 304 to 309 ft-msl, with an average water level of El. 306 ft-msl.

Groundwater levels measured in 2015, from wells surrounding the BAPs vary from approximately El. 304 ft-msl in the southeast corner to El. 307 ft-msl in the northwest corner.

2.1.2 Permanent Disposal Pond - 5

2.1.2.1 Subsurface Investigations and Laboratory Testing

In 2008, ETTL performed a pre-construction subsurface investigation for PDP-5 that included a total of eleven borings within the PDP-5 footprint. In addition, three cone penetrometer tests (CPTs) were performed. As part of a supplemental investigation in 2009, ETTL drilled four additional borings within the pond footprint. A map of borings, and boring and CPT logs are presented in Appendix A.

ETTL performed laboratory tests including natural moisture contents (ASTM D2216), Atterberg limits (ASTM D4318), particle size distributions (ASTM D 1140 and ASTM D422). Unconsolidated-undrained (UU) triaxial compression tests (ASTM D2850) were performed to determine the strength characteristics of cohesive substrata. Direct shear tests (ASTM D3080) were performed on coarser materials including remolded bulk ash samples. Consolidation tests (ASTM D2435) and permeability tests (ASTM D5084) were also performed but are not relevant to the current study. The results of the laboratory tests performed by ETTL are presented in Appendix B.

2.1.2.2 Subsurface Site Conditions

Most of the above borings were drilled through the bottom ash within closed PDP-1, 2, and 3. Based on particle size, the ash classifies as very loose to medium dense poorly graded sands in some locations, to silts in other locations and depths. The borings passing through existing embankments of PDP-1, 2, and 3 contained medium stiff to very stiff clay of low plasticity and/or high plasticity clay with clayey sand. Native soils were identified in deeper borings as very dense silt with hard low plasticity clay seams.

Since the subsurface investigations for the PDP-5 area were performed prior to construction of the PDP-5 embankment, there are no borings that pass through the embankment. However, ETTL (ETTL 2009) identified a site borrow source (characterized as sandy materials), soils from which were to be used in the construction of the embankment. Triaxial strength testing (CU tests) were also performed on these site soils, and hence, the embankment strength has been estimated.

Two borings located outside of the ash encountered water approximately between El. 355 to 368 ft-msl. Groundwater levels measured in 2015, from wells surrounding PDP-5, indicate that the groundwater level varies from approximately El. 355 ft-msl in the north to El. 375 ft-msl in the south.

3.0 STABILITY ANALYSIS - §257.73(e)

3.1 Safety Factor Assessment

According to the CCR rules, structural stability factors of safety need to be evaluated for the critical cross-section of each CCR facility under static and seismic loading for "Maximum Storage Pool" (2 feet of freeboard for this facility) and "Maximum Surcharge Pool" (no freeboard)conditions. Liquefaction potential analysis is only necessary when soil sampling, construction documentation or anecdotal evidence from personnel with knowledge about the facility, indicates that soils of the embankment are susceptible to liquefaction. Since ash classifying as sandy soil is present below portions of the PDP-5 embankment, liquefaction potential is considered for PDP-5 foundation soils.

The safety factor assessment [§257.73(e)] does not require evaluation of rapid-drawdown loading conditions; however, if the CCR unit has downstream slopes that can be inundated by an adjacent water body, the structural stability assessment requirements [§257.73(d)(1)(viii)] state that these slopes must be assessed. Since one of the cross-sections analyzed in this Safety Factor Assessment may be subjected to rapid draw-drawdown conditions, this condition was evaluated and presented herein. The results of the analysis are also reported in the Structural Stability Assessment Report (Golder, 2016).

Slope stability analyses were performed using a limit-equilibrium-based commercial computer program, Slide v7.0 by Rocscience. The analyses used a searching routine to identify the potential failure surface with minimum factor of safety for a given set of geometry, ground and groundwater conditions. The Spencer method of analysis was used in the analyses, while the Morgenstern Price method was used for verification. The factors of safety of numerous potential failure surfaces were computed to establish minimum factors of safety. Circular failure surfaces were considered for all cases. Stability analyses were performed for "Maximum Storage Pool" (freeboard of 2 feet) and "Maximum Surcharge Pool" (no freeboard) conditions for both the interior and exterior slopes of the ponds. In addition, the interior slopes were analyzed while the pond is empty. For each case, respective slopes were analyzed for both static and seismic loading conditions. The interior berms separating individual ponds were not analyzed since the failure of the interior berms will not result in any release of CCR materials beyond the embankment surrounding the BAPs and NSP.

3.2 Cross-Sections Analyzed

3.2.1 Bottom Ash Ponds and New Scrubber Pond

The BAPs and NSP are contiguous ponds surrounded by a continuous embankment that was built using the same site soils. Hence, the embankment is considered as one structure and a critical cross-section was identified after considering multiple cross-sections across the entire embankment. The geometry of the slopes, soil profile, loading conditions, and phreatic surface of each segment of the embankment were evaluated in identifying the critical cross-section. Cross-section (A-A'), located on the eastern slope of the EAP as shown on Figure 1, was identified as the critical cross-section for the BAPs and NSP and was selected for evaluation of factors of safety under the loading conditions identified in §257.74(e)(1)(i) - (iv).

3.2.2 Permanent Disposal Pond – 5

The geometry of the slopes, soil profile, loading conditions and phreatic surface of each segment of the embankment surrounding the PDP-5 was evaluated. Cross-Section B-B', located on the south side of PDP-5 as shown on Figure 1, was identified as the critical cross-section and was selected for evaluation of factors of safety under the loading conditions identified in §257.74(e)(1)(i) - (iv).

3.3 Material Properties

3.3.1 Bottom Ash Ponds and New Scrubber Pond – Cross Section A-A'

Based on the previous subsurface investigations, appropriate material properties were selected for use in the stability analysis. CU triaxial testing was performed on three samples on the BAP embankments, by ETTL (2008). The effective stress parameters from these three tests are averaged and used in the analysis. For the subsequent foundation soil layers, values of shear strength are chosen either based on testing of deeper samples by ETTL or by assuming typical, conservative values for sandy soils. Table 1 summarizes the material properties used in the stability analysis of Section A-A'.

Table 1: Soil Properties for Section A-A'

Soil Material	Description	Moist Unit Weight (lb/ft^3)	Saturated Unit Weight (lb/ft^3)	Drained Soil Properties	
				Cohesion, c' (lb/ft^2)	Friction Angle, ϕ' (°)
I	Fat Clay	120	125	542	23
II	Silty Sand	127	132	0	30
III	Clayey Sand	127	132	0	32
IV	Sand/Silty Sand	127	132	0	34

3.3.2 Permanent Disposal Pond – 5 – Cross Section B-B'

Based on the borings and CU tests performed as part of the 2009 investigation by ETTL, shear strength parameters were chosen for the soil layers for cross-section B-B'. For the deep sand layer, a conservative friction angle of 34° and zero cohesion was assumed. Table 2 summarizes the material properties used in the stability analysis of cross-section B-B'.

Table 2: Soil Properties for Section B-B'

Soil Material	Description	Moist Unit Weight (lb/ft^3)	Saturated Unit Weight (lb/ft^3)	Drained Soil Properties	
				Cohesion, c' (lb/ft^2)	Friction Angle, ϕ' (°)
I	New embankment	125	130	0	34.7
II	Clay liner	127	132	650	31.4
III	Old ash	90	95	0	34.6
IV	Native clay	127	132	175	31.9
V	Sandy Clay/Clayey Sand	127	132	650	31.4
VI	Deep sand	127	132	0	34

3.4 Phreatic Surface

3.4.1 Bottom Ash Ponds and New Scrubber Pond

For the purpose of this report, the phreatic surface is defined as the potential saturated zone within the embankment that could exist due to infiltration of water from the ponded CCR. As discussed earlier, measurements within the monitoring wells indicate groundwater levels across the BAPs and NSP vary between El. 304 to 307 ft-msl. At cross-section A-A', the groundwater level is assumed to be El. 306 ft-msl. The interior slopes of the ponds have a clay liner, a double HDPE geomembrane layer, overlain by a concrete revetment. Hence, it is unlikely that the phreatic surface will extend into the embankment, or into the ground below on the floor of the ponds.

Drawdown of the water level in Martin Lake can potentially affect the stability of Section A-A'. Based on the historic water level data available from the Texas Water Development Board (TWDB 2016), the maximum drawdown was observed to be about 10 feet. This drawdown, however, was not instant but spread across a period of approximately one year. Hence, effective stress-transient drawdown analyses were conducted for the exterior slope at Section A-A', for a 10-foot drawdown in water level at a uniform rate, over one year.

3.4.2 Permanent Disposal Pond – 5

As mentioned previously, groundwater levels measured in 2015, from wells surrounding PDP-5, indicate that the groundwater level around the pond varies from approximately El. 355 ft-msl in the north to El. 375 ft-msl in the south. Underlying PDP-5, the ash in PDP-1, 2 and 3 is at least partially saturated. A toe drain system keeps the water level within the ash below El. 380 feet. Therefore, the saturated zone within the ash is assumed to be at El. 380 ft-msl for cross-section B-B' on the upstream side.

For the stability analysis of the exterior embankment slope, the location of the phreatic surface is estimated by allowing steady state seepage conditions to develop based on the water level within PDP-5 and the elevation of the saturated ash in PDP-1, 2 and 3.

Note that the phreatic surface elevations were conservatively assumed for stability analysis purposes -- they do not represent the elevation of the uppermost aquifer.

3.5 Seismic Loading

Based on the "US Seismic Hazard 2014 Map" prepared by the United States Geologic Survey (USGS) and the "2008 Interactive Deaggregations" (USGS), the peak ground acceleration (PGA) for a 2% probability of exceedance in 50 years (return period of 2,475 years) is 0.09g for the site location (including amplification factors for site soil conditions). Hence, a horizontal seismic load coefficient of 0.09g was used in the pseudostatic analysis.

3.6 Liquefaction Potential

Soil liquefaction describes a phenomenon whereby a saturated or partially saturated soil substantially loses strength and stiffness in response to an applied stress, usually earthquake shaking or other sudden change in stress condition, causing it to behave like a liquid. The phenomenon is most often observed in saturated, loose (low density or uncompacted), sandy soils.

3.6.1 Bottom Ash Ponds and New Scrubber Pond

The embankment soils of the BAPs and NSP are composed of clayey materials with significant fines content. The immediate foundation materials are composed of sandy clay and compact to dense sand. The subsurface investigations do not indicate the presence of any soils in the embankment or its foundation that are susceptible to liquefaction. Hence, failure of the pond slopes due to liquefaction is considered unlikely for the BAPs and NSP.

3.6.2 Permanent Disposal Pond - 5

Based on particle size, the bottom ash within PDP-1, 2, and 3 classifies as very loose to medium dense, poorly graded sand at some locations and silts at other locations and depths. Therefore, portions of the foundation soils for PDP-5 embankments are founded above potentially liquefiable material. Based on the above mentioned ETTL reports and the preparation of foundation materials during construction, the foundations and abutments are generally considered to be stable. Nevertheless, due to the classification of the some of the underlying ash as poorly graded sand, the potential for cyclic liquefaction of the ash was evaluated.

As part of the 2008 investigation by ETTL, CPTs were conducted within the ash underlying PDP-5. Golder conducted a liquefaction analysis based on this CPT data using the commercially available program, CLiq v.2.0.6.85 released by GeoLogismiki. The method prescribed by Robertson (2009) was adopted in the cyclic liquefaction analysis. The site earthquake information (magnitude and PGA) was estimated using the seismic hazard tool developed by USGS (USGS 2008).

The analysis showed that all three CPT locations showed a low likelihood for cyclic liquefaction with a factor of safety greater than the minimum factor of safety of 1.20 specified in §257.73(e)(iv). The results from the cyclic liquefaction analysis are presented in Appendix C.

3.7 Stability Analysis Results

Slope stability analyses were performed for long-term conditions for each of the critical cross-sections considered under static and seismic loading conditions. Both interior and exterior slopes were analyzed for "Maximum Storage Pool" (2 feet of freeboard) and "Maximum Surcharge Pool" (no freeboard) conditions. The interior slopes were analyzed for the condition where the pond is empty.

The results of the slope stability analyses cases are presented in Table 3 and Appendix D. The results indicate that the BAP, NSP, and PDP-5 pond slopes are sufficiently stable under all considered loading scenarios.

Table 3: Slope Stability Analysis Results

Pond(s)	Cross-Section	Case #	Slope Location	Pond Pool level	Loading Condition	Req'd Safety Factor (1)	Calculated Safety Factor
BAP and NSP	A-A'	1a	Exterior	Storage	Static	1.50	1.94
		1b			Pseudostatic	1.00	1.45
		1c			Rapid Drawdown	1.30(2)	1.61
		2a		Surcharge	Static	1.40	1.94
		2b			Pseudostatic	1.00	1.45
		3a	Interior	Storage	Static	1.50	6.43
		3b			Pseudostatic	1.00	4.22
		4a		Surcharge	Static	1.40	7.21
		4b			Pseudostatic	1.00	4.60
		5a		Empty	Static	1.50	2.54
		5b			Pseudostatic	1.00	1.91
PDP-5	B-B'	1a	Exterior	Storage	Static	1.50	1.67
		1b			Pseudostatic	1.00	1.13
		2a		Surcharge	Static	1.40	1.67
		2b			Pseudostatic	1.00	1.13
		3a	Interior	Storage	Static	1.50	2.05
		3b			Pseudostatic	1.00	1.31
		4a		Surcharge	Static	1.40	2.43
		4b			Pseudostatic	1.00	1.45
		5a		Empty	Static	1.50	2.31
		5b			Pseudostatic	1.00	1.73

Note: (1) Required safety factors per §257.73(e)(i)-(iii)
(2) Required factor safety per EM 1110–2–1902 (USACE 2003)

4.0 CONCLUSION

Based on our review of the information provided by Luminant, on information prepared by Golder Associates Inc., and on our analyses, the calculated factors of safety through the critical cross sections in the surface impoundments exceed the values listed in §257.73(e)(1)(i)-(iv).

Golder appreciates the opportunity to assist Luminant with this project. If you have any questions, or require further assistance from Golder, please contact the undersigned at (281) 821-6868.

GOLDER ASSOCIATES INC.

Varenya Kumar
Staff Engineer

Jeffrey B. Fassett, PE
Associate Geotechnical Engineer

VK/JBF

5.0 CERTIFICATION

I hereby certify that this report has been prepared in general accordance with normally accepted civil engineering practices and in accordance with the requirements of 40 CFR 257.73(e).

STATE OF TEXAS
JEFFREY B. FASSETT
85675
LICENSED
PROFESSIONAL ENGINEER

10/10/16

Jeffrey B. Fassett, PE
Golder Associates Inc.
Firm Registration Number F-2578

Golder Associates

6.0 REFERENCES

ETTL Engineers and Consultants Inc. 2008, Geotechnical Investigation, Luminant Martin Lake SES, Reline East Ash Disposal Pond, Tatum, Texas

ETTL Engineers and Consultants Inc. 2008. Geotechnical Investigation, Luminant Martin Lake SES, Vertical Expansion of Permanent Disposal Ponds 1, 2, and 3, Tatum, Texas.

ETTL Engineers and Consultants Inc. 2009. Geotechnical Investigation, Luminant Martin Lake SES, Vertical Expansion of Permanent Disposal Ponds 1, 2, and 3, Tatum, Texas – Supplemental Seepage.

Golder Associates Inc. 2012. Ash and Scrubber Ponds and Permanent Disposal Pond #4 – Stability Investigation Report, Luminant Martin Lake Power Plant, Rusk County, Texas.

Golder Associates Inc. 2016. Structural Stability Assessment Report, Luminant Martin Lake Steam Electric Station.

Robertson, P.K. 2009. Performance based earthquake design using the CPT. In Proceedings of IS-Tokyo 2009: International Conference on Performance-Based Design in Earthquake Geotechnical Engineering — From Case History to Practice, Tokyo, Japan, 15–18 June 2009. Edited by T. Kokusho, Y. Tsukamoto, and M. Yoshimine. CRC Press/Balkema, Leiden, the Netherlands. pp. 3–20.

Rone Engineers, 1984, Geotechnical Investigation, Solid Waste Disposal Facility No. 5, Martin Lake Steam Electric Station, Rusk County, Texas.

Texas Water Development Board, 2016. Water data for Texas – Martin Lake Reservoir. (http://www.waterdatafortexas.org/reservoirs/individual/martin)

United States Army Corps of Engineers, 2003. Slope Stability – Engineering Manual. EM 1110–2–1902.

United States Department of Agriculture, Soil Conservation Service, 1990. Soil Survey of Camp, Franklin, Morris and Titus Counties, Texas.

United States Geologic Survey, 2008. Interactive Deaggregations Tool. Geologic Hazards Science Center. (http://geohazards.usgs.gov/deaggint/2008/)

REFERENCE(S)
AERIAL PHOTO SOURCED FROM GOOGLE EARTH PRO DATED: 2015-10-01

JEFFREY B. FASSETT
85675
STATE OF TEXAS
LICENSED PROFESSIONAL ENGINEER
10/10/16

Professional Engineering Firm
Registration Number F-2578

0 600 1200
1" = 1200' FEET

CLIENT	PROJECT
LUMINANT POWER MARTIN LAKE	2016 COAL COMBUSTION RESIDUALS ENGINEERING SERVICES

CONSULTANT: Golder Associates

YYYY-MM-DD	2016-09-22
PREPARED	VK
DESIGNED	TNB
REVIEWED	MX
APPROVED	JBF

TITLE
GENERAL SITE MAP

PROJECT NO.	REV.	FIGURE
164816402	----	1

APPENDIX A

BORING LOCATION MAP & BORING LOGS

BOTTOM ASH PONDS AND SCRUBBER POND

LEGEND

BH-101 BORING LOCATION

REFERENCE

1.) AERIAL SHOWN LICENSED FROM GOOGLE EARTH PROFESSIONAL.

700 0 700
SCALE FEET

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT
LUMINANT - MARTIN LAKE
ASH & SCRUBBER POND SLOPE STABILITY INVESTIGATION REPORT
RUSK COUNTY, TEXAS

TITLE
BORING LOCATIONS

Golder Associates
Mt. Laurel, New Jersey
NJ Authorization #24GA28029100

PROJECT No.		123-94128	FILE No.	12394128A003
DESIGN	MGP	12/04/12	SCALE AS SHOWN	REV. 0
CADD	RG	12/04/12	**FIGURE 1**	
CHECK	MGP	12/04/12		
REVIEW	PCM	12/04/12		

Drawing file: 12394128A003.dwg Dec 06, 2012 – 11:05am

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BORING NUMBER BH-201

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake
DATE STARTED 10/28/12 **COMPLETED** 10/28/12
GROUND ELEVATION 330 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING 28.30 ft / Elev 301.70 ft
LOGGED BY FW **CHECKED BY** MP
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0	Remove 8" sandy gravel as road base					
	(CL) SILTY CLAY, low plasticity, some sand, trace gravels, red, dry, hard	SH 1	44		5.0	
	(SC) CLAYEY SAND, non-plastic, some silt, tan and gray, dry, compact	SS 2	58	15-10-7 (17)		
5	(CL) SANDY CLAY, low plasticity, some silt, red, tan, and gray, mottled, dry, stiff	SH 3	44		3.5	
	(SC) CLAYEY SAND, fine, subangular, non-plastic, little silt, tan and gray, mottled, dry	SH 4	38		1.5	
10	(CL) SANDY CLAY, low plasticity, little silt and gravel, red, tan, and gray, mottled, dry, hard	SH 5	42		4.5	
15	some silt, no gravel, very stiff at 13.0'	SH 6	58		3.5	
20	some sand veins at 18.0'	SH 7	38		3.0	
25	gray, moist at 23.0'	SH 8	58		2.5	
30	(SC) CLAYEY SAND, fine, subangular, low plasticity, some to little silt	SH 9	71		2.0	
35	some silt, tan and gray, mottled, moist at 33.0'	SS 10	100	9-7-9 (16)		

▲ SPT N VALUE ▲ 20 40 60 80
PL MC LL 20 40 60 80
☐ FINES CONTENT (%) ☐ 20 40 60 80

(Continued Next Page)

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BORING NUMBER BH-201

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / □ FINES CONTENT (%) □ 20 40 60 80
35								
40		some silty sand veins at 38.0'	SH 11	50		2.0		
45		(SM) SILTY SAND, fine, subangular, non-plastic, little clay, tan and red, wet, compact	SS 12	100	11-11-11 (22)			
		(SP) SAND, medium to fine, subangular, poorly graded, some silt, tan, wet, compact	SS 13	100	5-9-11 (20)			
50								

Bottom of borehole at 50.0 feet.

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BORING NUMBER BH-202

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake
DATE STARTED 10/29/12 **COMPLETED** 10/29/12
GROUND ELEVATION 330 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
▽ **AT TIME OF DRILLING** 26.70 ft / Elev 303.30 ft
LOGGED BY FW **CHECKED BY** MP
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / □ FINES CONTENT (%) □ 20 40 60 80
0		Remove 6" sandy gravel from road bed						
		(CH) CLAY, medium to high plasticity, some silt, trace fine sand, tan and gray, dry, very stiff to hard	SH 1	50		4.5		
		some sand at 2.0'	SH 2	63		3.5		
5			SH 3	50		5.0		
			SH 4	63		3.75		
		(CL) SANDY CLAY, low plasticity, some to little silt, tan and gray, mottled, moist, firm	SH 5	42		4.0		
10								
		some sand seams, very stiff at 13.0'	SH 6	42		3.0		
15								
		(CL) SILTY CLAY, medium to high plasticity, little find sand, brown, moist, firm	SH 7	58		1.0		
20								
		low plasticity, gray, moist at 23.0'	SH 8	71		5.0		
25		▽						
		(SM) SILTY SAND, fine, subangular, non-plastic, some clay, gray and tan, wet, compact	SS 9	83	7-7-9 (16)			
30								
		(SC) CLAYEY SAND, fine, subangular, low plasticity, some silt, tan and gray, wet, compact	SS 10	100	3-5-6 (11)			
35								

(Continued Next Page)

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BORING NUMBER BH-202

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
35								
		interbedded clay and sand seams at 38.0'	SS 11	100	8-7-8 (15)			
40								
		no seams at 43.0'	SS 12	89	4-4-4 (8)			
45								
		(SP) SAND, medium to fine, poorly graded, subangular, non-plastic, some silt and clay, wet, loose	SS 13	100	2-3-4 (7)			
50								

Bottom of borehole at 50.0 feet.

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BORING NUMBER BH-203

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake
DATE STARTED 10/30/12 **COMPLETED** 10/30/12
GROUND ELEVATION 330 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
∇ **AT TIME OF DRILLING** 28.80 ft / Elev 301.20 ft
LOGGED BY FW **CHECKED BY** MP
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / □ FINES CONTENT (%) □ 20 40 60 80
0		remove 14" sandy GRAVEL as roadbed	SH 1	44		2.75		
		(CL) SILTY CLAY, low plasticity, little sand, gray and tan, mottled, dry, very stiff						
		(CL) SANDY CLAY, low plasticity, some silt, gray and tan, mottled, dry, stiff	SH 2	50		1.5		
5		low plasticity, some sand veins, soft	SH 3	42		1.25		
		(CL-CH) CLAY, low plasticity to medium plasticity, some silt, dark to light gray, dry, stiff	SH 4	67		1.75		
		very stiff at 8.0'	SH 5	50		3.25		
10								
		low plasticity, some silt and fine sand, little coarse sand and fine gravels, subrounded, red and tan, stiff at 13.0'	SH 6	38		1.5		
15								
		(CL) SANDY CLAY, low plasticity, some silt, tan and gray, mottled, dry, stiff	SH 7	44		2.0		
20								
		(SC) CLAYEY SAND, low plasticity, some silt, tan and gray, mottled, compact, moist	SS 8	94	3-7-7 (14)			
25								
	∇	low plasticity, with grey silty clay, some sand, tan at 28.0'	SS 9	94	4-7-8 (15)			
30								
		(SM) SILTY SAND, non-plastic, grading to sand, some silt, little to trace clay, gray, wet, compact	SS 10	100	3-8-9 (17)			
35								

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BORING NUMBER BH-203

CLIENT Luminant

PROJECT NAME Pond Slope Stability

PROJECT NUMBER 123-94128

PROJECT LOCATION Martin Lake

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
35								
		some clay and silt veins, tan at 38.0'	SS 11	100	3-6-6 (12)			
40								
		(SC) CLAYEY SAND, low plasticity, some silt, tan and brown, wet, compact	SS 12	100	4-8-10 (18)			
45								
		(SM) SILTY SAND, non-plastic, trace clay, tan and gray, wet, dense	SS 13	100	8-14-20 (34)			
50								

Bottom of borehole at 50.0 feet.

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BORING NUMBER BH-204

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake
DATE STARTED 10/30/12 **COMPLETED** 10/30/12
GROUND ELEVATION 330 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING 31.80 ft / Elev 298.20 ft
LOGGED BY FW **CHECKED BY** MP
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0	removed SANDY GRAVEL from roadbed					
	(CL) SILTY CLAY, low plasticity, some sand, tan and gray, mottled, dry, hard	SH 1	67		4.25	
	(CL) LEAN CLAY, low plasticity, some silt, sand, and sand veins, red and gray, dry, very stiff	SH 2	50		3.0	
5	(SC) CLAYEY SAND, low plasticity, some silt and black sandy gravel veins, tan and gray, dry	SH 3	33		5.0	
	(CL) SANDY CLAY, low plasticity, little silt, tan and gray, dry, stiff	SH 4	58		2.0	
10	(SC) CLAYEY SAND, non-plastic to low plasticity, little silty clay seam, tan, brown, with little gray, dry	SH 5	44		2.5	
15	(CL) LEAN CLAY, low to medium plasticity, some silt, trace fine sand, tan, brown, and gray, mottled, dry, stiff	SH 6	67		2.0	
20	some sand, little silt	SH 7	67		1.5	
25	(CL) SANDY CLAY, low plasticity, little silt, tan and gray, moist, very stiff	SH 8	46		3.0	
30	(ML) SANDY SILT, low plasticity to non-plastic, fine, subangular, some clay, tan and gray, moist, soft	SS 9	100	2-1-3 (4)		
35	(SM) SILTY SAND, low plasticity to non-plastic, fine, subangular, gray with little brown, dense	SS 10	94	11-14-18 (32)		

▲ SPT N VALUE ▲ 20 40 60 80
PL MC LL 20 40 60 80
□ FINES CONTENT (%) □ 20 40 60 80

(Continued Next Page)

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BORING NUMBER BH-204

CLIENT Luminant **PROJECT NAME** Pond Slope Stability

PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
35								
		(SC) CLAYEY SAND, fine, subangular, interbedded with gray, silty sand, some clay, tan, wet, compact	SS 11	94	4-5-6 (11)			
40								
		(CH) CLAY, medium plasticity, little silt, trace fine sand, gray, wet, stiff	SS 12	100	3-5-7 (12)			
45								
			SH 13	75		2.0		
50								

Bottom of borehole at 50.0 feet.

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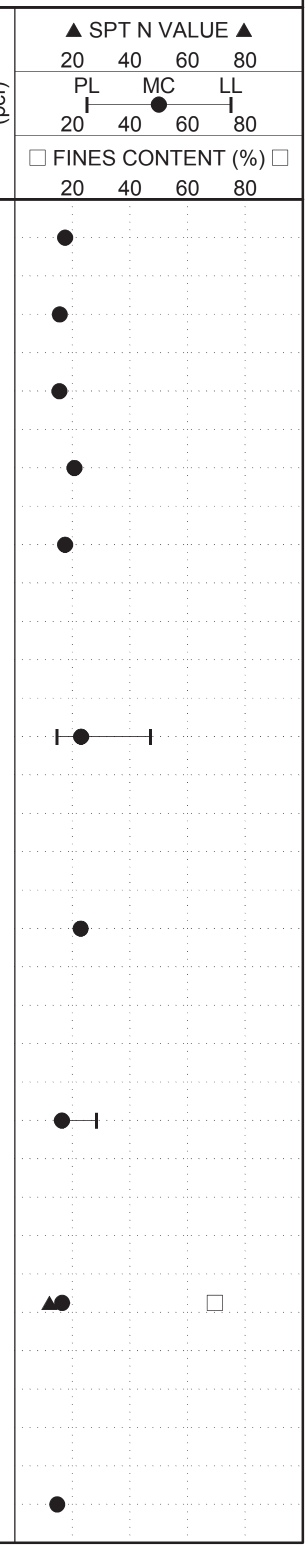
BORING NUMBER BH-205

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake
DATE STARTED 10/30/12 **COMPLETED** 10/30/12
GROUND ELEVATION 330.5 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
∇ **AT TIME OF DRILLING** 29.40 ft / Elev 301.10 ft
LOGGED BY FW **CHECKED BY** MP
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0		(CL) LEAN CLAY, medium plasticity, some silt, trace sand, tan and gray, mottled, dry, hard	SH 1	50		4.0	
		with silty sand seams, very stiff at 2.0'	SH 2	60		3.5	
5		stiff at 4.0'	SH 3	40		1.25	
		very stiff at 6.0'	SH 4	58		3.75	
10			SH 5	44		3.5	
15		some to little silt at 13.0'	SH 6	42		3.0	
20		some clayey sand seams, stiff at 18.0'	SH 7	40		1.5	
25		(CL) SILTY CLAY, low plasticity, some sand, dark gray, moist, stiff	SH 8	67		1.75	
30	∇	(CL) SANDY SILTY CLAY, low plasticity, little clay, light gray with little brown, moist, stiff	SS 9	67	2-5-7 (12)		
35		(CL) SANDY CLAY, low plasticity, some silt, tan and gray, moist, very stiff	SH 10	60		3.0	



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BORING NUMBER BH-205

CLIENT Luminant **PROJECT NAME** Pond Slope Stability

PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	SPT N VALUE / PL MC LL / FINES CONTENT (%) (20 40 60 80)
35								
40		(SC) CLAYEY SAND, interbedded with gray silty SAND, fine, subangular, little clay, compact, wet	SS 11	100	3-6-8 (14)			
45		(SP) SAND, fine, subangular, non-plastic, some clay, little silt, tan and brown, wet, compact	SS 12	100	4-9-12 (21)			
50		medium to fine, tan at 48.0'	SS 13	100	3-6-11 (17)			
55		very loose at 53.0'	SS 14	33				
60								

Bottom of borehole at 60.0 feet.

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BORING NUMBER BH-206

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake
DATE STARTED 10/30/12 **COMPLETED** 10/30/12
GROUND ELEVATION 330.5 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING 30.20 ft / Elev 300.30 ft
LOGGED BY FW **CHECKED BY** MP
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
0		(CL) SANDY CLAY, low plasticity, some silt, tan and gray, mottled, dry, stiff	SH 1	44		2.25		
		decreased sand content, very stiff at 2.0'	SH 2	67		3.5		
5		interbedded with silty clay layers, very stiff at 4.0'	SH 3	50		2.25		
		some silty sand veins, very stiff at 6.0'	SH 4	67		3.5		
			SH 5	52		3.5		
10								
		trace organics, hard at 13.0'	SH 6	54		4.5		
15								
		with clayey sand veins, hard at 18.0'	SH 7	50		5.0		
20								
		some red, moist at 23.0'	SH 8	50		4.5		
25								
		(CH) SANDY CLAY, medium to high plasticity, some silt, tan and gray, very stiff	SH 9	52		3.25		
30	▽							
		increased sand and silt content, dark gray, stiff at 33.0'	SH 10	56		1.5		
35								

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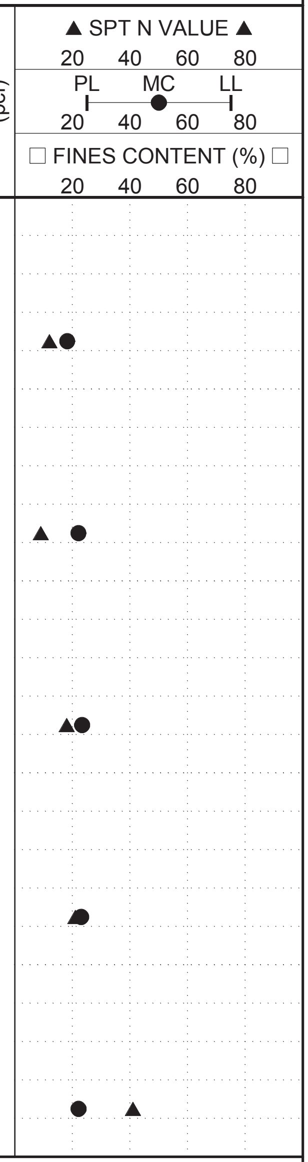
BORING NUMBER BH-206

CLIENT Luminant **PROJECT NAME** Pond Slope Stability
PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
35							
38.0		(SC) CLAYEY SAND, fine, subangular, low plasticity, some to little silt, gray, tan, and red, mottled, wet, compact	SS 11	100	5-6-6 (12)		
40							
43.0		(SM) SILTY SAND, fine, subangular, non-plastic, some clay, wet, loose	SS 12	100	3-4-5 (9)		
45							
48.0		(SP) SAND, medium to fine, trace coarse, poorly graded, subangular, non-plastic, some silt, tan, wet, compact	SS 13	100	2-6-12 (18)		
50							
53.0		no coarse, trace clay at 53.0'	SS 14	100	5-8-13 (21)		
55							
58.0		dense at 58.0'	SS 15	100	9-18-23 (41)		
60							



Bottom of borehole at 60.0 feet.

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BORING NUMBER BH-207

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake
DATE STARTED 10/31/12 **COMPLETED** 10/31/12
GROUND ELEVATION 330.5 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
▽ **AT TIME OF DRILLING** 34.40 ft / Elev 296.10 ft
LOGGED BY FW **CHECKED BY** MP
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0	remove 8" of SANDY GRAVEL from roadbed					
	(CL) SILTY CLAY, low plasticity, trace fine sand, gray, dry, hard	SH 1	33		5.0	
	(CL) SANDY CLAY, low plasticity, some silt and interbedded sand seams, tan and gray, mottled, dry, firm	SH 2	58		3.0	
5	(SP) SAND, poorly graded, non-plastic, some silt, clay, and gravel, black and tan, dry	SH 3	38		0.0	
	(CL) SANDY CLAY, low plasticity, some silt, gray and tan, dry, firm	SH 4	54		3.0	
	hard at 8.0'	SH 5	50		5.0	
10						
	decrease sand content, stiff at 13.0'	SH 6	56		3.75	
15						
	some sand seams at 18.0'	SH 7	52		2.5	
20						
	(SM) SILTY SAND, non-plastic, fine, subangular, little clay, gray, moist	SH 8	33			
25						
	(CL) SILTY CLAY, non-plastic, some sand, gray, moist, hard	SH 9	60		5.0	
30						
	(SM) SILTY SAND, non-plastic, fine, subangular, little clay, gray with little tan, moist, compact ▽	SS 10	89	6-7-7 (14)		
35						

▲ SPT N VALUE ▲ 20 40 60 80
PL MC LL 20 40 60 80
☐ FINES CONTENT (%) ☐ 20 40 60 80

LUMINANT

GEOTECH BH PLOTS - GINT STD US LAB.GDT - 12/4/12 15:58 - P:_2012 PROJECT FOLDERS\123-94128 LUMINANT POND SLOPE STABILITY\MARTIN LAKE\LAB TESTING\94128MARTINLAKE.GPJ

(Continued Next Page)

Golder Associates
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BORING NUMBER BH-207

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	SPT N VALUE / PL MC LL / FINES CONTENT (%) (20 40 60 80)
35								
40		(SC) CLAYEY SAND, non-plastic, fine, subangular, some silt, gray and tan, wet, loose	SS 11	67	2-3-4 (7)			
45		compact at 43.0'	SS 12	100	3-5-5 (10)			
50			SS 13	100	3-5-6 (11)			
55		(SP) SAND, medium to fine, non-plastic, some silt and clay, gray and tan, wet, loose	SS 14	89	2-2-5 (7)			
60		(CL) SILTY CLAY, low plasticity, trace fine sand, gray, wet, very stiff	SS 15	100	3-7-12 (19)			

Bottom of borehole at 60.0 feet.

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BORING NUMBER BH-208

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake
DATE STARTED 10/31/12 **COMPLETED** 10/31/12
GROUND ELEVATION 330.5 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
▽ **AT TIME OF DRILLING** 30.00 ft / Elev 300.50 ft
LOGGED BY FW **CHECKED BY** MP
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0	remove 12" of SANDY GRAVEL from roadbed					
	(CL) SANDY CLAY, low plasticity, some silt, tan and gray, dry, stiff	SH 1	44		3.5	
	stiff to very stiff at 2.0'	SH 2	50		4.0	
5	hard at 4.0'	SH 3	54		5.0	
	SILTY SAND, nonplastic, some clay, dry	SH 4	31		1.5	
10	(CL) SANDY CLAY, low plasticity, some silt, tan, gray, and red, dry, soft to firm	SH 5	50		2.0	
15		SH 6	40		2.5	
20	very stiff at 18.0'	SH 7	50		3.5	
25	hard at 23.0'	SH 8	46		5.0	
30	some sand seams, moist, very stiff at 28.0' ▽	SH 9	54		3.0	
35	(SC) CLAYEY SAND, fine, subangular, some silt, tan, gray, and red, moist	SH 10	60		2.5	

▲ SPT N VALUE ▲ 20 40 60 80
PL MC LL 20 40 60 80
□ FINES CONTENT (%) □ 20 40 60 80

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BORING NUMBER BH-208

CLIENT Luminant **PROJECT NAME** Pond Slope Stability

PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
35						
38	wet at 38.0'	SH 11	50			
40						
43	loose at 43.0'	SS 12	100	3-2-3 (5)		
45						
48	(SP) SAND, fine, little medium, non-plastic, subangular, little clay, tan, compact	SS 13	72	1-6-8 (14)		
50						
53		SS 14	100	3-6-7 (13)		
54	(SC) CLAYEY SAND, medium, some silt, brown					
55	(SM) SILTY SAND, fine, subangular, non-plastic, little clay, gray, compact					
58	(CL) SILTY CLAY, low plasticity, dark gray, dense	SS 15	100	7-43-50 (93)		
60	SANDY GRAVEL, non-plastic, planar, lignite coal seam, black, hard					

Bottom of borehole at 60.0 feet.

GEOTECH BH PLOTS - GINT STD US LAB.GDT - 12/4/12 15:58 - P:_2012 PROJECT FOLDERS\123-94128 LUMINANT POND SLOPE STABILITY\MARTIN LAKE\LAB TESTING\94128MARTINLAKE.GPJ

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BORING NUMBER BH-209

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake
DATE STARTED 11/1/12 **COMPLETED** 11/1/12
GROUND ELEVATION 360 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING 46.20 ft / Elev 313.80 ft no reading, cave in at 46
LOGGED BY FW **CHECKED BY** MP
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0	(SC) CLAYEY SAND, fine, subangular, medium plasticity, some fine rounded gravel, red and brown, dry	SH 1	33		5.0	
	trace fine rounded gravel, tan and gray, mottled at 2.0'	SH 2	38		5.0	
5	little silt, no gravel at 4.0'	SH 3	38		5.0	
	some silt at 6.0'	SH 4	29		4.5	
	(CL) SANDY CLAY, low plasticity, some silt, tan and gray, dry, firm	SS 5	33	2-2-5 (7)		
10						
	some red, hard at 13.0'	SH 6	21		5.0	
15						
	gray, moist, very stiff at 18.0'	SH 7	29		2.5	
20						
	(CL) LEAN CLAY, low plasticity, some silt, trace fine sand, gray and tan, moist, stiff	SS 8	67	4-6-8 (14)		
25						
	little silt, hard, gray at 28.0'	SH 9	50		5.0	
30						
	grading to clayey sand, very stiff at 33.0'	SH 10	42		3.0	
35						

▲ SPT N VALUE ▲ 20 40 60 80
PL MC LL 20 40 60 80
☐ FINES CONTENT (%) ☐ 20 40 60 80

(Continued Next Page)

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BORING NUMBER BH-209

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	SPT N VALUE / PL MC LL / FINES CONTENT (%) (20 40 60 80)
35								
40		some silt and sand, gray, tan, and brown, hard at 38.0'	SS 11	100	7-13-14 (27)			
45		(CL) SILTY CLAY, low plasticity, dark gray, moist, hard	SS 12	100	12-20-26 (46)			
50		(SM) SILTY SAND, fine, subangular, non-plastic, some clay, tan and gray, moist, very dense	SS 13	100	14-27-36 (63)			

Bottom of borehole at 50.0 feet.

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BORING NUMBER BH-210

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake
DATE STARTED 11/1/12 **COMPLETED** 11/1/12
GROUND ELEVATION 360 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
∇ **AT TIME OF DRILLING** 47.00 ft / Elev 313.00 ft no reading, cave in at 47
LOGGED BY FW **CHECKED BY** MP
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / □ FINES CONTENT (%) □ 20 40 60 80
0		(SC) CLAYEY SAND, fine, subangular, some silt, little fine rounded gravel, red, dry trace roots at 1.0'	SH 1	25		5.0		
		tan, gray, and red, mottled at 2.0'	SH 2	21		5.0		
5		compact at 4.0'	SS 3	67	4-7-10 (17)			
			SS 4	39	3-6-6 (12)			
10			SS 5	33	3-4-6 (10)			
15		(CL) SANDY CLAY, low to medium plasticity, little silt, red and gray, dry, very stiff	SH 6	21		3.0		
20		some silt and sand seams, gray and tan, moist, very stiff at 18.0'	SH 7	89		3.5		
25		little red, hard at 23.0'	SH 8	50		4.5		
30		trace subrounded fine gravels and coarse sand at 28.0'	SH 9	29		4.0		
35		(SC) CLAYEY SAND, fine, subangular, some silt, brown and tan, moist	SH 10	35		4.0		

(Continued Next Page)

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BORING NUMBER BH-210

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
35								
		(SM) SILTY SAND, fine, subangular, non-plastic, little clay, dark gray, moist, compact	SS 11	50	4-5-5 (10)			
40								
		(CL) SILTY CLAY, low plasticity, little fine sand, gray, moist, stiff	SS 12	94	2-4-5 (9)			
45								
	∇							
		(SM) SILTY SAND, fine, subangular, non-plastic, some clay, gray and tan, mottled, wet, compact	SS 13	100	4-7-8 (15)			
50								
			SS 14	89	5-9-9 (18)			
55								
		little tan, dense at 58.0'	SS 15	100	7-14-17 (31)			
60								
			SS 16	100	11-15-19 (34)			
65								
		some dark brown clay seams at 68.0'	SS 17	100	10-15-25 (40)			
70								

Bottom of borehole at 70.0 feet.

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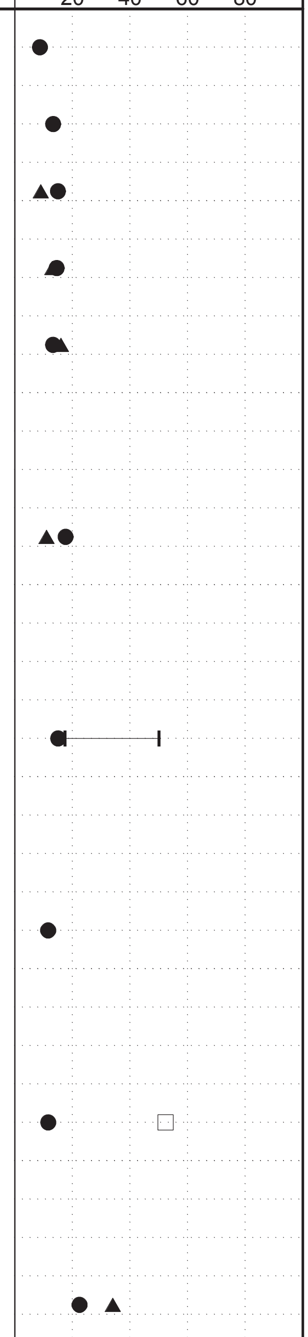
BORING NUMBER BH-211

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake
DATE STARTED 11/2/12 **COMPLETED** 11/2/12
GROUND ELEVATION 360 ft **HOLE SIZE** 8 inches
DRILLING CONTRACTOR WEST Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING 60.20 ft / Elev 299.80 ft no reading, cave in at 60
LOGGED BY FW **CHECKED BY** MP
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
0	(SC) CLAYEY SAND, some silt and fine rounded gravel, red, dry	SH 1	29		5.0	
	fine, subangular, gray, tan, and red at 2.0'	SH 2	29		3.5	
5	trace fine gravels and coarse sand, loose at 4.0'	SS 3	50	2-3-6 (9)		
	some sandy clay seams, compact at 6.0'	SS 4	39	4-5-8 (13)		
10	increase clay and silt content at 8.0'	SS 5	72	4-8-8 (16)		
15	(CL-CH) SANDY CLAY, low to medium plasticity, little silt, gray, tan, and red, dry, stiff	SS 6	33	2-5-6 (11)		
20	some silt at 18.0'	SH 7	50		3.25	
25	brown and tan at 23.0'	SH 8	44		5.0	
30	(ML) SANDY SILT, little clay, tan, moist	SH 9	25			
35	(SM) SILTY SAND, fine, subangular, some clay, tan and gray, dense	SS 10	67	7-15-19 (34)		

▲ SPT N VALUE ▲ 20 40 60 80
PL MC LL 20 40 60 80
□ FINES CONTENT (%) □ 20 40 60 80



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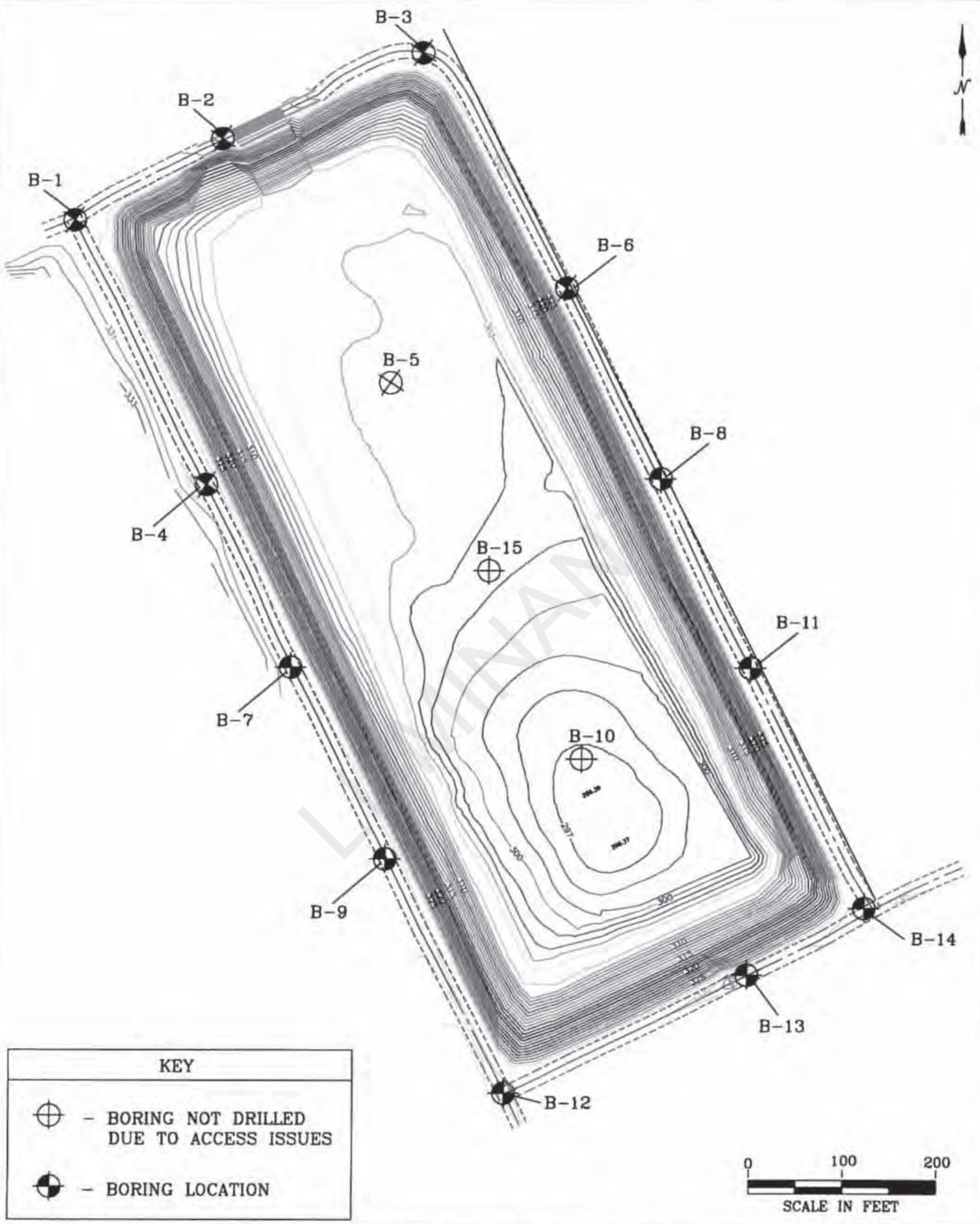
BORING NUMBER BH-211

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)
35–48						
38.5		SS 11	89	9-17-25 (42)		
43.5		SS 12	100	10-14-18 (32)		
48	(SC) CLAYEY SAND, low plasticity, fine, subangular, some silt and lean clay, gray and tan, wet, dense	SS 13	89	9-14-18 (32)		
53	(SP) SAND, fine, subangular, non-plastic, some silt, little to trace clay, tan, wet, very dense	SS 14	100	17-29-38 (67)		
58	little medium at 58.0'	SS 15	78	14-28-33 (61)		
63		SS 16	100	17-29-34 (63)		
68	(SM) SILTY SAND, fine, subangular, non-plastic, little to trace clay, gray and tan, wet, very dense	SS 17	72	18-27-37 (64)		

Bottom of borehole at 70.0 feet.



ETTL ENGINEERS & CONSULTANTS MAIN OFFICE 1717 East Erwin Tyler, Texas 75702 (903) 595-4421	MARTIN LAKE LUMINANT EAST ASH DISPOSAL POND RUSK COUNTY, TEXAS	PLATE 1 – PLAN OF BORINGS JOB NO.: G 2972-08 DATE: NOV. 2008 — SCALE: AS SHOWN	APPROVED BY: DRAWN BY: K.C.R.

LOG OF BORING B-1

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

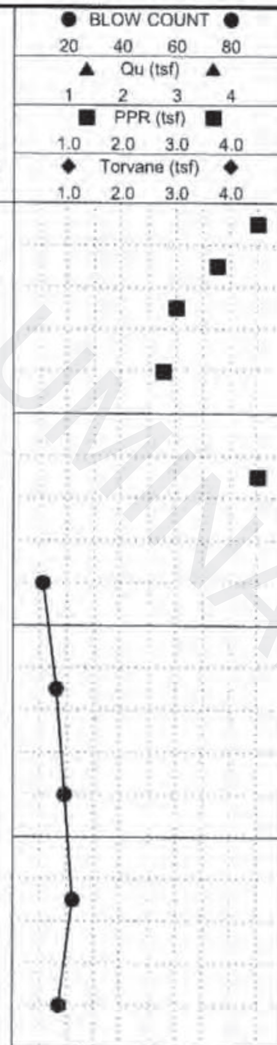
PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

DATE 10/8/08

SURFACE ELEVATION

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) hard; red, tan, and gray; mottled	P=4.5+	9	28	14	14	55	+40 Sieve =0%, +4 Sieve =0%
		–very stiff	P=3.75						
		–with trace lignite	P=3.0	16	37	14	23	66	+40 Sieve =1%, +4 Sieve =0%
			P=2.75						
10		–hard	P=4.5+						
20			N=11						
			N=16	17	39	16	23	70	+40 Sieve =1%, +4 Sieve =0%
30	SM	SILTY SAND(SM) medium dense; red, tan, and gray	N=19						
		–with gravel	N=22						
40	CL	LEAN CLAY WITH SAND(CL) very stiff; red, tan, and gray; interbedded; laminated	N=17						
		Bottom of Boring @ 40'							

Columns without entries: DRY DENSITY (pcf), COMPRESSIVE STRENGTH (tsf), FAILURE STRAIN (%), CONFINING PRESSURE (psi)



Water Level Est: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 28' while drilling. Water level @ 26' and open to 33' upon completion. Water level @ 24' and open to 27' on 10/9/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes: GPS Coordinates: N 32°15.850', W 94°33.910'

ETTL
ENGINEERS &
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MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING B-11

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

DATE 10/7/08

SURFACE ELEVATION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SC	CLAYEY SAND(SC) tan, gray, and red; mottled; with gravel	P=3.0	6	28	12	16	33	+40 Sieve =28%, +4 Sieve =24%
		P=2.25						
CL	SANDY LEAN CLAY(CL) very stiff; tan, gray, and red; mottled	N=17	13	32	13	19	56	+40 Sieve =1%, +4 Sieve =0%
	--stiff	N=11						
		P=2.25						
		P=3.25	16	38	14	24	68	+40 Sieve =1%, +4 Sieve =0%
	--red and gray; mottled	P=2.25						
	--tan, red, and gray; mottled	N=15						
SM	SILTY SAND(SM) medium dense; gray	N=16						
	Bottom of Boring @ 40'							

DEPTH (ft): 0, 10, 20, 30, 40 — SAMPLES — WATER LEVEL

BLOW COUNT: 20 40 60 80
Qu (tsf): 1 2 3 4
PPR (tsf): 1.0 2.0 3.0 4.0
Torvane (tsf): 1.0 2.0 3.0 4.0

DRY DENSITY (pcf) — COMPRESSIVE STRENGTH (tsf) — FAILURE STRAIN (%) — CONFINING PRESSURE (psi)

Natural Moisture Content and Atterberg Limits
Plastic Limit — Moisture Content — Liquid Limit
20 40 60 80

ATTERBERG LIMITS(%)

Water Level Est: Measured: Perched:

Water Observations: Seepage @ 38' while drilling. Water level @ 36' and open to 37' upon completion. Water level @ 21' and open to 22' on 10/8/08.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.773', W 94°33.782'

LOG OF BORING B-12

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

DATE 10/9/08

SURFACE ELEVATION

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) brown; with gravel							
				13	32	15	17	54	+40 Sieve =1%, +4 Sieve =0%
		–mottled; tan, red, and gray; with sand seams	P=3.5	13	34	15	19	57	+40 Sieve =0%, +4 Sieve =0%
10		–with silty sand							
	CL	LEAN CLAY WITH SAND(CL) very stiff; tan, red, and gray; mottled	N=18	16	30	14	16	75	+40 Sieve =1%, +4 Sieve =0%
20			N=15						
		–with sand seams	N=22						
30	SM	SILTY SAND(SM) dense; gray and red; mottled	N=38						
	CL	SANDY LEAN CLAY(CL) very stiff; gray, red, and tan; mottled	N=18						
40		Bottom of Boring @ 40'							

Chart headings: BLOW COUNT (20, 40, 60, 80); Qu (tsf) (1, 2, 3, 4); PPR (tsf) (1.0, 2.0, 3.0, 4.0); Torvane (tsf) (1.0, 2.0, 3.0, 4.0). DRY DENSITY (pcf); COMPRESSIVE STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi). Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20, 40, 60, 80). ATTERBERG LIMITS(%).

Water Level: Est. Measured: Perched:

Water Observations: Seepage @ 33' while drilling. Water level @ 34' and open to 35' upon completion. Water level @ 23' and open to 31' on 10/10/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes: GPS Coordinates: N 32°15.696', W 94°33.830'

LOG OF BORING B-13

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

DATE 10/7/08

SURFACE ELEVATION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) very stiff; tan, gray, and red; mottled	P=3.25						
CL	LEAN CLAY WITH SAND(CL) very stiff; tan, gray, and red; mottled	P=3.0	15	39	16	23	70	+40 Sieve =6%
	–tan and brown	P=3.75						
SC	CLAYEY SAND(SC) dense; tan, brown, and red; with gravel	P=3.25	10	40	16	24	47	+40 Sieve =36%, +4 Sieve =33%
CL	LEAN CLAY WITH SAND(CL) very stiff; tan, brown, and red; with lignite	P=2.75						
	–red and tan	P=2.0	17	38	16	22	74	+40 Sieve =3%, +4 Sieve =0%
		P=2.25						
	–tan, red, and gray; mottled	N=18						
SC	CLAYEY SAND(SC) loose; tan, red, and gray; with trace gravel and ferric material	N=9	18	36	17	19	43	+40 Sieve =36%, +4 Sieve =25%
	–medium dense	N=18						
	Bottom of Boring @ 40'							

Column headings: DEPTH (ft) (0, 10, 20, 30, 40); SAMPLES; USC; WATER LEVEL; BLOW COUNT (20, 40, 60, 80); Qu (tsf) (1, 2, 3, 4); PPR (tsf) (1.0, 2.0, 3.0, 4.0); Torvane (tsf) (1.0, 2.0, 3.0, 4.0); DRY DENSITY (pcf); COMPRESSIVE STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi); Natural Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 20, 40, 60, 80); ATTERBERG LIMITS(%)

Water Level Est: Measured: Perched:

Water Observations: Seepage @ 37' while drilling. Water level @ 36' and open to 38' upon completion. Water level @ 25' and open to 26' on 10/8/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.713', W 94°33.777'

LOG OF BORING B-14

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

DATE: 10/6/08

SURFACE ELEVATION:

PROJECT: Martin Lake - Luminant East Ash Disposal, Rusk County, Texas

PROJECT NO.: G 2972-08

BORING TYPE: Flight Auger

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) hard; tan, gray, and red; mottled; with gravel	P=4.5+						
			P=4.5+	14	40	16	24	53	+40 Sieve =50%, +4 Sieve =49%
			P=4.5+ P=4.5+						
		--stiff	N=12	13	29	13	16	63	+40 Sieve =1%, +4 Sieve =0%
10	CL	SANDY LEAN CLAY(CL) very stiff; tan, gray, and red; mottled	N=16						
		--stiff; interbedded	N=14	16	31	16	15	58	+40 Sieve =2%, +4 Sieve =0%
20			N=15						
		--hard; brown, tan, and red	P=4.5+	12	40	14	26	77	+40 Sieve =1%, +4 Sieve =0%
30			N=19						
		--hard; with gray and brown silty sand	P=4.25						
40	SM	SILTY SAND(SM) medium dense; red and gray; saturated							

Plot columns: BLOW COUNT (20, 40, 60, 80); Qu (tsf) (1, 2, 3, 4); PPR (tsf) (1.0, 2.0, 3.0, 4.0); Torvane (tsf) (1.0, 2.0, 3.0, 4.0); DRY DENSITY (pcf); COMPRESSIVE STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi); Natural Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 20, 40, 60, 80); ATTERBERG LIMITS(%)

Water Level: Est.: ∇ Measured: ▼ Perched: ∇

Water Observations: Water level @ 22' and open to 89' upon completion. Water level @ 26' and open to 27' on 10/9/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.723', W 94°33.756'

LOG OF BORING B-14

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

DATE 10/6/08

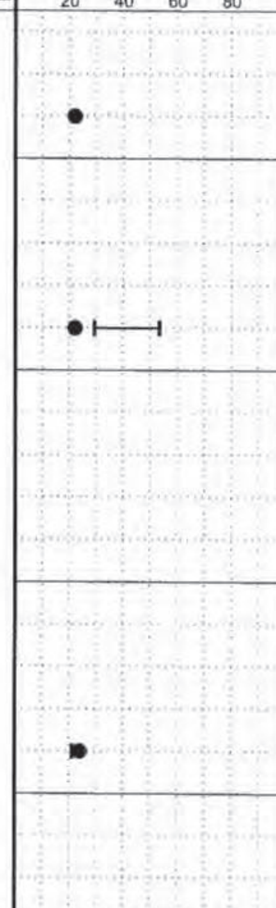
SURFACE ELEVATION

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
			N=18						
50			N=16	22				25	+40 Sieve =1%, +4 Sieve =0%
		–red and tan	N=23						
60	CL	LEAN CLAY WITH SAND(CL) hard; red and tan; interbedded; laminated; with ferric material seams	N=32	22	53	29	24	77	+40 Sieve =3%, +4 Sieve =0%
		–with black lignite seams	N=50/3"						
70	SM	SILTY SAND(SM) very dense; gray; with fat clay partings	N=50/5.5"						
		–gray	N=50/5"						
80			N=50/6"	24	24	21	3	41	+40 Sieve =0%, +4 Sieve =0%
	CL	LEAN CLAY(CL) hard; gray	N=50/6"						

Blow count / strength plot: BLOW COUNT 20 40 60 80; Qu (tsf) 1 2 3 4; PPR (tsf) 1.0 2.0 3.0 4.0; Torvane (tsf) 1.0 2.0 3.0 4.0

DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80



Water Level: Est. Measured Perched

Water Observations: Water level @ 22' and open to 89' upon completion. Water level @ 26' and open to 27' on 10/9/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.723', W 94°33.756'

LOG OF BORING B-14

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

DATE 10/6/08

SURFACE ELEVATION

DEPTH (ft)	MATERIAL DESCRIPTION	FIELD STRENGTH DATA
90	–with black lignite	N=50/3.5"
	–dark brown; with silt seams; with lignite seam	N=50/6"
100		N=88
	Bottom of Boring @ 100'	

Column headings: DEPTH (ft); SAMPLES; USC; WATER LEVEL; MATERIAL DESCRIPTION; FIELD STRENGTH DATA; ● BLOW COUNT ● 20 40 60 80; ▲ Qu (tsf) ▲ 1 2 3 4; ■ PPR (tsf) ■ 1.0 2.0 3.0 4.0; ◆ Torvane (tsf) ◆ 1.0 2.0 3.0 4.0; DRY DENSITY (pcf); COMPRESSIVE STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi); Natural Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80); MOISTURE CONTENT (%); ATTERBERG LIMITS(%): LIQUID LIMIT LL, PLASTIC LIMIT PL, PLASTICITY INDEX PI; MINUS #200 SIEVE (%); OTHER TESTS PERFORMED (Page Ref. #)

Water Level Est: ▽ Measured: ▼ Perched: ▼

Water Observations: Water level @ 22' and open to 89' upon completion. Water level @ 26' and open to 27' on 10/9/08.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.723', W 94°33.756'

LOG OF BORING B-2

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

DATE 10/8/08

SURFACE ELEVATION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) very stiff; tan, red, and gray	N=19	8	32	14	18	50	+40 Sieve =0%, +4 Sieve =0%
	–hard; red, tan, and gray; mottled	P=4.25						
		P=3.75						
		P=4.0						
	–with some gravel	P=4.5+						
	–tan, red, and gray; mottled	N=1	17	28	15	13	63	+40 Sieve =1%, +4 Sieve =0%
	–gray, red, and tan; mottled	N=22	13	39	15	24	54	+40 Sieve =0%, +4 Sieve =0%
SM	SILTY SAND(SM) medium dense; red and gray; saturated	N=15						
		N=13						
	Bottom of Boring @ 40'							

Blank columns (no entries): DRY DENSITY (pcf); COMPRESSIVE STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi).

Chart legend: BLOW COUNT 20 40 60 80; Qu (tsf) 1 2 3 4; PPR (tsf) 1.0 2.0 3.0 4.0; Torvane (tsf) 1.0 2.0 3.0 4.0. Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80.

Depth (ft): 0, 10, 20, 30, 40

Water Level: Est: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 32' while drilling. Water level @ 29' and open to 32' upon completion. Water level @ 25' and open to 25' on 10/9/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.860', W 94°33.890'

LOG OF BORING B-3

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

DATE 10/8/08

SURFACE ELEVATION

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) very stiff; tan, red, and gray; mottled	P=3.5										
			P=2.5					18	33	13	20	68	+40 Sieve =1%, +4 Sieve =0%
			P=3.0										
			P=3.5										
10		--stiff	P=1.5										
20	SC	CLAYEY SAND(SC) medium dense; red	N=15					10	37	15	22	19	+40 Sieve =15%, +4 Sieve =7%
		--gray	N=4										
30	CL	LEAN CLAY WITH SAND(CL) stiff; red, tan, and gray; mottled	N=15					18	34	16	18	71	+40 Sieve =5%, +4 Sieve =0%
		--with sand seams	N=13										
40	SC	CLAYEY SAND(SC) medium dense; gray and red; mottled; with clay seams	N=13										
		Bottom of Boring @ 40'											

Legend for plotted values: BLOW COUNT (20, 40, 60, 80); Qu (tsf) (1, 2, 3, 4); PPR (tsf) (1.0, 2.0, 3.0, 4.0); Torvane (tsf) (1.0, 2.0, 3.0, 4.0)

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20, 40, 60, 80)

Water Level: Est. Measured: Perched:

Water Observations: Seepage @ 29' while drilling. Water level @ 28' and open to 34' upon completion. Water level @ 25' and open to 32' on 10/9/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.876', W 94°33.842'

LOG OF BORING B-4

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

DATE 10/8/08

SURFACE ELEVATION

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) stiff; tan, red, and gray; mottled	N=13										
			P=2.5 P=4.5+					13	28	14	14	60	+40 Sieve =1%, +4 Sieve =0%
			P=2.0										
10													
	SC	CLAYEY SAND(SC) red, tan, and gray; mottled						14	29	14	15	36	+40 Sieve =0%, +4 Sieve =0%
	CL	SANDY LEAN CLAY(CL) stiff; tan, red, and gray; mottled; with sand seams	N=14										
20													
		–red and tan	N=12					15	44	15	29	67	+40 Sieve =0%, +4 Sieve =0%
		–with sand seams	N=20										
30													
	SM	SILTY SAND(SM) medium dense; red; saturated	N=20										
		–red and tan; with gravel	N=39										
40		Bottom of Boring @ 40'											

Water Level Est: Measured: Perched:

Water Observations: Seepage @ 28' while drilling. Water level @ 27' and open to 30' upon completion. Water level @ 23' and open to 28' on 10/9/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.804', W 94°33.891'

LOG OF BORING B-6

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

DATE 10/7/08

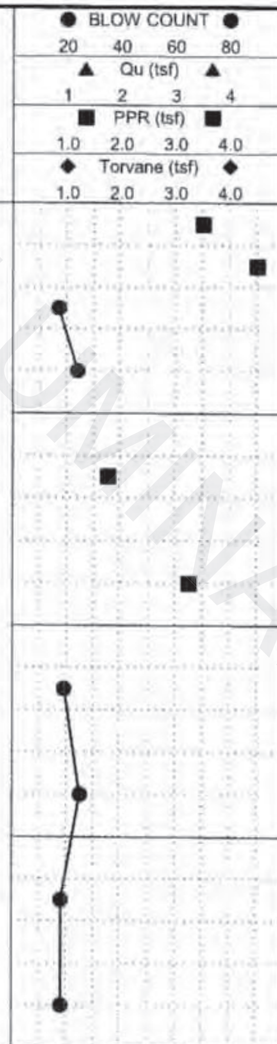
SURFACE ELEVATION

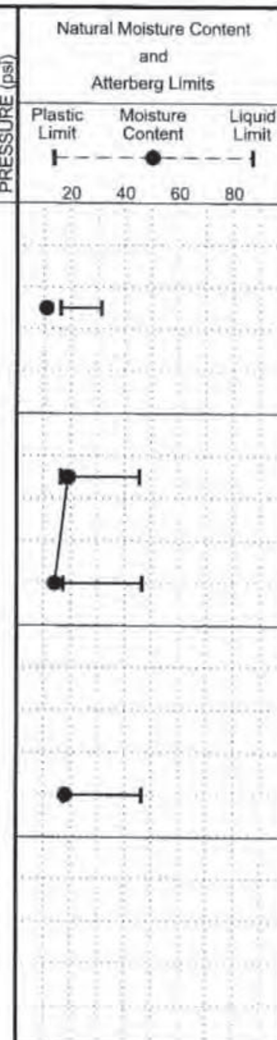
PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) very stiff; tan, red, and gray; mottled	P=3.5						
		P=4.5+						
SC	CLAYEY SAND(SC) medium dense; tan, red, and gray; mottled	N=17	11	31	16	15	43	+40 Sieve =1%, +4 Sieve =0%
		N=24						
CL	LEAN CLAY(CL) stiff; tan, red, and gray; mottled	P=1.75	19	45	16	29	88	+40 Sieve =0%, +4 Sieve =0%
	-very stiff; brown, gray, and red; with sand; trace ferric material and lignite	P=3.25	14	46	17	29	74	+40 Sieve =0%, +4 Sieve =0%
	-with sand seams	N=19						
	-tan, red, and gray; mottled	N=25	18	46	17	29	84	+40 Sieve =8%, +4 Sieve =3%
	-tan and gray; mottled	N=18						
SM	SILTY SAND(SM) tan and gray	N=18						
CL	SANDY LEAN CLAY(CL) very stiff; tan and gray							
	Bottom of Boring @ 40'							

DEPTH (ft) 0 10 20 30 40 — SAMPLES — WATER LEVEL — DRY DENSITY (pcf) — COMPRESSIVE STRENGTH (tsf) — FAILURE STRAIN (%) — CONFINING PRESSURE (psi)





Water Level Est: Measured: Perched:

Water Observations: Seepage @ 28' while drilling. Water level @ 26' and open to 34' upon completion. Water level @ 25' and open to 27' on 10/8/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.833', W 94°33.814'

LOG OF BORING B-7

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

DATE: 10/8/08

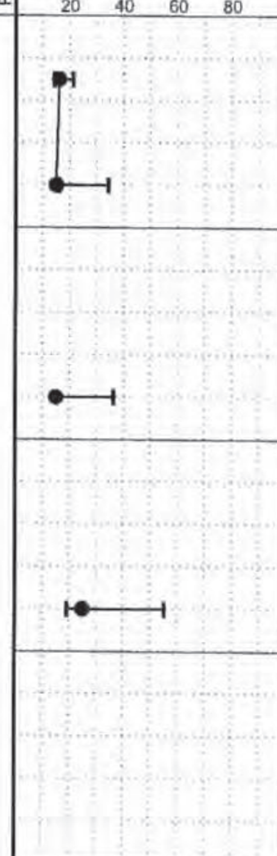
SURFACE ELEVATION:

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

PROJECT NO.: G 2972-08

BORING TYPE: Flight Auger

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) hard; tan, red, and gray; mottled	P=4.0						
CL ML	SANDY SILTY CLAY(CL-ML) very stiff; tan, red, and gray; mottled	P=3.0	16	21	14	7	63	+40 Sieve =0%, +4 Sieve =0%
		P=3.0						
CL	LEAN CLAY WITH SAND(CL) very stiff; tan, red, and gray; mottled	P=3.25	15	34	16	18	74	+40 Sieve =1%, +4 Sieve =0%
	–stiff	P=1.5						
		P=1.5	15	36	15	21	72	+40 Sieve =0%, +4 Sieve =0%
CH	FAT CLAY(CH) stiff; gray, red, and tan; mottled	N=11	25	55	19	36	88	+40 Sieve =1%, +4 Sieve =0%
SM	SILTY SAND(SM) medium dense; tan, red, gray, mottled	N=10						
CL	SANDY LEAN CLAY(CL) very stiff; red, tan, and gray; mottled	N=20						
	Bottom of Boring @ 40'							



Columns without entries: DRY DENSITY (pcf), COMPRESSIVE STRENGTH (tsf), FAILURE STRAIN (%), CONFINING PRESSURE (psi)

Depth (ft): 0, 10, 20, 30, 40

Water Level: Est: ∇ Measured: ▼ Perched: ∇

Water Observations: Seepage @ 33' while drilling. Water level @ 32' and open to 35' upon completion. Water level @ 23' and open to 27' on 10/9/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.775', W 94°33.875'

ETTL
ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING B-8

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

DATE 10/7/08

SURFACE ELEVATION

DEPTH (ft) | SAMPLES | USC | WATER LEVEL

● BLOW COUNT ● 20 40 60 80; ▲ Qu (tsf) ▲ 1 2 3 4; ■ PPR (tsf) ■ 1.0 2.0 3.0 4.0; ◆ Torvane (tsf) ◆ 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) hard; tan, red, and gray; mottled	P=4.5+					11	30	13	17	67	+40 Sieve =2%, +4 Sieve =0%
		P=4.5+										
		P=3.5					13	29	13	16	67	+40 Sieve =0%, +4 Sieve =0%
		P=4.0										
		P=3.5										
	–very stiff	N=15					18	44	18	26	70	+40 Sieve =3%, +4 Sieve =0%
		P=2.5										
		N=15					16	36	16	20	63	+40 Sieve =9%, +4 Sieve =3%
	–red and gray; mottled	N=16										
SM	SILTY SAND(SM) dense; red, tan, and reddish gray; mottled; saturated	N=26										
	Bottom of Boring @ 40'											

Depth scale: 0, 10, 20, 30, 40

Water Level Est: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 38' while drilling. Water level @ 35' and open to 36' upon completion. Water level @ 23' and open to 27' on 10/8/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.803', W 94°33.798'

LOG OF BORING B-9

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Martin Lake - Luminant East Ash Disposal
Rusk County, Texas

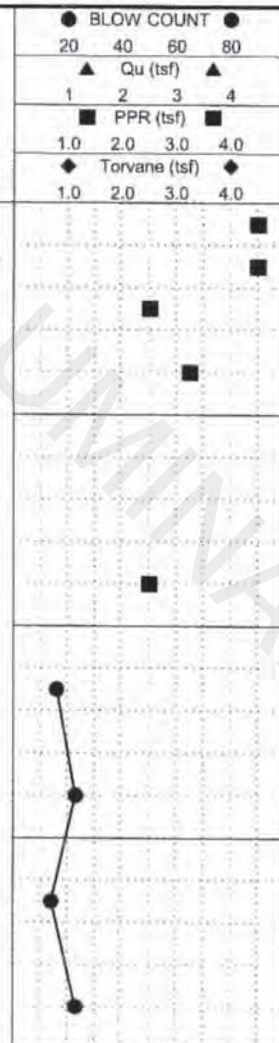
PROJECT NO.: G 2972-08 **BORING TYPE:** Flight Auger

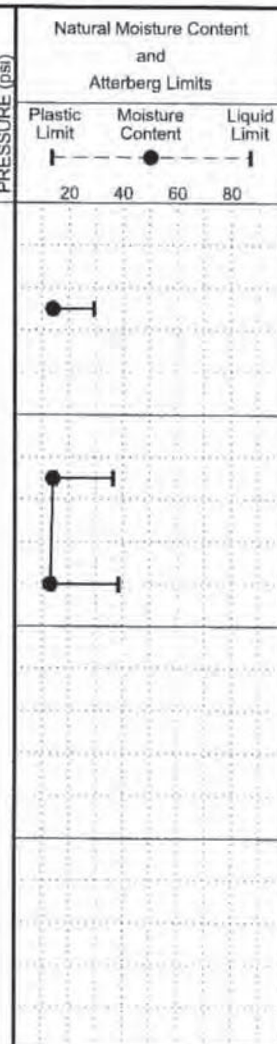
DATE 10/9/08

SURFACE ELEVATION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) hard; tan, red, and gray; mottled	P=4.5+						
		P=4.5						
		P=2.5	14	29	14	15	59	+40 Sieve =2%, +4 Sieve =0%
		P=3.25						
	--sand content increasing	SF	14	36	15	21	58	+40 Sieve =1%, +4 Sieve =0%
	--with bluish green sandy clay	P=2.5	13	38	14	24	56	+40 Sieve =1%, +4 Sieve =0%
SM	SILTY SAND(SM) medium dense; gray, tan, and red; mottled	N=16						
CL	SANDY LEAN CLAY(CL) very stiff; gray, tan, and red; mottled							
SM	SILTY SAND(SM) medium dense; tan, red, and gray	N=23						
	--with clay seams	N=14						
	--saturated	N=23						
	Bottom of Boring @ 40'							

Columns with no entries: DRY DENSITY (pcf); COMPRESSIVE STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi).





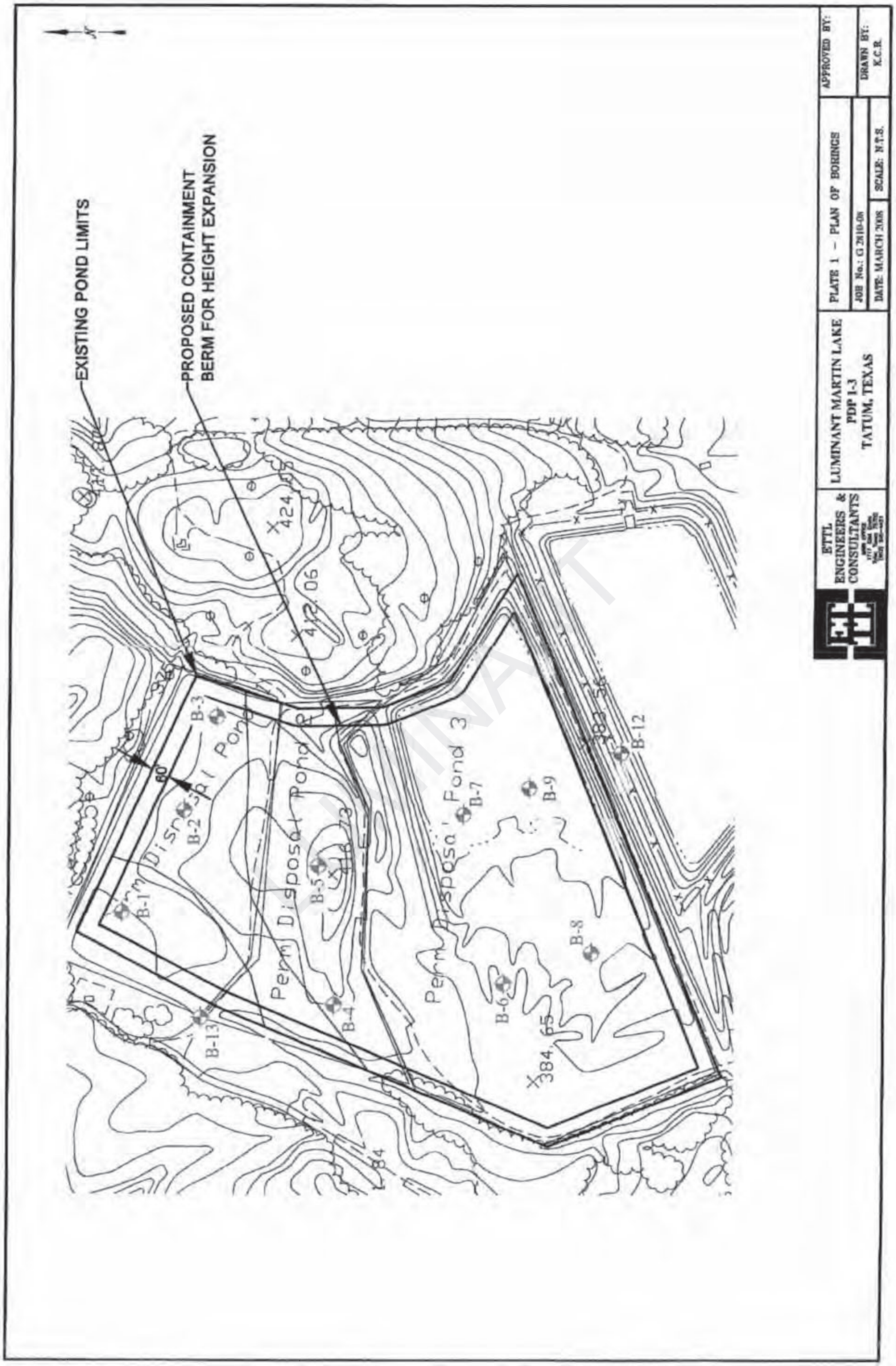
Water Level Est: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 28' while drilling. Water level @ 23' and open to 31' upon completion. Water level @ 23' and open to 29' on 10/10/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.745', W 94°33.857'

PERMANENT DISPOSAL POND - 5


EXISTING POND LIMITS
PROPOSED CONTAINMENT BERM FOR HEIGHT EXPANSION
Perm Disposal Pond
Perm Disposal Pond
Perm Disposal Pond 3
B-1
B-2
B-3
B-4
B-5
B-6
B-7
B-8
B-9
B-12
B-13
60
424.05
412.06
416.73
384.65
ETTL ENGINEERS & CONSULTANTS
LUMINANT MARTIN LAKE
PDP 1-3
TATUM, TEXAS
PLATE 1 - PLAN OF BORINGS
JOB No.: G 2818-08
DATE: MARCH 2008
SCALE: N.T.S.
APPROVED BY:
DRAWN BY: K.C.R.

LOG OF BORING B-1

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

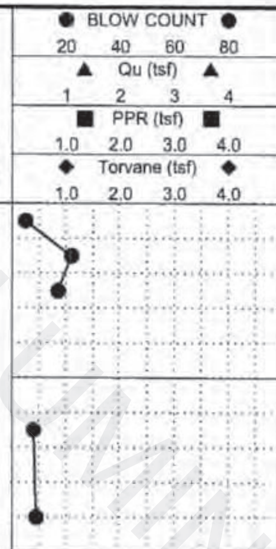
PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

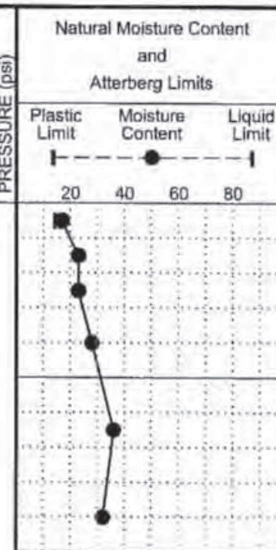
PROJECT NO.: G 2810-08 **BORING TYPE:** Flight Auger

DATE 2/22/08

SURFACE ELEVATION 390'

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	SM	SILTY SAND(SM) loose; tan; moist; with ferric oxide; with organics	N=5					17	16	14	2	34	+40 Sieve =8%, +4 Sieve =3%
		ASH SEDIMENT medium dense; black and gray; coarse to very fine-grained sand	N=22	101				23					
			N=17					23					
10		–black		82				28				23	+40 Sieve =55%, +4 Sieve =26%
		–loose; black and gray; coarse to very fine-grained sand	N=8					36					
20			N=9					32				53	
		Bottom of Boring @ 20'											





Water Level: Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 7' while drilling. Water level @ 1' and caved to 6' on 2/29/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.790', W 94°34.996'. Minus #200 Sieve (53%) @ 18' (Hydrometer - Specific Gravity 2.608). Dry Density (82) @ 8' (Hydraulic Conductivity K=2.79E-04 cm/sec).

LOG OF BORING B-12

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3, Tatum, Texas

PROJECT NO.: G 2810-08 **BORING TYPE:** Rotary Wash

DATE 2/27/08

SURFACE ELEVATION 380'

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SC	CLAYEY SAND(SC) medium dense; red and orange	N=25	16	35	15	20	37	+40 Sieve =10%, +4 Sieve =3%
	–loose; gray, red, and orange	N=9						
CL	LEAN CLAY WITH SAND(CL) stiff; red, orange, and tan	N=10						
	–gray and red	N=13	24	47	19	28	79	+40 Sieve =3%, +4 Sieve =0%
	–red and orange							
SC	CLAYEY SAND(SC) medium dense; red and orange	N=11						
	–with iron oxide cemented sandstone gravel	N=12	17	36	15	21	44	+40 Sieve =21%, +4 Sieve =18%
SM	SILTY SAND(SM) medium dense; gray, red, and orange	N=17						
CL	SANDY LEAN CLAY(CL) medium dense; red, orange, and gray	N=20	20	40	16	24	61	+40 Sieve =5%, +4 Sieve =3%
		N=17						
	–red and orange; with iron oxide cemented sandstone seam @ 45'							
SM	SILTY SAND(SM) medium dense; gray, orange, and tan	N=23						

Column headings also printed: DEPTH (ft) 0, 10, 20, 30, 40, 50; SAMPLES; WATER LEVEL; BLOW COUNT 20 40 60 80; Qu (tsf) 1 2 3 4; PPR (tsf) 1.0 2.0 3.0 4.0; Torvane (tsf) 1.0 2.0 3.0 4.0; DRY DENSITY (pcf); COMPRESSIVE STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi); Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit, 20 40 60 80; ATTERBERG LIMITS(%)

Water Level: Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Dry and open to 25' on 2/29/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.513', W 94°34.904'.

LOG OF BORING B-12

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

PROJECT NO.: G 2810-08 **BORING TYPE:** Rotary Wash

DATE 2/27/08

SURFACE ELEVATION 380'

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
	-gray, red, brown	N=26										
	-gray and brown	N=28										
ML	SILT(ML) dense; brown and gray	N=46	99				26				96	+40 Sieve =2%, +4 Sieve =0%
	-very dense	N=66										
CL	LEAN CLAY WITH SAND(CL) hard; gray	N=50/3"										
		N=50/4"	102				22	45	24	21	73	+40 Sieve =24%, +4 Sieve =23%
ML	SILT(ML) very dense; gray	N=71										
		N=50/5"	107				23				94	+40 Sieve =2%, +4 Sieve =0%
		N=70										
		N=80										
	Bottom of Boring @ 100'											

Depth (ft): 60, 70, 80, 90, 100

BLOW COUNT: 20, 40, 60, 80 · Qu (tsf): 1, 2, 3, 4 · PPR (tsf): 1.0, 2.0, 3.0, 4.0 · Torvane (tsf): 1.0, 2.0, 3.0, 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit: 20, 40, 60, 80

Water Level: Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Dry and open to 25' on 2/29/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes: GPS Coordinates: N 32°15.513', W 94°34.904'.

LOG OF BORING B-13

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

PROJECT NO.: G 2810-08 **BORING TYPE:** Rotary Wash

DATE 2/19/08

SURFACE ELEVATION 380'

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	SC	CLAYEY SAND(SC) medium dense; red	N=11										
			N=16					14	24	14	10	46	+40 Sieve =3%, +4 Sieve =1%
		–brown and gray	N=38										
		–dense; red and tan	N=47										
10													
		–tan, red, and gray	N=37										
20	CH	FAT CLAY(CH) stiff; red, gray, and tan	P=1.5					23	51	20	31	89	+40 Sieve =7%, +4 Sieve =1%
		–with iron laminations	P=1.5 P=1.5										
30	CL	LEAN CLAY(CL) very stiff; gray	N=26					23	48	21	27	94	+40 Sieve =2%, +4 Sieve =0%
		–hard	P=4.5+										
40		–gray and brown; with iron oxide cemented sandstone seams	P=4.5+										
	ML	SANDY SILT(ML) very dense; gray; with clay seams	N=63					26				66	+40 Sieve =2%, +4 Sieve =0%
50			N=63										

Chart legend: BLOW COUNT 20 40 60 80; Qu (tsf) 1 2 3 4; PPR (tsf) 1.0 2.0 3.0 4.0; Torvane (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

Water Level Est: Measured: Perched:

Water Observations: Seepage @ 29' while drilling. Water level @ 28' and open upon completion. Water level @ 12' and caved to 14' on 2/29/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes: GPS Coordinates: N 32°15.752', W 94°35.072'.

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ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING B-13

PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

PROJECT NO.: G 2810-08 **BORING TYPE:** Rotary Wash

DATE 2/19/08

SURFACE ELEVATION 380'

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
		--hard; laminated with sand seams	P=4.5+										
60		--very stiff; gray and green; with sand seams	P=2.5										
	CL	LEAN CLAY(CL) hard; gray; laminated with sand seams	N=76					26	47	24	23	96	+40 Sieve =2%, +4 Sieve =0%
70	SM	SILTY SAND(SM) very dense; gray	N=75										
			N=50/3.5"										
80	ML	SILT(ML) very dense; gray	N=78										
		--with clay seams	P=SF										
90			N=50/5"										
			N=50/3"										
100			N=50/4"										
		Bottom of Boring @ 100'											

BLOW COUNT 20 40 60 80; Qu (tsf) 1 2 3 4; PPR (tsf) 1.0 2.0 3.0 4.0; Torvane (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 29' while drilling. Water level @ 28' and open upon completion. Water level @ 12' and caved to 14' on 2/29/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.752', W 94°35.072'.

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MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING B-2

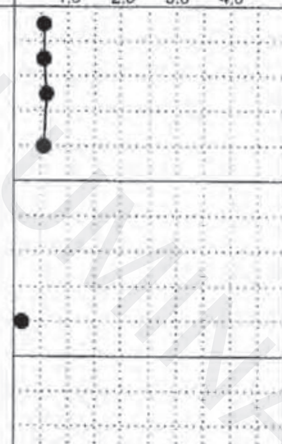
PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

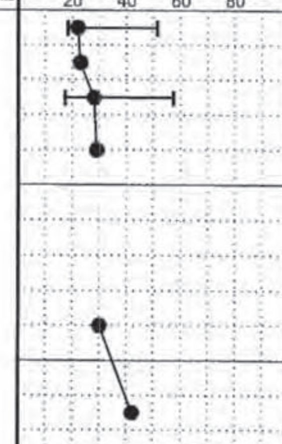
PROJECT NO.: G 2810-08 **BORING TYPE:** Flight Auger

DATE 2/22/08

SURFACE ELEVATION 390'

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CH	SANDY FAT CLAY(CH) stiff; red and orange	N=11					22	51	18	33	65	+40 Sieve =9%, +4 Sieve =6%
			N=11					23					
		–with sand	N=12					28	57	17	40	78	+40 Sieve =2%, +4 Sieve =0%
10		ASH SEDIMENT medium dense; black	N=11					29				16	+40 Sieve =63%, +4 Sieve =40%
20		–very loose; with organic odor	N=3					30				39	+40 Sieve =36%, +4 Sieve =12%
		–light gray						42				93	
		Bottom of Boring @ 25'											





Water Level Est.: ▽ Measured: ▼ Parched: ▼

Water Observations: Seepage @ 13' while drilling. Water level @ 1' and caved to 8' on 2/29/08.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.764', W 94°34.903'. Minus #200 Sieve (93%) @ 23' (Hydrometer - Specific Gravity 2.675).

LOG OF BORING B-3

ETTL ENGINEERS & CONSULTANTS
MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3, Tatum, Texas
PROJECT NO.: G 2810-08
BORING TYPE: Flight Auger
DATE: 2/22/08
SURFACE ELEVATION: 390'

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CH	SANDY FAT CLAY(CH) medium stiff; red and orange	N=10										
	–stiff	N=15					21	54	19	35	69	+40 Sieve =5%, +4 Sieve =1%
	ASH SEDIMENT dense; black	N=42					26				42	
	–medium dense; black and gray; coarse-grained sand	N=20					26				10	+40 Sieve =60%, +4 Sieve =10%
	–very loose; black; coarse to fine-grained sand	N=4					28				9	+40 Sieve =67%, +4 Sieve =35%
	–no recovery											
	–loose; light gray	N=5					69	49	41	8	100	+40 Sieve =0%, +4 Sieve =0%
	–medium dense; black; with organic odor	N=21										
	Bottom of Boring @ 30'											

Graph legend: BLOW COUNT 20 40 60 80; Qu (tsf) 1 2 3 4; PPR (tsf) 1.0 2.0 3.0 4.0; Torvane (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

Depth (ft): 0, 10, 20, 30

Water Level — Est: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 8' while drilling. Water level @ 2' and caved to 8' on 2/29/08..

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.746', W 94°34.855'. Minus #200 Sieve (42%) @ 5' (Hydrometer - Specific Gravity 2.561).

LOG OF BORING B-4

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

PROJECT NO.: G 2810-08 **BORING TYPE:** Flight Auger

DATE 2/22/08

SURFACE ELEVATION 385'

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	SC SM	SILTY CLAYEY SAND(SC-SM) medium dense; red and brown	N=14										
		–very stiff; red and orange	N=21					15	20	14	6	42	+40 Sieve =1%, +4 Sieve =0%
	SM	SILTY SAND(SM) medium dense; red and tan	N=22										
10	CL	LEAN CLAY(CL) very stiff; red, orange, and tan	N=18					18	35	18	17	85	+40 Sieve =5%, +4 Sieve =1%
		–red, tan, and gray	P=3.5	99	2.40	10	13	22					
20			N=25					21	39	21	18	81	+40 Sieve =0%, +4 Sieve =0%
		Bottom of Boring @ 20'											

Graph scales: BLOW COUNT 20 40 60 80; Qu (tsf) 1 2 3 4; PPR (tsf) 1.0 2.0 3.0 4.0; Torvane (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

Water Level Est: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 3' while drilling. Water level @ Surface and caved to 15' on 2/29/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes: GPS Coordinates: N 32°15.675', W 94°35.083'.

LOG OF BORING B-5

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

PROJECT NO.: G 2810-08 **BORING TYPE:** Flight Auger

DATE 2/22/08

SURFACE ELEVATION 415'

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CH	FAT CLAY WITH SAND(CH) medium stiff; red, orange, and gray	N=6					23	51	16	35	77	+40 Sieve =4%, +4 Sieve =1%
	–soft	N=4										
CL	SANDY LEAN CLAY(CL) medium stiff; red and orange	N=6					17	28	14	14	60	+40 Sieve =6%, +4 Sieve =1%
CH	FAT CLAY WITH SAND(CH) very stiff; red and orange	N=23					23	52	17	35	77	+40 Sieve =4%, +4 Sieve =1%
	ASH SEDIMENT medium dense; gray and black	N=23					25				16	+40 Sieve =54%, +4 Sieve =24%
	–loose	N=7										
	–medium dense	N=15	62				34				32	+40 Sieve =37%, +4 Sieve =16%
	–loose	N=8										
	–gray	N=5	62				57				99	+40 Sieve =1%, +4 Sieve =0%
	–very loose	N=4										
	–loose	N=7										
	Bottom of Boring @ 45'											

Chart scales: BLOW COUNT 20 40 60 80; Qu (tsf) 1 2 3 4; PPR (tsf) 1.0 2.0 3.0 4.0; Torvane (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit — 20 40 60 80

Water Level — Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Water level @ 23' and caved to 26' on 2/29/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes: GPS Coordinates: N 32°15.667', W 94°34.936'.

LUMINANT

LOG OF BORING B-6

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

PROJECT NO.: G 2810-08 **BORING TYPE:** Flight Auger

DATE 2/22/08

SURFACE ELEVATION 385'

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0		ASH SEDIMENT medium dense; black and tan	N=19					26				44	+40 Sieve =30%, +4 Sieve =13%
			P=SF										
	CL	SANDY LEAN CLAY(CL) stiff; red and tan	N=10					22	35	19	16	61	+40 Sieve =7%, +4 Sieve =4%
10		–very stiff	P=2.5										
		ASH SEDIMENT loose; black	N=9					40				61	+40 Sieve =5%, +4 Sieve =2%
20		–medium dense	N=12					68				84	
		Bottom of Boring @ 20'											

Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 4' while drilling. Water level @ 4' and caved to 7' upon completion. Water level @ 1' and caved to 8' on 2/29/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.591', W 94°35.088', Minus #200 Sieve (84) @ 18' (Hydrometer - Specific Gravity 2.732).

LOG OF BORING B-7

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

PROJECT NO.: G 2810-08   **BORING TYPE:** Rotary Wash

DATE 2/28/08

SURFACE ELEVATION 390'

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0		ASH SEDIMENT medium dense; black	N=13					37				16	+40 Sieve =49%, +4 Sieve =10%
		–dense; black	N=40										
			P=4.5	98	2.30	2	6	23					
10		–loose	N=7										
		–very loose	N=4					38				11	
20	CL	LEAN CLAY WITH SAND(CL) medium stiff; orange and black	N=7					27	42	17	25	75	+40 Sieve =4%, +4 Sieve =0%
		–tan and red		104	0.50	13	22	21					
30		–medium dense; red and orange	N=22										
	CH	SANDY FAT CLAY(CH) medium dense; red and orange	N=23					27	53	20	33	69	+40 Sieve =27%, +4 Sieve =22%
40			N=22										
		Bottom of Boring @ 40'											

BLOW COUNT (20, 40, 60, 80); Qu (tsf) (1, 2, 3, 4); PPR (tsf) (1.0, 2.0, 3.0, 4.0); Torvane (tsf) (1.0, 2.0, 3.0, 4.0)

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20, 40, 60, 80)

Water Level: Est.: ∇ Measured: ▼ Perched: ∇

Water Observations: Water level @ 3' and caved to 24' on 2/29/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.646', W 94°34.870'. Minus #200 Sieve (11%) @ 13' (Hydrometer - Specific Gravity 2.655).

LOG OF BORING B-8

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

PROJECT NO.: G 2810-08 **BORING TYPE:** Flight Auger

DATE 2/20/08

SURFACE ELEVATION 390'

DEPTH (ft)	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	ASH SEDIMENT loose; gray	N=7										
	–very loose; gray and black	N=0					73				95	+40 Sieve =3%, +4 Sieve =0%
	–medium dense; brown	N=14										
10												
	–very loose; black	N=1										
20		N=3					72				95	+40 Sieve =1%, +4 Sieve =0%
		N=0										
30	–strong odor	N=0					85				99	+40 Sieve =0%, +4 Sieve =0%
	Bottom of Boring @ 30'											

Chart scales: BLOW COUNT 20, 40, 60, 80; Qu (tsf) 1, 2, 3, 4; PPR (tsf) 1.0, 2.0, 3.0, 4.0; Torvane (tsf) 1.0, 2.0, 3.0, 4.0. Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20, 40, 60, 80.

Water Level — Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 4' while drilling. Water level @ 6' and caved to 17' upon completion. Dry and caved to 3' and on 2/29/08.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.548', W 94°34.570'.

LOG OF BORING B-9

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3
Tatum, Texas

PROJECT NO.: G 2810-08 **BORING TYPE:** Flight Auger

DATE 2/20/08

SURFACE ELEVATION 390'

DEPTH (ft)	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	ASH SEDIMENT very loose; gray	N=3					45				89	
	–loose; black and gray	N=10										
	–medium dense	N=18					45				77	+40 Sieve =4%, +4 Sieve =0%
	–very loose; black	N=0										
10	–loose	N=10					57				94	+40 Sieve =3%, +4 Sieve =0%
20		N=5										
	–very loose	N=1					49				68	+40 Sieve =4%, +4 Sieve =0%
30	–gray and black; strong odor	N=0					88				97	+40 Sieve =2%, +4 Sieve =0%
	Bottom of Boring @ 30'											

BLOW COUNT 20 40 60 80; Qu (tsf) 1 2 3 4; PPR (tsf) 1.0 2.0 3.0 4.0; Torvane (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

Water Level Est.: Measured: Perched:

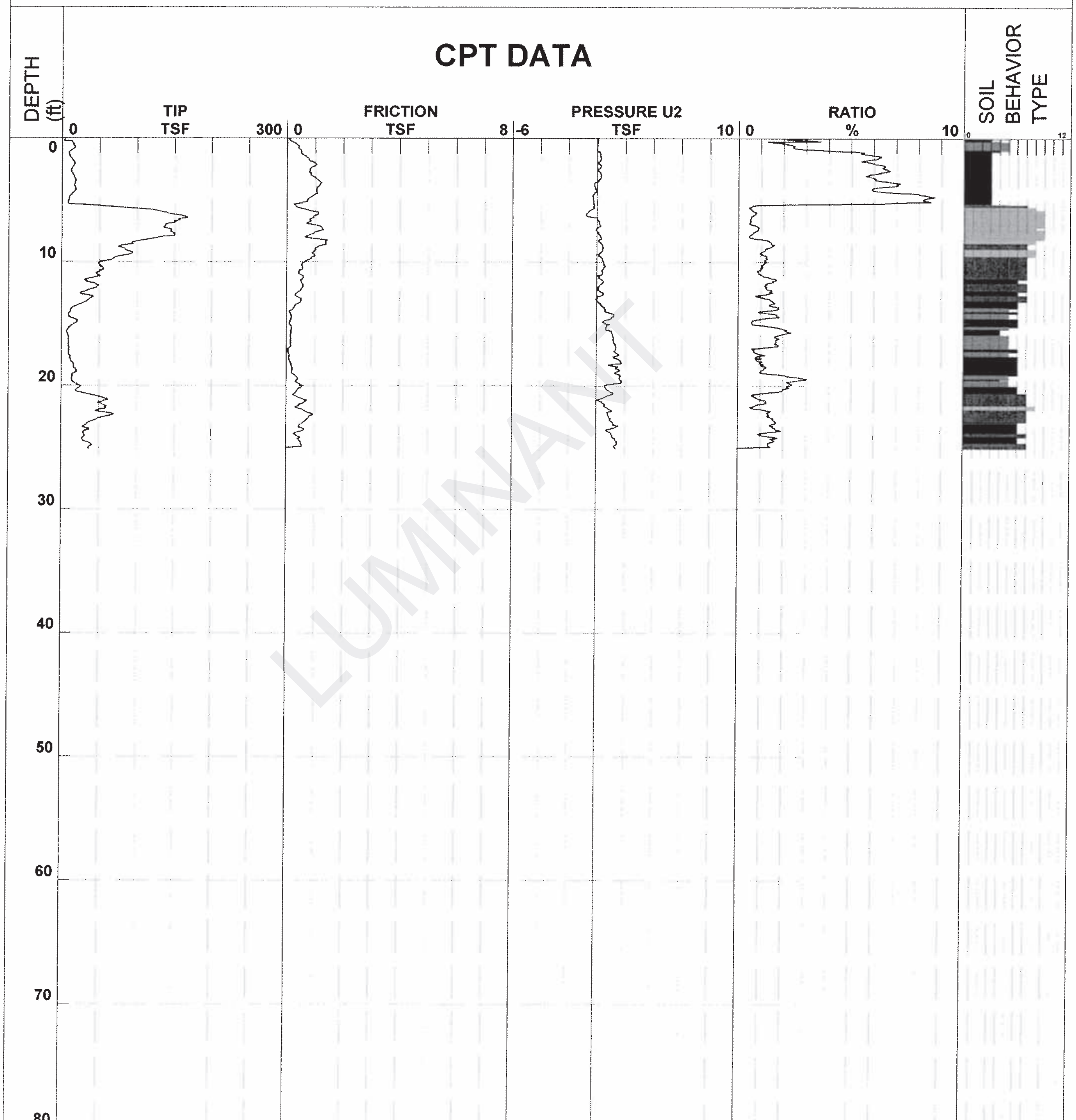
Water Observations: Seepage @ 4' while drilling. Water level @ 6' and caved to 18' upon completion. Dry and caved to 4' on 2/29/08.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°15.556', W 94°34.913'. Minus #200 Sieve (89%) @ 1' (Hydrometer - Specific Gravity 2.761).

CPT Data

Job Number 04.1908-0020
CPT Number B-02
Location Tatum-Tx
Operator GLENN JOHNSON
Date and T 16-Apr-2008 13:47:38
Cone Number F7.5CKEW2/B 1866
Client
Elevation
Water Table

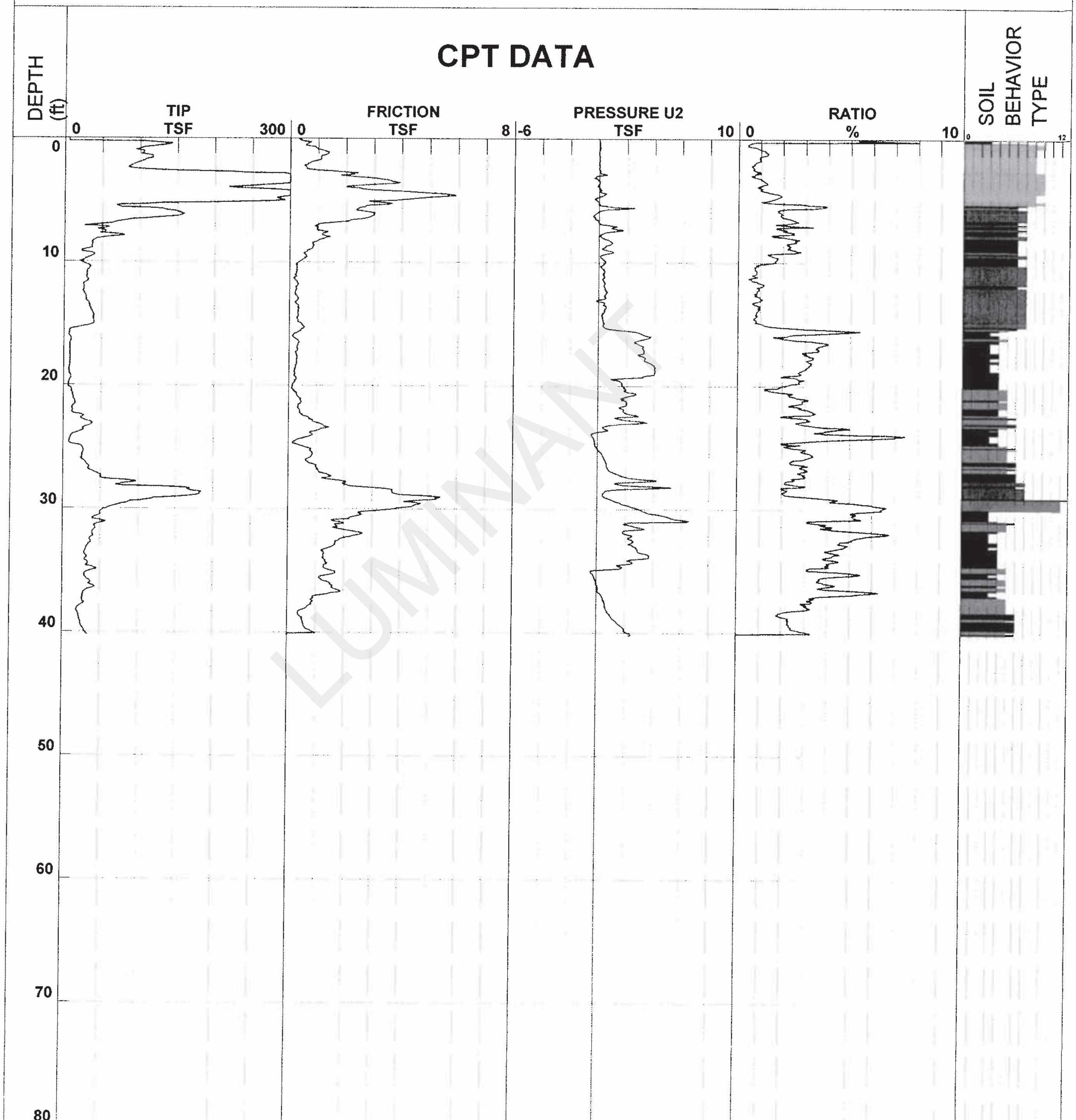


1 - sensitive fine grained	4 - silty clay to clay	7 - silty sand to sandy silt	10 - gravelly sand to sand
2 - organic material	5 - clayey silt to silty clay	8 - sand to silty sand	11 - very stiff fine grained (*)
3 - clay	6 - sandy silt to clayey silt	9 - sand	12 - sand to clayey sand (*)

(*) Overconsolidated or Cemented

CPT Data

Job Number	04.1908-0020	CPT Number	B-07	Location	Tatum-Tx
Operator	GLENN JOHNSON	Date and T	16-Apr-2008 12:40:51	Cone Number	F7.5CKEW2/B 1866
Client		Elevation		Water Table	

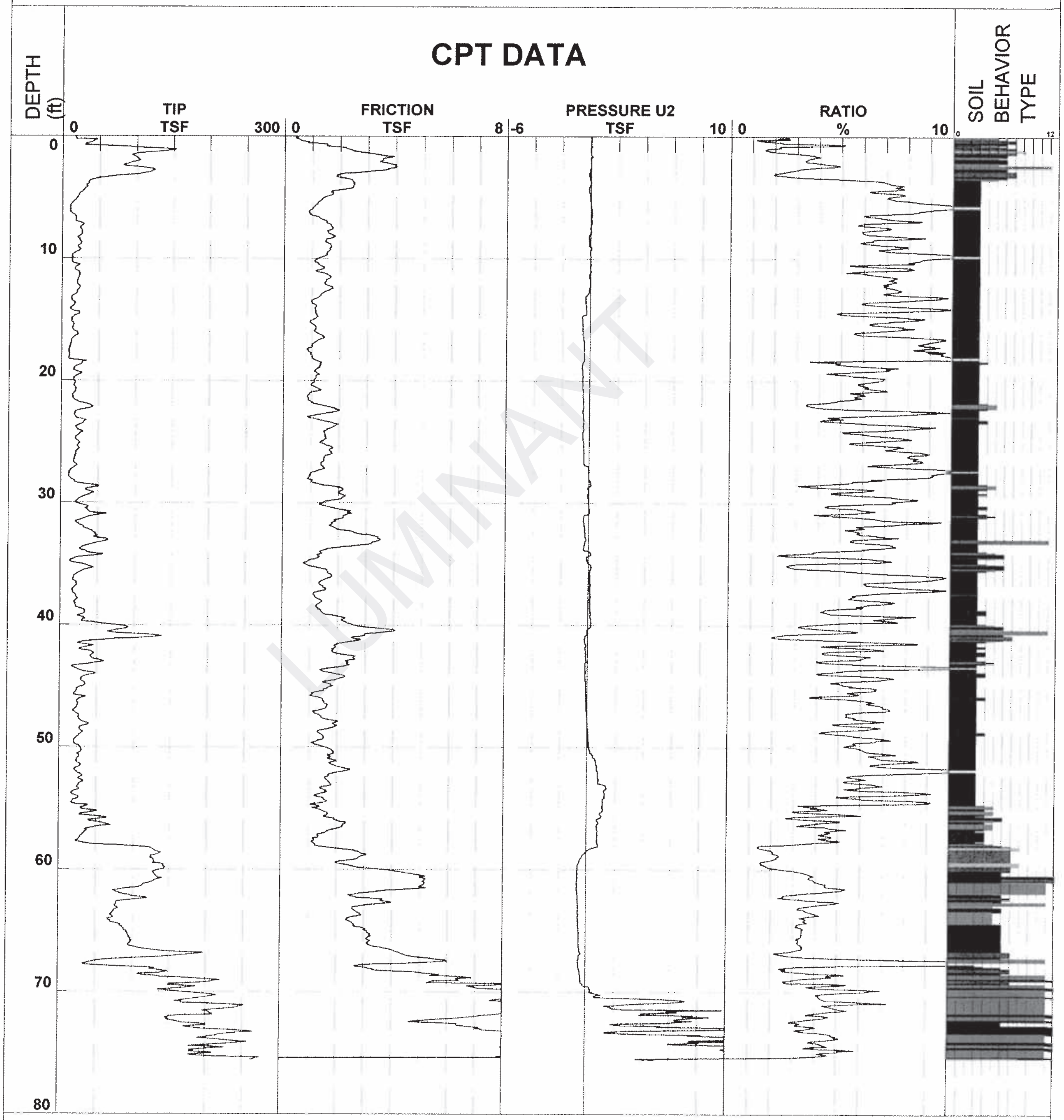


1 - sensitive fine grained	4 - silty clay to clay	7 - silty sand to sandy silt	10 - gravelly sand to sand
2 - organic material	5 - clayey silt to silty clay	8 - sand to silty sand	11 - very stiff fine grained (*)
3 - clay	6 - sandy silt to clayey silt	9 - sand	12 - sand to clayey sand (*)

Robertson et al 1986 * Overconsolidated or Cemented

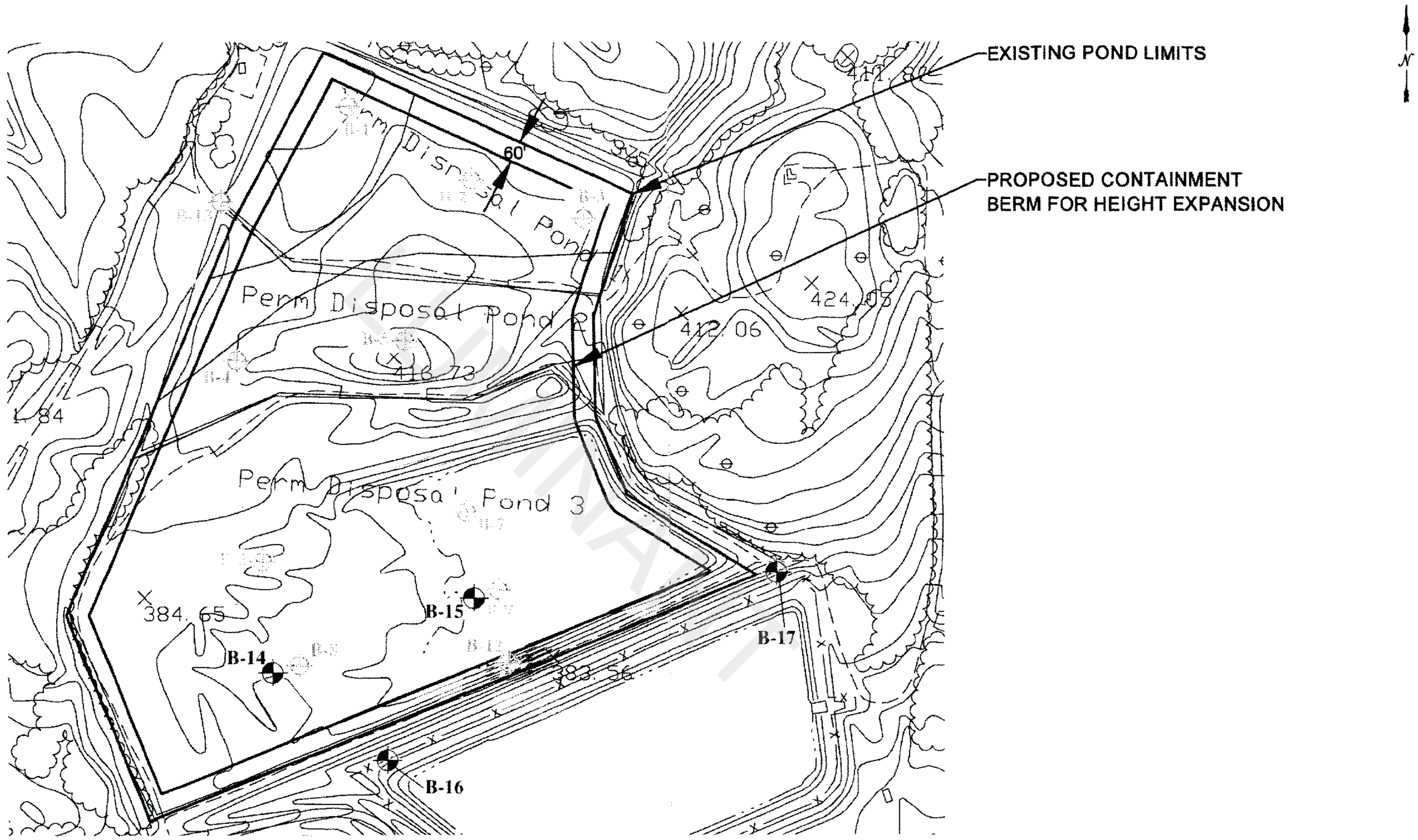
CPT Data

Job Number	04.1908-0020	CPT Number	B-12	Location	Tatum-Tx
Operator	GLENN JOHNSON	Date and T	16-Apr-2008 10:58:47	Cone Number	F7.5CKEW2/B 1866
Client		Elevation		Water Table	



1 - sensitive fine grained	4 - silty clay to clay	7 - silty sand to sandy silt	10 - gravelly sand to sand
2 - organic material	5 - clayey silt to silty clay	8 - sand to silty sand	11 - very stiff fine grained (*)
3 - clay	6 - sandy silt to clayey silt	9 - sand	12 - sand to clayey sand (*)

Robertson et al. 1986 * Overconsolidated or Cemented



ETTL ENGINEERS & CONSULTANTS
MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LUMINANT MARTIN LAKE
PDP 1-3
TATUM, TEXAS

PLATE 1 – PLAN OF BORINGS		APPROVED BY:
JOB No.: G 3219-09		DRAWN BY: K.C.R.
DATE: MARCH 2008	SCALE: N.T.S.	

LOG OF BORING B-14

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3 Supplemental
Tatum, Texas

PROJECT NO.: G3219-09 **BORING TYPE:** Rotary Wash

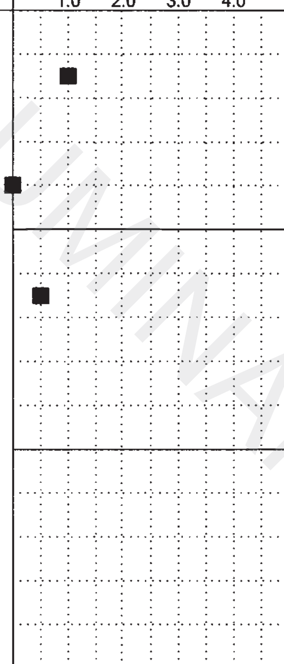
DATE 8/18/09

SURFACE ELEVATION

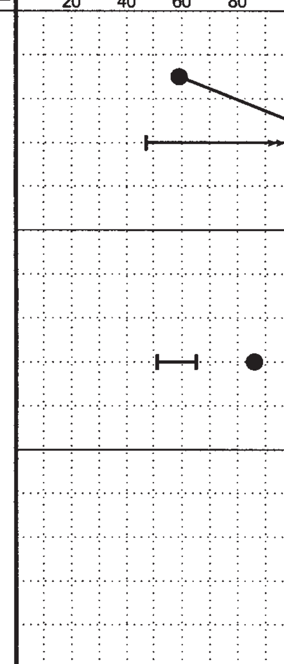
MATERIAL DESCRIPTION

Depth (ft)	Material Description
0	ASH SEDIMENT black;
	--dark gray; with silty clay
	--black; with sand
	--gray
	--black; with silt
30	Bottom of Boring @ 30'

FIELD STRENGTH DATA: ● BLOW COUNT ● 20 40 60 80; ▲ Qu (tsf) ▲ 1 2 3 4; ■ PPR (tsf) ■ 1.0 2.0 3.0 4.0; ◆ Torvane (tsf) ◆ 1.0 2.0 3.0 4.0



Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80



MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
59				83	+40 Sieve=3%, +4 Sieve=0%
119	111	47	64	89	+40 Sieve=1%, +4 Sieve=0%
86	65	51	14	95	+40 Sieve=1%, +4 Sieve=0%

Columns DRY DENSITY (pcf), COMPRESSIVE STRENGTH (tsf), FAILURE STRAIN (%), CONFINING PRESSURE (psi): no entries.

Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 5' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32° 15.549', W 94°34.971'

LOG OF BORING B-15

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

DATE 8/18/09

SURFACE ELEVATION

PROJECT: Luminant Martin Lake PDP 1-3 Supplemental
Tatum, Texas

PROJECT NO.: G3219-09 **BORING TYPE:** Rotary Wash

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	LEAN CLAY(CL) tan, gray, and red							
		ASH SEDIMENT gray	N=16						
		--no recovery	N=10						
		--black; with clay and silt	N=22						
		ASH SEDIMENT gray; with sand; laminated		42				47	+40 Sieve=9%, +4 Sieve=1%
		--with silt	N=2						
10									
		--with sand	N=1	79				95	+40 Sieve=2%, +4 Sieve=0%
		--full recovery							
20									
		--no recovery							
		--black	N=9						
		--black and gray	N=1	54				85	+40 Sieve=7%, +4 Sieve=3%
30		Bottom of Boring @ 30'							

Column headings without data: SAMPLES; GEOLOGIC UNIT; WATER LEVEL; DRY DENSITY (pcf); COMPRESSIVE STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi).

Chart scales: BLOW COUNT 20 40 60 80; Qu (tsf) 1 2 3 4; PPR (tsf) 1.0 2.0 3.0 4.0; Torvane (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

ATTERBERG LIMITS(%)

Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 5' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32° 15.556', W 94°34.913'

LOG OF BORING B-16

ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Luminant Martin Lake PDP 1-3 Supplemental
Tatum, Texas

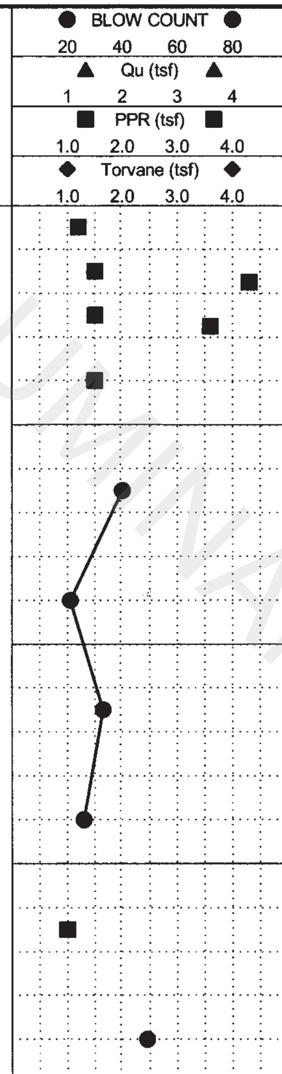
PROJECT NO.: G3219-09 **BORING TYPE:** Rotary Wash

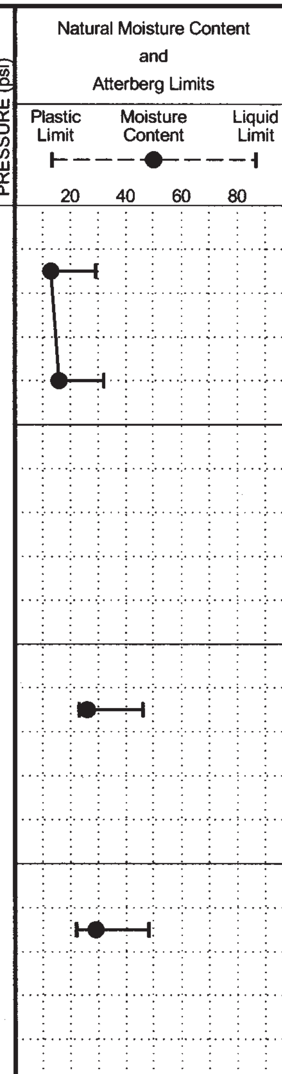
DATE 8/18/09

SURFACE ELEVATION

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) orange and tan	P=1.2						
		--tan and gray	P=1.5 P=4.3	13	29	14	15	34	+40 Sieve=1%, +4 Sieve=0%
		--orange and tan	P=1.25 P=3.6						
	SC	CLAYEY SAND(SC) gray and orange	P=1.5	16	32	16	16	37	+40 Sieve=0%, +4 Sieve=0%
10			N=40						
	ML	SANDY CLAYEY SILT(ML) orange and light gray	N=21						
20	CL	LEAN CLAY(CL) gray and reddish tan	N=33	26	46	23	23	82	+40 Sieve=4%, +4 Sieve=1%
		--orange and tan; with trace of lignite	N=26						
30	SC	CLAYEY SAND(SC) tan and brown	P=1.0	29	48	22	26	85	+40 Sieve=5%, +4 Sieve=0%
	SP	SAND(SP) gray	N=49						
40		Bottom of Boring @ 40'							

Column headings also printed: SAMPLES, GEOLOGIC UNIT, WATER LEVEL, DRY DENSITY (pcf), COMPRESSIVE STRENGTH (tsf), FAILURE STRAIN (%), CONFINING PRESSURE (psi), ATTERBERG LIMITS(%)





Water Level Est.: Measured: Perched:

Water Observations:

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32° 15.484', W 94°34.965'

LOG OF BORING B-17

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

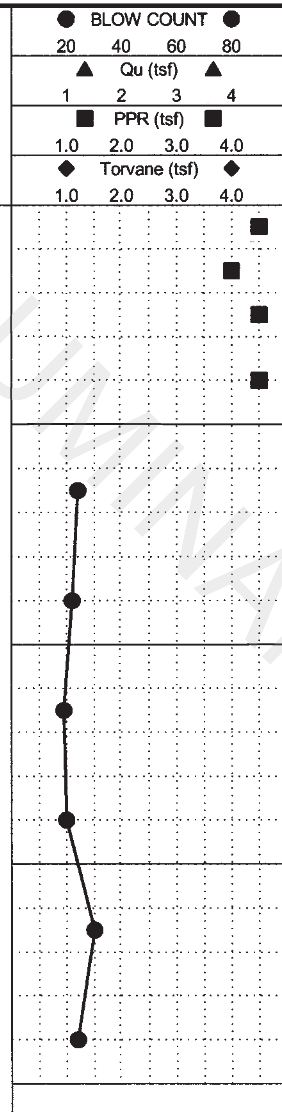
PROJECT: Luminant Martin Lake PDP 1-3 Supplemental
Tatum, Texas

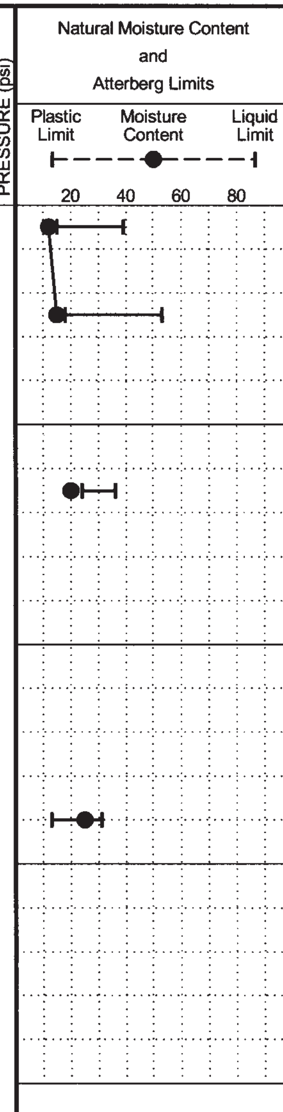
PROJECT NO.: G3219-09 **BORING TYPE:** Rotary Wash

DATE 8/18/09

SURFACE ELEVATION

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) orange and tan	P=4.5+					12	39	15	24	60	+40 Sieve=7%, +4 Sieve=4%
		--orange and brown	P=4.0										
		--red, tan, and yellow	P=4.5					15	53	18	35	51	+40 Sieve=7%, +4 Sieve=1%
		--tan and gray	P=4.5+										
10													
	SC	CLAYEY SAND(SC) tan	N=40					20	36	24	12	52	+40 Sieve=0%, +4 Sieve=0%
		--tan and brown	N=22										
20													
		--tan and gray; laminated	N=19										
		--gray and orange	N=20					25	31	13	18	39	+40 Sieve=0%, +4 Sieve=0%
30													
		--tan	N=30										
		--tan and orange	N=24										
40		Bottom of Boring @ 40'											





Water Level Est.: Measured: Perched:

Water Observations: Bailed to 20' and open upon completion.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32° 15.566', W 94°34.736'

APPENDIX B

LABORATORY TEST RESULTS

BOTTOM ASH PONDS AND SCRUBBER POND

Golder Associates
500 Century Plaza Drive, Suite 190
Houston, Texas 77073
Telephone: (281) 821-6868
Fax: (281) 821-6870

SUMMARY OF LABORATORY RESULTS

CLIENT Luminant **PROJECT NAME** Pond Slope Stability

PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
BH-201	0.0							19.2			
BH-201	2.0							13.7			
BH-201	6.0	26	14	12				9.4			
BH-201	8.0							15.1			
BH-201	13.0							16.3			
BH-201	18.0							20.8			
BH-201	23.0	36	14	22				19.9			
BH-201	28.0							18.2			
BH-201	33.0							15.0			
BH-201	38.0				0.85	40		14.9			
BH-201	43.0							21.4			
BH-201	48.0							23.5			
BH-202	0.0							20.8			
BH-202	2.0	55	19	36				17.1			
BH-202	4.0							20.5			
BH-202	6.0							26.7			
BH-202	8.0							15.3			
BH-202	13.0							14.9			
BH-202	18.0	29	13	16				17.1			
BH-202	23.0							17.6			
BH-202	28.0				0.85	49		18.1			
BH-202	33.0							17.0			
BH-202	38.0							20.8			
BH-202	43.0							23.0			
BH-202	48.0							26.2			
BH-203	0.0							12.6			
BH-203	2.0							14.6			
BH-203	4.0							16.1			
BH-203	6.0	50	19	31				21.5			
BH-203	8.0							22.3			
BH-203	13.0							18.0			
BH-203	18.0							14.6			
BH-203	23.0							17.3			
BH-203	25.0							19.9			
BH-203	28.0				2	17		23.6			
BH-203	30.0							27.7			
BH-203	33.0							29.1			
BH-203	38.0							29.4			
BH-204	0.0							13.9			
BH-204	2.0							21.1			
BH-204	4.0							15.0			
BH-204	6.0							16.6			
BH-204	8.0							13.5			

Golder Associates
500 Century Plaza Drive, Suite 190
Houston, Texas 77073
Telephone: (281) 821-6868
Fax: (281) 821-6870

SUMMARY OF LABORATORY RESULTS

CLIENT Luminant **PROJECT NAME** Pond Slope Stability

PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
BH-204	28.0				4.75	58		19.1			
BH-204	33.0							13.8			
BH-204	38.0							21.0			
BH-204	43.0	51	20	31				26.6			
BH-204	48.0							23.8			
BH-205	0.0							17.5			
BH-205	2.0							15.6			
BH-205	4.0							15.5			
BH-205	6.0							20.7			
BH-205	8.0							17.4			
BH-205	13.0	47	15	32				23.0			
BH-205	18.0							22.9			
BH-205	23.0	28	17	11				16.3			
BH-205	28.0				4.75	69		16.4			
BH-205	33.0							14.7			
BH-205	38.0							25.4			
BH-205	43.0							26.7			
BH-205	48.0							25.0			
BH-205	53.0				9.5	11		25.9			
BH-206	0.0							17.1			
BH-206	2.0	44	15	29				15.6			
BH-206	4.0							14.0			
BH-206	6.0							16.2			
BH-206	8.0							21.7			
BH-206	13.0							18.1			
BH-206	18.0							12.2			
BH-206	23.0							15.9			
BH-206	28.0	59	17	42				20.3			
BH-206	33.0							19.8			
BH-206	38.0							18.2			
BH-206	43.0							22.1			
BH-206	48.0							23.3			
BH-206	53.0							23.0			
BH-206	58.0							22.1			
BH-207	0.0							15.6			
BH-207	2.0							15.3			
BH-207	4.0							14.9			
BH-207	6.0							18.2			
BH-207	13.0							18.9			
BH-207	18.0							13.0			
BH-207	23.0							16.9			
BH-207	28.0	31	16	15				16.7			
BH-207	33.0							17.4			

Golder Associates
500 Century Plaza Drive, Suite 190
Houston, Texas 77073
Telephone: (281) 821-6868
Fax: (281) 821-6870

SUMMARY OF LABORATORY RESULTS

CLIENT Luminant **PROJECT NAME** Pond Slope Stability
PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
BH-207	38.0							19.0			
BH-207	43.0							21.8			
BH-207	48.0							22.2			
BH-207	53.0							25.2			
BH-207	58.0							29.8			
BH-208	0.0							20.2			
BH-208	2.0							16.2			
BH-208	4.0							12.9			
BH-208	6.0							11.5			
BH-208	8.0	28	15	13				15.2			
BH-208	13.0							15.9			
BH-208	18.0							20.2			
BH-208	23.0							18.0			
BH-208	28.0							21.3			
BH-208	33.0							18.1			
BH-208	38.0							19.1			
BH-208	43.0							23.7			
BH-208	48.0				4.75	11		24.5			
BH-208	53.0							27.1			
BH-208	58.0							26.1			
BH-209	0.0							9.0			
BH-209	2.0							11.8			
BH-209	4.0	62	21	41				11.8			
BH-209	6.0							12.1			
BH-209	8.0							19.2			
BH-209	13.0							12.3			
BH-209	18.0							21.0			
BH-209	28.0	41	15	26				23.3			
BH-209	33.0							20.0			
BH-209	35.0							21.2			
BH-209	38.0							17.9			
BH-209	43.0							24.0			
BH-209	48.0							21.2			
BH-210	0.0							8.2			
BH-210	2.0							10.7			
BH-210	4.0							13.4			
BH-210	6.0							14.4			
BH-210	8.0							15.7			
BH-210	13.0							21.3			
BH-210	18.0	36	14	22				22.9			
BH-210	23.0							25.0			
BH-210	28.0							18.5			
BH-210	33.0							19.3			

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Houston, Texas 77073
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Fax: (281) 821-6870

SUMMARY OF LABORATORY RESULTS

CLIENT Luminant **PROJECT NAME** Pond Slope Stability
PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake

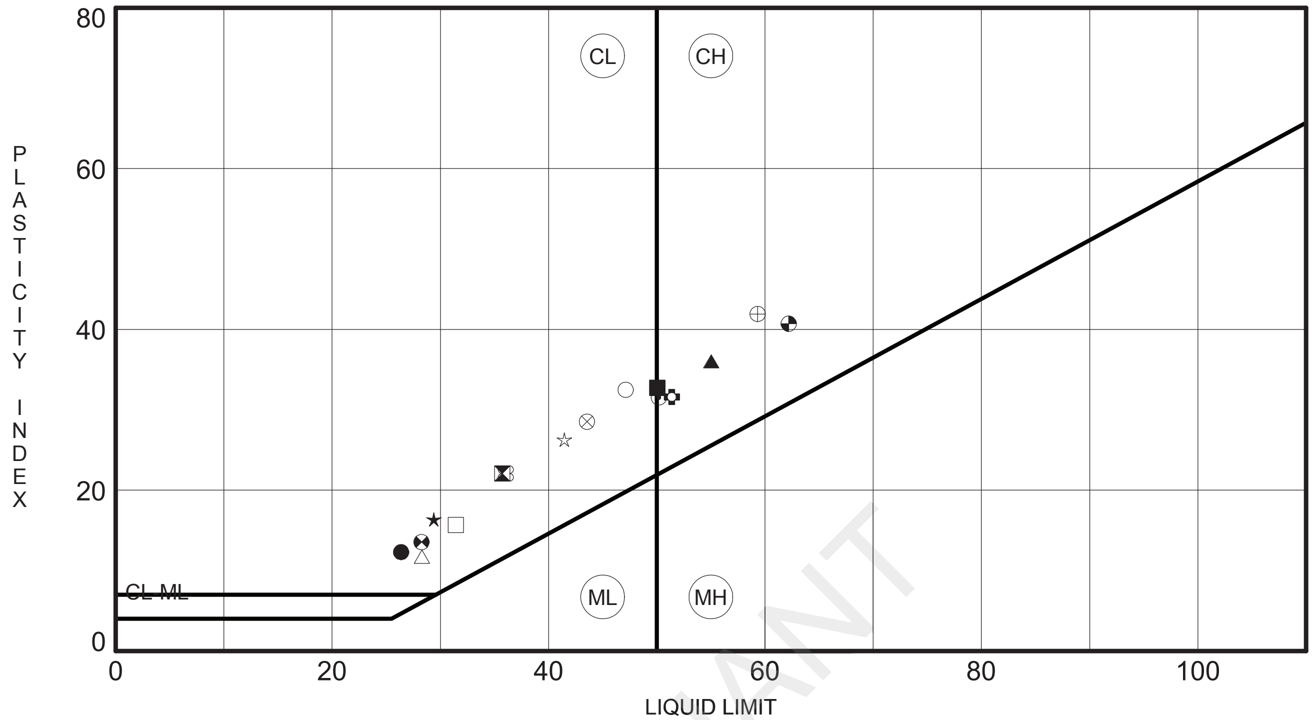
Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
BH-210	38.0							17.2			
BH-210	43.0							25.6			
BH-210	48.0				9.5	33		33.4			
BH-210	53.0							29.3			
BH-210	58.0							29.3			
BH-210	63.0							26.6			
BH-210	68.0							31.1			
BH-211	0.0							8.7			
BH-211	2.0							13.3			
BH-211	4.0							15.0			
BH-211	6.0							14.5			
BH-211	8.0							13.2			
BH-211	13.0							17.6			
BH-211	18.0	50	17	33				15.0			
BH-211	23.0							11.6			
BH-211	28.0				9.5	52		11.6			
BH-211	33.0							22.5			
BH-211	38.0							21.1			
BH-211	43.0							24.3			
BH-211	48.0							24.3			
BH-211	53.0							24.9			
BH-211	58.0							22.9			
BH-211	63.0							29.5			
BH-211	68.0							26.6			

Golder Associates
500 Century Plaza Drive, Suite 190
Houston, Texas 77073
Telephone: (281) 821-6868
Fax: (281) 821-6870

ATTERBERG LIMITS' RESULTS

CLIENT Luminant **PROJECT NAME** Pond Slope Stability

PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake



	BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
●	**BH-201**	**6.0**	**26**	**14**	**12**		
⧗	**BH-201**	**23.0**	**36**	**14**	**22**		
▲	**BH-202**	**2.0**	**55**	**19**	**36**		
★	**BH-202**	**18.0**	**29**	**13**	**16**		
⊙	**BH-203**	**6.0**	**50**	**19**	**31**		
✿	**BH-204**	**43.0**	**51**	**20**	**31**		
○	**BH-205**	**13.0**	**47**	**15**	**32**		
△	**BH-205**	**23.0**	**28**	**17**	**11**		
⊗	**BH-206**	**2.0**	**44**	**15**	**29**		
⊕	**BH-206**	**28.0**	**59**	**17**	**42**		
□	**BH-207**	**28.0**	**31**	**16**	**15**		
⊛	**BH-208**	**8.0**	**28**	**15**	**13**		
◕	**BH-209**	**4.0**	**62**	**21**	**41**		
☆	**BH-209**	**28.0**	**41**	**15**	**26**		
⌘	**BH-210**	**18.0**	**36**	**14**	**22**		
■	**BH-211**	**18.0**	**50**	**17**	**33**		

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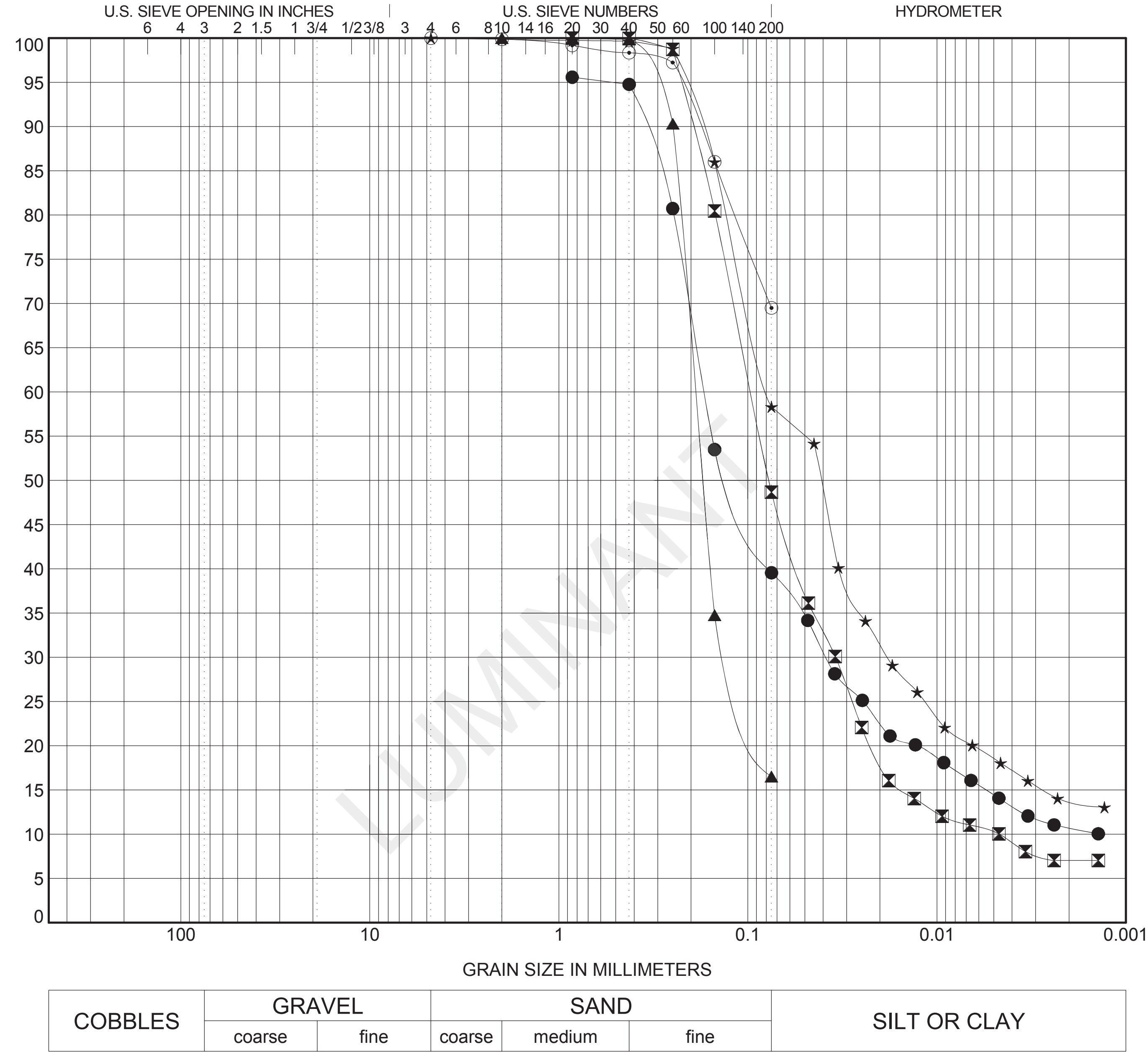
GRAIN SIZE DISTRIBUTION

CLIENT Luminant
PROJECT NAME Pond Slope Stability
PROJECT NUMBER 123-94128
PROJECT LOCATION Martin Lake



BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
● BH-201	38						
⧗ BH-202	28					2.63	20.54
▲ BH-203	28						
★ BH-204	28						
⊙ BH-205	28						

BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● BH-201	38	0.85	0.169	0.038			56.0	25.1	14.4
⧗ BH-202	28	0.85	0.096	0.034	0.005	0.0	51.3	38.4	10.2
▲ BH-203	28	2	0.189	0.125		0.0	83.5	16.5	
★ BH-204	28	4.75	0.078	0.018		0.0	41.7	39.8	18.5
⊙ BH-205	28	4.75				0.0	30.5	69.5	

GRAIN SIZE - CQA - GINT STD US LAB.GDT - 11/29/12 16:21 - P:_2012 PROJECT FOLDERS\123-94128 LUMINANT POND SLOPE STABILITY\MARTIN LAKE\94128MARTINLAKE.GPJ

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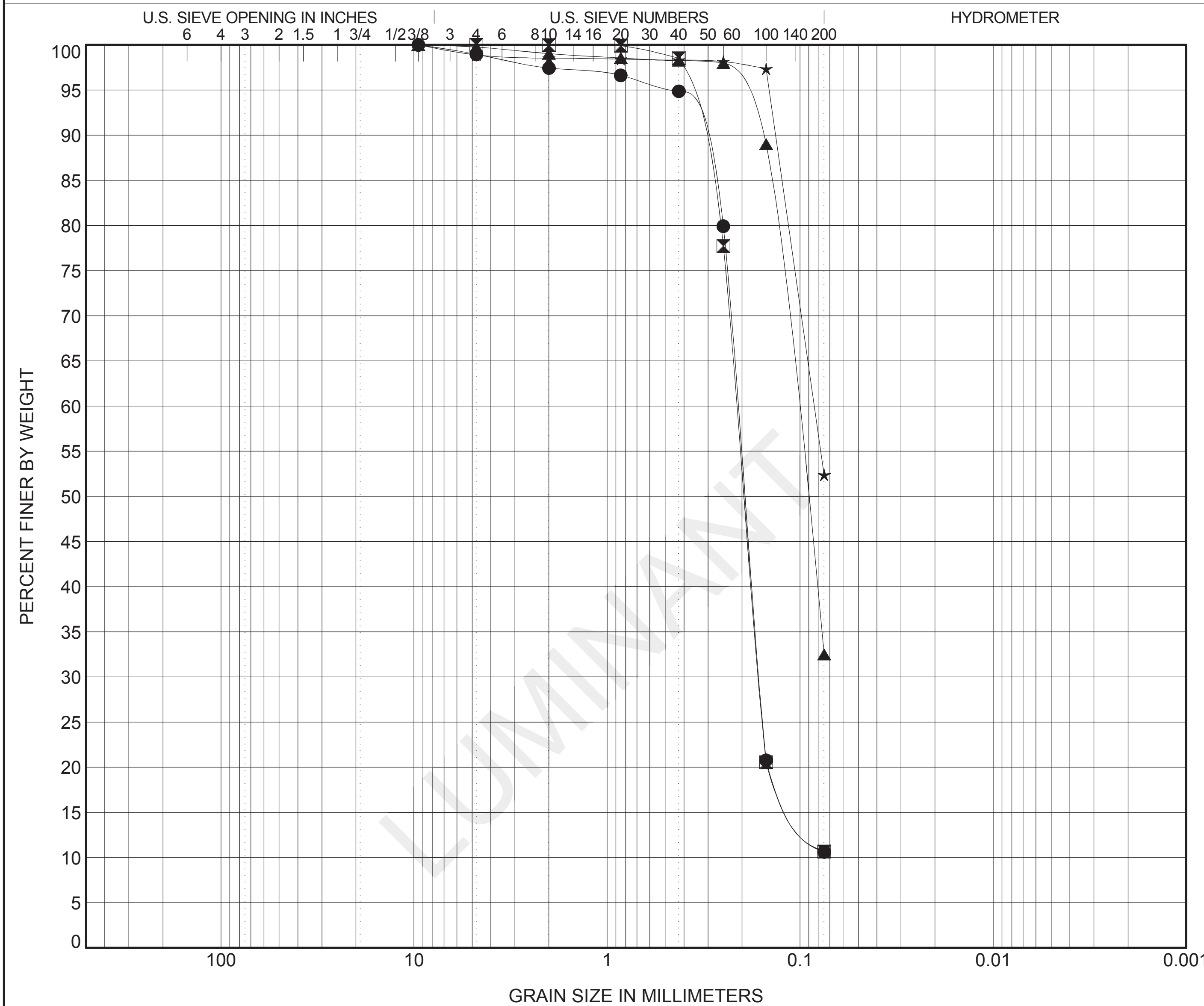
GRAIN SIZE DISTRIBUTION

CLIENT Luminant **PROJECT NAME** Pond Slope Stability

PROJECT NUMBER 123-94128 **PROJECT LOCATION** Martin Lake

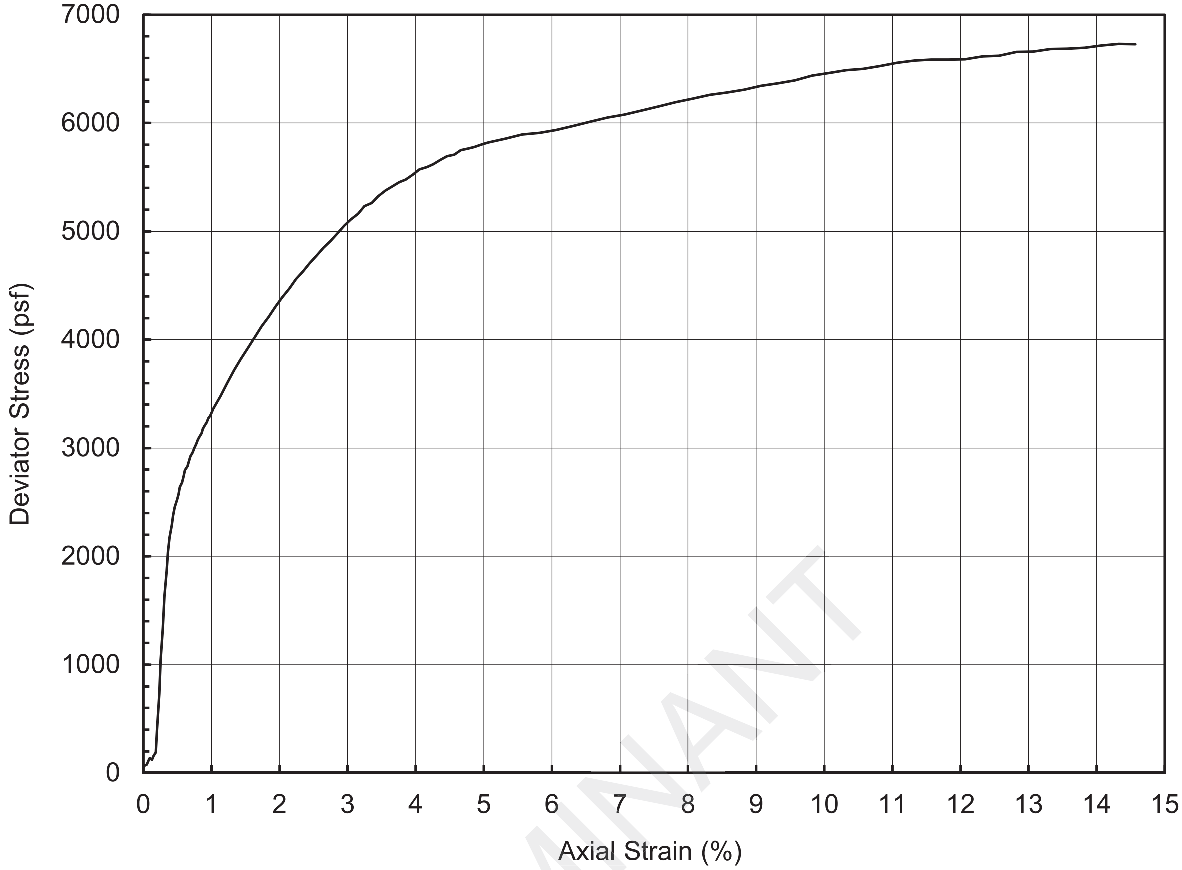


COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**BH-205**	**53**					**1.74**	**2.93**
⧗	**BH-208**	**48**					**1.75**	**2.98**
▲	**BH-210**	**48**						
★	**BH-211**	**28**						

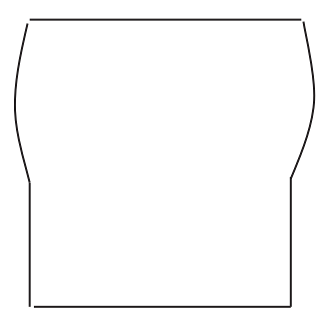
	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH-205**	**53**	**9.5**	**0.21**	**0.162**		**1.1**	**88.3**	**10.6**	
⧗	**BH-208**	**48**	**4.75**	**0.213**	**0.163**		**0.0**	**89.3**	**10.7**	
▲	**BH-210**	**48**	**9.5**	**0.105**			**0.2**	**67.2**	**32.5**	
★	**BH-211**	**28**	**9.5**	**0.084**			**1.1**	**46.5**	**52.4**	

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Reddish Yellow Clay (visual classification)						
LL		PI		LI		USCS	

Depth (ft)	4.0	Confining Pressure (psf)	617
Specimen Height (inch)	6.0	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	6732
Initial Specimen Weight (g)	1263.7	Axial Strain at Peak Stress (%)	14.3
Moist Unit Weight (pcf)	131.9		
Initial Water Content (%)	15		
Initial Dry Unit Weight (pcf)	114.6		



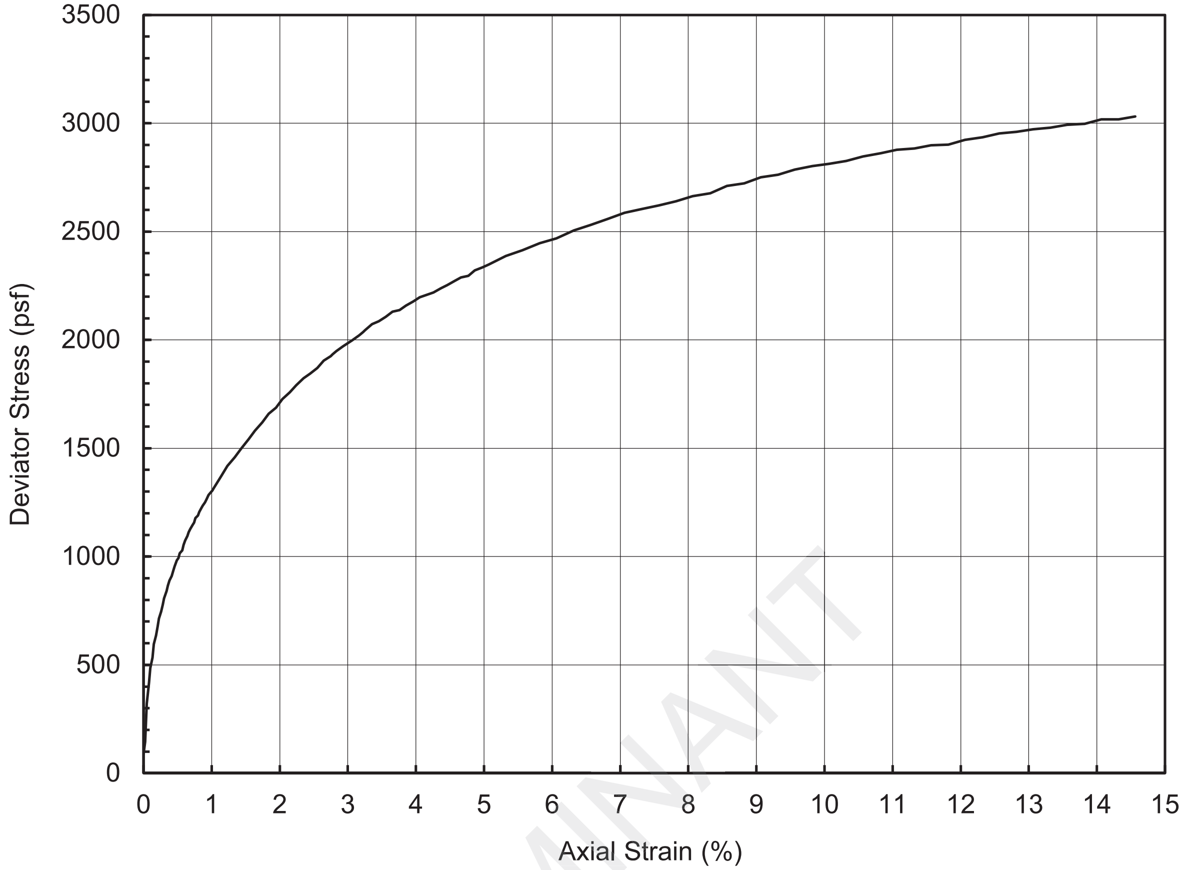
Failure Sketch

Project Title	Luminant - Martin Lake Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-201 TO-3
Comments	

Golder Associates

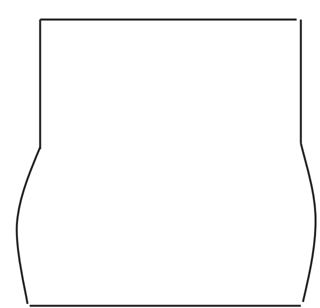
Performed by	**PN**
Date	**12-Nov-12**
Check	**HR**
Review	**SBK**

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Reddish Yellow Clay (visual classification)						
LL		PI		LI		USCS	

Depth (ft)	18.0	Confining Pressure (psf)	2371
Specimen Height (inch)	5.9	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	3035
Initial Specimen Weight (g)	1232.8	Axial Strain at Peak Stress (%)	14.8
Moist Unit Weight (pcf)	132.4		
Initial Water Content (%)	19		
Initial Dry Unit Weight (pcf)	111.7		



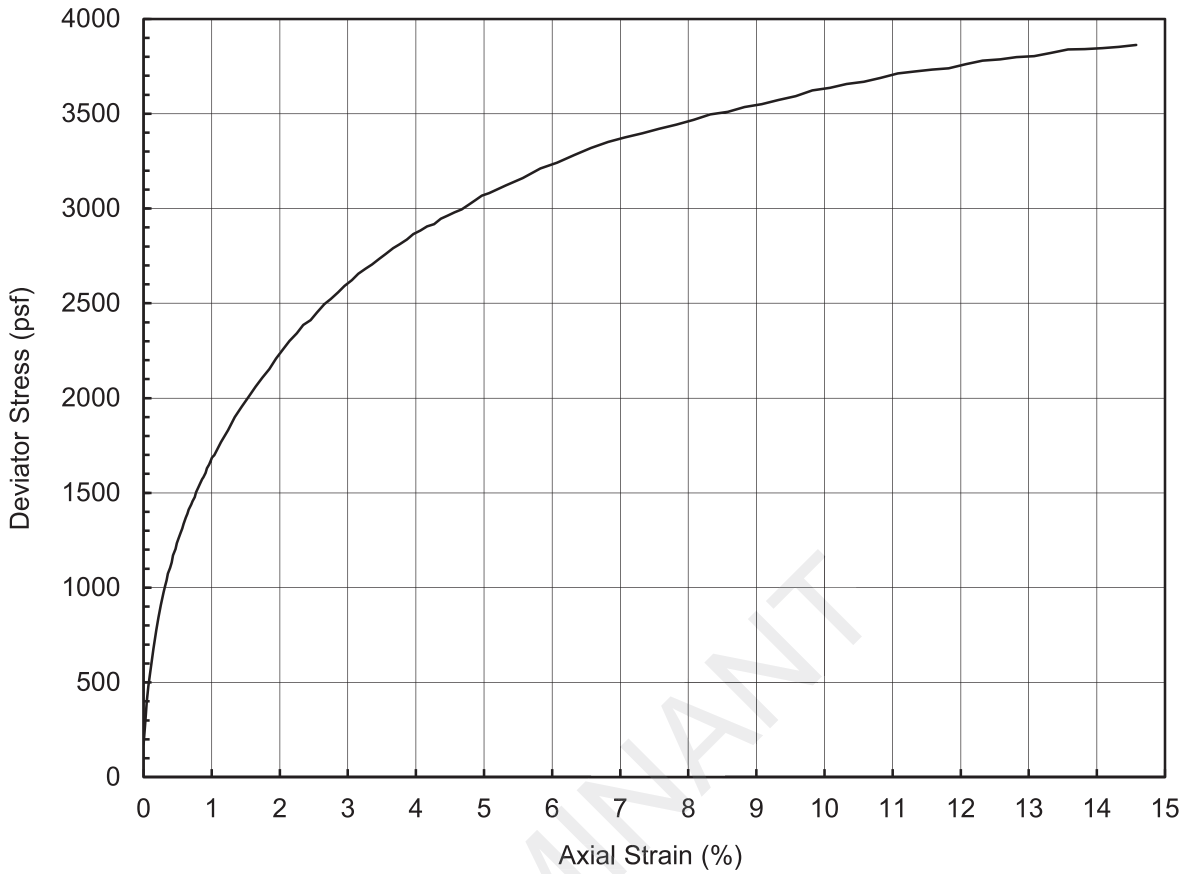
Failure Sketch

Project Title	Luminant - Martin Lake Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-202 TO-7
Comments	

Golder Associates

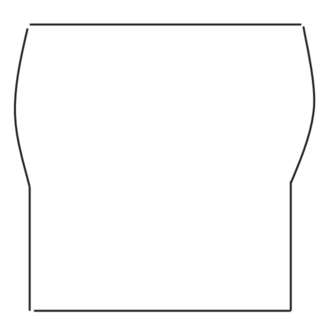
Performed by	**PN**
Date	**13-Nov-12**
Check	**HR**
Review	**SBK**

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Reddish Gray Clay (visual classification)						
LL		PI		LI		USCS	

Depth (ft)	6.0	Confining Pressure (psf)	858
Specimen Height (inch)	6.0	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	3877
Initial Specimen Weight (g)	1199.6	Axial Strain at Peak Stress (%)	14.8
Moist Unit Weight (pcf)	124.7		
Initial Water Content (%)	21		
Initial Dry Unit Weight (pcf)	102.7		



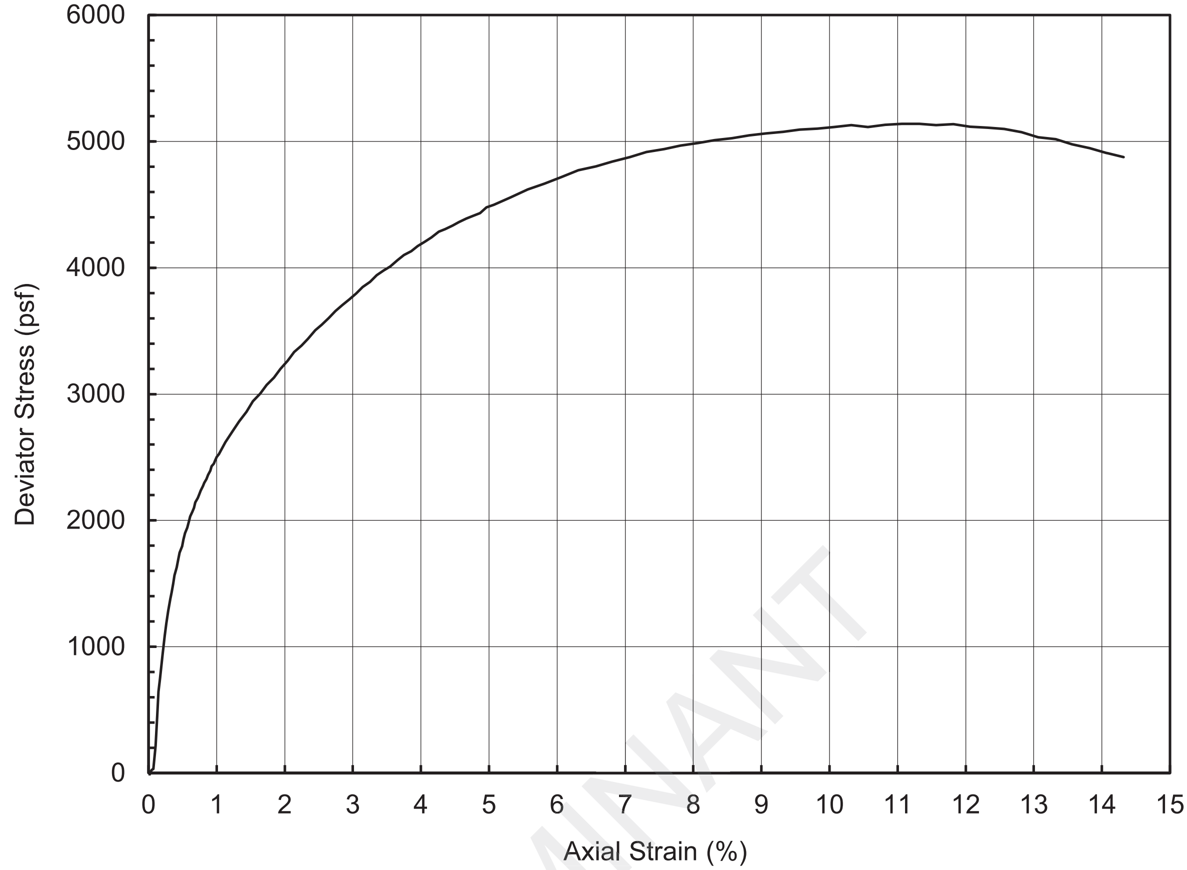
Failure Sketch

Project Title	Luminant - Martin Lake Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-203 TO-4
Comments	

Golder Associates

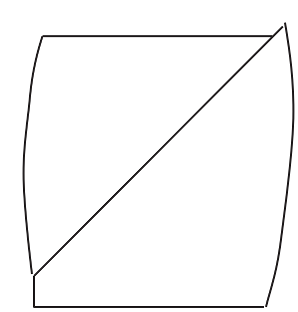
Performed by	**PN**
Date	**13-Nov-12**
Check	**HR**
Review	**SBK**

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Reddish Gray Clay (visual classification)						
LL		PI		LI		USCS	

Depth (ft)	23.0	Confining Pressure (psf)	3008
Specimen Height (inch)	6.0	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	5139
Initial Specimen Weight (g)	1192.8	Axial Strain at Peak Stress (%)	11.3
Moist Unit Weight (pcf)	126.6		
Initial Water Content (%)	26		
Initial Dry Unit Weight (pcf)	100.9		



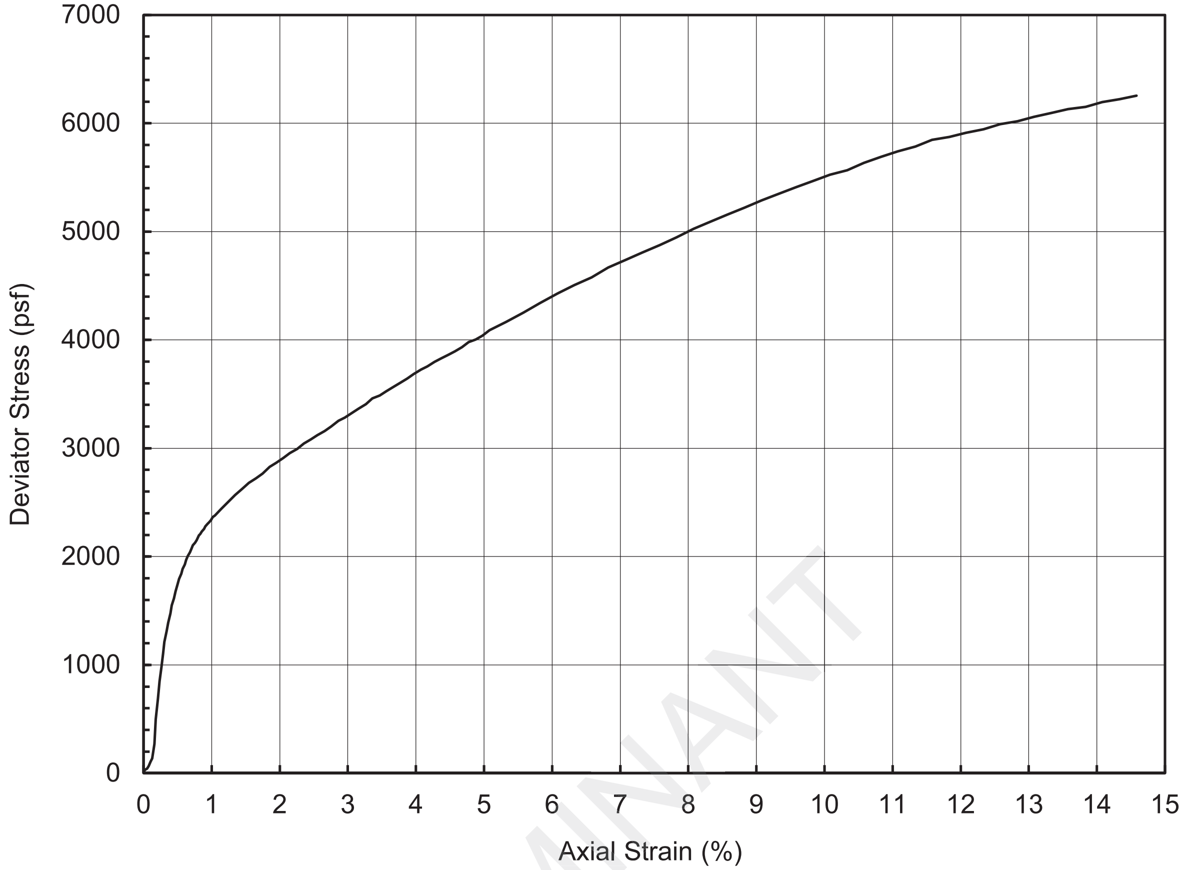
Failure Sketch

Project Title	Luminant - Martin Lake Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-204 TO-8
Comments	

Golder Associates

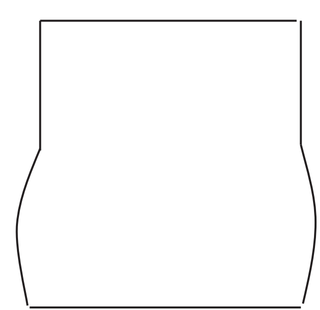
Performed by	**PN**
Date	**13-Nov-12**
Check	**HR**
Review	**SBK**

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Reddish Yellow Clay (visual classification)						
LL		PI		LI		USCS	

Depth (ft)	13.0	Confining Pressure (psf)	1760
Specimen Height (inch)	5.9	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	6270
Initial Specimen Weight (g)	1252.5	Axial Strain at Peak Stress (%)	14.8
Moist Unit Weight (pcf)	131.9		
Initial Water Content (%)	27		
Initial Dry Unit Weight (pcf)	104.1		



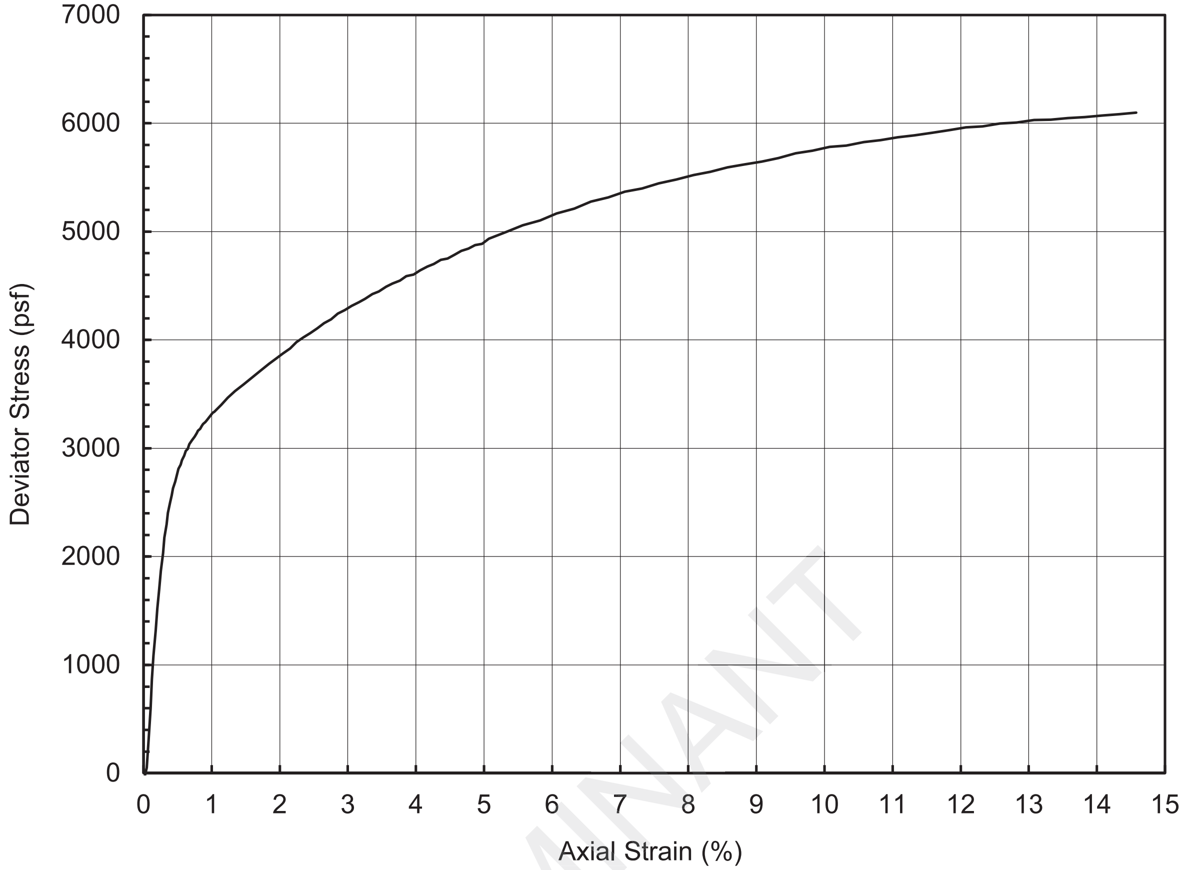
Failure Sketch

Project Title	Luminant - Martin Lake Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-205 TO-6
Comments	

Performed by	PN
Date	13-Nov-12
Check	HR
Review	SBK

Golder Associates

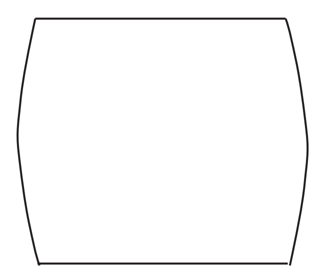
UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Grayish Brown Fat Clay						
LL	59	PI	42	LI	0.1	USCS	CH

Depth (ft)	28.0	Confining Pressure (psf)	3627
Specimen Height (inch)	5.9	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	6110
Initial Specimen Weight (g)	1219.7	Axial Strain at Peak Stress (%)	14.8
Moist Unit Weight (pcf)	127.5		
Initial Water Content (%)	20		
Initial Dry Unit Weight (pcf)	106.6		

Project Title	Luminant - Martin Lake Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-206 TO-9
Comments	

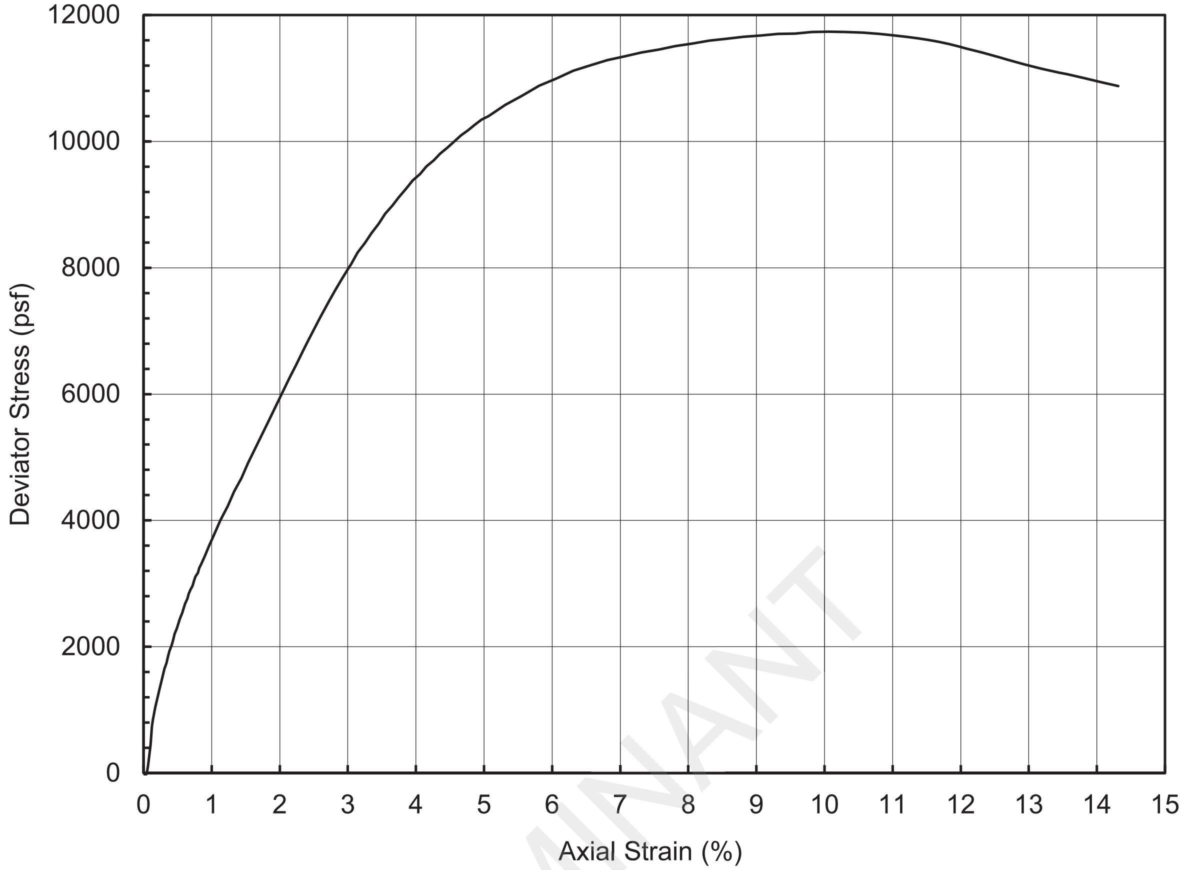


Failure Sketch

Performed by	**PN**
Date	**15-Nov-12**
Check	**HR**
Review	**JF**

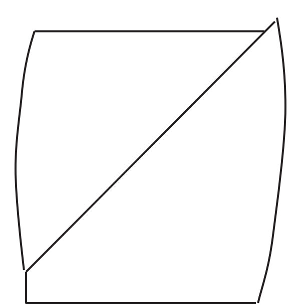
Golder Associates

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Grayish Brown Lean Clay						
LL	31	PI	15	LI	0.0	USCS	CL

Depth (ft)	28.0	Confining Pressure (psf)	3620
Specimen Height (inch)	5.9	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	11735
Initial Specimen Weight (g)	1251.9	Axial Strain at Peak Stress (%)	10.1
Moist Unit Weight (pcf)	127.7		
Initial Water Content (%)	16		
Initial Dry Unit Weight (pcf)	109.9		



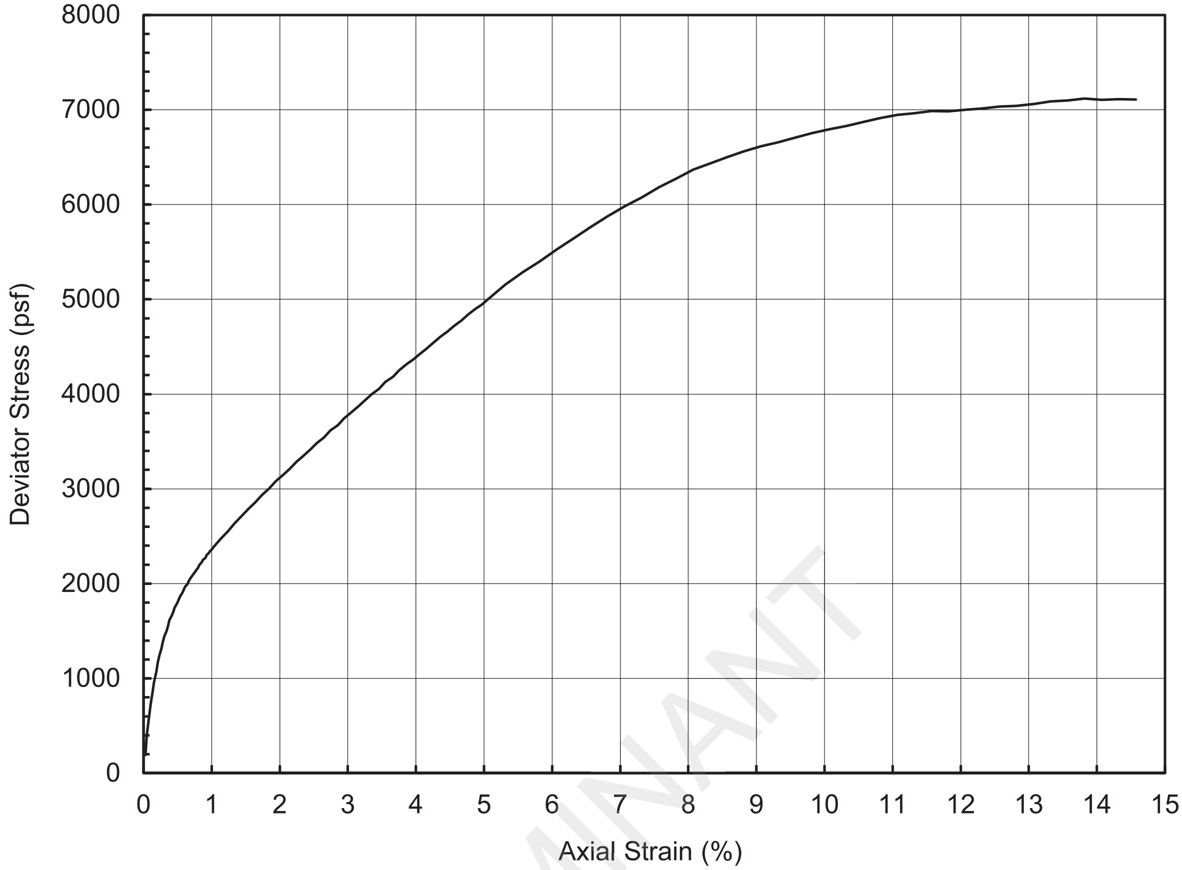
Failure Sketch

Project Title	Luminant - Martin Lake Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-207 TO-9
Comments	

Golder Associates

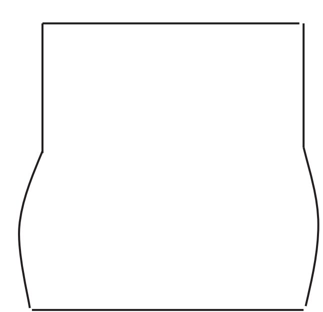
Performed by	**PN**
Date	**15-Nov-12**
Check	**HR**
Review	**JF**

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Reddish Yellow Lean Clay						
LL	28	PI	13	LI	0.0	USCS	CL

Depth (ft)	8.0	Confining Pressure (psf)	1046
Specimen Height (inch)	5.9	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	7118
Initial Specimen Weight (g)	1287.7	Axial Strain at Peak Stress (%)	13.8
Moist Unit Weight (pcf)	138.1		
Initial Water Content (%)	14		
Initial Dry Unit Weight (pcf)	120.7		

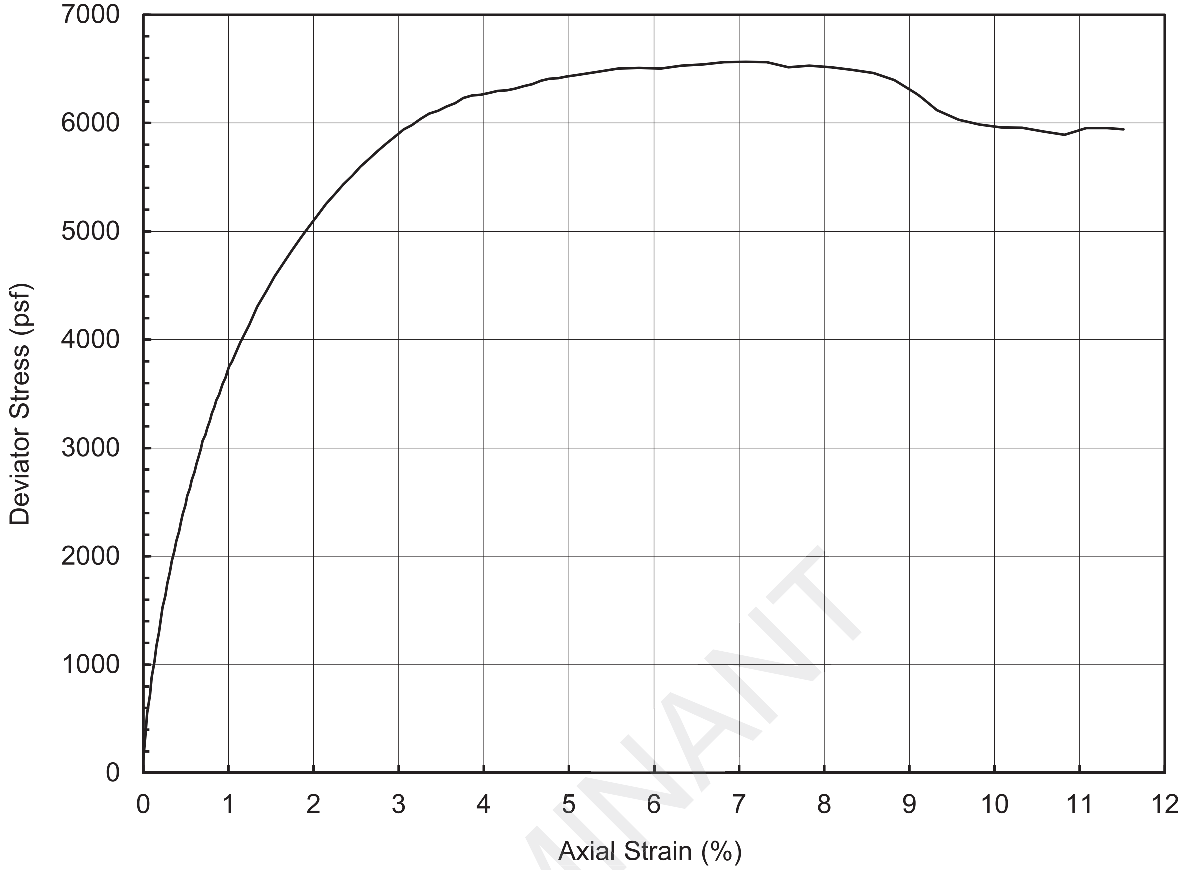

Failure Sketch

Project Title	Luminant - Martin Lake Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-208 TO-5
Comments	

Golder Associates

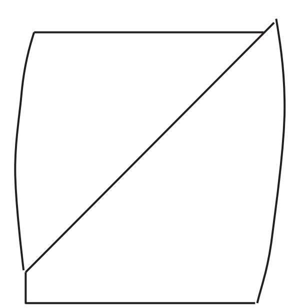
Performed by	**PN**
Date	**16-Nov-12**
Check	**HR**
Review	**JF**

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Grayish Brown Lean Clay						
LL	41	PI	26	LI	0.3	USCS	CL

Depth (ft)	28.0	Confining Pressure (psf)	3624
Specimen Height (inch)	6.0	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	6566
Initial Specimen Weight (g)	1202.8	Axial Strain at Peak Stress (%)	7.1
Moist Unit Weight (pcf)	128.0		
Initial Water Content (%)	22		
Initial Dry Unit Weight (pcf)	104.7		



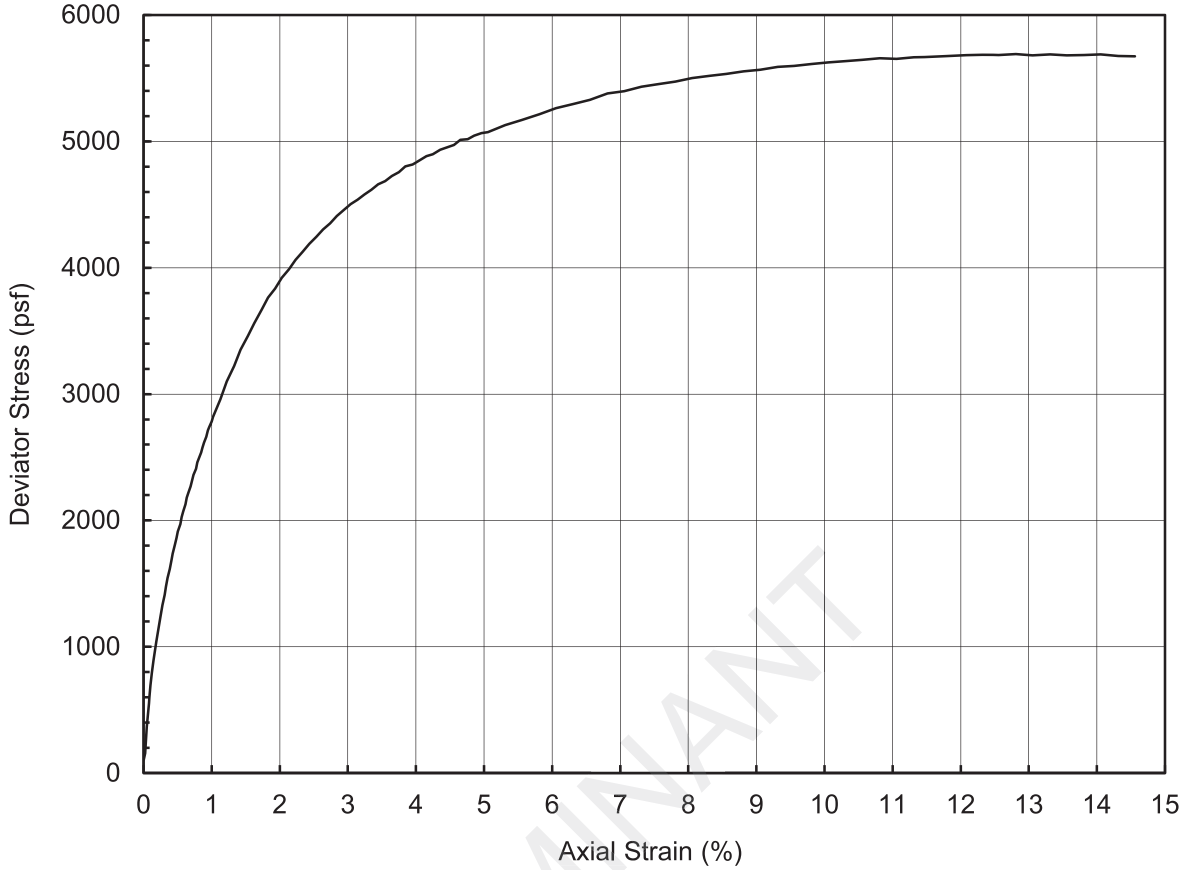
Failure Sketch

Project Title	Luminant - Martin Lake Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-209 TO-9
Comments	

Golder Associates

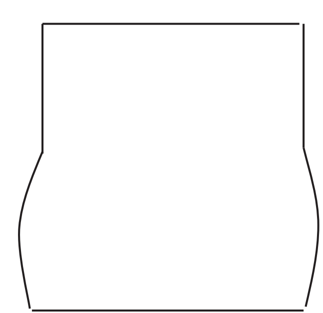
Performed by	**PN**
Date	**16-Nov-12**
Check	**HR**
Review	**JF**

UNCONSOLIDATED / UNDRAINED COMPRESSIVE STRENGTH
ASTM D 2850



Specimen Description	Reddish Gray Lean Clay						
LL	36	PI	22	LI	0.5	USCS	CL

Depth (ft)	18.0	Confining Pressure (psf)	2375
Specimen Height (inch)	6.0	Strain Rate (%/min)	1.0
Specimen Diameter (inch)	2.8	Peak Deviator Stress (psf)	5691
Initial Specimen Weight (g)	1192.0	Axial Strain at Peak Stress (%)	12.8
Moist Unit Weight (pcf)	126.7		
Initial Water Content (%)	24		
Initial Dry Unit Weight (pcf)	102.2		



Failure Sketch

Project Title	Luminant - Martin Lake Slope Stability
Project Number	123-94128
Sample Type	Shelby Tube
Sample ID	BH-210 TO-7
Comments	

Golder Associates

Performed by	**PN**
Date	**16-Nov-12**
Check	**HR**
Review	**JF**

PROJECT INFORMATION

PROJECT: Luminant East Ash Disposal
LOCATION: Rusk County, Texas
PROJECT NO.: G 2972 - 08
CLIENT:
Movember 2008

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Possible Fill Sample
DESCRIPTION: Tan, Brown & Red Sandy Lean Clay
Sampled on Site, B-13 3' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Both Ends & Diameter Trimmed + # 4 Sieve

PLATE: B.1

PLATE: B.2

PLATE: B.3

TRIAXIAL TEST PROGRAM BY GARRY H. GREGORY, P.E.

VERSION 1.0 - AUGUST 1998 - REVISED MARCH 24, 1999

THIS COPY LICENSED TO:
ETTL ENGINEERS AND CONSULTANTS, INC.
1717 East Erwin
Tyler, TX 75702

Number of Specimens = 3

SPECIMEN DATA

SPECIMEN NO. 1

	initial		final		Diameter			Height		
Moist soil & Tare :	522.40	g	621.30	g	top	2.04	in	Ht 1	4.44	in
Dry soil and Tare :	468.70	g	544.40	g	mid	2.04	in	Ht 2	4.44	in
Tare :	129.80	g	119.40	g	bot	2.04	in	Ht 3	4.44	in
Moisture content :	[redacted]	%	[redacted]	%	Avg	[redacted]	in	Ht4	4.44	in
Weight:	496.1	g						Avg Ht	[redacted]	in

Change in Ht due to saturation :	-0.02	in	Initial specimen vol :	[redacted]	cc
Change in Ht due to consolidation :	-0.018	in	At test specimen vol :	[redacted]	cc
Change in pipet vol due to consolidation :	2.0	cc	Initial dry density :	[redacted]	pcf
Saturation Parameter " B " =	0.95		At test dry density:	[redacted]	pcf

Strain Rate (in/min) =	0.0005	Failure Strain % =	2.7	Effective Cell Pressure (psi) =	[redacted]
σ_1' Failure (psi) =	20.41	σ_1 Failure (psi) =	[redacted]	Estimated ν =	0.35
σ_3' Failure (psi) =	5.41	σ_3 Failure (psi) =	[redacted]	Back Pressure (psi) =	50.0
ΔU =	[redacted]	Total Pore Pressure =	54.6	Cell Pressure (psi) =	60.0

SPECIMEN NO. 2

	initial		final		Diameter			Height		
Moist soil & Tare :	549.80	g	636.40	g	top	2.01	in	Ht 1	4.44	in
Dry soil and Tare :	469.20	g	560.20	g	mid	2.01	in	Ht 2	4.44	in
Tare :	123.20	g	139.10	g	bot	2.01	in	Ht 3	4.44	in
Moisture content :	[redacted]	%	[redacted]	%	Avg	[redacted]	in	Ht4	4.44	in
Weight:	496.0	g						Avg Ht	[redacted]	in

Change in Ht due to saturation :	-0.006	in	Initial specimen vol :	[redacted]	cc
Change in Ht due to consolidation :	-0.034	in	At test specimen vol :	[redacted]	cc
Change in pipet vol due to consolidation :	3.9	cc	Initial dry density :	[redacted]	pcf
Saturation Parameter " B " =	0.97		At test dry density:	[redacted]	pcf

Strain Rate (in/min) =	0.0005	Failure Strain % =	3.9	Effective Cell Pressure (psi) =	[redacted]
σ_1' Failure (psi) =	37.62	σ_1 Failure (psi) =	[redacted]	Estimated ν =	0.35
σ_3' Failure (psi) =	12.02	σ_3 Failure (psi) =	[redacted]	Back Pressure (psi) =	50.0
ΔU =	[redacted]	Total Pore Pressure =	58.0	Cell Pressure (psi) =	70.0

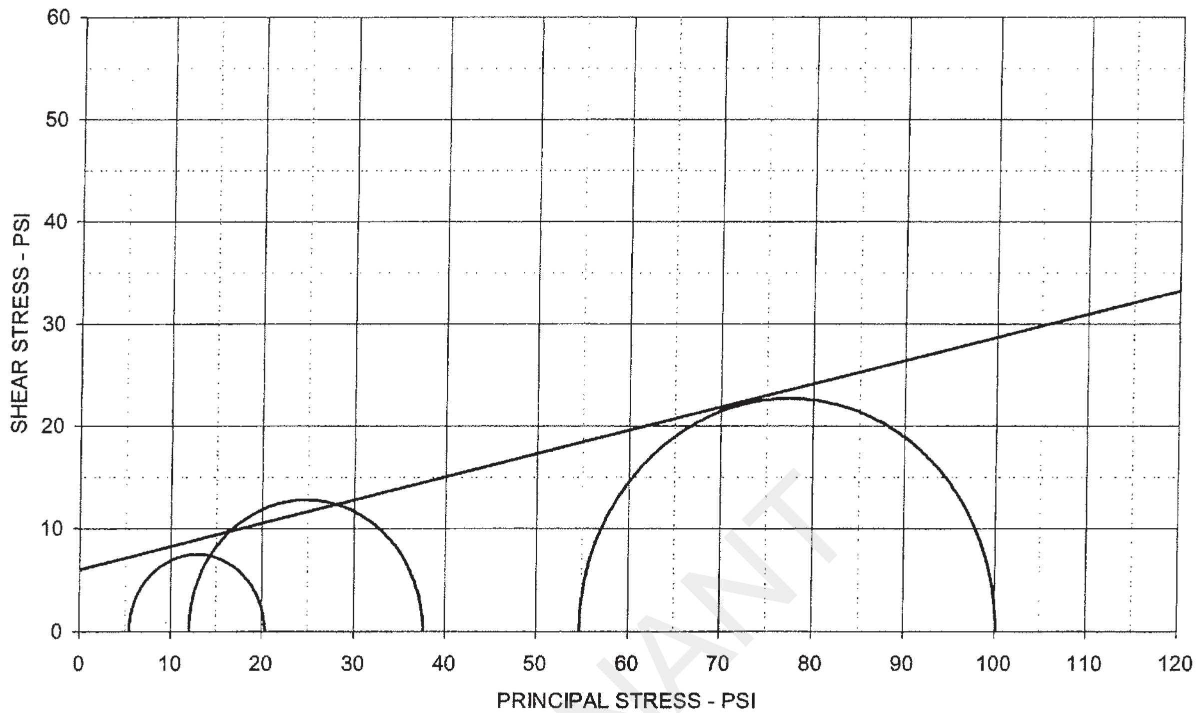
SPECIMEN NO. 3

	initial		final		Diameter			Height		
Moist soil & Tare :	594.50	g	656.50	g	top	2.06	in	Ht 1	4.54	in
Dry soil and Tare :	530.10	g	579.20	g	mid	2.06	in	Ht 2	4.54	in
Tare :	126.30	g	139.30	g	bot	2.06	in	Ht 3	4.54	in
Moisture content :	[redacted]	%	[redacted]	%	Avg	[redacted]	in	Ht4	4.54	in
Weight:	518.0	g						Avg Ht	[redacted]	in

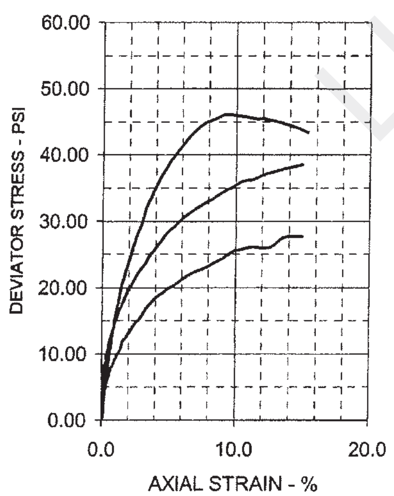
Change in Ht due to saturation :	-0.001	in	Initial specimen vol :	[redacted]	cc
Change in Ht due to consolidation :	-0.052	in	At test specimen vol :	[redacted]	cc
Change in pipet vol due to consolidation :	5.6	cc	Initial dry density :	[redacted]	pcf
Saturation Parameter " B " =	0.97		At test dry density:	[redacted]	pcf

Strain Rate (in/min) =	0.0005	Failure Strain % =	8.5	Effective Cell Pressure (psi) =	[redacted]
σ_1' Failure (psi) =	100.17	σ_1 Failure (psi) =	[redacted]	Estimated ν =	0.35
σ_3' Failure (psi) =	54.77	σ_3 Failure (psi) =	[redacted]	Back Pressure (psi) =	50.0
ΔU =	[redacted]	Total Pore Pressure =	35.2	Cell Pressure (psi) =	90.0

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	φ ' = 12.8 deg		c' = 6.0 psi	
SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	15.8	16.6	15.9	
Dry Density - pcf	113.0	115.0	112.5	
Diameter - inches	2.04	2.01	2.06	
Height - inches	4.44	4.44	4.54	
AT TEST				
Final Moisture - %	18.1	18.1	17.6	
Dry Density - pcf	114.0	116.9	115.1	
Calculated Diameter (in.)	2.02	2.00	2.04	
Height - inches	4.40	4.40	4.49	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.00	25.60	45.40	
Total Pore Pressure - psi	54.6	58.0	35.2	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.7	3.9	8.5	
σ_1' Failure - psi	20.41	37.62	100.17	
σ_3' Failure - psi	5.41	12.02	54.77	



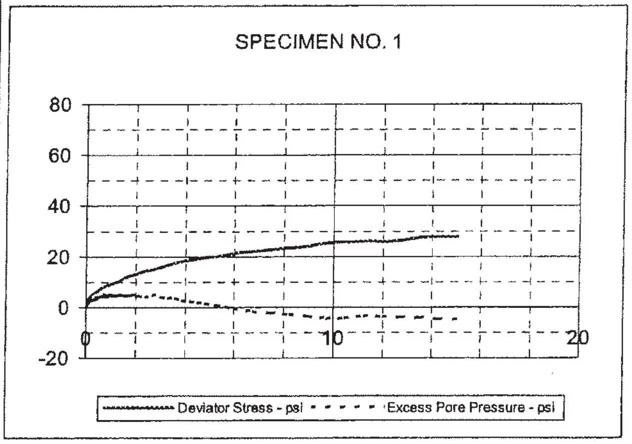
TEST DESCRIPTION

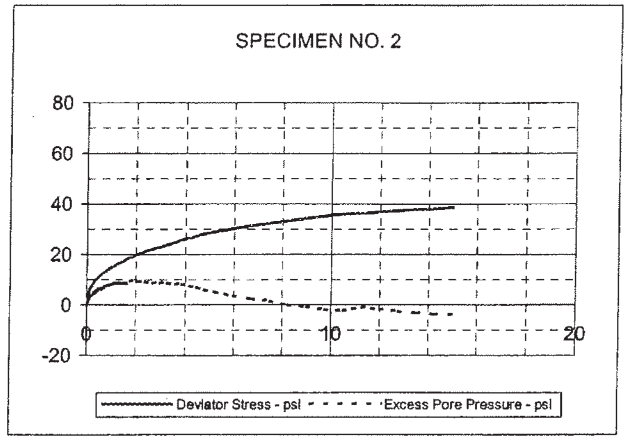
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Possible Fill Sample
DESCRIPTION: Tan, Brown & Red Sandy Lean Clay
Sampled on Site, B-13 3' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Both Ends & Diameter Trimmed + # 4 Sieve
G 2972-08, B-13, 3'-10' Fill

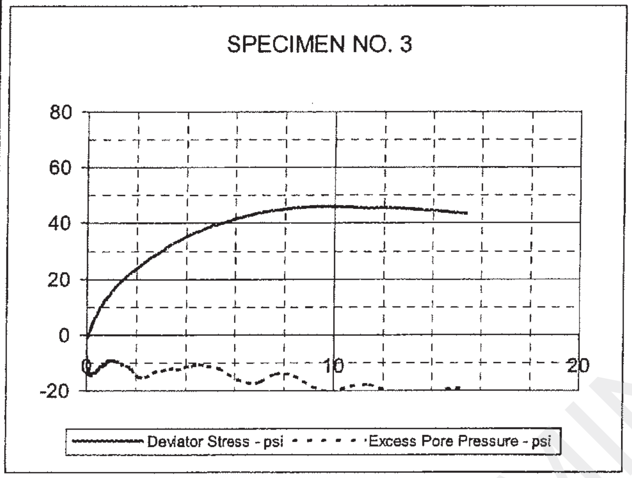
PROJECT INFORMATION

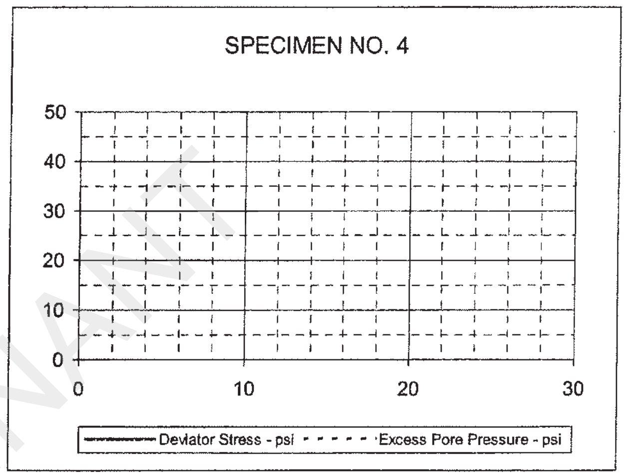
PROJECT: Luminant East Ash Disposal
LOCATION: Rusk County, Texas
PROJECT NO: G 2972 - 08
CLIENT:
Movember 2008

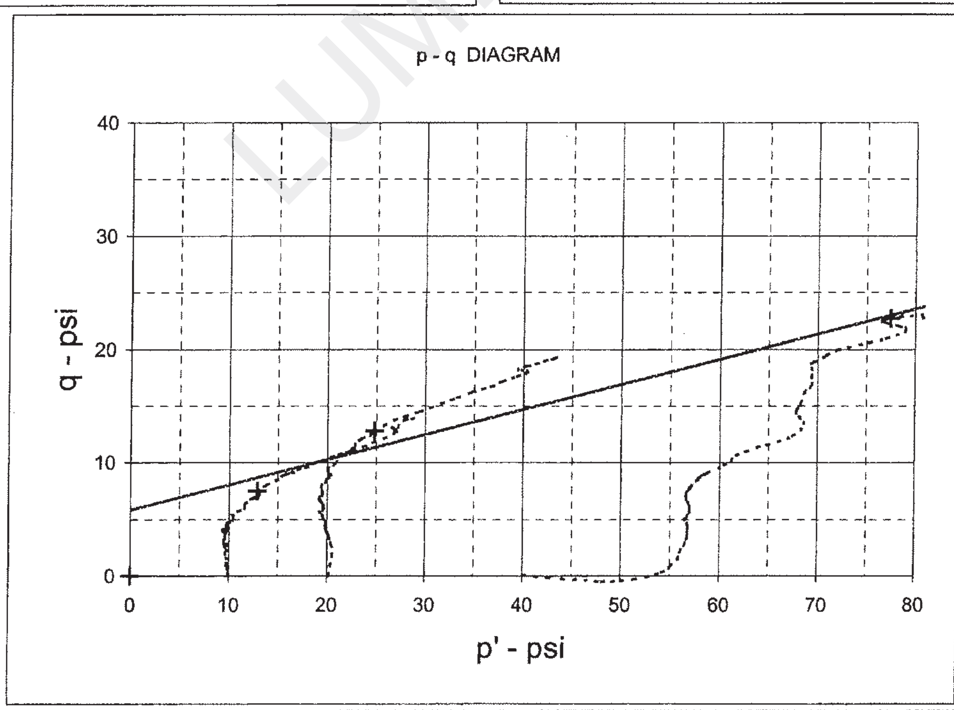
ETTL ENGINEERS & CONSULTANTS | PLATE: B.1







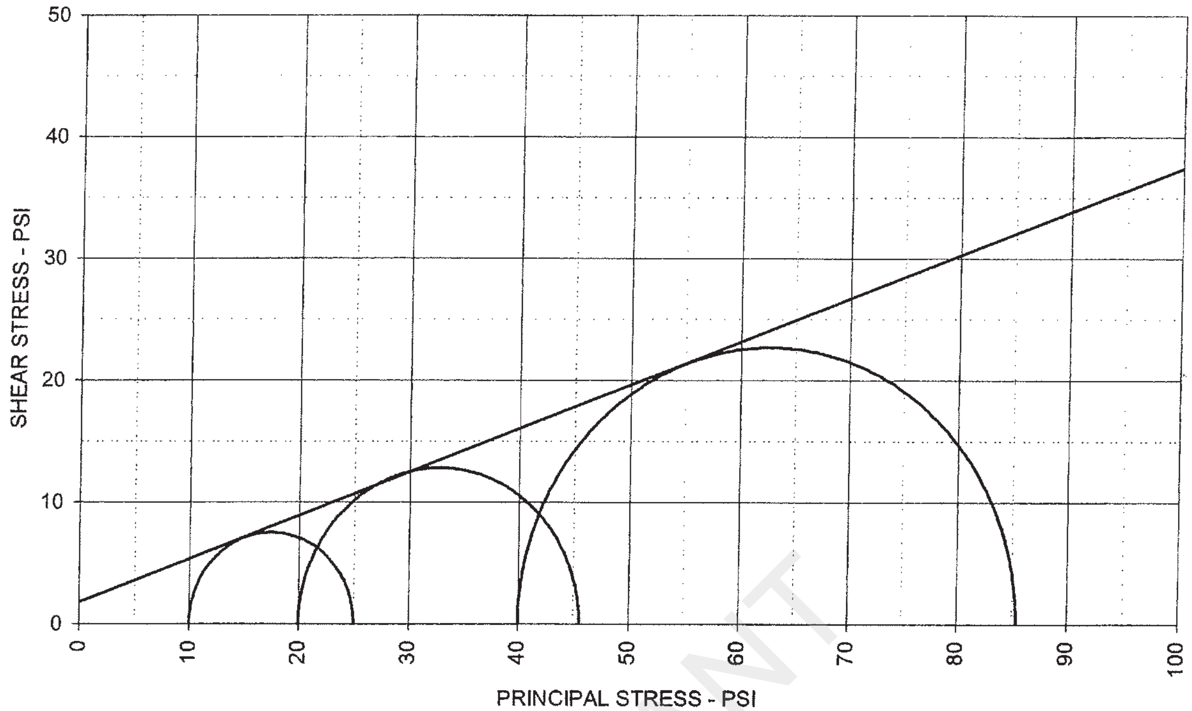




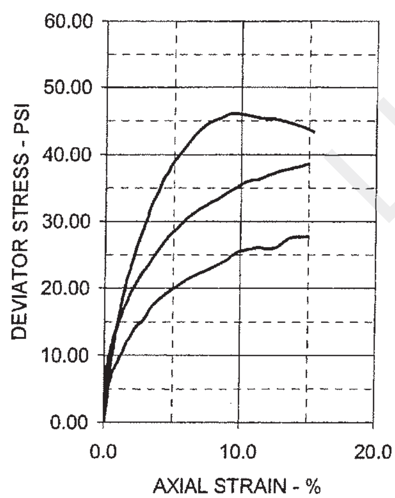
EFFECTIVE STRESS PARAMETERS	R^2 = 0.97	α (deg) = 12.5	a (psi) = 5.8
PROJECT: Luminant East Ash Disposal		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 2972 - 08		ETTL ENGINEERS & CONSULTANTS	PLATE: B.2
DESCRIPTION: Tan, Brown & Red Sandy Lean Clay			

G 2972-08, B-13, 3'-10' Fill

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	φ = 19.6 deg	c = 1.8 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	15.8	16.6	15.9	
Dry Density - pcf	113.0	115.0	112.5	
Diameter - inches	2.04	2.01	2.06	
Height - inches	4.44	4.44	4.54	
AT TEST				
Final Moisture - %	18.1	18.1	17.6	
Dry Density - pcf	114.0	116.9	115.1	
Calculated Diameter (In.)	2.02	2.00	2.04	
Height - inches	4.40	4.40	4.49	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.00	25.60	45.40	
Total Pore Pressure - psi	54.6	58.0	35.2	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.7	3.9	8.5	
σ_1 Failure - psi	25.00	45.60	85.40	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Possible Fill Sample
DESCRIPTION: Tan, Brown & Red Sandy Lean Clay
Sampled on Site, B-13 3' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Both Ends & Diameter Trimmed + # 4 Sieve

PROJECT INFORMATION

PROJECT: Luminant East Ash Disposal
LOCATION: Rusk County, Texas
PROJECT NO: G 2972 - 08
CLIENT:
Movember 2008

ETTL ENGINEERS & CONSULTANTS PLATE: B.3

PROJECT INFORMATION

PROJECT: Luminant East Ash Disposal
LOCATION: Rusk County, Texas
PROJECT NO: G 2972 - 08
CLIENT:
Movember 2008

TRIAXIAL TEST PROGRAM BY GARRY H. GREGORY, P.E.

VERSION 1.0 - AUGUST 1998 - REVISED MARCH 24, 1999

THIS COPY LICENSED TO:
ETTL ENGINEERS AND CONSULTANTS, INC.
1717 East Erwin
Tyler, TX 75702

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Sample
DESCRIPTION: Gray, Tan & Redd. Br Sandy Clay w/ some Gravel
Sampled on Site, B-2 8' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Both Ends & Diameter Trimmed + # 4 Sieve

PLATE: B.1

PLATE: B.2

PLATE: B.3

Number of Specimens = 3

SPECIMEN DATA

SPECIMEN NO. 1

	initial		final		Diameter			Height		
Moist soil & Tare :	479.30	g	630.20	g	top	2.08	in	Ht 1	4.25	in
Dry soil and Tare :	429.60	g	548.70	g	mid	2.08	in	Ht 2	4.25	in
Tare :	129.70	g	128.00	g	bot	2.08	in	Ht 3	4.25	in
Moisture content :	[redacted]	%	[redacted]	%	Avg	[redacted]	in	Ht4	4.25	in
Weight:	496.8	g						Avg Ht	[redacted]	in

Change in Ht due to saturation :	-0.014	in	Initial specimen vol :	[redacted]	cc
Change in Ht due to consolidation :	0.005	in	At test specimen vol :	[redacted]	cc
Change in pipet vol due to consolidation :	0.6	cc	Initial dry density :	[redacted]	pcf
Saturation Parameter " B " = 0.96			At test dry density:	[redacted]	pcf

Strain Rate (in/min) =	0.0005	Failure Strain % =	2.4	Effective Cell Pressure (psi) =	[redacted]
σ_1' Failure (psi) =	36.26	σ_1 Failure (psi) =	[redacted]	Estimated ν =	0.35
σ_3' Failure (psi) =	8.24	σ_3 Failure (psi) =	[redacted]	Back Pressure (psi) =	50.0
ΔU =	[redacted]	Total Pore Pressure =	51.8	Cell Pressure (psi) =	60.0

SPECIMEN NO. 2

	initial		final		Diameter			Height		
Moist soil & Tare :	505.50	g	616.20	g	top	2.08	in	Ht 1	4.40	in
Dry soil and Tare :	451.40	g	537.60	g	mid	2.06	in	Ht 2	4.40	in
Tare :	114.00	g	102.60	g	bot	2.08	in	Ht 3	4.40	in
Moisture content :	[redacted]	%	[redacted]	%	Avg	[redacted]	in	Ht4	4.40	in
Weight:	611.6	g						Avg Ht	[redacted]	in

Change in Ht due to saturation :	0.01	in	Initial specimen vol :	[redacted]	cc
Change in Ht due to consolidation :	-0.048	in	At test specimen vol :	[redacted]	cc
Change in pipet vol due to consolidation :	7.0	cc	Initial dry density :	[redacted]	pcf
Saturation Parameter " B " = 0.98			At test dry density:	[redacted]	pcf

Strain Rate (in/min) =	0.0005	Failure Strain % =	3.4	Effective Cell Pressure (psi) =	[redacted]
σ_1' Failure (psi) =	48.53	σ_1 Failure (psi) =	[redacted]	Estimated ν =	0.35
σ_3' Failure (psi) =	13.88	σ_3 Failure (psi) =	[redacted]	Back Pressure (psi) =	50.0
ΔU =	[redacted]	Total Pore Pressure =	56.1	Cell Pressure (psi) =	70.0

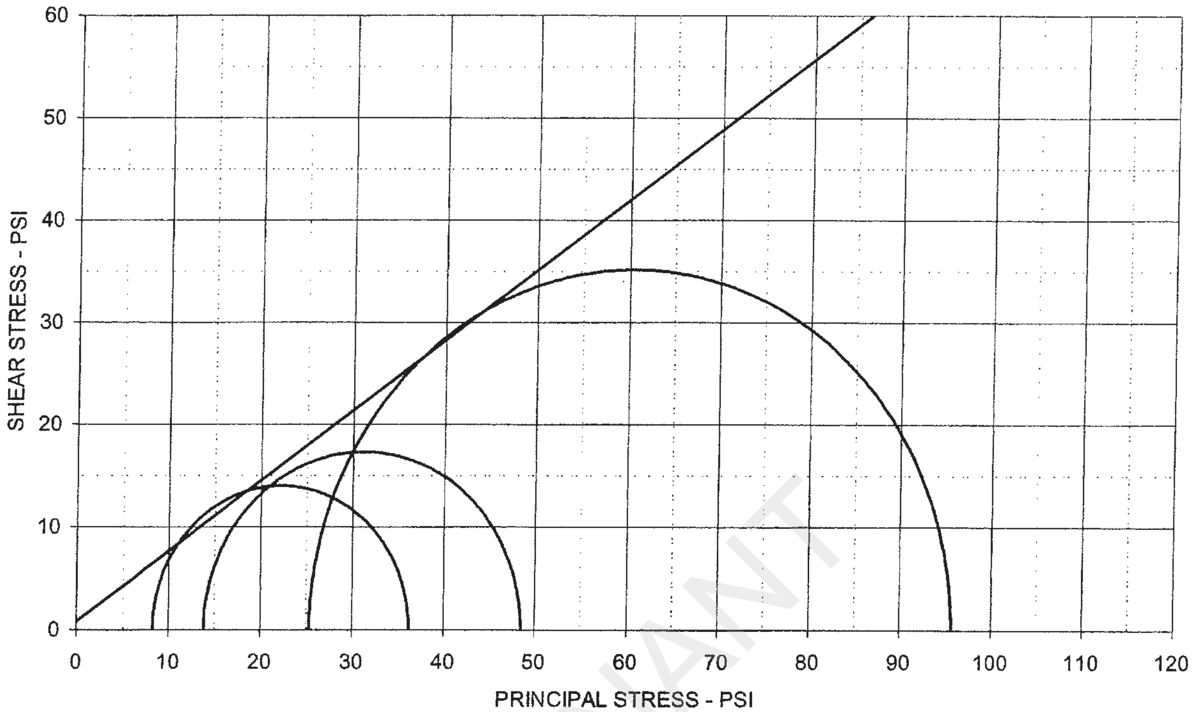
SPECIMEN NO. 3

	initial		final		Diameter			Height		
Moist soil & Tare :	414.70	g	721.60	g	top	2.11	in	Ht 1	4.62	in
Dry soil and Tare :	381.70	g	652.20	g	mid	2.11	in	Ht 2	4.62	in
Tare :	102.50	g	139.10	g	bot	2.11	in	Ht 3	4.62	in
Moisture content :	[redacted]	%	[redacted]	%	Avg	[redacted]	in	Ht4	4.62	in
Weight:	579.6	g						Avg Ht	[redacted]	in

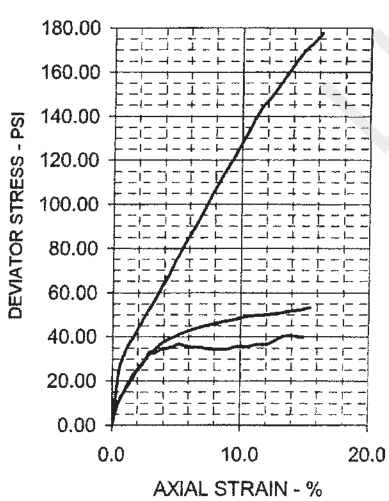
Change in Ht due to saturation :	-0.021	in	Initial specimen vol :	[redacted]	cc
Change in Ht due to consolidation :	-0.018	in	At test specimen vol :	[redacted]	cc
Change in pipet vol due to consolidation :	5.4	cc	Initial dry density :	[redacted]	pcf
Saturation Parameter " B " = 0.99			At test dry density:	[redacted]	pcf

Strain Rate (in/min) =	0.0005	Failure Strain % =	4.6	Effective Cell Pressure (psi) =	[redacted]
σ_1' Failure (psi) =	95.68	σ_1 Failure (psi) =	[redacted]	Estimated ν =	0.35
σ_3' Failure (psi) =	25.40	σ_3 Failure (psi) =	[redacted]	Back Pressure (psi) =	50.0
ΔU =	[redacted]	Total Pore Pressure =	64.6	Cell Pressure (psi) =	90.0

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	ϕ ' =	34.4 deg	c' =	0.8 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	16.6	16.0	11.8	
Dry Density - pcf	112.3	112.1	122.3	
Diameter - inches	2.08	2.08	2.11	
Height - inches	4.25	4.40	4.62	
AT TEST				
Final Moisture - %	19.4	18.1	13.5	
Dry Density - pcf	112.6	115.3	124.9	
Calculated Diameter (in.)	2.08	2.07	2.10	
Height - inches	4.24	4.37	4.58	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	28.02	34.65	70.28	
Total Pore Pressure - psi	51.8	56.1	64.6	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.4	3.4	4.6	
σ_1' Failure - psi	36.26	48.53	95.68	
σ_3' Failure - psi	8.24	13.88	25.40	

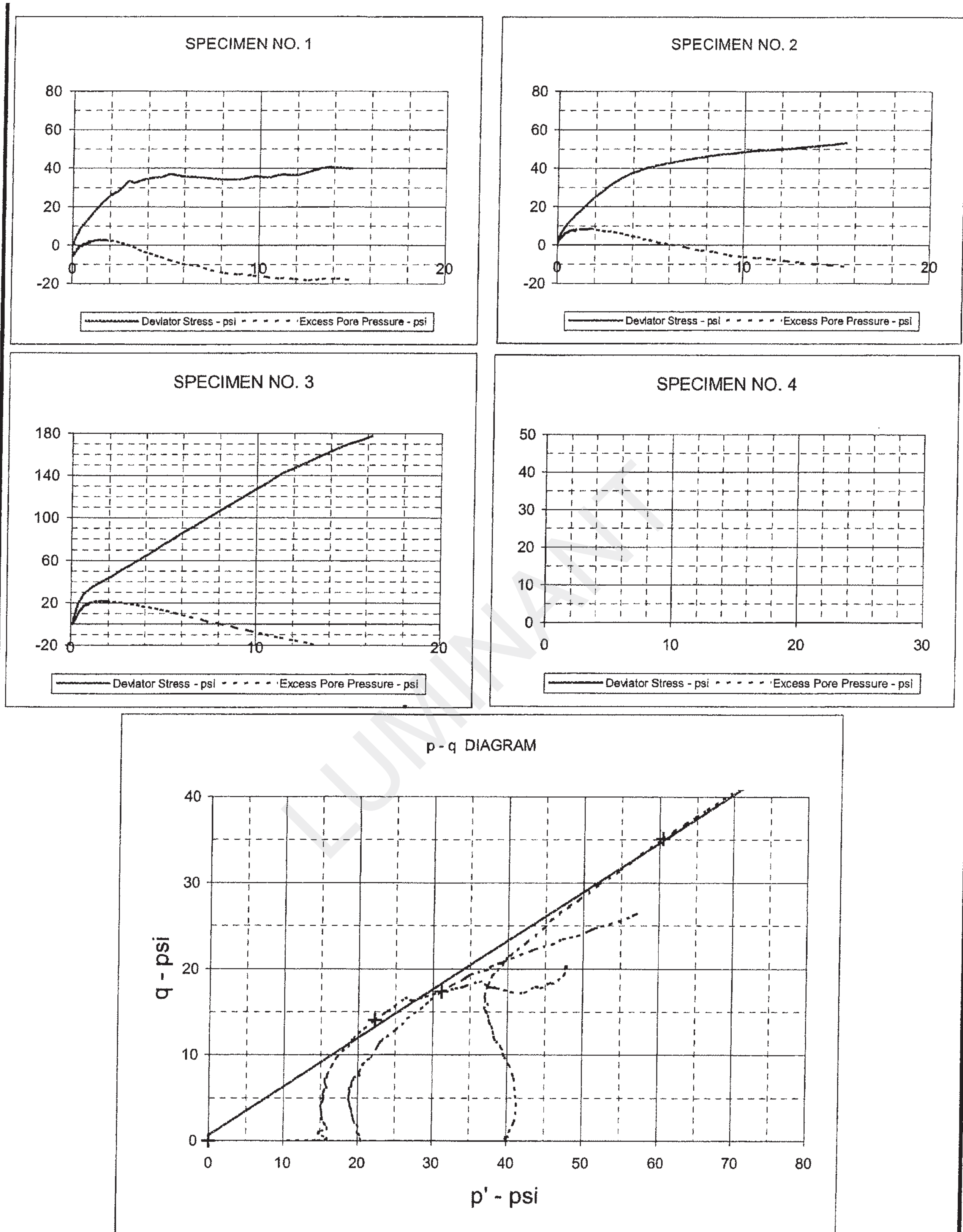
TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Sample
DESCRIPTION: Gray, Tan & Redd. Br Sandy Clay w/ some Gravel
Sampled on Site, B-2 8' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Both Ends & Diameter Trimmed + # 4 Sieve
G 2972-08, B-2, 8'-20' Native

PROJECT INFORMATION

PROJECT: Luminant East Ash Disposal
LOCATION: Rusk County, Texas
PROJECT NO: G 2972 - 08
CLIENT:
Movember 2008

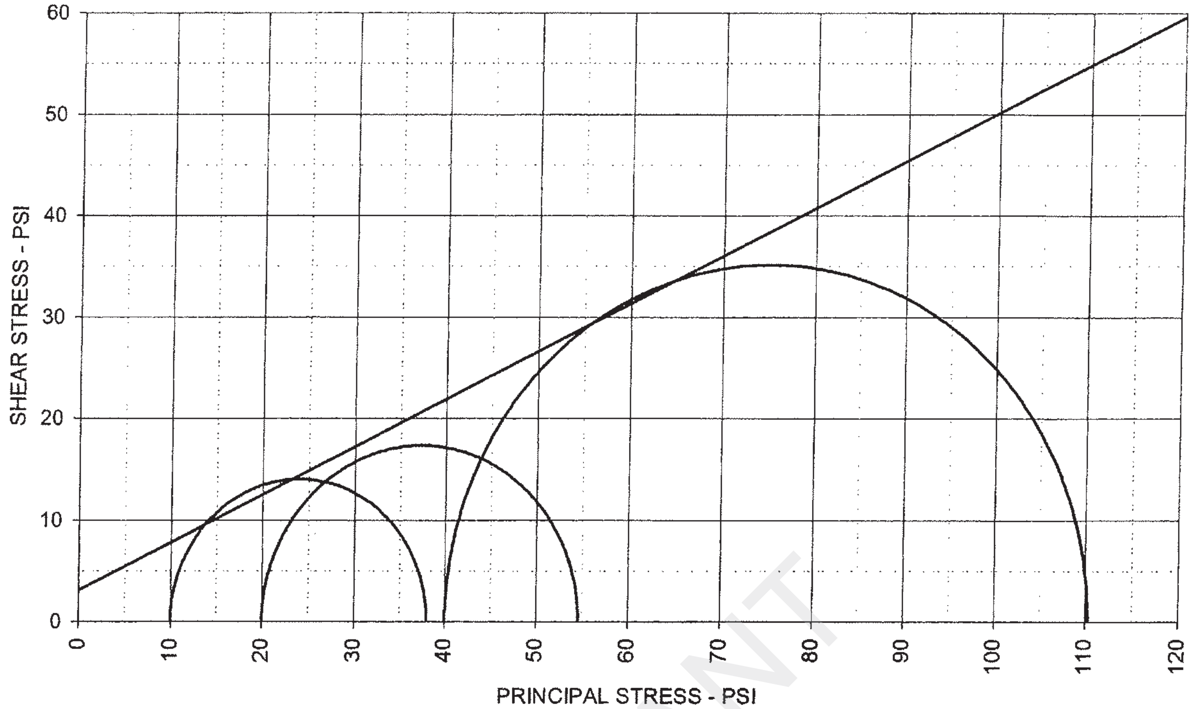
ETTL ENGINEERS & CONSULTANTS	PLATE: B.1



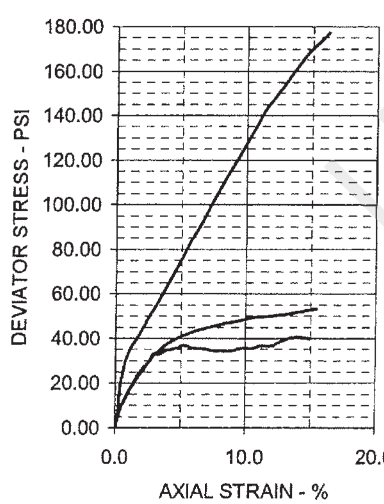
EFFECTIVE STRESS PARAMETERS	R^2 = 0.99	α (deg) = 29.5	a (psi) = 0.7
PROJECT: Luminant East Ash Disposal		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 2972 - 08		ETTL ENGINEERS & CONSULTANTS	PLATE: B.2
DESCRIPTION: Gray, Tan & Redd. Br Sandy Clay w/ some Gravel			

G 2972-08, B-2, 8'-20' Native

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	ϕ = 25.2 deg	c = 3.1 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	16.6	16.0	11.8	
Dry Density - pcf	112.3	112.1	122.3	
Diameter - inches	2.08	2.08	2.11	
Height - inches	4.25	4.40	4.62	
AT TEST				
Final Moisture - %	19.4	18.1	13.5	
Dry Density - pcf	112.6	115.3	124.9	
Calculated Diameter (in.)	2.08	2.07	2.10	
Height - inches	4.24	4.37	4.58	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	28.02	34.65	70.28	
Total Pore Pressure - psi	51.8	56.1	64.6	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.4	3.4	4.6	
σ_1 Failure - psi	38.02	54.65	110.28	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Sample
DESCRIPTION: Gray, Tan & Redd. Br Sandy Clay w/ some Gravel
Sampled on Site, B-2 8' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Both Ends & Diameter Trimmed + # 4 Sieve

PROJECT INFORMATION

PROJECT: Luminant East Ash Disposal
LOCATION: Rusk County, Texas
PROJECT NO: G 2972 - 08
CLIENT:
Movember 2008

ETTL ENGINEERS & CONSULTANTS PLATE: B.3

PROJECT INFORMATION

PROJECT: Luminant East Ash Disposal
LOCATION: Rusk County, Texas
PROJECT NO: G 2972 - 08
CLIENT:
Movember, 2008

TRIAXIAL TEST PROGRAM BY GARRY H. GREGORY, P.E.

VERSION 1.0 - AUGUST 1998 - REVISED MARCH 24, 1999

THIS COPY LICENSED TO:
ETTL ENGINEERS AND CONSULTANTS, INC.
1717 East Erwin
Tyler, TX 75702

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Possible Fill Sample
DESCRIPTION: Tan & Red Sandy Lean Clay w/ Roots
Sampled on Site, B-1, 3' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200
REMARKS: Both Ends & Diameter Trimmed + # 4 Sieve

PLATE: B.1

PLATE: B.2

PLATE: B.3

Number of Specimens = 3

SPECIMEN DATA

SPECIMEN NO. 1

	initial		final		Diameter			Height		
Moist soil & Tare :	539.30	g	625.10	g	top	2.07	in	Ht 1	4.23	in
Dry soil and Tare :	482.00	g	546.00	g	mid	2.07	in	Ht 2	4.23	in
Tare :	127.40	g	126.90	g	bot	2.07	in	Ht 3	4.23	in
Moisture content :	[illegible]	%	[illegible]	%	Avg	[illegible]	in	Ht4	4.23	in
Weight:	493.2	g						Avg Ht	[illegible]	in

Change in Ht due to saturation :	0.02	in	Initial specimen vol :	[illegible]	cc
Change in Ht due to consolidation :	-0.006	in	At test specimen vol :	[illegible]	cc
Change in pipet vol due to consolidation :	3.2	cc	Initial dry density :	[illegible]	pcf
Saturation Parameter " B " =	0.97		At test dry density:	[illegible]	pcf

Strain Rate (in/min) =	0.0005	Failure Strain % =	1.4	Effective Cell Pressure (psi) =	[illegible]
σ_1' Failure (psi) =	29.29	σ_1 Failure (psi) =	[illegible]	Estimated ν =	0.35
σ_3' Failure (psi) =	6.35	σ_3 Failure (psi) =	[illegible]	Back Pressure (psi) =	50.0
ΔU =	[illegible]	Total Pore Pressure =	53.7	Cell Pressure (psi) =	60.0

SPECIMEN NO. 2

	initial		final		Diameter			Height		
Moist soil & Tare :	548.00	g	591.00	g	top	2.01	in	Ht 1	4.25	in
Dry soil and Tare :	492.70	g	519.10	g	mid	2.01	in	Ht 2	4.25	in
Tare :	136.60	g	124.60	g	bot	2.01	in	Ht 3	4.25	in
Moisture content :	[illegible]	%	[illegible]	%	Avg	[illegible]	in	Ht4	4.25	in
Weight:	462.2	g						Avg Ht	[illegible]	in

Change in Ht due to saturation :	-0.009	in	Initial specimen vol :	[illegible]	cc
Change in Ht due to consolidation :	-0.033	in	At test specimen vol :	[illegible]	cc
Change in pipet vol due to consolidation :	4.2	cc	Initial dry density :	[illegible]	pcf
Saturation Parameter " B " =	0.99		At test dry density:	[illegible]	pcf

Strain Rate (in/min) =	0.0005	Failure Strain % =	3.0	Effective Cell Pressure (psi) =	[illegible]
σ_1' Failure (psi) =	40.52	σ_1 Failure (psi) =	[illegible]	Estimated ν =	0.35
σ_3' Failure (psi) =	14.53	σ_3 Failure (psi) =	[illegible]	Back Pressure (psi) =	50.0
ΔU =	[illegible]	Total Pore Pressure =	55.5	Cell Pressure (psi) =	70.0

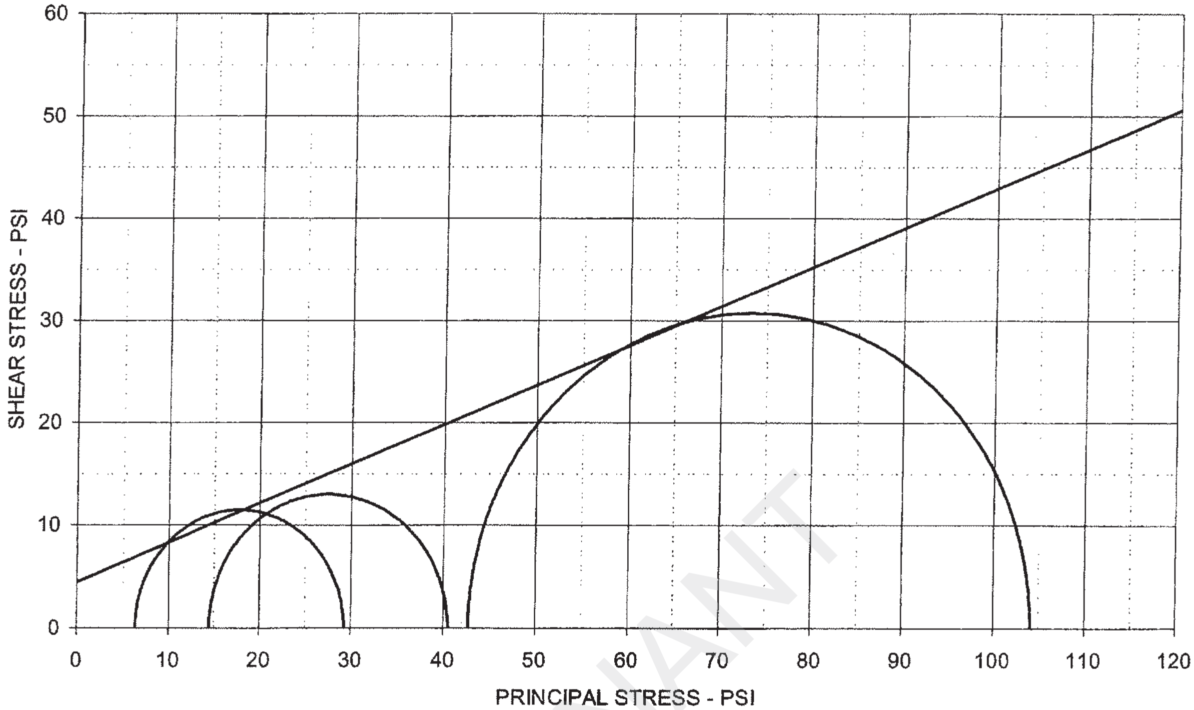
SPECIMEN NO. 3

	initial		final		Diameter			Height		
Moist soil & Tare :	431.00	g	628.40	g	top	2.10	in	Ht 1	4.28	in
Dry soil and Tare :	385.90	g	558.80	g	mid	2.10	in	Ht 2	4.28	in
Tare :	105.00	g	119.40	g	bot	2.10	in	Ht 3	4.28	in
Moisture content :	[illegible]	%	[illegible]	%	Avg	[illegible]	in	Ht4	4.28	in
Weight:	510.5	g						Avg Ht	[illegible]	in

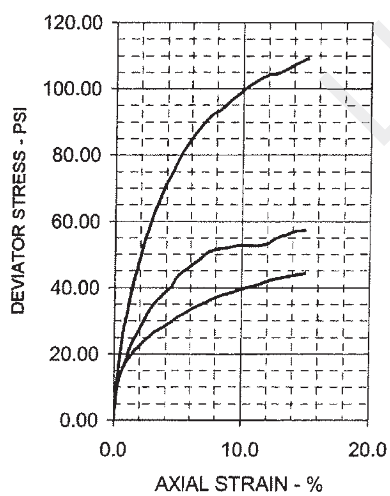
Change in Ht due to saturation :	-0.017	in	Initial specimen vol :	[illegible]	cc
Change in Ht due to consolidation :	-0.039	in	At test specimen vol :	[illegible]	cc
Change in pipet vol due to consolidation :	4.6	cc	Initial dry density :	[illegible]	pcf
Saturation Parameter " B " =	0.97		At test dry density:	[illegible]	pcf

Strain Rate (in/min) =	0.0005	Failure Strain % =	3.0	Effective Cell Pressure (psi) =	[illegible]
σ_1' Failure (psi) =	104.13	σ_1 Failure (psi) =	[illegible]	Estimated ν =	0.35
σ_3' Failure (psi) =	42.71	σ_3 Failure (psi) =	[illegible]	Back Pressure (psi) =	50.0
ΔU =	[illegible]	Total Pore Pressure =	47.3	Cell Pressure (psi) =	90.0

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	φ ' = 21.0 deg	c' = 4.5 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	16.2	15.5	16.1	
Dry Density - pcf	113.6	113.1	113.3	
Diameter - inches	2.07	2.01	2.10	
Height - inches	4.23	4.25	4.28	
AT TEST				
Final Moisture - %	18.3	18.2	15.8	
Dry Density - pcf	115.2	115.3	115.5	
Calculated Diameter (in.)	2.08	1.99	2.08	
Height - inches	4.24	4.21	4.22	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	22.94	25.99	61.42	
Total Pore Pressure - psi	53.7	55.5	47.3	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.4	3.0	3.0	
σ_1' Failure - psi	29.29	40.52	104.13	
σ_3' Failure - psi	6.35	14.53	42.71	

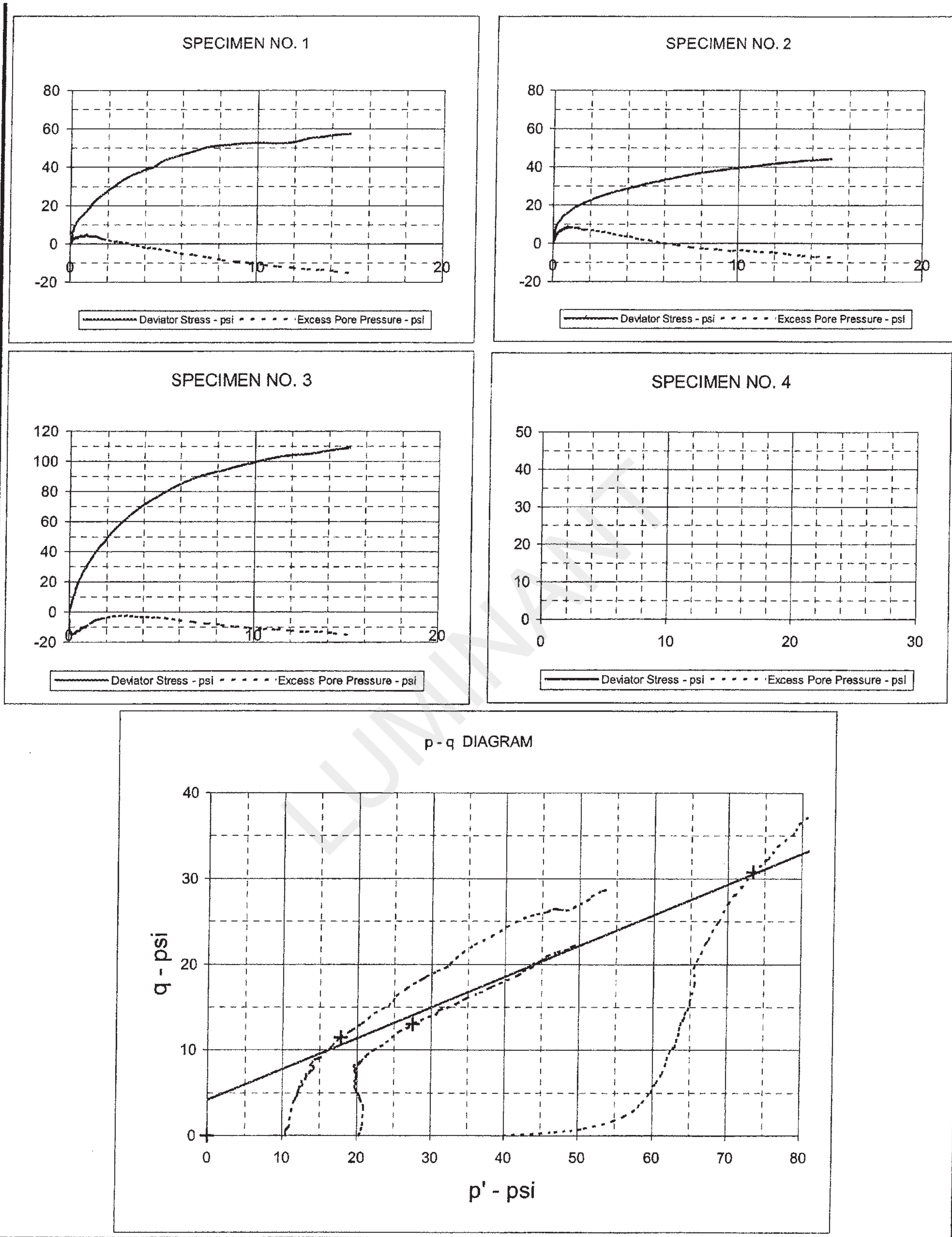
TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Possible Fill Sample
DESCRIPTION: Tan & Red Sandy Lean Clay w/ Roots
Sampled on Site, B-1 3' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Both Ends & Diameter Trimmed + # 4 Sieve
G 2972-08, B-1, 3'-10' Fill

PROJECT INFORMATION

PROJECT: Luminant East Ash Disposal
LOCATION: Rusk County, Texas
PROJECT NO: G 2972 - 08
CLIENT:
Movember 2008

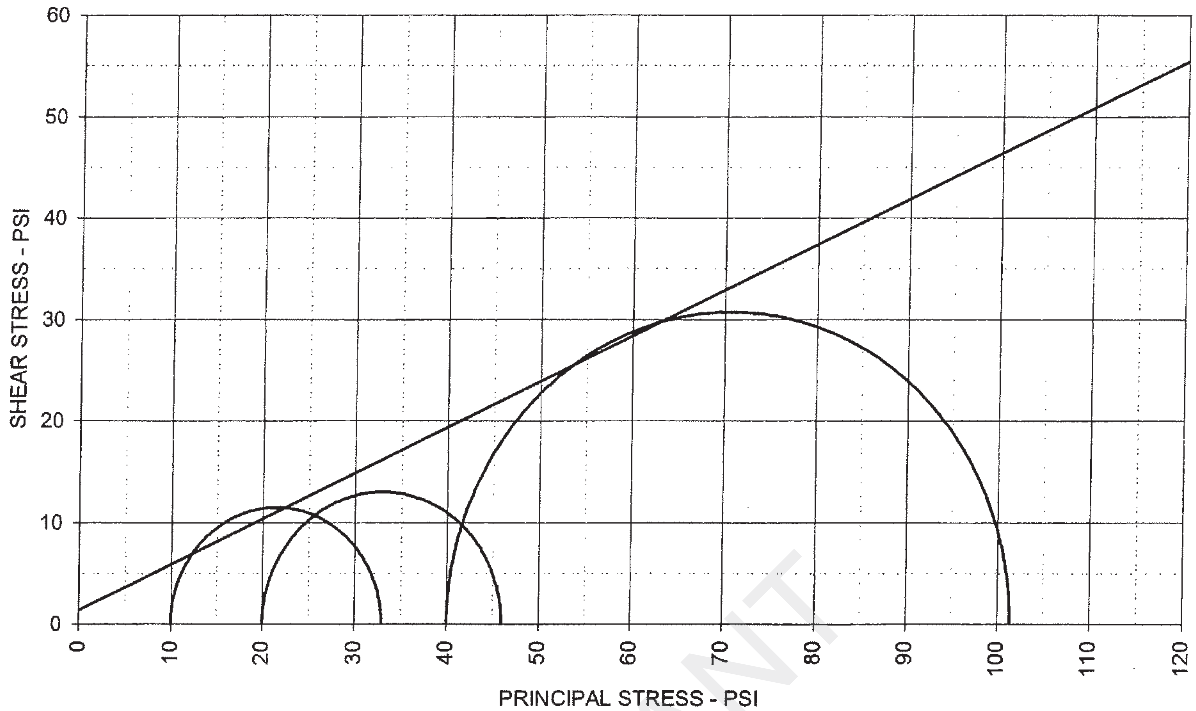
ETTL ENGINEERS & CONSULTANTS | PLATE: B.1



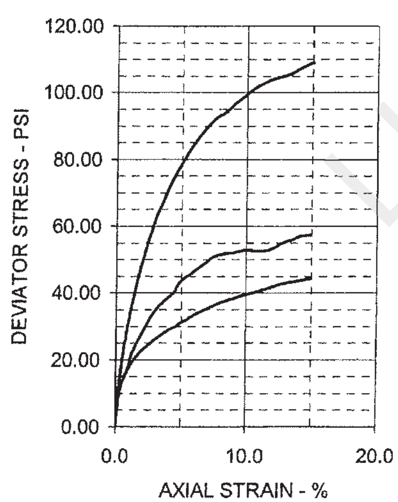
EFFECTIVE STRESS PARAMETERS	R^2 = 0.99	α (deg) = 19.7	a (psi) = 4.2
PROJECT: Luminant East Ash Disposal		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 2972 - 08		**ETTL ENGINEERS & CONSULTANTS**	PLATE: B.2
DESCRIPTION: Tan & Red Sandy Lean Clay w/ Roots			

G 2972-08, B-1, 3'-10' Fill

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	φ = 24.2 deg	c = 1.4 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	16.2	15.5	16.1	
Dry Density - pcf	113.6	113.1	113.3	
Diameter - inches	2.07	2.01	2.10	
Height - inches	4.23	4.25	4.28	
AT TEST				
Final Moisture - %	18.3	18.2	15.8	
Dry Density - pcf	115.2	115.3	115.5	
Calculated Diameter (in.)	2.08	1.99	2.08	
Height - inches	4.24	4.21	4.22	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	22.94	25.99	61.42	
Total Pore Pressure - psi	53.7	55.5	47.3	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.4	3.0	3.0	
σ_1 Failure - psi	32.94	45.99	101.42	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Possible Fill Sample
DESCRIPTION: Tan & Red Sandy Lean Clay w/ Roots
Sampled on Site, B-1 3' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Both Ends & Diameter Trimmed + # 4 Sieve

PROJECT INFORMATION

PROJECT: Luminant East Ash Disposal
LOCATION: Rusk County, Texas
PROJECT NO: G 2972 - 08
CLIENT:
Movember 2008

ETTL ENGINEERS & CONSULTANTS PLATE: B.3

PERMANENT DISPOSAL POND - 5

HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

PROJECT:	Luminant Martin Lake, PDP 1-3
CLIENT:	TXU
CONTRACTOR:	not given
JOB No. :	**G 2810 - 08**
REPORT No.:	
DATE SAMPLED:	February 2008
SAMPLED BY:	ETTL Drill Crew
LOCATION:	MLSES
SAMPLE No. :	
DESCRIPTION:	Gray & Dark Gray Bottom Ash
TECHNICIAN:	M. Thompson
DATE:	04/15/08

RESULTS

	Grain Diameter	
% Retain	+2.0 mm	**47.69**
% Retain	+0.05 mm	**99.26**
% Passing	0.05 to 2.0 mm	**51.57**
% Passing	0.002 to 0.05 mm	**0.72**
% Passing	> 0.002 mm	**0.02**

WEIGHT OF SAMPLE (AIR DRY)	100.00
WEIGHT OF SAMPLE (OVEN DRY)	99.90
PERCENT RETAINED ON # 10	47.69
SPECIFIC GRAVITY	2.563

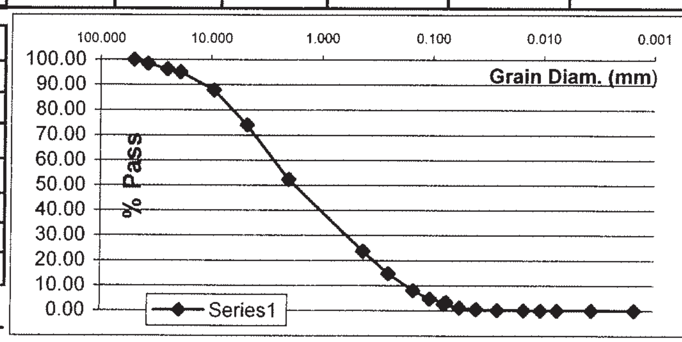
Mc Hydrom	
Tare Wt	29.89
Wet Wt.	68.94
Dry Wt	68.90
MC	0.1025%

SIEVE	WEIGHT	%RETAIN	GRAIN DIA	%PASSING
40	54.66	76.31	0.425	23.69
60	71.63	85.20	0.250	14.80
100	84.45	91.91	0.150	8.09
140	90.93	95.30	0.105	4.70
200	93.54	96.67	0.075	3.33

TEMP (C)	HYDROMETER CORRECTION	HYDROMETER READING	CORRECTED READING	L.Hydrom FACTOR	K. Diam. FACTOR	a. SP.GR. FACTOR	TIME (MIN)	GRAIN DIA (MM)	% SOIL PASSING
21.5	5.7	11.0	5.3	15.5	0.0141	1.02	0.5	0.0787	2.82
21.5	5.7	8.0	2.3	16	0.0141	1.02	1	0.0566	1.21
21.5	5.7	6.8	1.1	16.1	0.0141	1.02	2	0.0401	0.57
21.5	5.7	6.2	0.5	16.3	0.0141	1.02	5	0.0255	0.25
21.5	5.7	6.0	0.3	16.3	0.0141	1.02	15	0.0147	0.15
21.5	5.7	5.8	0.1	16.3	0.0141	1.02	30	0.0104	0.04
21.5	5.7	5.8	0.1	16.3	0.0141	1.02	60	0.0074	0.04
21.5	5.7	5.8	0.1	16.3	0.0141	1.02	250	0.0036	0.04
22.0	5.6	5.6	0.0	16.3	0.0140	1.02	1440	0.0015	0.02

SPECIFIC GRAVITY		BOTTLE #	Bottle Wt	Bott & Water	WaterTemp	Corr.Soil	Bott, S & Water	WaterTemp	Specif. Grav
Air dry Sample(gr)	100	10	188.06	686.13	22.5	99.90	747.18	21.5	**2.563**

	Sieve Size	Grams Retain	% Pass
Sieve % Pass	2"	0.00	100.00
	1-1/2"	89.00	98.47
Air Dry Start Wt.:	1"	215.04	96.31
5836.8	3/4"	288.14	95.06
Dry Start Wt.:	3/8"	709.78	87.83
5830.82	No 4	1510.97	74.09
	No 10	2780.46	52.31



Remarks:

HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

PROJECT:	Luminant Martin Lake, PDP 1-3
CLIENT:	TXU
CONTRACTOR:	not given
JOB No. :	**G 2810 - 08**
REPORT No.:	
DATE SAMPLED:	February 2008
SAMPLED BY:	ETTL Drill Crew
LOCATION:	B-9, 1'-3'
SAMPLE No. :	
DESCRIPTION:	Gray Ash (Cementing)
TECHNICIAN:	H. Walka
DATE:	03/14/08

RESULTS

	Grain Diameter	
% Retain	+2.0 mm	**0.08**
% Retain	+0.05 mm	**41.35**
% Passing	0.05 to 2.0 mm	**41.27**
% Passing	0.002 to 0.05 mm	**56.63**
% Passing	> 0.002 mm	**2.02**

WEIGHT OF SAMPLE (AIR DRY)	100.00
WEIGHT OF SAMPLE (OVEN DRY)	99.73
PERCENT RETAINED ON # 10	0.08
SPECIFIC GRAVITY	2.761

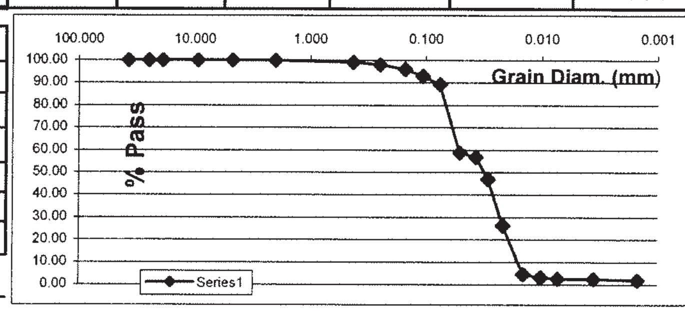
Mc Hydrom	
Tare Wt	29.50
Wet Wt.	62.41
Dry Wt	62.32
MC	0.2742%

SIEVE	WEIGHT	%RETAIN	GRAIN DIA	%PASSING
40	0.92	1.00	0.425	99.00
60	1.92	2.00	0.250	98.00
100	3.90	3.99	0.150	96.01
140	7.07	7.16	0.105	92.84
200	10.67	10.77	0.075	89.23

TEMP (C)	HYDROMETER CORRECTION	HYDROMETER READING	CORRECTED READING	L.Hydrom FACTOR	K. Diam. FACTOR	a. SP.GR. FACTOR	TIME (MIN)	GRAIN DIA (MM)	% SOIL PASSING
23.0	5.2	65.0	59.8	6.6	0.0138	0.98	0.5	0.0502	58.67
23.0	5.2	63.0	57.8	7	0.0138	0.98	1	0.0365	56.71
23.0	5.2	53.0	47.8	8.6	0.0138	0.98	2	0.0286	46.89
23.0	5.2	32.0	26.8	12	0.0138	0.98	5	0.0214	26.27
22.5	5.4	10.0	4.6	15.6	0.0140	0.98	15	0.0142	4.51
22.5	5.4	8.5	3.1	15.8	0.0140	0.98	30	0.0101	3.04
22.5	5.4	8.0	2.6	16	0.0140	0.98	60	0.0072	2.55
22.0	5.6	8.0	2.4	16	0.0140	0.98	250	0.0035	2.39
22.0	5.6	7.5	1.9	16.1	0.0140	0.98	1440	0.0015	1.90

SPECIFIC GRAVITY		BOTTLE #	Bottle Wt	Bott & Water	WaterTemp	Corr.Soil	Bott, S & Water	WaterTemp	Specif. Grav
Air dry Sample(gr)	50	7	179.97	678.12	22.5	49.86	709.93	22.5	**2.761**

	Sieve Size	Grams Retain	% Pass
Sieve % Pass	1-1/2"	0.00	100.00
Air Dry Start Wt.:	1"	0.00	100.00
334.9	3/4"	0.00	100.00
Dry Start Wt.:	3/8"	0.00	100.00
333.98	No 4	0.00	100.00
	No 10	0.26	99.92



Remarks:

HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

PROJECT: Luminant Martin Lake, PDP 1-3
CLIENT: TXU
CONTRACTOR: not given
JOB No. : **G 2810 - 08**

REPORT No.:
DATE SAMPLED: February 2008
SAMPLED BY: ETTL Drill Crew
LOCATION: B-7, 13'-15'
SAMPLE No. :
DESCRIPTION: Gray Ash
TECHNICIAN: H. Walka
DATE: 03/14/08

RESULTS

	Grain Diameter	
% Retain	+2.0 mm	**59.89**
% Retain	+0.05 mm	**92.28**
% Passing	0.05 to 2.0 mm	**32.39**
% Passing	0.002 to 0.05 mm	**4.63**
% Passing	> 0.002 mm	**3.09**

WEIGHT OF SAMPLE (AIR DRY)	50.00
WEIGHT OF SAMPLE (OVEN DRY)	49.81
PERCENT RETAINED ON # 10	59.89
SPECIFIC GRAVITY	2.655

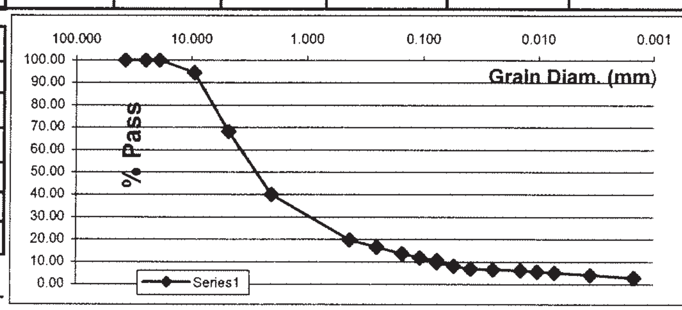
Mc Hydrom	
Tare Wt	30.03
Wet Wt.	45.86
Dry Wt	45.80
MC	0.3805%

SIEVE	WEIGHT	%RETAIN	GRAIN DIA	%PASSING
40	25.25	80.22	0.425	19.78
60	29.25	83.44	0.250	16.56
100	32.74	86.25	0.150	13.75
140	35.11	88.16	0.105	11.84
200	36.67	89.42	0.075	10.58

TEMP (C)	HYDROMETER CORRECTION	HYDROMETER READING	CORRECTED READING	L.Hydrom FACTOR	K. Diam. FACTOR	a. SP.GR. FACTOR	TIME (MIN)	GRAIN DIA (MM)	% SOIL PASSING
22.0	5.6	17.5	11.9	14.5	0.0140	1.00	0.5	0.0752	9.61
22.0	5.6	15.5	9.9	14.8	0.0140	1.00	1	0.0537	8.00
22.0	5.6	14.0	8.4	15	0.0140	1.00	2	0.0383	6.79
22.0	5.6	13.5	7.9	15.2	0.0140	1.00	5	0.0244	6.39
22.0	5.6	13.0	7.4	15.2	0.0140	1.00	15	0.0141	5.99
21.5	5.7	12.5	6.8	15.3	0.0141	1.00	30	0.0101	5.46
21.5	5.7	12.0	6.3	15.3	0.0141	1.00	60	0.0071	5.05
22.0	5.6	10.5	4.9	15.6	0.0140	1.00	250	0.0035	3.97
22.0	5.6	9.0	3.4	15.8	0.0140	1.00	1440	0.0015	2.77

SPECIFIC GRAVITY		BOTTLE #	Bottle Wt	Bott & Water	WaterTemp	Corr.Soil	Bott, S & Water	WaterTemp	Specif. Grav
Air dry Sample(gr)	25	4	179.25	677.26	22.5	24.91	692.79	22.5	**2.655**

	Sieve Size	Grams Retain	% Pass
Sieve % Pass	1-1/2"	0.00	100.00
Air Dry Start Wt.:	1"	0.00	100.00
243.3	3/4"	0.00	100.00
Dry Start Wt.:	3/8"	13.45	94.47
242.38	No 4	77.42	68.18
	No 10	145.71	40.11



Remarks:

HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

PROJECT:	Luminant Martin Lake, PDP 1-3
CLIENT:	TXU
CONTRACTOR:	not given
JOB No. :	**G 2810 - 08**
REPORT No.:	
DATE SAMPLED:	February 2008
SAMPLED BY:	ETTL Drill Crew
LOCATION:	B-6, 18'-20'
SAMPLE No. :	
DESCRIPTION:	Tan Ash
TECHNICIAN:	H. Walka
DATE:	03/14/08

RESULTS

	Grain Diameter	
% Retain	+2.0 mm	**10.97**
% Retain	+0.05 mm	**18.74**
% Passing	0.05 to 2.0 mm	**7.77**
% Passing	0.002 to 0.05 mm	**77.39**
% Passing	> 0.002 mm	**3.87**

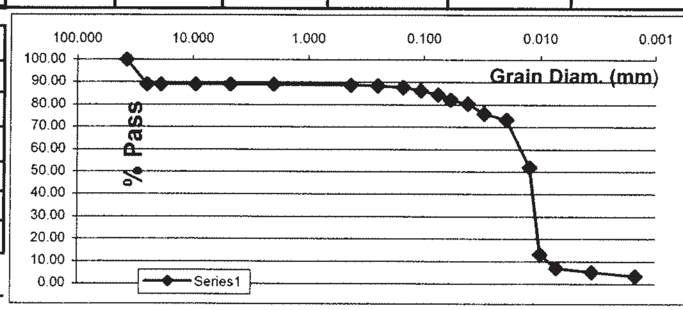
					SIEVE	WEIGHT	%RETAIN	GRAIN DIA	%PASSING
		Mc Hydrom			40	0.26	11.44	0.425	88.56
WEIGHT OF SAMPLE (AIR DRY)	50.00	Tare Wt	29.86		60	0.42	11.72	0.250	88.28
WEIGHT OF SAMPLE (OVEN DRY)	49.81	Wet Wt.	51.33		100	0.78	12.36	0.150	87.64
PERCENT RETAINED ON # 10	10.97	Dry Wt	51.25		140	1.61	13.85	0.105	86.15
SPECIFIC GRAVITY	2.732	MC	0.3740%		200	2.62	15.65	0.075	84.35

TEMP (C)	HYDROMETER CORRECTION	HYDROMETER READING	CORRECTED READING	L.Hydrom FACTOR	K. Diam. FACTOR	a. SP.GR. FACTOR	TIME (MIN)	GRAIN DIA (MM)	% SOIL PASSING
22.0	5.6	52.0	46.4	8.8	0.0140	0.99	0.5	0.0586	82.16
22.0	5.6	51.0	45.4	8.9	0.0140	0.99	1	0.0417	80.39
22.0	5.6	48.5	42.9	9.4	0.0140	0.99	2	0.0303	75.97
22.0	5.6	47.0	41.4	9.6	0.0140	0.99	5	0.0194	73.31
22.0	5.6	35.0	29.4	11.5	0.0140	0.99	15	0.0122	52.08
22.0	5.6	13.0	7.4	15.2	0.0140	0.99	30	0.0099	13.15
22.0	5.6	9.5	3.9	15.8	0.0140	0.99	60	0.0072	6.96
22.0	5.6	8.5	2.9	16	0.0140	0.99	250	0.0035	5.19
22.0	5.6	7.5	1.9	16.1	0.0140	0.99	1440	0.0015	3.42

SPECIFIC GRAVITY		BOTTLE #	Bottle Wt	Bott & Water	WaterTemp	Corr.Soil	Bott, S & Water	WaterTemp	Specif. Grav
Air dry Sample(gr)	50	3	179.93	678.11	22.5	49.81	709.70	22.5	**2.732**

	Sieve Size	Grams Retain	% Pass
Sieve % Pass	1-1/2"	0.00	100.00
Air Dry Start Wt.:	1"	28.83	89.03
262.8	3/4"	28.83	89.03
Dry Start Wt.:	3/8"	28.83	89.03
261.82	No 4	28.83	89.03
	No 10	28.83	89.03

Remarks:



HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

PROJECT:	Luminant Martin Lake, PDP 1-3
CLIENT:	TXU
CONTRACTOR:	not given
JOB No. :	**G 2810 - 08**
REPORT No.:	
DATE SAMPLED:	February 2008
SAMPLED BY:	ETTL Drill Crew
LOCATION:	B-3, 5'-7'
SAMPLE No. :	
DESCRIPTION:	Black Ash
TECHNICIAN:	H. Walka
DATE:	03/06/08

RESULTS

	Grain Diameter	
% Retain	+2.0 mm	**11.60**
% Retain	+0.05 mm	**76.50**
% Passing	0.05 to 2.0 mm	**64.91**
% Passing	0.002 to 0.05 mm	**21.88**
% Passing	> 0.002 mm	**1.62**

WEIGHT OF SAMPLE (AIR DRY)	50.00
WEIGHT OF SAMPLE (OVEN DRY)	49.53
PERCENT RETAINED ON # 10	11.60
SPECIFIC GRAVITY	2.561

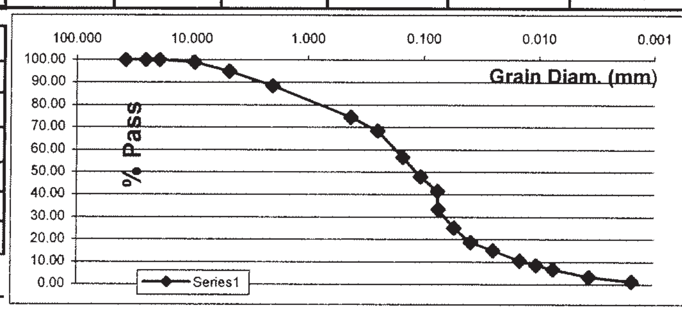
Mc Hydrom	
Tare Wt	29.43
Wet Wt.	65.41
Dry Wt	65.07
MC	0.9540%

SIEVE	WEIGHT	%RETAIN	GRAIN DIA	%PASSING
40	7.81	25.54	0.425	74.46
60	11.21	31.61	0.250	68.39
100	17.82	43.41	0.150	56.59
140	22.64	52.01	0.105	47.99
200	26.25	58.45	0.075	41.55

TEMP (C)	HYDROMETER CORRECTION	HYDROMETER READING	CORRECTED READING	L.Hydrom FACTOR	K. Diam. FACTOR	a. SP.GR. FACTOR	TIME (MIN)	GRAIN DIA (MM)	% SOIL PASSING
20.0	6.2	24.5	18.3	13.3	0.0143	1.02	0.5	0.0738	33.31
20.0	6.2	20.0	13.8	14.2	0.0143	1.02	1	0.0539	25.11
20.0	6.2	16.5	10.3	14.7	0.0143	1.02	2	0.0388	18.74
20.0	6.2	14.5	8.3	15	0.0143	1.02	5	0.0248	15.10
20.0	6.2	12.0	5.8	15.5	0.0143	1.02	15	0.0145	10.55
19.5	6.4	11.0	4.6	15.6	0.0145	1.02	30	0.0104	8.44
19.5	6.4	10.0	3.6	15.8	0.0145	1.02	60	0.0074	6.62
20.0	6.2	8.0	1.8	16.1	0.0143	1.02	250	0.0036	3.27
19.5	6.4	7.0	0.6	16.3	0.0145	1.02	1440	0.0015	1.15

SPECIFIC GRAVITY		BOTTLE #	Bottle Wt	Bott & Water	WaterTemp	Corr.Soil	Bott, S & Water	WaterTemp	Specif. Grav
Air dry Sample(gr)	100	7	179.97	678.12	22.5	99.06	738.67	21.0	**2.561**

	Sieve Size	Grams Retain	% Pass
Sieve % Pass	1-1/2"	0.00	100.00
Air Dry Start Wt.:	1"	0.00	100.00
335.3	3/4"	0.00	100.00
Dry Start Wt.:	3/8"	3.42	98.98
332.13	No 4	17.17	94.88
	No 10	38.89	88.40



Remarks:

HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

PROJECT:	Luminant Martin Lake, PDP 1-3
CLIENT:	TXU
CONTRACTOR:	not given
JOB No. :	**G 2810 - 08**

REPORT No.:	
DATE SAMPLED:	February 2008
SAMPLED BY:	ETTL Drill Crew
LOCATION:	B-2, 23'-25'
SAMPLE No. :	
DESCRIPTION:	Light Gray & Black Ash
TECHNICIAN:	H. Walka
DATE:	03/06/08

RESULTS

	Grain Diameter	
% Retain	+2.0 mm	**0.76**
% Retain	+0.05 mm	**16.00**
% Passing	0.05 to 2.0 mm	**15.24**
% Passing	0.002 to 0.05 mm	**83.90**
% Passing	> 0.002 mm	**0.09**

WEIGHT OF SAMPLE (AIR DRY)	50.00	Tare Wt	29.91
WEIGHT OF SAMPLE (OVEN DRY)	49.16	Wet Wt.	55.02
PERCENT RETAINED ON # 10	0.76	Dry Wt	54.60
SPECIFIC GRAVITY	2.675	MC	1.7011%

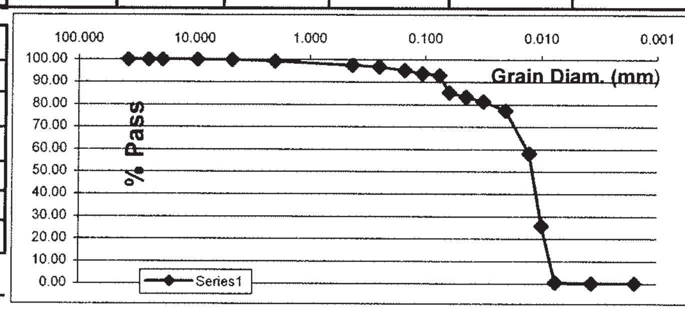
Mc Hydrom

SIEVE	WEIGHT	%RETAIN	GRAIN DIA	%PASSING
40	0.89	2.56	0.425	97.44
60	1.22	3.22	0.250	96.78
100	2.01	4.82	0.150	95.18
140	2.67	6.15	0.105	93.85
200	3.07	6.96	0.075	93.04

TEMP (C)	HYDROMETER CORRECTION	HYDROMETER READING	CORRECTED READING	L.Hydrom FACTOR	K. Diam. FACTOR	a. SP.GR. FACTOR	TIME (MIN)	GRAIN DIA (MM)	% SOIL PASSING
20.0	6.2	48.5	42.3	9.4	0.0143	1.00	0.5	0.0620	85.37
20.0	6.2	47.5	41.3	9.6	0.0143	1.00	1	0.0443	83.35
20.0	6.2	46.5	40.3	9.7	0.0143	1.00	2	0.0315	81.33
20.0	6.2	44.5	38.3	10.1	0.0143	1.00	5	0.0203	77.30
20.0	6.2	35.0	28.8	11.7	0.0143	1.00	15	0.0126	58.12
20.0	6.2	19.0	12.8	14.3	0.0143	1.00	30	0.0099	25.83
20.0	6.2	6.5	0.3	16.3	0.0143	1.00	60	0.0075	0.59
20.0	6.2	6.3	0.1	16.3	0.0143	1.00	250	0.0037	0.19
19.5	6.4	6.4	0.0	16.3	0.0145	1.00	1440	0.0015	0.07

SPECIFIC GRAVITY		BOTTLE #	Bottle Wt	Bott & Water	WaterTemp	Corr.Soil	Bott, S & Water	WaterTemp	Specif. Grav
Air dry Sample(gr)	50	4	179.25	677.26	22.5	49.16	708.22	21.0	**2.675**

	Sieve Size	Grams Retain	% Pass
Sieve % Pass	1-1/2"	0.00	100.00
Air Dry Start Wt.:	1"	0.00	100.00
144.3	3/4"	0.00	100.00
Dry Start Wt.:	3/8"	0.00	100.00
141.89	No 4	0.10	99.93
	No 10	1.10	99.24



Remarks:

HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

PROJECT:	Luminant Martin Lake, PDP 1-3
CLIENT:	TXU
CONTRACTOR:	not given
JOB No. :	**G 2810 - 08**
REPORT No.:	
DATE SAMPLED:	February 2008
SAMPLED BY:	ETTL Drill Crew
LOCATION:	B-1, 18'-20'
SAMPLE No. :	
DESCRIPTION:	Black, Tan & Gray Ash
TECHNICIAN:	H. Walka
DATE:	03/06/08

RESULTS

	Grain Diameter	
% Retain	+2.0 mm	**14.96**
% Retain	+0.05 mm	**64.42**
% Passing	0.05 to 2.0 mm	**49.46**
% Passing	0.002 to 0.05 mm	**35.29**
% Passing	> 0.002 mm	**0.29**

WEIGHT OF SAMPLE (AIR DRY)	50.00
WEIGHT OF SAMPLE (OVEN DRY)	49.29
PERCENT RETAINED ON # 10	14.96
SPECIFIC GRAVITY	2.608

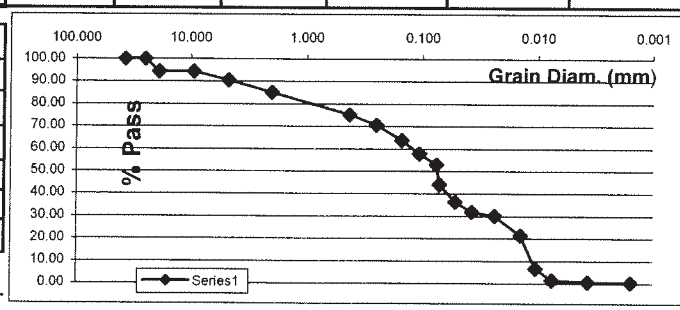
Mc Hydrom	
Tare Wt	29.29
Wet Wt.	59.40
Dry Wt	58.97
MC	1.4488%

SIEVE	WEIGHT	%RETAIN	GRAIN DIA	%PASSING
40	5.76	24.90	0.425	75.10
60	8.38	29.42	0.250	70.58
100	12.31	36.20	0.150	63.80
140	15.78	42.19	0.105	57.81
200	18.60	47.05	0.075	52.95

TEMP (C)	HYDROMETER CORRECTION	HYDROMETER READING	CORRECTED READING	L.Hydrom FACTOR	K. Diam. FACTOR	a. SP.GR. FACTOR	TIME (MIN)	GRAIN DIA (MM)	% SOIL PASSING
20.0	6.2	31.5	25.3	12.2	0.0143	1.01	0.5	0.0707	44.08
20.0	6.2	27.0	20.8	13	0.0143	1.01	1	0.0516	36.24
20.0	6.2	24.5	18.3	13.3	0.0143	1.01	2	0.0369	31.88
20.0	6.2	23.5	17.3	13.5	0.0143	1.01	5	0.0235	30.14
20.0	6.2	18.5	12.3	14.3	0.0143	1.01	15	0.0140	21.43
20.0	6.2	10.0	3.8	15.8	0.0143	1.01	30	0.0104	6.61
20.0	6.2	7.0	0.8	16.3	0.0143	1.01	60	0.0075	1.38
20.0	6.2	6.5	0.3	16.3	0.0143	1.01	250	0.0037	0.51
19.5	6.4	6.5	0.1	16.3	0.0145	1.01	1440	0.0015	0.23

SPECIFIC GRAVITY		BOTTLE #	Bottle Wt	Bott & Water	WaterTemp	Corr.Soil	Bott, S & Water	WaterTemp	Specif. Grav
Air dry Sample(gr)	100	3	179.93	678.11	22.5	98.57	739.11	20.5	**2.608**

	Sieve Size	Grams Retain	% Pass
Sieve % Pass	1-1/2"	0.00	100.00
Air Dry Start Wt.:	1"	0.00	100.00
268.4	3/4"	15.10	94.37
Dry Start Wt.:	3/8"	15.10	94.37
264.57	No 4	25.58	90.47
	No 10	40.15	85.04



Remarks:

HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

PROJECT:	Luminant Martin Lake, PDP 1-3
CLIENT:	TXU
CONTRACTOR:	not given
JOB No. :	**G 2810 - 08**
REPORT No.:	
DATE SAMPLED:	February 2008
SAMPLED BY:	ETTL Drill Crew
LOCATION:	MLSES
SAMPLE No. :	
DESCRIPTION:	Tan & Gray Econimizet Ash
TECHNICIAN:	M. Thompson
DATE:	04/15/08

RESULTS

	Grain Diameter	
% Retain	+2.0 mm	**41.02**
% Retain	+0.05 mm	**95.89**
% Passing	0.05 to 2.0 mm	**54.87**
% Passing	0.002 to 0.05 mm	**3.55**
% Passing	> 0.002 mm	**0.55**

WEIGHT OF SAMPLE (AIR DRY)	50.00	Tare Wt	30.27
WEIGHT OF SAMPLE (OVEN DRY)	49.98	Wet Wt.	62.43
PERCENT RETAINED ON # 10	41.02	Dry Wt	62.42
SPECIFIC GRAVITY	2.670	MC	0.0311%

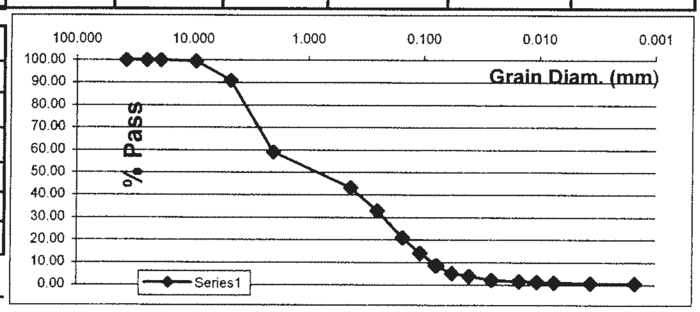
Mc Hydrom

SIEVE	WEIGHT	%RETAIN	GRAIN DIA	%PASSING
40	13.34	56.76	0.425	43.24
60	22.12	67.12	0.250	32.88
100	32.26	79.09	0.150	20.91
140	38.01	85.87	0.105	14.13
200	42.66	91.36	0.075	8.64

TEMP (C)	HYDROMETER CORRECTION	HYDROMETER READING	CORRECTED READING	L.Hydrom FACTOR	K. Diam. FACTOR	a. SP.GR. FACTOR	TIME (MIN)	GRAIN DIA (MM)	% SOIL PASSING
21.5	5.7	13.0	7.3	15.2	0.0141	1.00	0.5	0.0780	8.58
21.5	5.7	10.0	4.3	15.6	0.0141	1.00	1	0.0558	5.04
21.5	5.7	9.0	3.3	15.8	0.0141	1.00	2	0.0397	3.86
21.5	5.7	7.5	1.8	16.1	0.0141	1.00	5	0.0254	2.09
21.5	5.7	7.0	1.3	16.1	0.0141	1.00	15	0.0146	1.50
21.5	5.7	6.8	1.1	16.1	0.0141	1.00	30	0.0104	1.27
21.5	5.7	6.5	0.8	16.3	0.0141	1.00	60	0.0074	0.91
21.5	5.7	6.3	0.6	16.3	0.0141	1.00	250	0.0036	0.68
22.0	5.6	6.0	0.4	16.3	0.0140	1.00	1440	0.0015	0.51

SPECIFIC GRAVITY		BOTTLE #	Bottle Wt	Bott & Water	WaterTemp	Corr.Soil	Bott, S & Water	WaterTemp	Specif. Grav
Air dry Sample(gr)	100	7	179.97	678.12	22.5	99.97	740.78	21.5	**2.670**

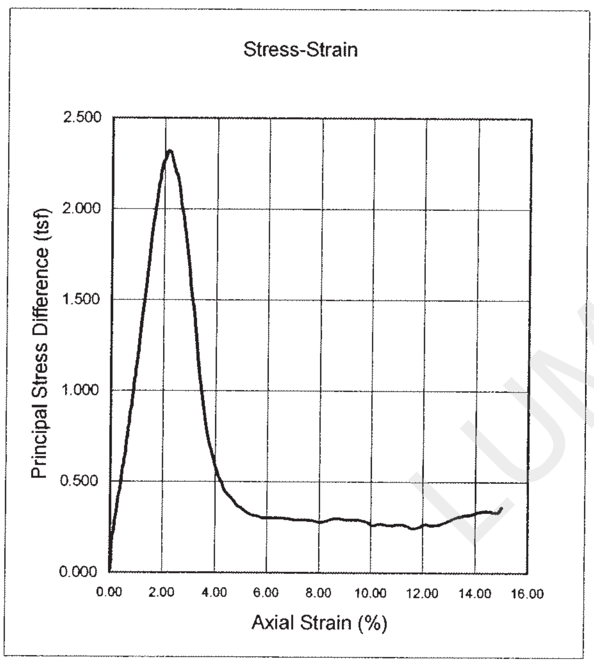
	Sieve Size	Grams Retain	% Pass
Sieve % Pass	1-1/2"	0.00	100.00
Air Dry Start Wt.:	1"	0.00	100.00
2182.9	3/4"	0.00	100.00
Dry Start Wt.:	3/8"	12.53	99.43
2182.22	No 4	200.01	90.83
	No 10	895.12	58.98



Remarks:

ASTM D 2850 Confined Compressive Strength of Cohesive Soil

Project: Luminant Martin Lake: PDP 1-3



Project No.:	G 2810-08	
Boring No.:	B-7	
Depth, ft.:	5'-7'	
Material:	Black Ash with Gravel	
Initial Height	5.706	Inches
Initial Diameter	2.767	Inches
Moisture Content:	22.9%	%
Dry Density:	97.5	lbs/cu ft
Specific Gravity (Assumed)	2.670	
Volume of Solids:	0.585	
Volume of Voids	0.415	
Void Ratio:	0.709	
Confining Pressure:	6.1	PSI
Pocket Penetr. Reading:	4.5	
Torvane (T)		
Rate of Strain: (%/ min)	1.0%	
Peak Strain:	**2.1**	%
Max Stress:	**2.32**	**TSF**
Date:	3/11/2008	

1/2 Stress (KSF) 2.321

Strain at 1/2 Stress (%) 0.99

Type of Specimen: Native

Remarks:

Secant Modulus (KSF) @ 1/2 Peak Stress 234

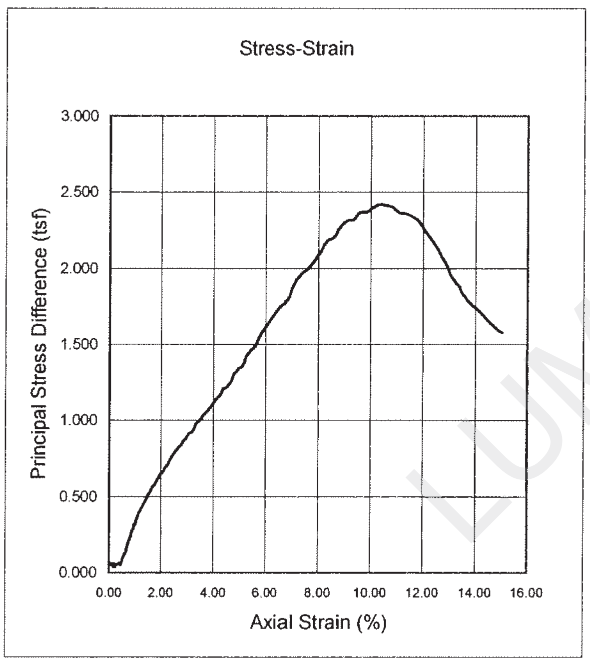
RQD Value: 100%

Angle of Fracture in Degrees: 65

Sketch of Fracture:

ASTM D 2850 Confined Compressive Strength of Cohesive Soil

Project: TXU PDP: Martin Lake, TX



Project No.:	G 2810-08	
Boring No.:	B-4	
Depth, ft.:	13'-15'	
Material:	Red & Gray Laminated Lean Clay	
Initial Height	3.613	Inches
Initial Diameter	2.667	Inches
Moisture Content:	22.3%	%
Dry Density:	99.4	lbs/cu ft
Specific Gravity (Assumed)	2.670	
Volume of Solids:	0.596	
Volume of Voids	0.404	
Void Ratio:	0.677	
Confining Pressure:	13	PSI
Pocket Penetr. Reading:	3.5	
Torvane (T)		
Rate of Strain: (%/ min)	1.0%	
Peak Strain:	**10.3**	%
Max Stress:	**2.42**	**TSF**
Date:	5/12/2008	

1/2 Stress (KSF) 2.416

Secant Modulus (KSF) @ 1/2 Peak Stress 61

Strain at 1/2 Stress (%) 3.94

RQD Value: 100%

Type of Specimen: Native

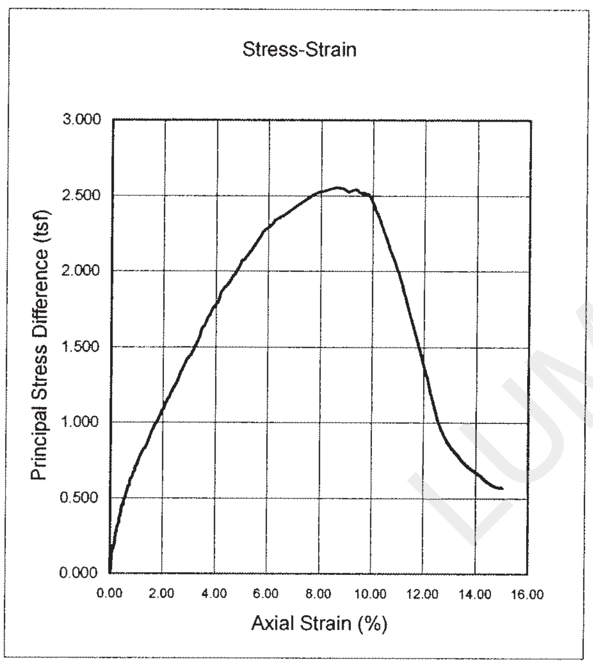
Angle of Fracture in Degrees: N/A

Remarks: undefined fracture

Sketch of Fracture:

ASTM D 2850 Confined Compressive Strength of Cohesive Soil

Project: Luminant Martin Lake: PDP 1-3



Project No.:	G 2810-08	
Boring No.:	B-4	
Depth, ft.:	13'-15'	
Material:	Light Gray & Red Slity Clayey Sand w/ Ferric seams	
Initial Height	5.688	Inches
Initial Diameter	2.75	Inches
Moisture Content:	21.5%	%
Dry Density:	104.6	lbs/cu ft
Specific Gravity (Assumed)	2.670	
Volume of Solids:	0.628	
Volume of Voids	0.372	
Void Ratio:	0.593	
Confining Pressure:	13	PSI
Pocket Penetr. Reading:	3.9	
Torvane (T)	1.138	
Rate of Strain: (%/ min)	1.0%	
Peak Strain:	**8.6**	%
Max Stress:	**2.55**	**TSF**
Date:	4/11/2008	

1/2 Stress (KSF) 2.552

Strain at 1/2 Stress (%) 2.54

Type of Specimen: Native

Remarks:

Secant Modulus (KSF) @ 1/2 Peak Stress 100

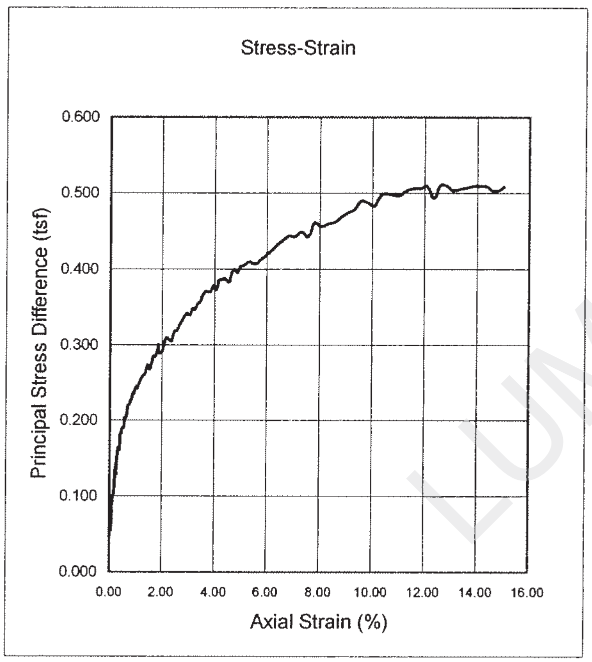
RQD Value: 100%

Angle of Break in Degrees: 60

Sketch of Fracture:

ASTM D 2850 Confined Compressive Strength of Cohesive Soil

Project: Luminant Martin Lake: PDP 1-3



Project No.:	G 2810-08	
Boring No.:	B-7	
Depth, ft.:	23'-25'	
Material:	Black, Red, Tan, & Gray Clay w/ gravel	
Initial Height	5.686	Inches
Initial Diameter	2.717	Inches
Moisture Content:	21.0%	%
Dry Density:	103.9	lbs/cu ft
Specific Gravity (Assumed)	2.670	
Volume of Solids:	0.624	
Volume of Voids	0.376	
Void Ratio:	0.603	
Confining Pressure:	21.7	PSI
Pocket Penetr. Reading:		
Torvane (T)		
Rate of Strain: (%/ min)	1.0%	
Peak Strain:	**12.8**	%
Max Stress:	**0.51**	**TSF**
Date:	3/11/2008	

1/2 Stress (KSF) 0.510

Secant Modulus (KSF) @ 1/2 Peak Stress 43

Strain at 1/2 Stress (%) 1.20

RQD Value: 100%

Type of Specimen: Native

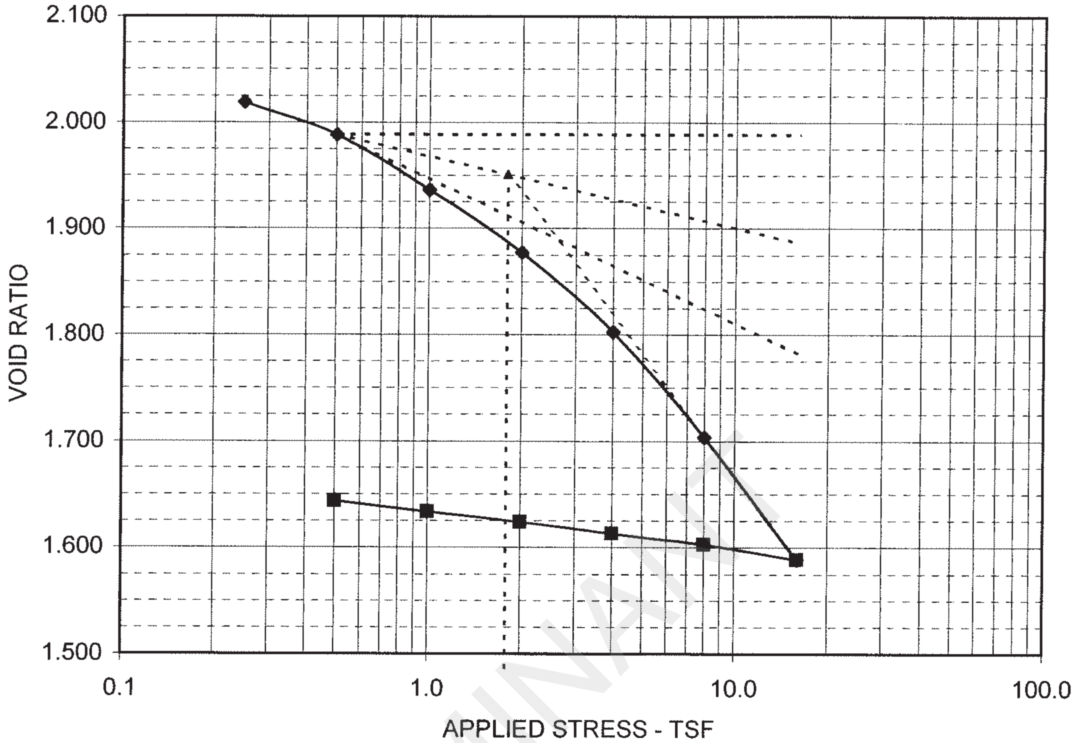
Angle of Break in Degrees: 53

Remarks: Not able to find a well defined fracture

Sketch of Fracture:

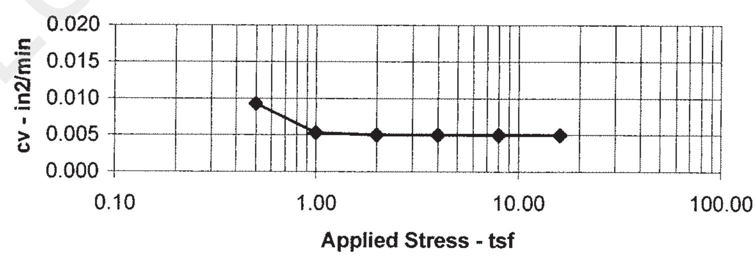
CONSOLIDATION TEST REPORT

ASTM D 2435



C_c = 0.381	C_r = 0.033	e_0 = 2.0191	Pc (tsf) = 1.79	OCR = 10.2

LOAD tsf	c_v in^2/min	k in/min
Seating	NA	NA
0.50	9.34E-03	9.85E-07
1.00	5.36E-03	4.89E-07
2.00	5.03E-03	2.65E-07
4.00	5.04E-03	1.73E-07
8.00	5.03E-03	1.18E-07
16.00	5.03E-03	7.08E-08



c_v values calculated by Sivaram and Swamee's Method

SAMPLE AND TEST DATA

SAMPLE LOCATION: B-6, 3-5'
DESCRIPTION: Ash, black and dark gray

LL: NA PL: NA PI: NA -200:NA
ASSUMED SPECIFIC GRAVITY: 2.70
MC Initial: 58.1% MC Final: 47.2%
Dia. (in.) : 2.50 Height (in.) : 1.000
Initial Sat %: 70.2 Final Sat %: 100.0
DRY DENSITY (pcf): 55.8

PROJECT INFORMATION

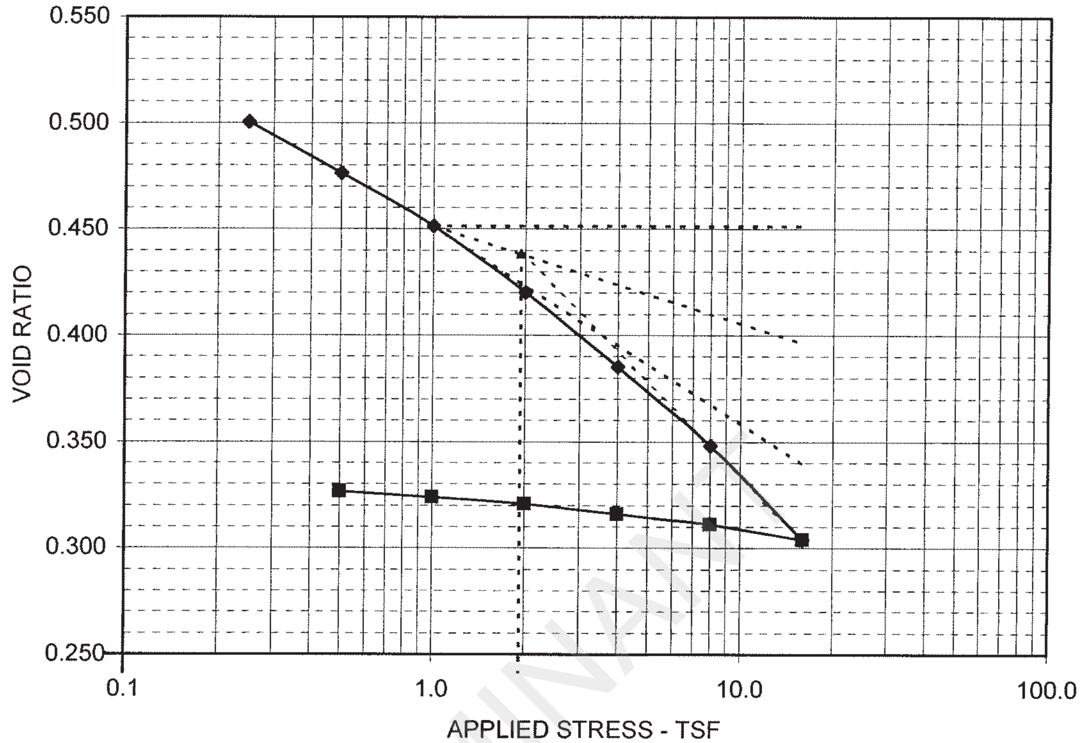
PROJECT:	Luminant Martin Lake PDP 1-3
LOCATION:	Rusk, TX.
PROJECT NO.:	ETT08002-07
CLIENT:	ETTL Engineers & Consultants, Inc.
CLIENT NO.:	G2810-08
DATE:	4/24/2008

REMARKS: OCR calculated based on Pc and vertical overburden

GREGORY GEOTECHNICAL PLATE B-CN.1

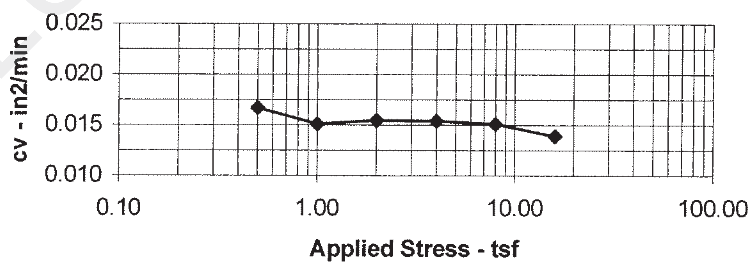
CONSOLIDATION TEST REPORT

ASTM D 2435



C_c = 0.146	C_r = 0.012	e_0 = 0.5597	Pc (tsf) = 1.93	OCR = 3.5

LOAD tsf	c_v in^2/min	k in/min
Seating	NA	NA
0.50	1.67E-02	2.82E-06
1.00	1.51E-02	1.33E-06
2.00	1.55E-02	8.75E-07
4.00	1.54E-02	5.00E-07
8.00	1.51E-02	2.67E-07
16.00	1.39E-02	1.50E-07

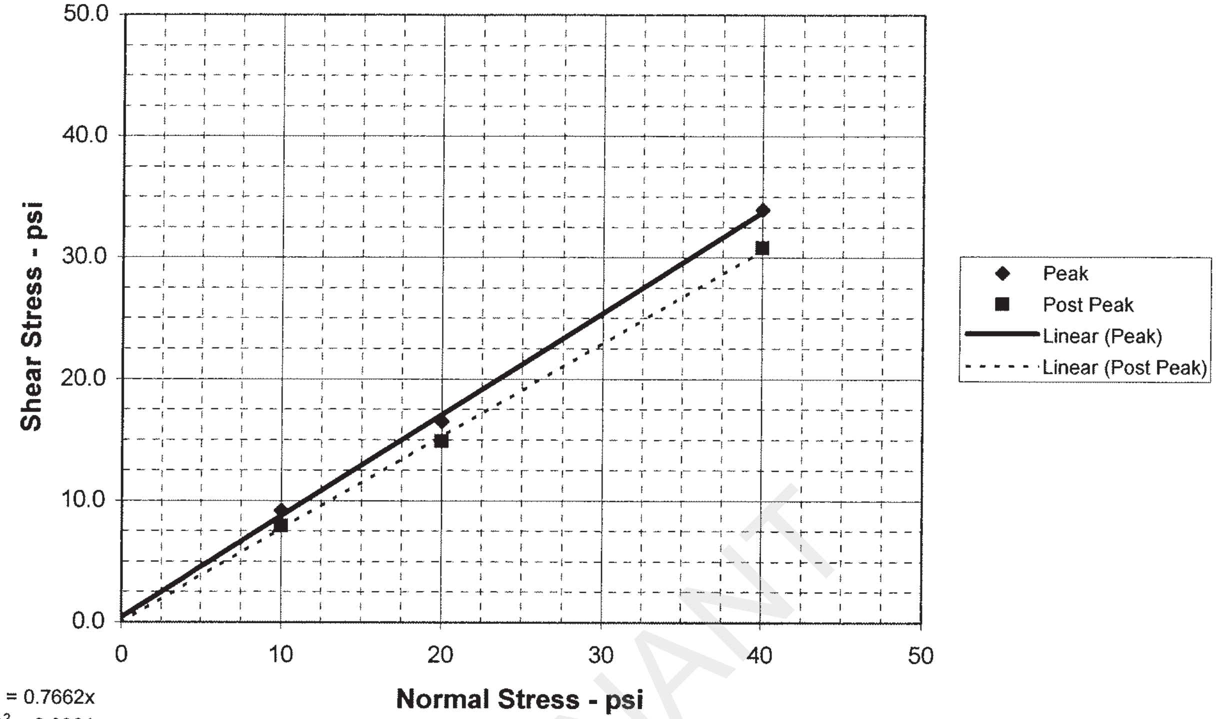


c_v values calculated by Sivaram and Swamee's Method

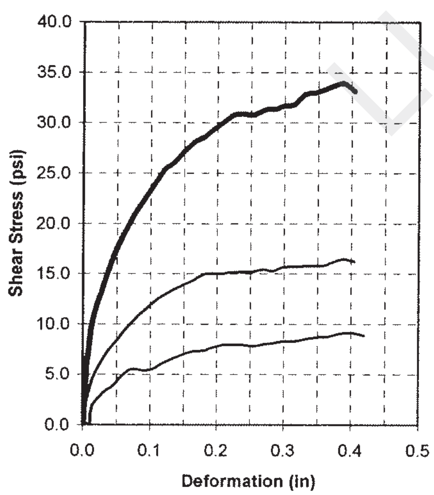
SAMPLE AND TEST DATA			
SAMPLE LOCATION: B-4, 8-10'			
DESCRIPTION: Clayey Sand , reddish brown with gray			
LL: NA	PL: NA	PI: NA	-200: NA
ASSUMED SPECIFIC GRAVITY:			2.70
MC Initial:	13.0%	MC Final:	19.6%
Dia. (in.) :	2.50	Height (in.) :	1.000
Initial Sat %:	70.2	Final Sat %:	100.0
DRY DENSITY (pcf):		108.0	

PROJECT INFORMATION	
PROJECT:	Luminant Martin Lake PDP 1-3
LOCATION:	Rusk, TX.
PROJECT NO.:	ETT08002-07
CLIENT:	ETTL Engineers & Consultants, Inc.
CLIENT NO.:	G2810-08
DATE:	4/24/2008
REMARKS: OCR calculated based on Pc and vertical overburden	
GREGORY GEOTECHNICAL	PLATE B-CN.2

DIRECT SHEAR TEST REPORT



PEAK STRENGTH PARAMETERS	ϕ =	39.8 deg	c =	0.5 psi
POST PEAK STRENGTH PARAMETERS	ϕ =	37.5 deg	c =	0.0 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	52.1	29.3	21.2	
Dry Density - pcf	50.2	71.7	95.2	
Diameter - inches	2.50	2.50	2.50	
Height - inches	1.13	1.13	1.13	
AT TEST				
Final Moisture - %	64.3	25.0	31.6	
Dry Density - pcf	55.8	79.1	117.3	
Height-End of Consol. (in.)	1.02	1.03	0.92	
Height-End of Shear (in.)	0.97	0.99	0.89	
Normal Stress - psi	10.0	20.0	40.0	
Peak Failure Stress-psi	9.2	16.5	34.0	
Post Peak Failure Stress-psi	7.9	14.9	30.8	
Strain Rate - inches/min.	0.00300	0.00300	0.00300	
Peak Failure Strain - %	16.2	15.6	15.6	
Post Peak Failure Strain %	8.4	7.2	9.6	

Dry Density at test based on initial moisture and height at end of consolidation.

TEST DESCRIPTION

TYPE OF TEST & NO: CD-DS-1
SAMPLE TYPE: Shelby Tube
DESCRIPTION: Ash, black and gray
SAMPLE LOCATION: B-6, 3-5 ft
ASSUMED SPECIFIC GRAVITY: 2.65
LL: 35 PL: 19 PI: 16 Percent -200: 61
REMARKS: Multi-Specimen

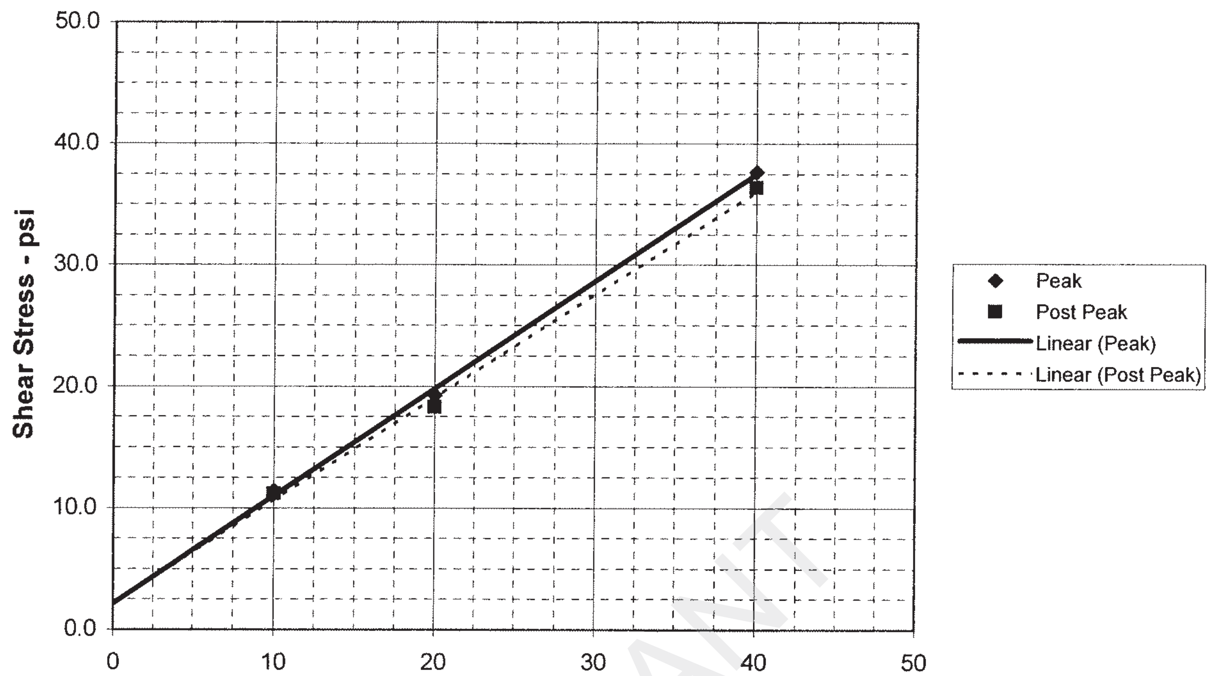
PROJECT INFORMATION

PROJECT: Luminant Martin Lake PDP 1-3
LOCATION: Rusk , TX
PROJECT NO: ETT08002-07 (G2810-08)
CLIENT : ETTL Engineers & Consultants, Inc
DATE:4/25/08

GREGORY GEOTECHNICAL PLATE: B-DS.1

$y = 0.8829x + 2.2$
$R^2 = 0.9987$

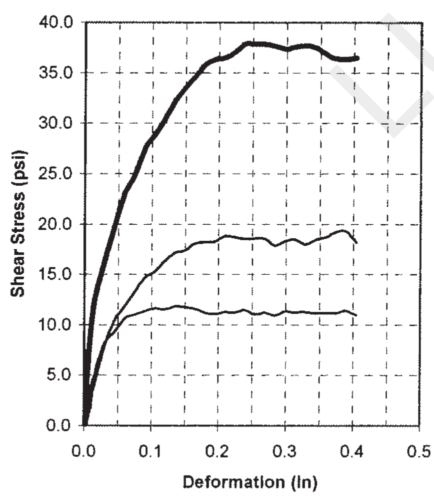
DIRECT SHEAR TEST REPORT



$y = 0.8493x + 2.15$
$R^2 = 0.9968$

Normal Stress - psi

PEAK STRENGTH PARAMETERS	ϕ =	41.4 deg	c =	2.2 psi
POST PEAK STRENGTH PARAMETERS	ϕ =	40.3 deg	c =	2.2 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	13.1	13.1	13.1	
Dry Density - pcf	71.8	71.7	71.7	
Diameter - inches	2.50	2.50	2.50	
Height - inches	1.00	1.00	1.00	
AT TEST				
Final Moisture - %	38.5	37.4	31.6	
Dry Density - pcf	73.6	73.7	75.8	
Height-End of Consol. (in.)	0.98	0.97	0.95	
Height-End of Shear (in.)	1.00	0.96	0.92	
Normal Stress - psi	10.0	20.0	40.0	
Peak Failure Stress-psi	11.4	19.3	37.7	
Post Peak Failure Stress-psi	11.2	18.3	36.4	
Strain Rate - inches/min.	0.00300	0.00300	0.00300	
Peak Failure Strain - %	15.6	15.6	13.2	
Post Peak Failure Strain %	13.8	12.0	15.0	

Dry Density at test based on initial moisture and height at end of consolidation.

TEST DESCRIPTION

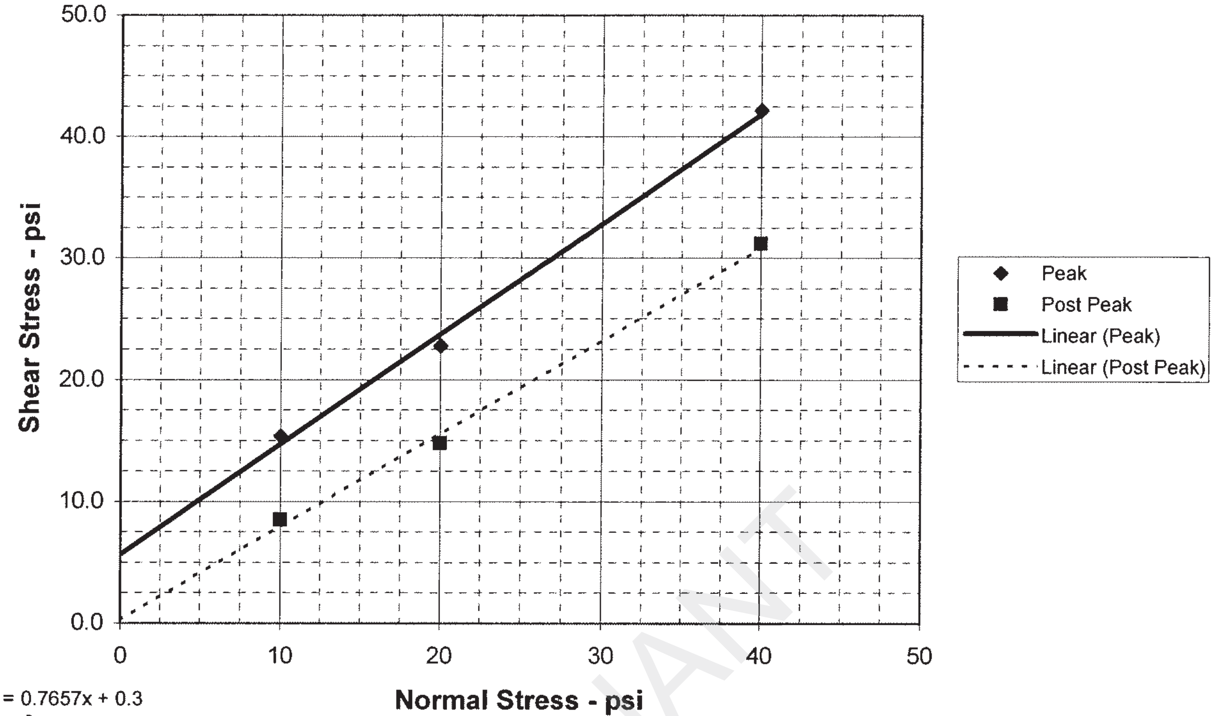
TYPE OF TEST & NO: CD-DS-2
SAMPLE TYPE: Re-Compacted
DESCRIPTION: Ash, black and dark gray
SAMPLE LOCATION: MLSES (Bulk)
SPECIFIC GRAVITY: 2.56
LL: NP PL: NP PI: NP Percent -200: 3.33
REMARKS: Multi-Specimen

PROJECT INFORMATION

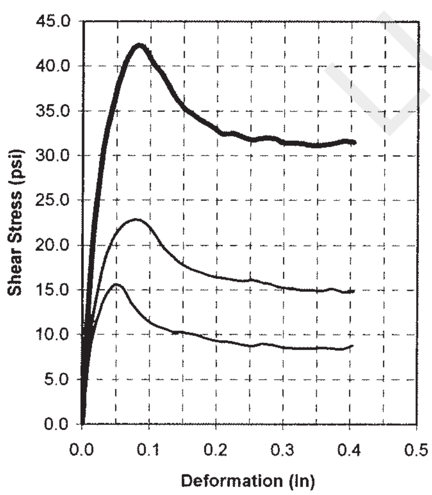
PROJECT: Luminant Martin Lake PDP 1-3
LOCATION: Rusk , TX
PROJECT NO: ETT08002-07 (G2810-08)
CLIENT : ETTL Engineers & Consultants, Inc
DATE:5/6/08

GREGORY GEOTECHNICAL PLATE: B-DS.2

DIRECT SHEAR TEST REPORT



PEAK STRENGTH PARAMETERS	ϕ =	42.1 deg	c =	5.7 psi
POST PEAK STRENGTH PARAMETERS	ϕ =	37.4 deg	c =	0.3 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	0.1	0.1	0.1	
Dry Density - pcf	71.7	71.7	71.7	
Diameter - inches	2.50	2.50	2.50	
Height - inches	1.00	1.00	1.00	
AT TEST				
Final Moisture - %	50.3	37.4	31.6	
Dry Density - pcf	73.4	73.1	73.1	
Height-End of Consol. (in.)	0.98	0.98	0.98	
Height-End of Shear (in.)	1.01	1.01	0.99	
Normal Stress - psi	10.0	20.0	40.0	
Peak Failure Stress-psi	15.4	22.8	42.2	
Post Peak Failure Stress-psi	8.5	14.8	31.2	
Strain Rate - inches/min.	0.00300	0.00300	0.00300	
Peak Failure Strain - %	17.6	3.0	3.6	
Post Peak Failure Strain %	15.0	15.6	13.8	

Dry Density at test based on initial moisture and height at end of consolidation.

TEST DESCRIPTION	PROJECT INFORMATION
TYPE OF TEST & NO: CD-DS-2	PROJECT: Luminant Martin Lake PDP 1-3
SAMPLE TYPE: Re-Compacted	LOCATION: Rusk , TX
DESCRIPTION: Economized Ash, tan and gray	PROJECT NO: ETT08002-07 (G2810-08)
SAMPLE LOCATION: MLSES (Bulk)	CLIENT : ETTL Engineers & Consultants, Inc
SPECIFIC GRAVITY: 2.67	DATE:5/20/08
LL: NP PL: NP PI: NP Percent -200: 8.64	***GREGORY GEOTECHNICAL*** PLATE: B-DS.3
REMARKS: Multi-Specimen	

PROJECT INFORMATION

PROJECT: Martin Lake PDP 1 - 3 Supplemental
LOCATION:
PROJECT NO: G 3219 - 09
CLIENT: HDR
September 2009

TRIAXIAL TEST PROGRAM BY GARRY H. GREGORY, P.E.

VERSION 1.0 - AUGUST 1998 - REVISED MARCH 24, 1999

THIS COPY LICENSED TO:
ETTL ENGINEERS AND CONSULTANTS, INC.
1717 East Erwin
Tyler, TX 75702

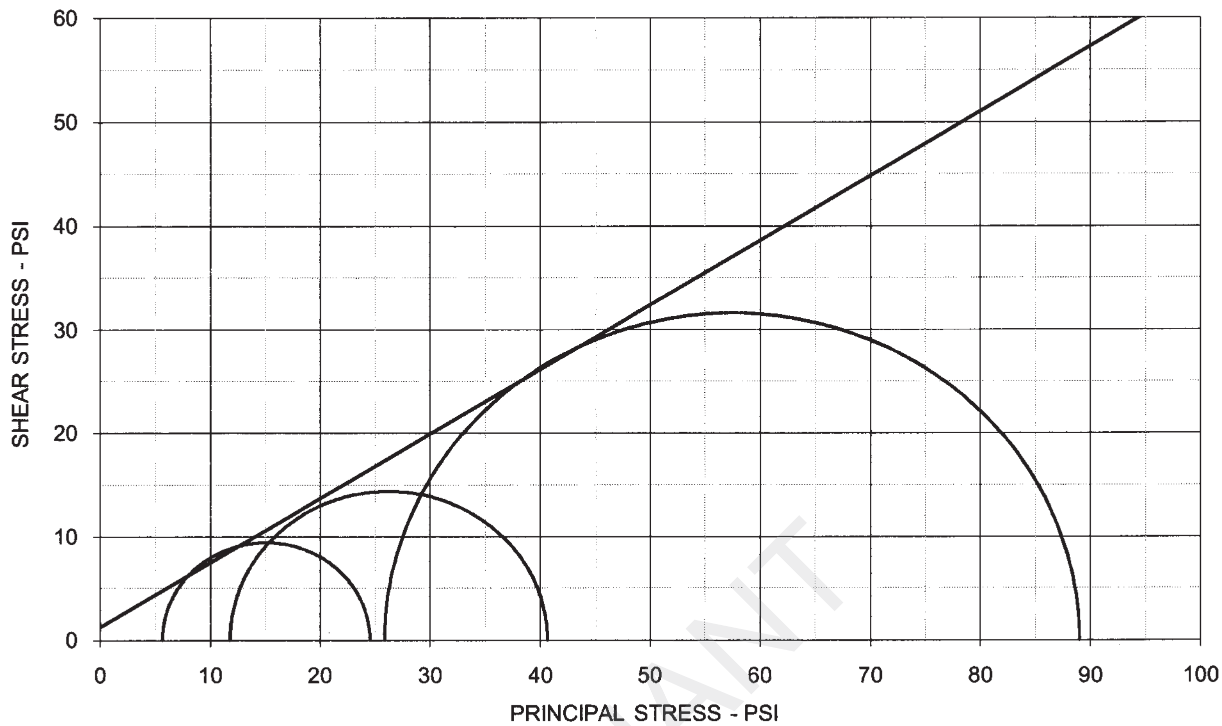
TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Shelby Tube Sample
DESCRIPTION: Tan w/ Red & Gray Clayey Sand
Sampled on Site, B-16 8' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

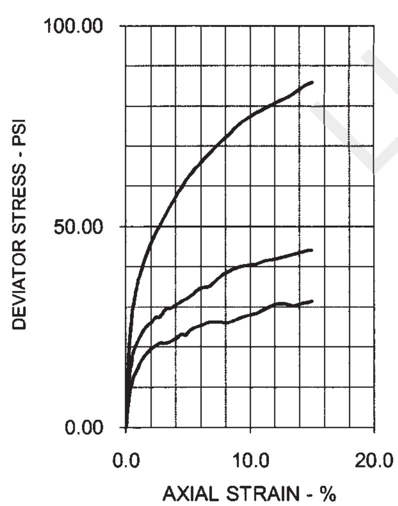
PLATE: B.1
PLATE: B.2
PLATE: B.3

Number of Specimens = 3

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	φ ' =	31.9 deg	c' =	1.3 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	17.2	16.8	16.3	
Dry Density - pcf	112.6	114.4	115.0	
Diameter - inches	2.47	2.46	2.48	
Height - inches	4.98	4.97	5.00	
AT TEST				
Final Moisture - %	18.4	16.5	16.0	
Dry Density - pcf	113.1	115.3	116.9	
Calculated Diameter (in.)	2.47	2.46	2.50	
Height - inches	5.00	4.97	5.06	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	18.88	28.83	63.14	
Total Pore Pressure - psi	54.3	58.2	64.1	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.8	3.0	5.2	
σ_1' Failure - psi	24.54	40.64	89.01	
σ_3' Failure - psi	5.66	11.81	25.87	

TEST DESCRIPTION

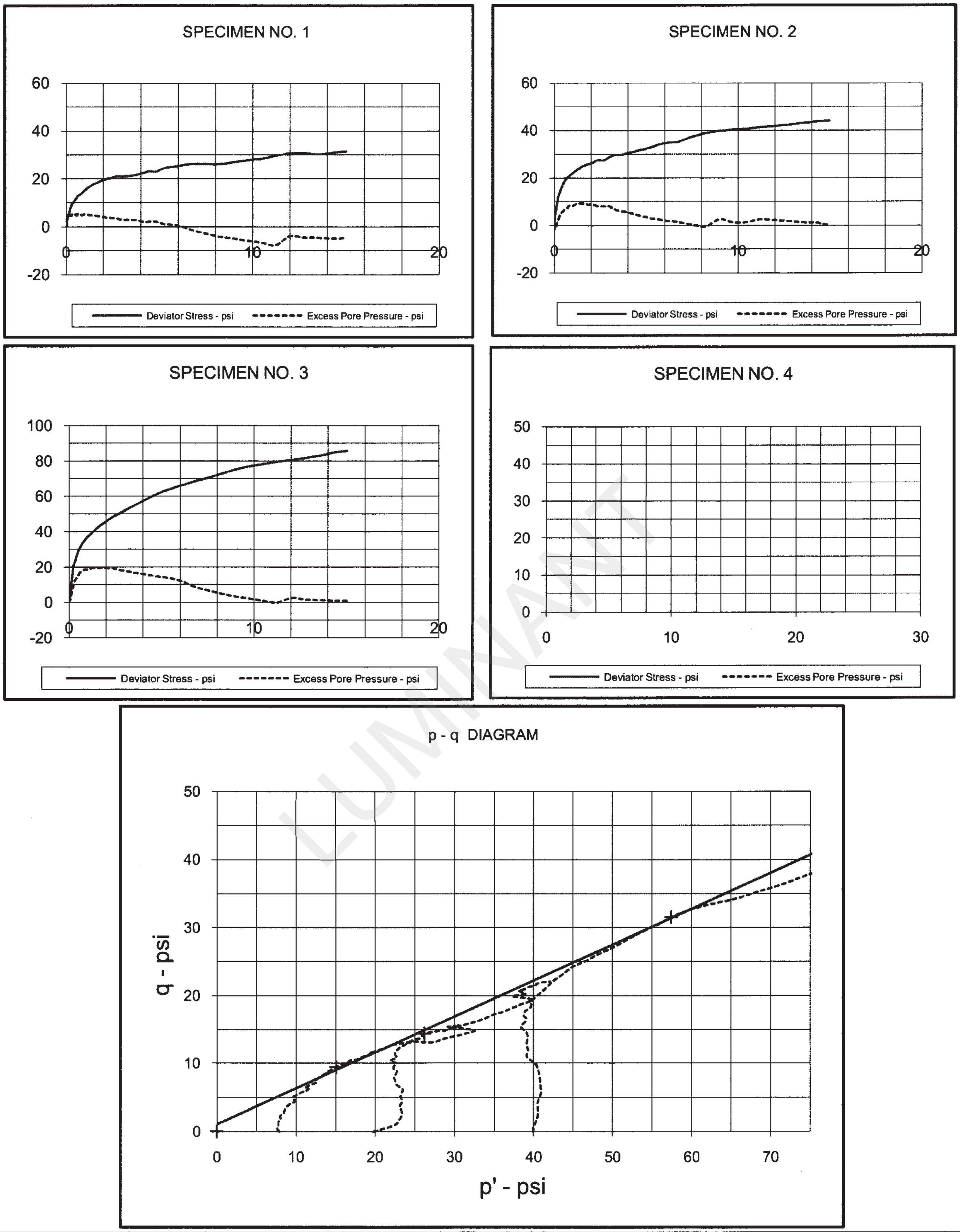
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Shelby Tube Sample
DESCRIPTION: Tan w/ Red & Gray Clayey Sand
Sampled on Site, B-16 8' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

PROJECT INFORMATION

PROJECT: Martin Lake PDP 1 - 3 Supplemental
LOCATION:
PROJECT NO: G 3219 - 09
CLIENT: HDR
September 2009

ETTL ENGINEERS & CONSULTANTS PLATE: B.1

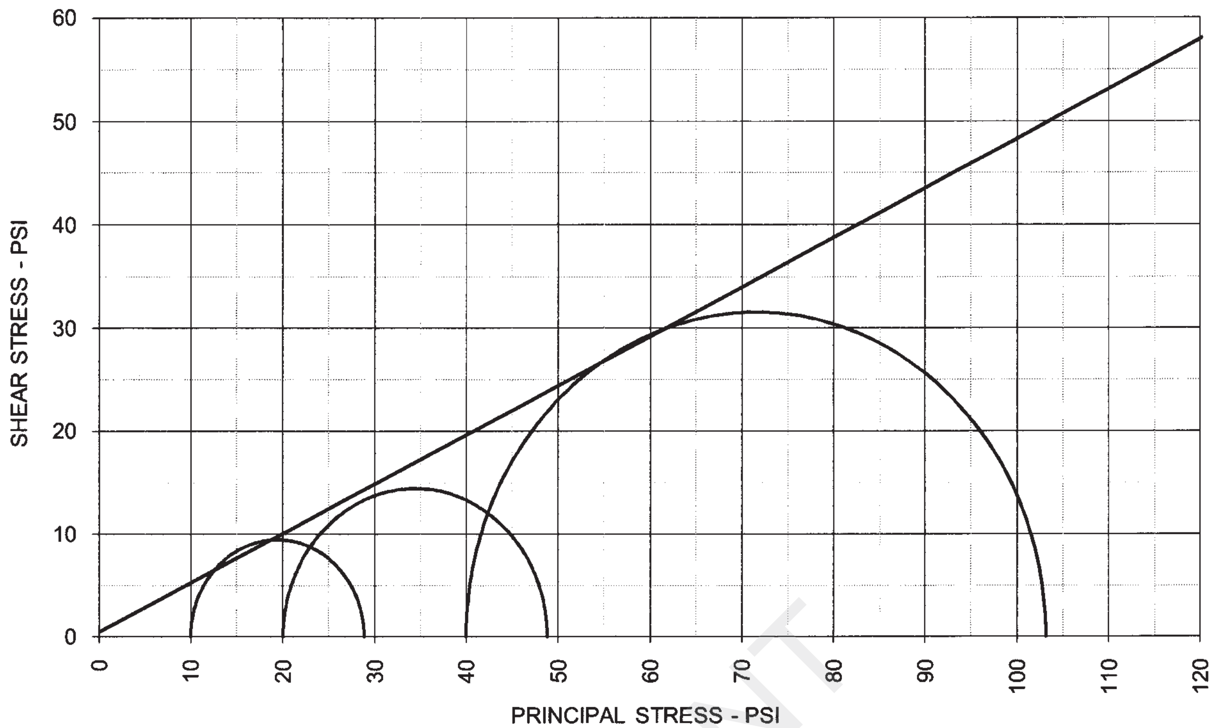
G 3219-09, B-16 8'-10' Native



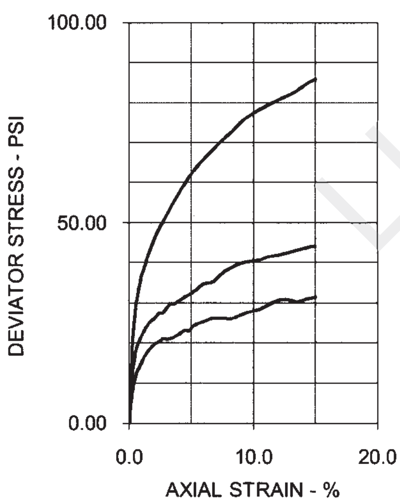
EFFECTIVE STRESS PARAMETERS	R^2 = 1.00	α (deg) = 27.9	a (psi) = 1.1
PROJECT: Martin Lake PDP 1 - 3 Supplemental		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3219 - 09		ETTL ENGINEERS & CONSULTANTS	PLATE: B.2
DESCRIPTION: Tan w/ Red & Gray Clayey Sand			

G 3219-09, B-16 8'-10' Native

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	ϕ = 25.6 deg	c = 0.5 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	17.2	16.8	16.3	
Dry Density - pcf	112.6	114.4	115.0	
Diameter - inches	2.47	2.46	2.48	
Height - inches	4.98	4.97	5.00	
AT TEST				
Final Moisture - %	18.4	16.5	16.0	
Dry Density - pcf	113.1	115.3	116.9	
Calculated Diameter (in.)	2.47	2.46	2.50	
Height - inches	5.00	4.97	5.06	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	18.88	28.83	63.14	
Total Pore Pressure - psi	54.3	58.2	64.1	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.8	3.0	5.2	
σ_1 Failure - psi	28.88	48.83	103.14	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Shelby Tube Sample
DESCRIPTION: Tan w/ Red & Gray Clayey Sand
Sampled on Site, B-16 8' to 10' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

PROJECT INFORMATION

PROJECT: Martin Lake PDP 1 - 3 Supplemental
LOCATION:
PROJECT NO: G 3219 - 09
CLIENT: HDR
September 2009

ETTL ENGINEERS & CONSULTANTS PLATE: B.3

PROJECT INFORMATION

PROJECT: Martin Lake PDP 1 - 3 Supplemental
LOCATION:
PROJECT NO: G 3219 - 09
CLIENT: HDR
September 2009

TRIAXIAL TEST PROGRAM BY GARRY H. GREGORY, P.E.

VERSION 1.0 - AUGUST 1998 - REVISED MARCH 24, 1999

THIS COPY LICENSED TO:
ETTL ENGINEERS AND CONSULTANTS, INC.
1717 East Erwin
Tyler, TX 75702

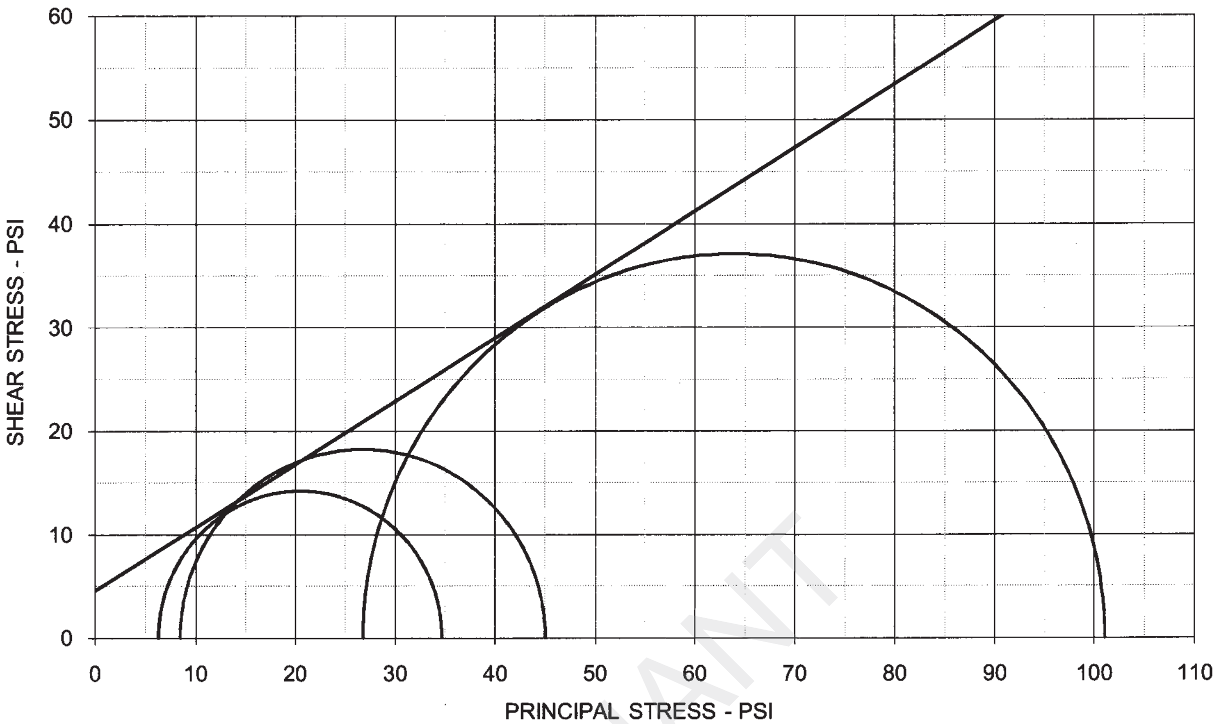
TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Shelby Tube Sample
DESCRIPTION: Tan & Red Sandy Lean Clay
Sampled on Site, B-17 3' to 7' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

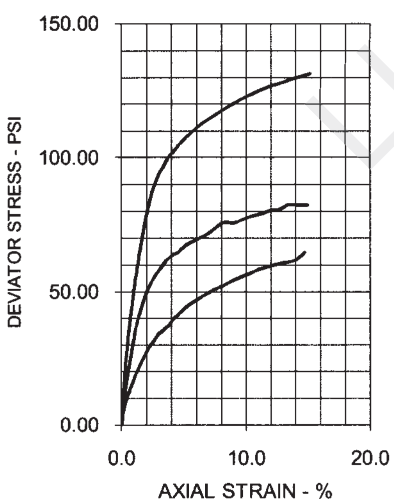
Number of Specimens = 3

PLATE: B.1
PLATE: B.2
PLATE: B.3

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	ϕ ' = 31.4 deg	c' = 4.6 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	16.2	13.3	13.9	
Dry Density - pcf	113.5	121.6	115.5	
Diameter - inches	2.49	2.49	2.50	
Height - inches	5.08	5.00	5.16	
AT TEST				
Final Moisture - %	18.1	14.7	16.3	
Dry Density - pcf	114.1	123.3	117.2	
Calculated Diameter (in.)	2.50	2.50	2.52	
Height - inches	5.10	5.04	5.22	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	28.40	36.54	74.24	
Total Pore Pressure - psi	53.7	61.5	63.2	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	0.8	3.5	1.8	
σ_1' Failure - psi	34.71	45.04	101.03	
σ_3' Failure - psi	6.31	8.50	26.79	

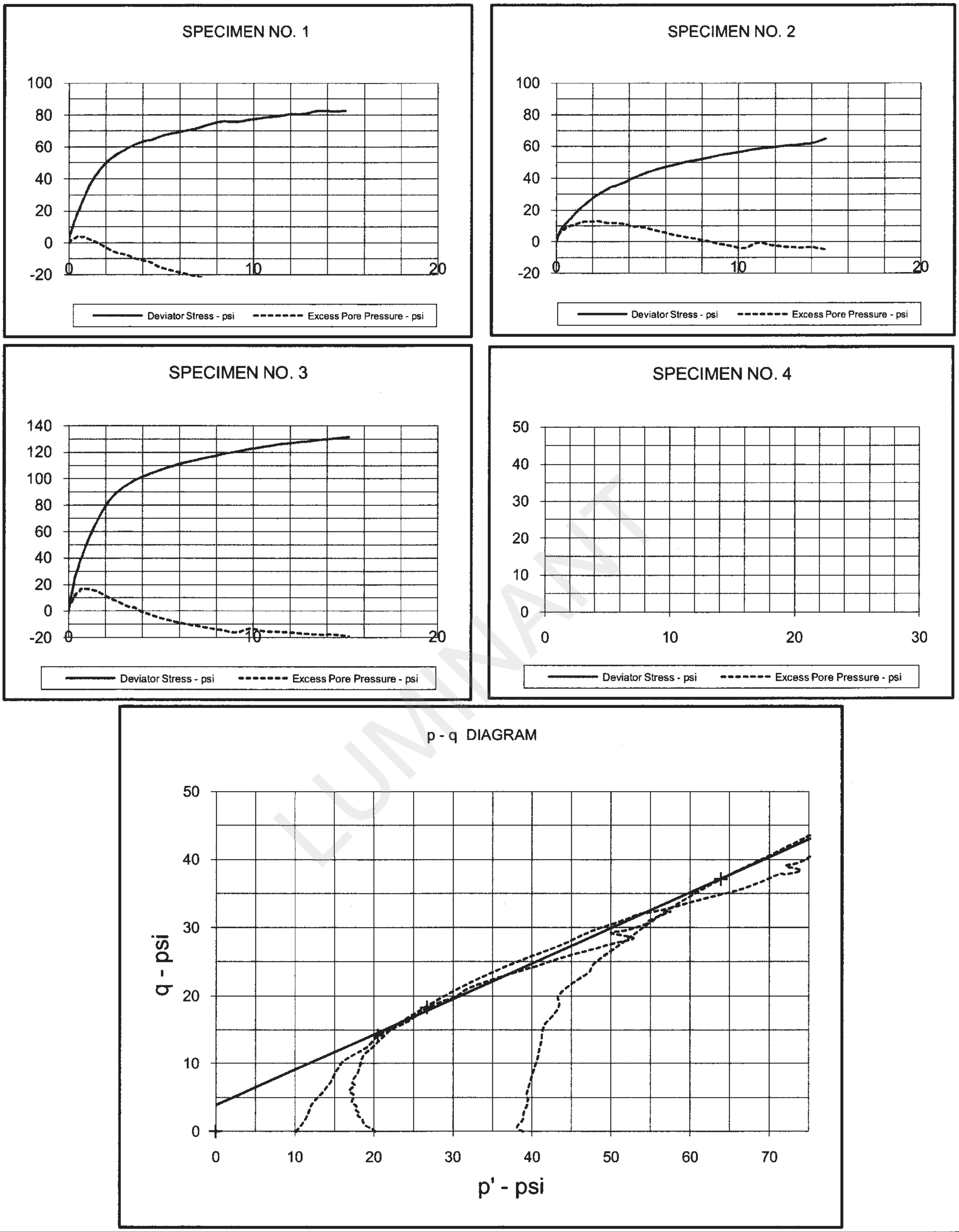
TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Shelby Tube Sample
DESCRIPTION: Tan & Red Sandy Lean Clay
Sampled on Site, B-17 3' to 7' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve
G 3219-09, B-17 3'-7' Native

PROJECT INFORMATION

PROJECT: Martin Lake PDP 1 - 3 Supplemental
LOCATION:
PROJECT NO: G 3219 - 09
CLIENT: HDR
September 2009

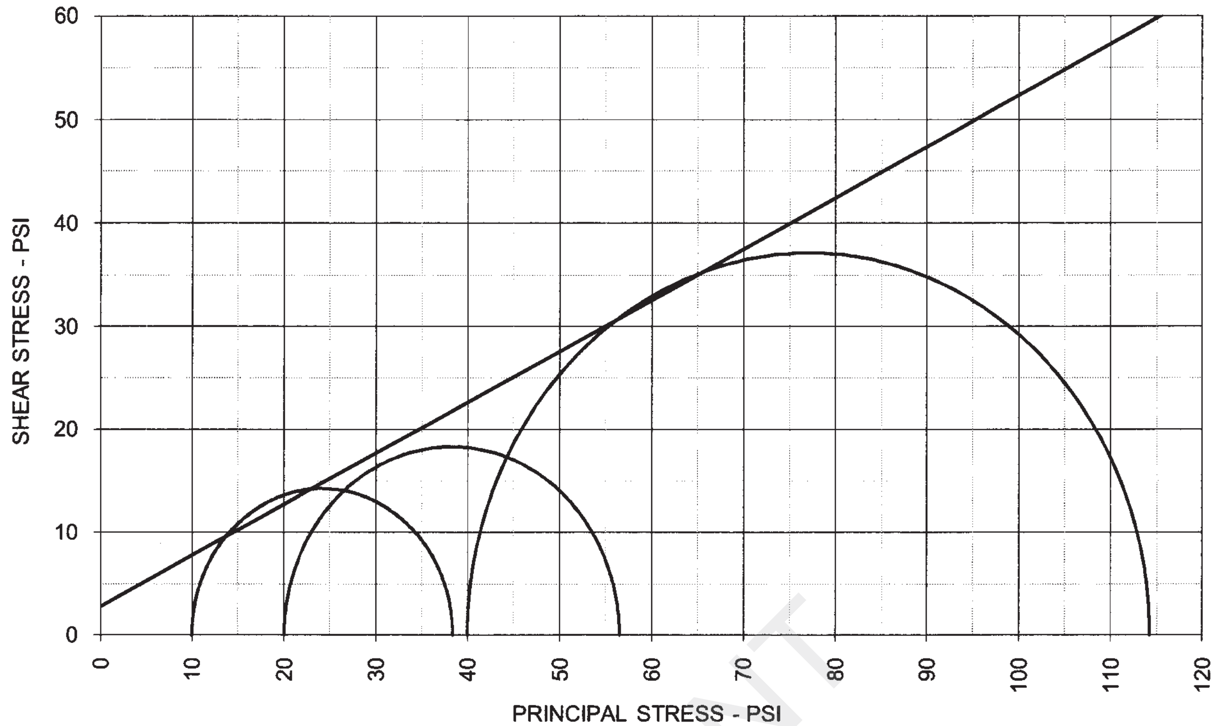
ETTL ENGINEERS & CONSULTANTS PLATE: B.1



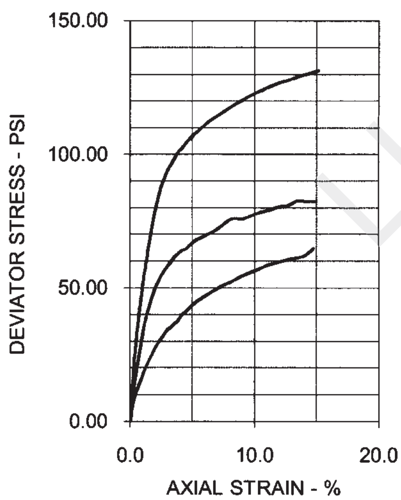
EFFECTIVE STRESS PARAMETERS	R^2 = 1.00	α (deg) = 27.5	a (psi) = 3.9
PROJECT: Martin Lake PDP 1 - 3 Supplemental		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3219 - 09		ETTL ENGINEERS & CONSULTANTS	PLATE: B.2
DESCRIPTION: Tan & Red Sandy Lean Clay			

G 3219-09, B-17 3'-7' Native

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	ϕ = 26.4 deg	c = 2.8 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	16.2	13.3	13.9	
Dry Density - pcf	113.5	121.6	115.5	
Diameter - inches	2.49	2.49	2.50	
Height - inches	5.08	5.00	5.16	
AT TEST				
Final Moisture - %	18.1	14.7	16.3	
Dry Density - pcf	114.1	123.3	117.2	
Calculated Diameter (in.)	2.50	2.50	2.52	
Height - inches	5.10	5.04	5.22	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	28.40	36.54	74.24	
Total Pore Pressure - psi	53.7	61.5	63.2	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	0.8	3.5	1.8	
σ_1 Failure - psi	38.40	56.54	114.24	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Shelby Tube Sample
DESCRIPTION: Tan & Red Sandy Lean Clay
Sampled on Site, B-17 3' to 7' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve
LL: PL: PI: Percent -200:
REMARKS: Diameter and Both Ends Trimmed + # 4 Sieve

PROJECT INFORMATION

PROJECT: Martin Lake PDP 1 - 3 Supplemental
LOCATION:
PROJECT NO: G 3219 - 09
CLIENT: HDR
September 2009

ETTL ENGINEERS & CONSULTANTS PLATE: B.3

PROJECT INFORMATION

PROJECT: Martin Lake PDP 1 - 3 Supplemental
LOCATION:
PROJECT NO: G 3219 - 09
CLIENT: HDR
September 2009

TRIAXIAL TEST PROGRAM BY GARRY H. GREGORY, P.E.

VERSION 1.0 - AUGUST 1998 - REVISED MARCH 24, 1999

THIS COPY LICENSED TO:
ETTL ENGINEERS AND CONSULTANTS, INC.
1717 East Erwin
Tyler, TX 75702

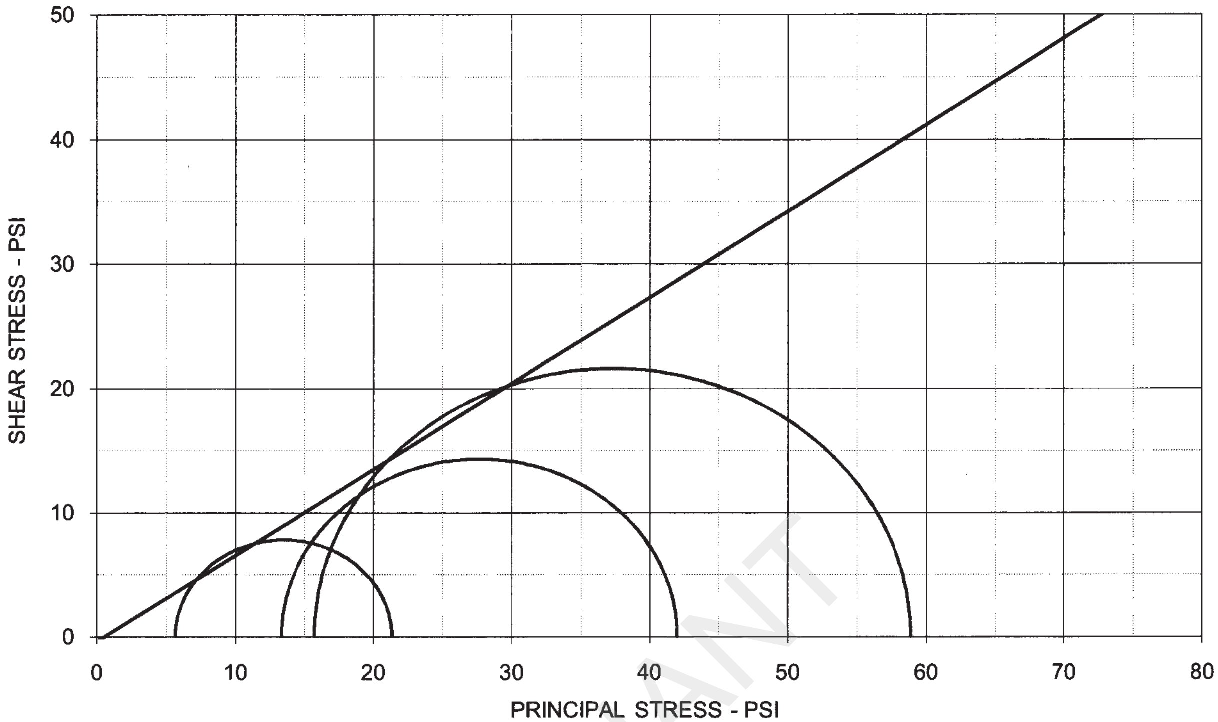
TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Lab Molded
DESCRIPTION: Tan & Reddish Tan Silty Sand
Sampled on Site, TP- 31 0' to 5' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 2%
LL: 20 PL: 17 PI: 3 Percent -200: 27%
REMARKS: Both Ends Trimmed + # 4 Sieve 1%

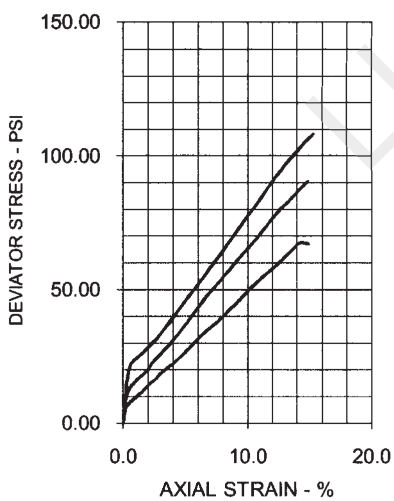
PLATE: B.1
PLATE: B.2
PLATE: B.3

Number of Specimens = 3

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	φ ' = 34.7 deg	c' = -0.4 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	17.3	17.2	17.4	
Dry Density - pcf	110.3	110.5	110.4	
Diameter - inches	2.87	2.87	2.85	
Height - inches	5.57	5.59	5.61	
AT TEST				
Final Moisture - %	17.2	16.7	16.5	
Dry Density - pcf	110.6	111.6	112.0	
Calculated Diameter (in.)	2.87	2.88	2.87	
Height - inches	5.58	5.62	5.66	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.65	28.63	43.17	
Total Pore Pressure - psi	54.3	56.7	74.3	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.4	3.5	4.6	
σ_1' Failure - psi	21.35	41.97	58.90	
σ_3' Failure - psi	5.70	13.34	15.73	

TEST DESCRIPTION

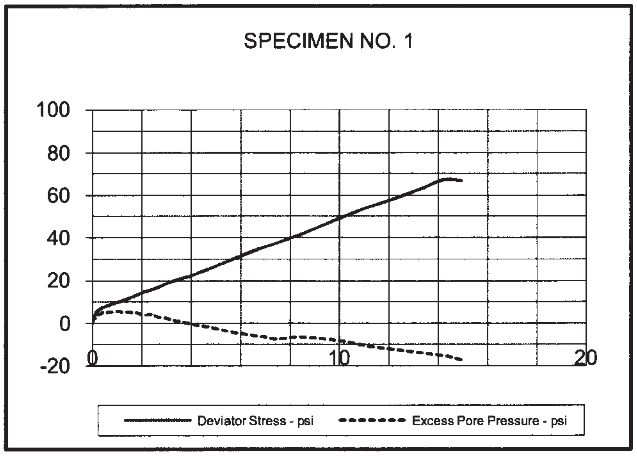
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Lab Molded
DESCRIPTION: Tan & Reddish Tan Silty Sand
Sampled on Site, TP- 31 0' to 5' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 2%
LL: 20 PL: 17 PI: 3 Percent -200: 27%
REMARKS: Both Ends Trimmed + # 4 Sieve 1%

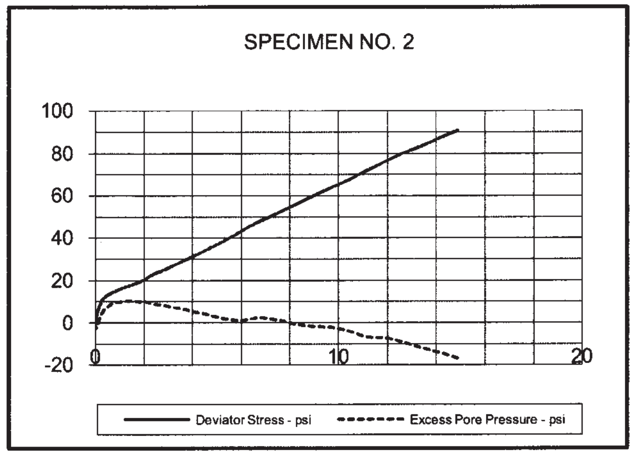
G 3219-09, TP-31 0'-5' Lab Molded

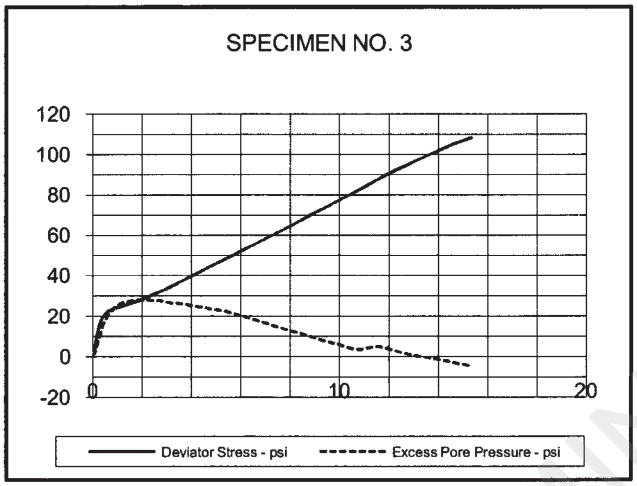
PROJECT INFORMATION

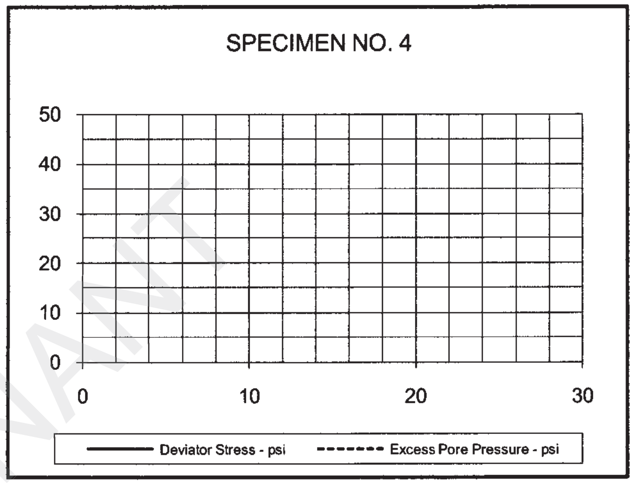
PROJECT: Martin Lake PDP 1 - 3 Supplemental
LOCATION:
PROJECT NO: G 3219 - 09
CLIENT: HDR
September 2009

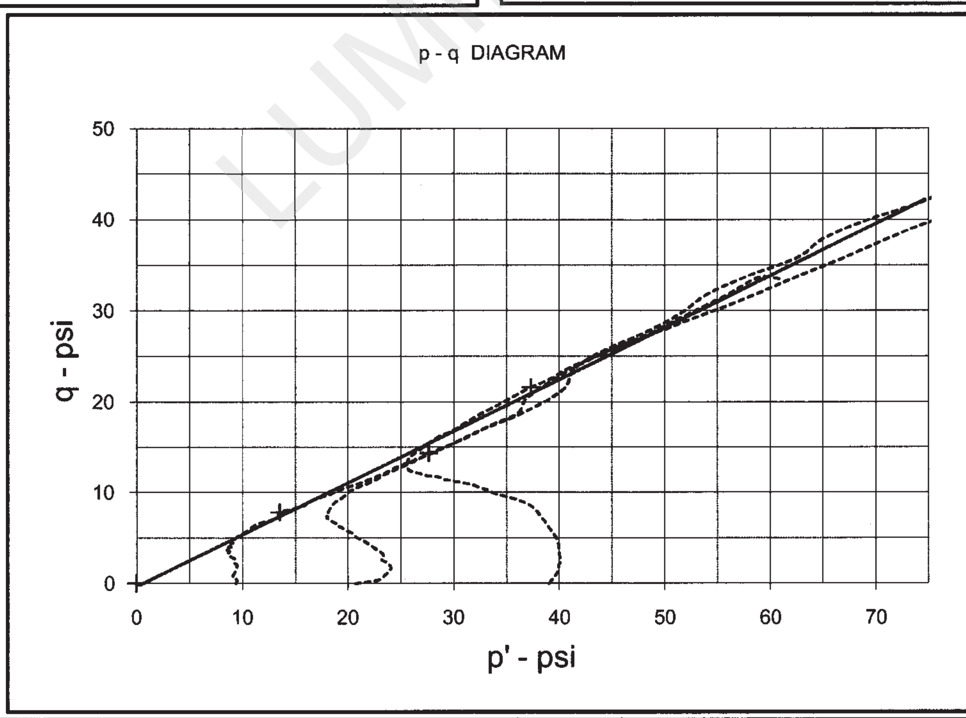
ETTL ENGINEERS & CONSULTANTS PLATE: B.1







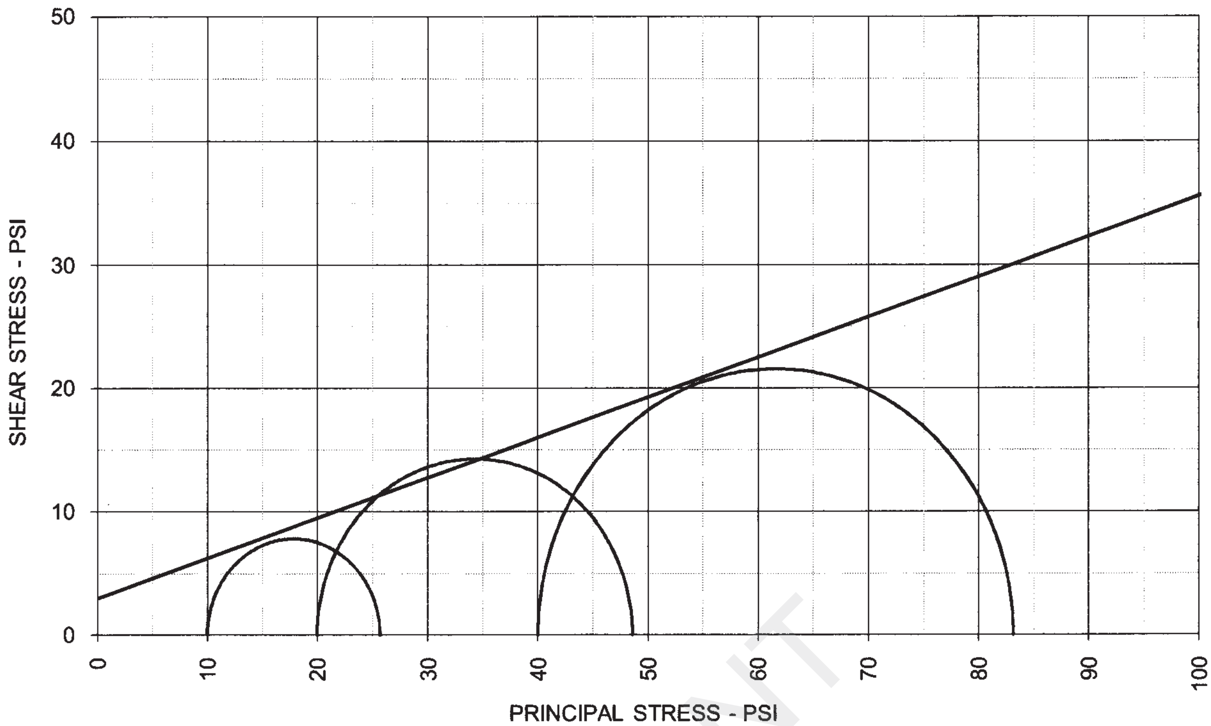




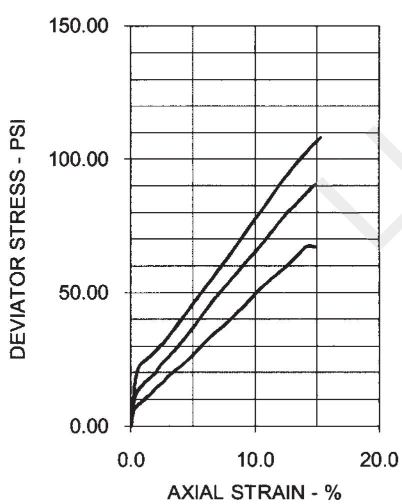
EFFECTIVE STRESS PARAMETERS	R^2 = 0.98	α (deg) = 29.7	a (psi) = -0.3
PROJECT: Martin Lake PDP 1 - 3 Supplemental		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3219 - 09		ETTL ENGINEERS & CONSULTANTS	PLATE: B.2
DESCRIPTION: Tan & Reddish Tan Silty Sand			

G 3219-09, TP-31 0'-5' Lab Molded

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	ϕ = 18.0 deg	c = 3.0 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	17.3	17.2	17.4	
Dry Density - pcf	110.3	110.5	110.4	
Diameter - inches	2.87	2.87	2.85	
Height - inches	5.57	5.59	5.61	
AT TEST				
Final Moisture - %	17.2	16.7	16.5	
Dry Density - pcf	110.6	111.6	112.0	
Calculated Diameter (in.)	2.87	2.88	2.87	
Height - inches	5.58	5.62	5.66	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.65	28.63	43.17	
Total Pore Pressure - psi	54.3	56.7	74.3	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.4	3.5	4.6	
σ_1 Failure - psi	25.65	48.63	83.17	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

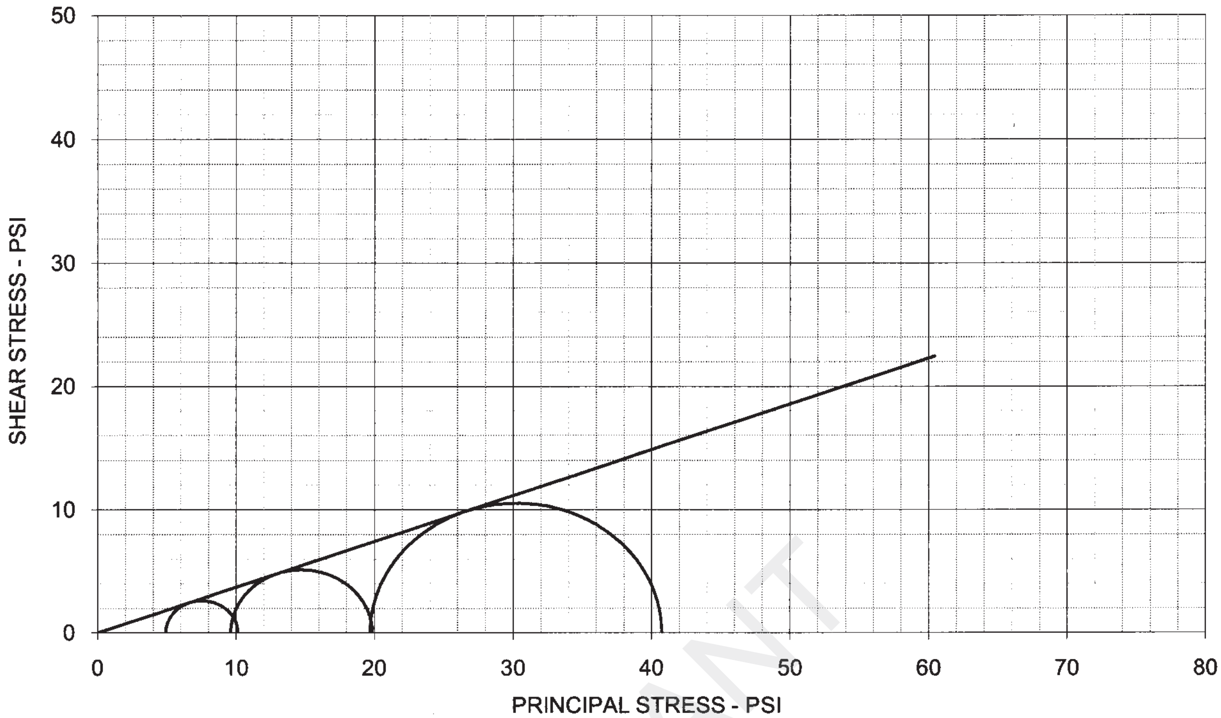
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Lab Molded
DESCRIPTION: Tan & Reddish Tan Silty Sand
Sampled on Site, TP- 31 0' to 5' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 2%
LL: 20 PL: 17 PI: 3 Percent -200: 27%
REMARKS: Both Ends Trimmed + # 4 Sieve 1%

PROJECT INFORMATION

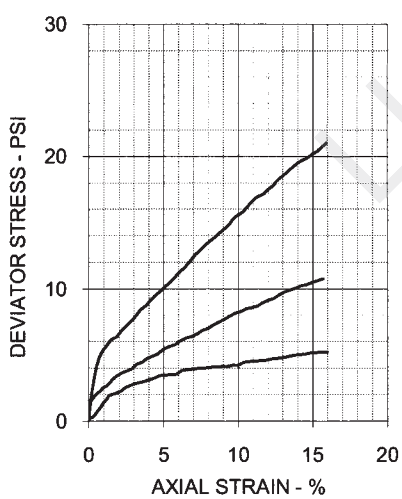
PROJECT: Martin Lake PDP 1 - 3 Supplemental
LOCATION:
PROJECT NO: G 3219 - 09
CLIENT: HDR
September 2009

ETTL ENGINEERS & CONSULTANTS PLATE: B.3

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	φ ' = 20.4 deg	c' = 0.0 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	26.1	24.6	21.3	
Dry Density - pcf	94.3	95.8	101.6	
Diameter - inches	1.40	1.40	1.40	
Height - inches	2.81	2.85	3.20	
AT TEST				
Final Moisture - %	26.1	24.6	21.3	
Dry Density - pcf	94.3	97.0	101.6	
Calculated Diameter (in.)	1.40	1.40	1.40	
Height - inches	2.81	2.85	3.20	
Effect. Cell Pressure - psi	5.0	10.0	20.0	
Failure Stress - psi	5.21	10.25	21.03	
Total Pore Pressure - psi	20.0	20.0	20.0	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	15.6	14.2	15.9	
σ_1' Failure - psi	10.11	19.85	40.73	
σ_3' Failure - psi	4.90	9.60	19.70	

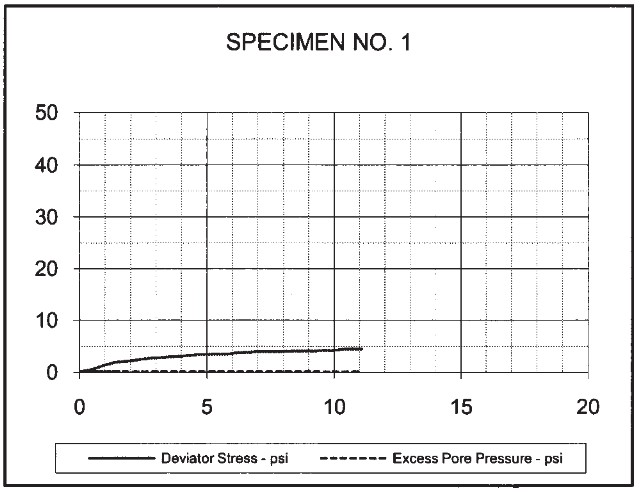
TEST DESCRIPTION

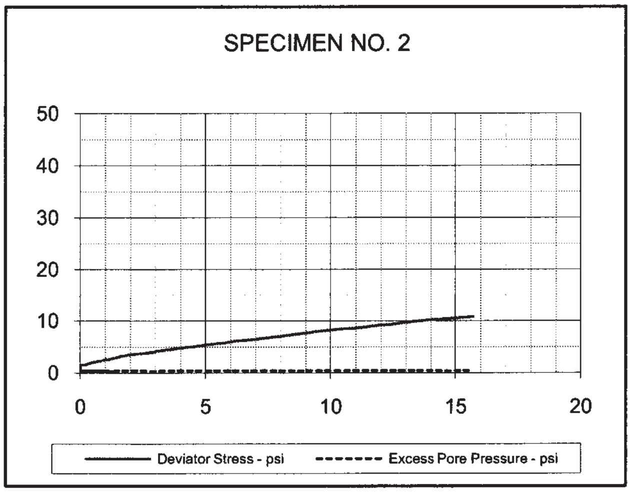
TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: SHELBY TUBE
DESCRIPTION:SANDY LEAN CLAY(CL), tan br w/ red br and gray
SAMPLE LOCATION: B-16, 3-5'
ASSUMED SPECIFIC GRAVITY: 2.70
LL: 43 PL: 14 PI: 29 Percent -200: 56
REMARKS: Tested in a fully softened remolded state

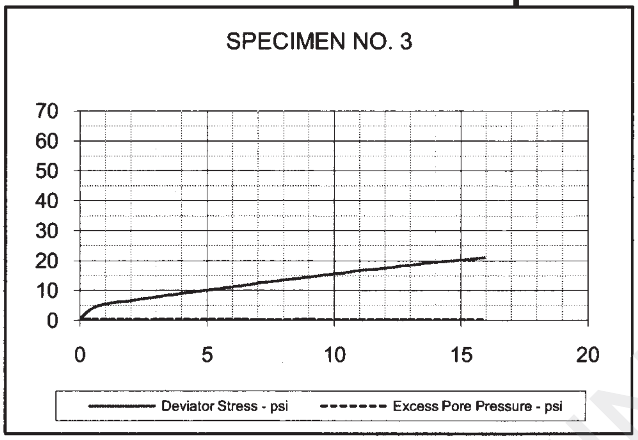
PROJECT INFORMATION

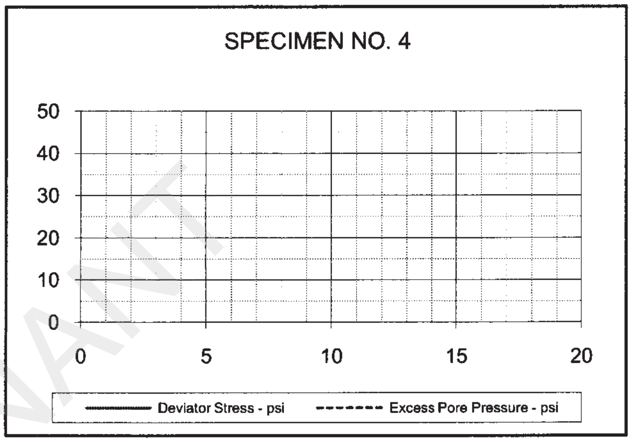
PROJECT: Luminant Martin Lake PDP 1-3 Vertical Expansion
LOCATION: Tatum, TX
PROJECT NO: ETT08002-11
CLIENT: ETTL Engineers & Consultants, Inc.
DATE: 9/15/09

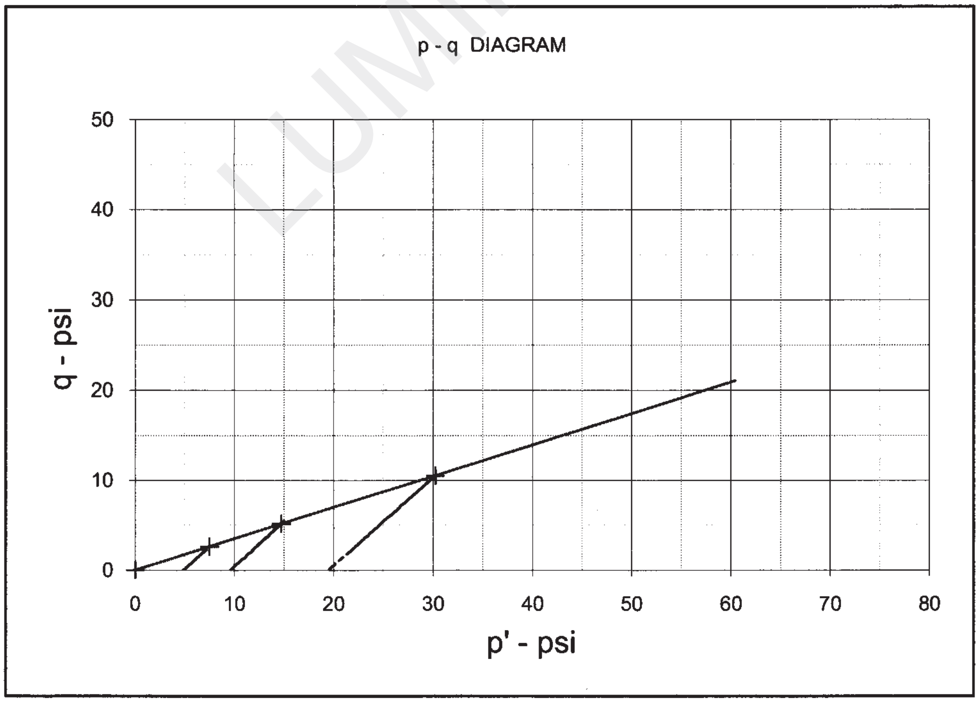
GREGORY GEOTECHNICAL | PLATE: B-CD.1







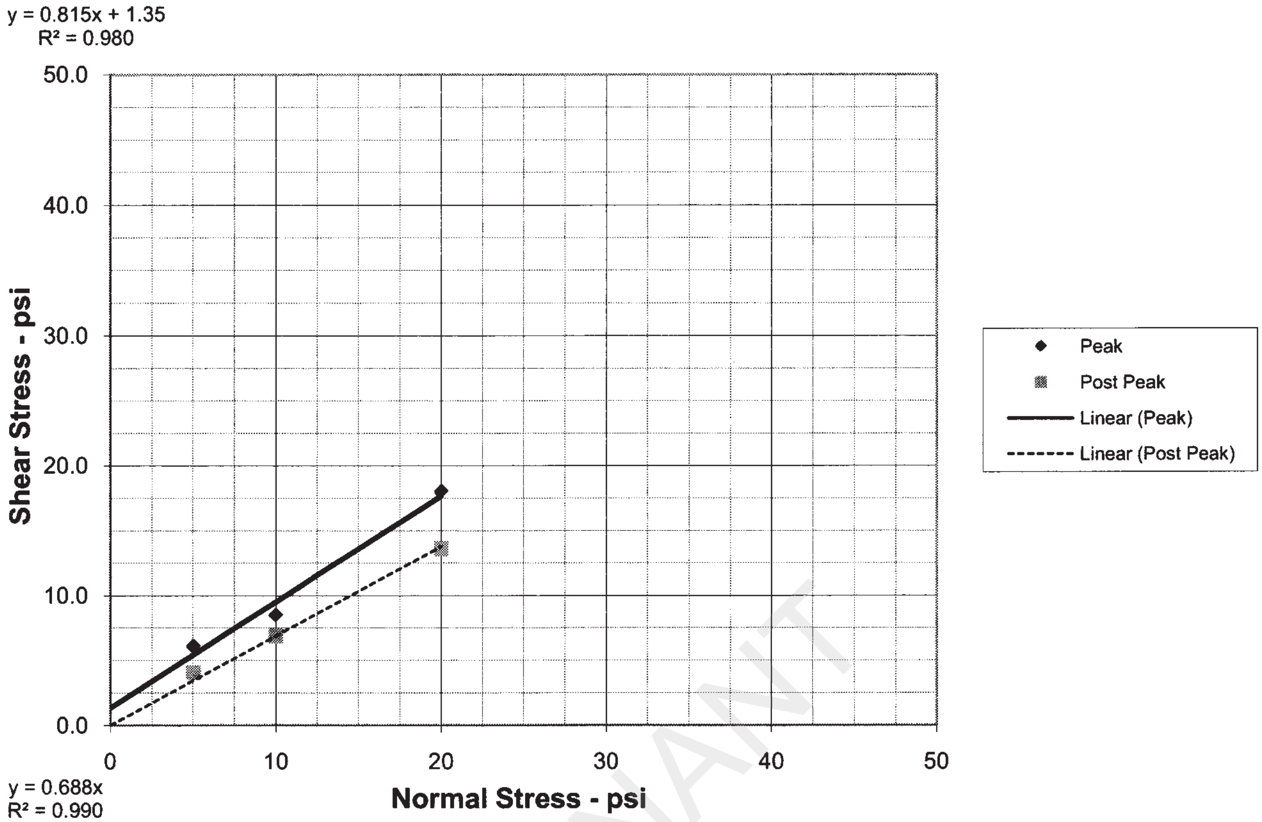




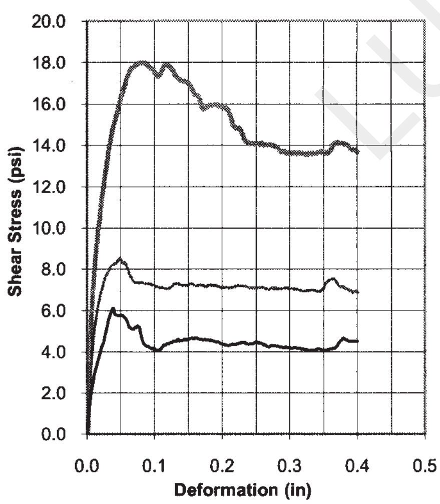
EFFECTIVE STRESS PARAMETERS	R^2 = 1.000	α (deg) = 19.2	a (psi) = 0.0
PROJECT: Luminant Martin Lake PDP 1-3 Vertical Expansion		TYPE OF TEST & NO: CD Triaxial - CD-1	
PROJECT NO: ETT08002-11		**GREGORY GEOTECHNICAL**	PLATE: B-CD.2
DESCRIPTION:SANDY LEAN CLAY(CL), tan br w/ red br and gray			

CD-08002-11-01.xls

DIRECT SHEAR TEST REPORT



PEAK STRENGTH PARAMETERS	φ =	39.2 deg	c =	1.4 psi
POST PEAK STRENGTH PARAMETERS	φ =	34.6 deg	c =	0.0 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	41.3	42.3	48.4	
Dry Density - pcf	78.9	72.5	72.9	
Diameter - inches	2.50	2.50	2.50	
Height - inches	1.00	1.00	1.00	
AT TEST				
Final Moisture - %	46.6	59.5	31.6	
Dry Density - pcf	81.0	74.2	73.0	
Height-End of Consol. (in.)	1.03	1.02	1.00	
Height-End of Shear (in.)	1.03	1.03	1.01	
Normal Stress - psi	5.0	10.0	20.0	
Peak Failure Stress-psi	6.1	8.5	18.0	
Post Peak Failure Stress-psi	4.1	6.9	13.6	
Strain Rate - inches/min.	0.00030	0.00030	0.00030	
Peak Failure Strain - %	1.6	1.9	3.1	
Post Peak Failure Strain %	4.3	12.7	11.8	

Dry Density at test based on initial moisture and height at end of consolidation.

TEST DESCRIPTION

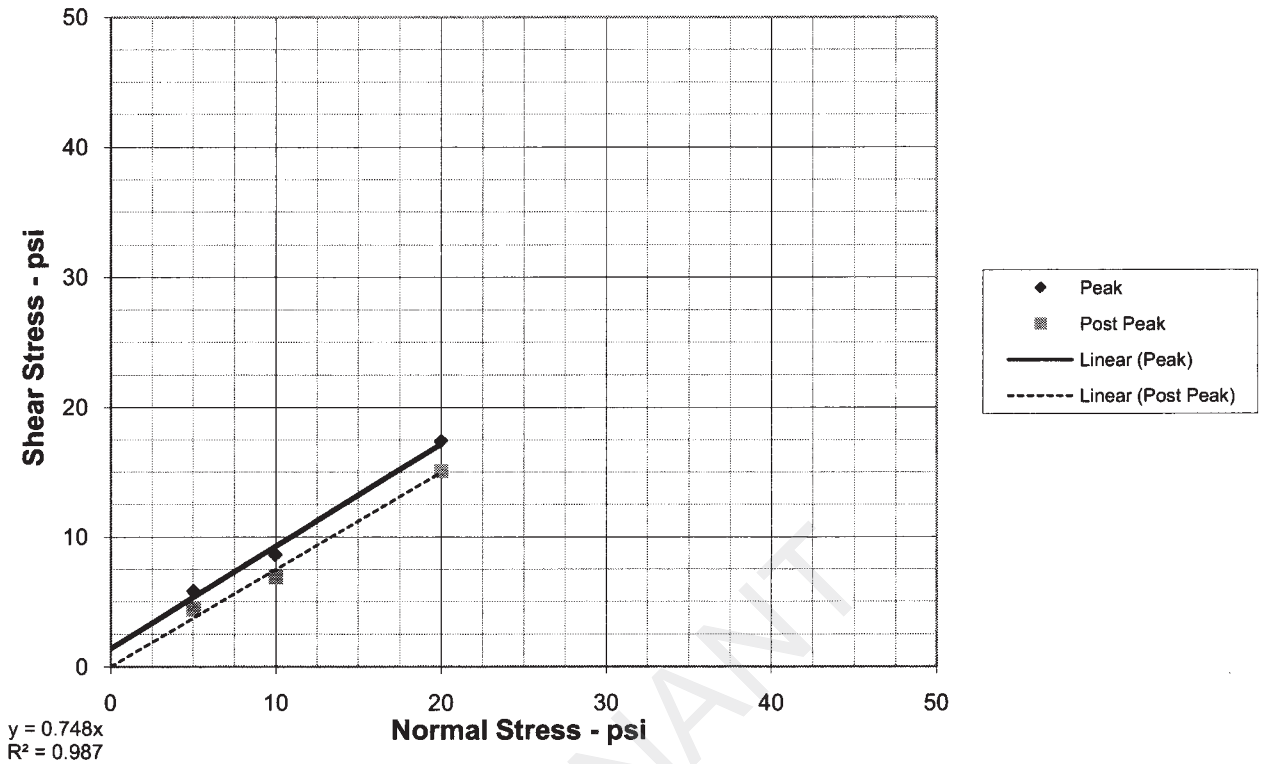
TYPE OF TEST & NO: CD-DS-1
SAMPLE TYPE: Shelby Tube
DESCRIPTION: SILT(MH), black (classification tests from 13-15 ft)
SAMPLE LOCATION: B-15, 18-20 ft
ASSUMED SPECIFIC GRAVITY: 2.65
LL: NP PL: NP PI: NP Percent -200: 95
REMARKS: Tested at natural MC

PROJECT INFORMATION

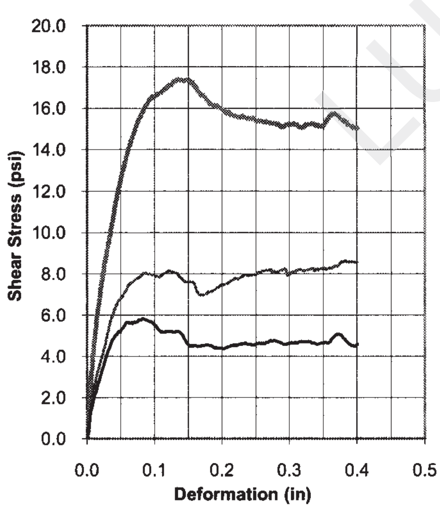
PROJECT: Luminant Martin Lake PDP 1-3 Vertical Expansion
LOCATION: Tatum, TX
PROJECT NO: ETT08002-11 (G3219-09)
CLIENT : ETTL Engineers & Consultants, Inc
DATE: 9/25/09

GREGORY GEOTECHNICAL PLATE: B-DS. 1

DIRECT SHEAR TEST REPORT



PEAK STRENGTH PARAMETERS	φ =	38.3 deg	c =	1.4 psi
POST PEAK STRENGTH PARAMETERS	φ =	36.8 deg	c =	0.0 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	47.2	47.5	46.5	
Dry Density - pcf	77.0	73.3	72.6	
Diameter - inches	2.50	2.50	2.50	
Height - inches	1.00	1.00	1.00	
AT TEST				
Final Moisture - %	47.2	47.5	31.6	
Dry Density - pcf	77.0	73.3	72.6	
Height-End of Consol. (in.)	1.00	1.00	1.00	
Height-End of Shear (in.)	0.98	0.98	0.99	
Normal Stress - psi	5.0	10.0	20.0	
Peak Failure Stress-psi	5.8	8.6	17.4	
Post Peak Failure Stress-psi	4.4	6.9	15.1	
Strain Rate - inches/min.	0.00030	0.00030	0.00030	
Peak Failure Strain - %	3.1	15.0	3.1	
Post Peak Failure Strain %	7.8	6.8	12.8	

Dry Density at test based on initial moisture and height at end of consolidation.

TEST DESCRIPTION

TYPE OF TEST & NO: CD-DS-2
SAMPLE TYPE: Shelby Tube
DESCRIPTION: SILT(MH), black (classification tests from 13-15 ft)
SAMPLE LOCATION: B-15, 18-20 ft
ASSUMED SPECIFIC GRAVITY: 2.65
LL: NP PL: NP PI: NP Percent -200: 95
REMARKS: Tested in a fully softened remolded state

PROJECT INFORMATION

PROJECT: Luminant Martin Lake PDP 1-3 Vertical Expansion
LOCATION: Tatum, TX
PROJECT NO: ETT08002-11 (G3219-09)
CLIENT : ETTL Engineers & Consultants, Inc
DATE: 9/23/09

GREGORY GEOTECHNICAL PLATE: B-DS. 2

ETTL Engineers & Consultants Inc.
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HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project : Martin Lake PDP 1 - 3 Supplemental, Tatum, Texas
Date: 8/26/2009 Panel Number : P 1 ; ASTM D 5084
Project No. : G 3219-09 Permometer Data

Boring No.:	B - 14	ap =	0.031416 cm2	Set Mercury to Pipet Rp at		Equilibrium	1.8 cm3
Sample:		aa =	0.767120 cm2			Pipet Rp	**6.7** cm3
Depth (ft):	3' to 5'	M1 =	0.030180	C =	0.000414194	Annulus Ra	1.5 cm3
Other Location:		M2 =	1.040953	T =	0.203859738		

Material Description : Dark Gray Ash

SAMPLE DATA

Wet Wt. sample + ring or tare :			502.16	g
Tare or ring Wt. :			0.0	g
Wet Wt: of Sample :			502.16	g
Diameter :	2.85	in	7.24	cm2
Length :	2.80	in	7.12	cm
Area:	6.38	in^2	41.16	cm2
Volume :	17.88	in^3	292.92	cm3
Unit Wt.(wet):	**106.97**	pcf	**1.71**	g/cm^3
Unit Wt.(dry):	**68.77**	pcf	**1.10**	g/cm^3

	Before Test		After Test
Tare No.:	T 20	Tare No.:	T 22
Wet Wt.+tare:	522.84	Wet Wt.+tare:	625.95
Dry Wt.+tare:	393.34	Dry Wt.+tare:	480.79
Tare Wt:	160.27	Tare Wt:	140.47
Dry Wt.:	233.07	Dry Wt.:	340.32
Water Wt.:	129.5	Water Wt.:	145.16
% moist.:	**55.6**	% moist.:	**42.7**

Specific Gravity: **2.60** Max Dry Density(pcf) = 68.7952 OMC = 55.5627065
% of max = 100.0 +/- OMC = 0.00
Calculated % saturation: 81.52 Void ratio (e) = **1.36** Porosity (n)= **0.58**

TEST READINGS

Z1(Mercury Height Difference @ t1): 5.1 cm Hydraulic Gradient = 9.04

Date	elapsed t (seconds)	Z (pipet @ t)	ΔZπ (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
8/26/2009	8	4.5	2.1553335	25	0.889	2.66E-05	7.55E-02	
8/26/2009	10	4.05	2.6053335	25	0.889	2.79E-05	7.91E-02	
8/26/2009	12	3.6	3.0553335	25	0.889	2.99E-05	8.48E-02	
8/26/2009	14	3.25	3.4053335	25	0.889	3.12E-05	8.84E-02	

SUMMARY

ka = 2.89E-05 cm/sec Acceptance criteria = 25 %

ki			Vm	
k1 =	2.66E-05	cm/sec	7.8	%
k2 =	2.79E-05	cm/sec	3.5	%
k3 =	2.99E-05	cm/sec	3.5	%
k4 =	3.12E-05	cm/sec	7.8	%

$$Vm = \frac{|ka-ki|}{ka} \times 100$$

Hydraulic conductivity	k =	**2.89E-05**	cm/sec	**8.19E-02**	ft/day
Void Ratio	e =	**1.36**			
Porosity	n =	**0.58**			
Bulk Density	γ =	**1.71**	g/cm3	**107.0**	pcf
Water Content	W =	**0.61**	cm3/cm3	(at 20 deg C)	
Intrinsic Permeability	kint =	**2.96E-10**	cm2	(at 20 deg C)	

Liquid Limit LL		
Plastic Limit PL		
Plasticity Index PI		
- 200 Sieve		%
+ No 40 Sieve		%
+ No 4 Sieve		%

Respectfully Submitted

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ETTL Engineers & Consultants Inc.
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HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project : Martin Lake PDP 1 - 3 Supplemental, Tatum, Texas
Date: 8/26/2009 Panel Number : P 2 ; ASTM D 5084
Project No. : G 3219-09 Permometer Data

Boring No.:	B - 14	ap =	0.031416 cm2	Set Mercury to Pipet Rp at		Equilibrium	1.8	cm3
Sample:		aa =	0.767120 cm2			Pipet Rp	**6.7**	cm3
Depth (ft):	16' to 17'	M1 =	0.030180	C =	0.000414194	Annulus Ra	1.5	cm3
Other Location:		M2 =	1.040953	T =	0.203859738			

Material Description : Dark Gray Ash

SAMPLE DATA

Wet Wt. sample + ring or tare :			457.47	g
Tare or ring Wt. :			0.0	g
Wet Wt: of Sample :			457.47	g
Diameter :	2.85	in	7.24	cm2
Length :	2.80	in	7.12	cm
Area:	6.38	in^2	41.16	cm2
Volume :	17.88	in^3	292.92	cm3
Unit Wt.(wet):	**97.45**	pcf	**1.56**	g/cm^3
Unit Wt.(dry):	**57.36**	pcf	**0.92**	g/cm^3

Before Test		After Test	
Tare No.:	T 18	Tare No.:	T 16
Wet Wt.+tare:	711.07	Wet Wt.+tare:	569.97
Dry Wt.+tare:	478.92	Dry Wt.+tare:	412.38
Tare Wt:	146.73	Tare Wt:	151.98
Dry Wt.:	332.19	Dry Wt.:	260.4
Water Wt.:	232.15	Water Wt.:	157.59
% moist.:	**69.9**	% moist.:	**60.5**

Specific Gravity: **2.50** Max Dry Density(pcf) = 57.38916 OMC = 69.8847045
% of max = 100.0 +/- OMC = 0.00
Calculated % saturation: 87.92 Void ratio (e) = **1.72** Porosity (n)= **0.63**

TEST READINGS

Z1(Mercury Height Difference @ t1): 5.1 cm Hydraulic Gradient = 9.04

Date	elapsed t (seconds)	Z (pipet @ t)	ΔZπ (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
8/26/2009	80	4.2	2.4553335	25	0.889	3.20E-06	9.06E-03	
8/26/2009	90	4.05	2.6053335	25	0.889	3.10E-06	8.79E-03	
8/26/2009	100	3.9	2.7553335	25	0.889	3.04E-06	8.61E-03	
8/26/2009	110	3.75	2.9053335	25	0.889	3.00E-06	8.52E-03	

SUMMARY

ka = 3.08E-06 cm/sec Acceptance criteria = 25 %

ki			Vm	
k1 =	3.20E-06	cm/sec	3.6	%
k2 =	3.10E-06	cm/sec	0.5	%
k3 =	3.04E-06	cm/sec	1.5	%
k4 =	3.00E-06	cm/sec	2.6	%

$$Vm = \frac{|ka-ki|}{ka} \times 100$$

Hydraulic conductivity	k =	**3.08E-06**	cm/sec	**8.74E-03**	ft/day
Void Ratio	e =	**1.72**			
Porosity	n =	**0.63**			
Bulk Density	γ =	**1.56**	g/cm3	**97.5**	pcf
Water Content	W =	**0.64**	cm3/cm3	(at 20 deg C)	
Intrinsic Permeability	kint =	**3.16E-11**	cm2	(at 20 deg C)	

Liquid Limit LL		
Plastic Limit PL		
Plasticity Index PI		
- 200 Sieve		%
+ No 40 Sieve		%
+ No 4 Sieve		%

Respectfully Submitted

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HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project : Luminant Martin Lake Supplemental, TP-31, Tatum, Texas

Date: 9/9/2009 Panel Number : P 1 ; ASTM D 5084

Project No. : G 3219-09 Permometer Data

Boring No.:	TP- 31	ap =	0.031416 cm2	Set Mercury to Pipet Rp at		Equilibrium	1.8	cm3
Sample:	9228	aa =	0.767120 cm2			Pipet Rp	**6.7**	cm3
Depth (ft):	0' to 5'	M1 =	0.030180	C =	0.000414162	Annulus Ra	1.5	cm3
Other Location:		M2 =	1.040953	T =	0.203870442			

Material Description : Tan & Reddish Tan Silty Sand

SAMPLE DATA

Wet Wt. sample + ring or tare :			627.20	g						
Tare or ring Wt. :			0.0	g		Before Test			After Test	
Wet Wt: of Sample :			627.20	g	Tare No.:		T 6	Tare No.:		T 1
Diameter :	2.89	in	7.33	cm2	Wet Wt.+tare:		841.20	Wet Wt.+tare:		841.71
Length :	2.88	in	7.30	cm	Dry Wt.+tare:		749.54	Dry Wt.+tare:		741.72
Area:	6.55	in^2	42.23	cm2	Tare Wt:		217.39	Tare Wt:		217.29
Volume :	18.82	in^3	308.41	cm3	Dry Wt.:		532.15	Dry Wt.:		524.43
Unit Wt.(wet):	**126.90**	pcf	**2.03**	g/cm^3	Water Wt.:		91.66	Water Wt.:		99.99
Unit Wt.(dry):	**108.26**	pcf	**1.73**	g/cm^3	% moist.:		**17.2**	% moist.:		**19.1**

Specific Gravity: **2.65** Max Dry Density(pcf) = 108.3018 OMC = 17.2244668

% of max = 100.0 +/- OMC = 0.00

Calculated % saturation: 95.65 Void ratio (e) = **0.53** Porosity (n)= **0.35**

TEST READINGS

Z1(Mercury Height Difference @ t1): 5.1 cm Hydraulic Gradient = 8.81

Date	elapsed t (seconds)	Z (pipet @ t)	$\Delta Z\pi$ (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
7/31/2009	600	5.3	1.3550759	25	0.889	1.98E-07	5.63E-04	
7/31/2009	720	5.1	1.5550759	25	0.889	1.95E-07	5.53E-04	
7/31/2009	840	5	1.6550759	25	0.889	1.80E-07	5.12E-04	
7/31/2009	960	4.8	1.8550759	25	0.889	1.82E-07	5.17E-04	

SUMMARY

ka = 1.89E-07 cm/sec Acceptance criteria = 25 %

ki			Vm	
k1 =	1.98E-07	cm/sec	5.0	%
k2 =	1.95E-07	cm/sec	3.2	%
k3 =	1.80E-07	cm/sec	4.5	%
k4 =	1.82E-07	cm/sec	3.6	%

$$Vm = \frac{|ka-ki|}{ka} \times 100$$

Hydraulic conductivity	k =	**1.89E-07**	cm/sec	**5.36E-04**	ft/day
Void Ratio	e =	**0.53**			
Porosity	n =	**0.35**			
Bulk Density	γ =	**2.03**	g/cm3	**126.9**	pcf
Water Content	W =	**0.30**	cm3/cm3	(at 20 deg C)	
Intrinsic Permeability	kint =	**1.94E-12**	cm2	(at 20 deg C)	

Liquid Limit	LL	20	
Plastic Limit	PL	17	
Plasticity Index	**PI**	3	
- 200 Sieve		27	%
+ No 40 Sieve		2	%
+ No 4 Sieve		1	%

Respectfully Submitted

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Project:	Luminant Martin Lake Supplemental, Tatum, Texas
Client:	HDR
Contractor:	
Job No.	**G 3219 - 09**

Sample No.:	**9228**	Date Sampled:	8/26/2009
Material Origin:	TP- 31		
Sampling Info. provided By:	Jacob LeNoir		
Location Sampled:	TP- 31		
Material Description:	Tan & Reddish Tan Silty Sand		
Sampled By:	Jacob LeNoir		
Technician:	T. Sliger	Date:	8/28/2009

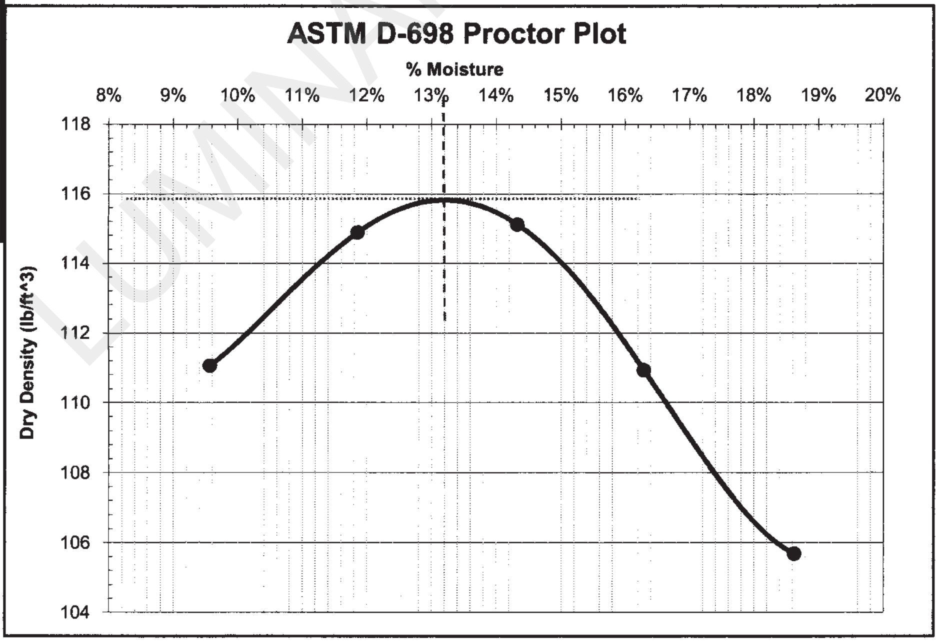
Maximum Dry Density: (ASTM D 698)	115.9	(lb/ft^3)
Optimum Moisture Content:	13.2	(%)

Classification

LL	20
PL	17
PI	3

-200 Sieve	27%
+40 Sieve	2%
+4 Sieve	1%

Proctor Points	
% Moisture	Dry Density (lb/ft^3)
9.6%	111.1
11.9%	114.9
14.3%	115.1
16.3%	110.9
18.6%	105.7



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APPENDIX C

CPT-BASED LIQUEFACTION POTENTIAL ANALYSIS

T A B L E   O F   C O N T E N T S

GeoLogismiki
Geotechnical Engineers
Merarhias 56
http://www.geologismiki.gr

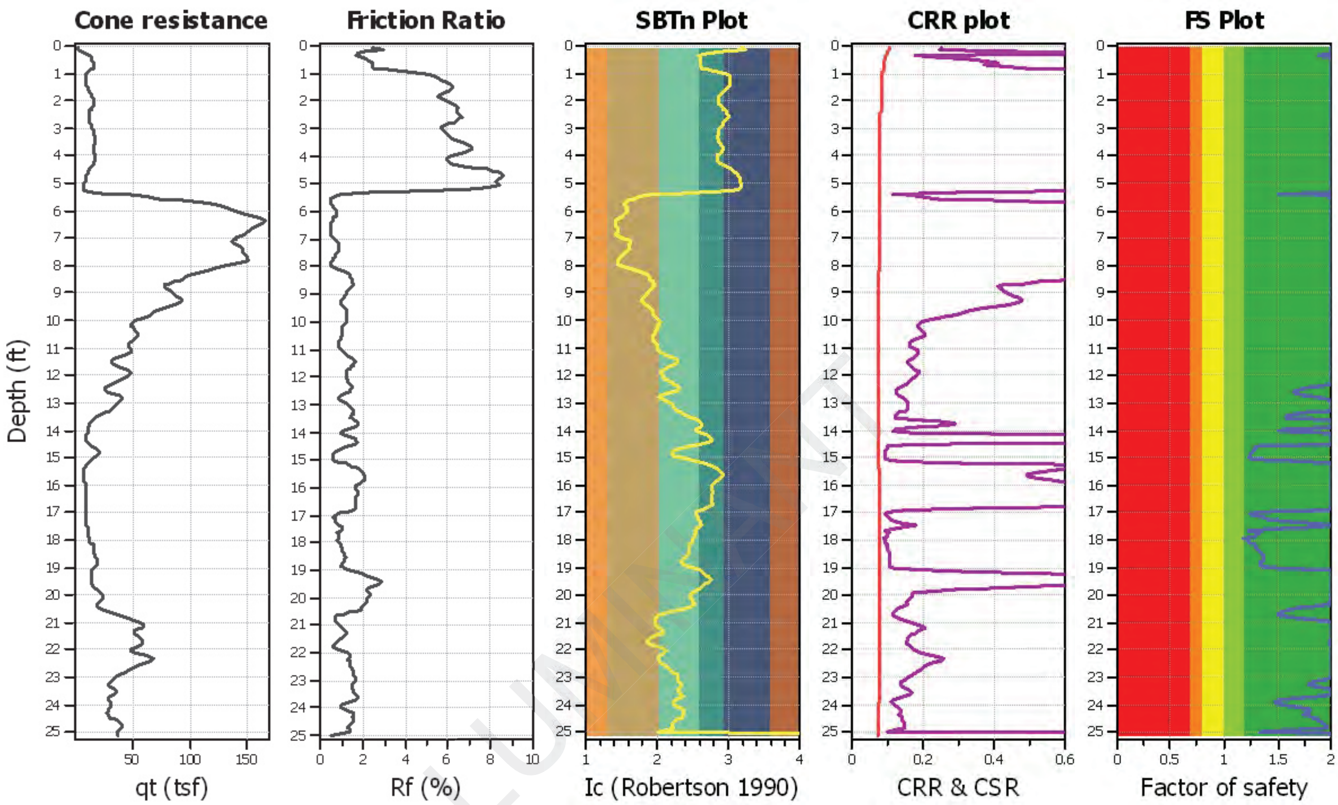
LIQUEFACTION ANALYSIS REPORT

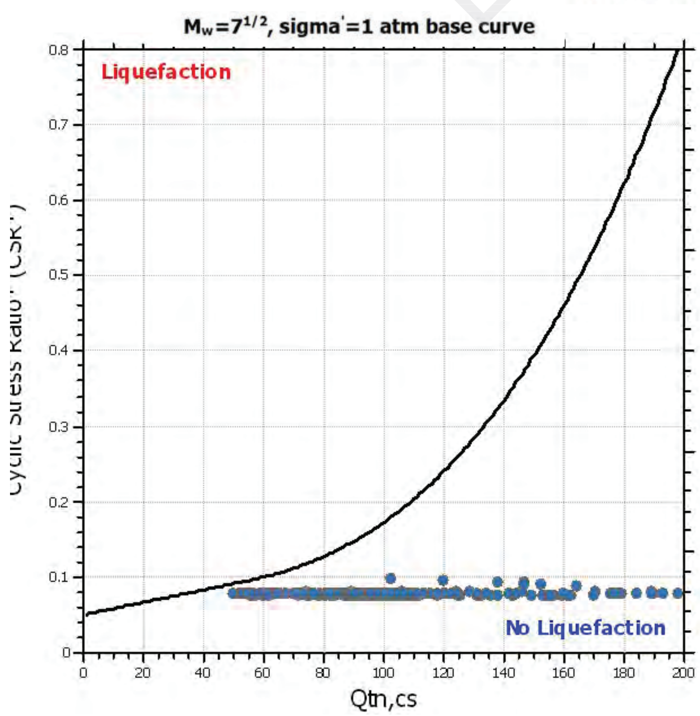
Project title : Martin Lake **Location : PDP-5**

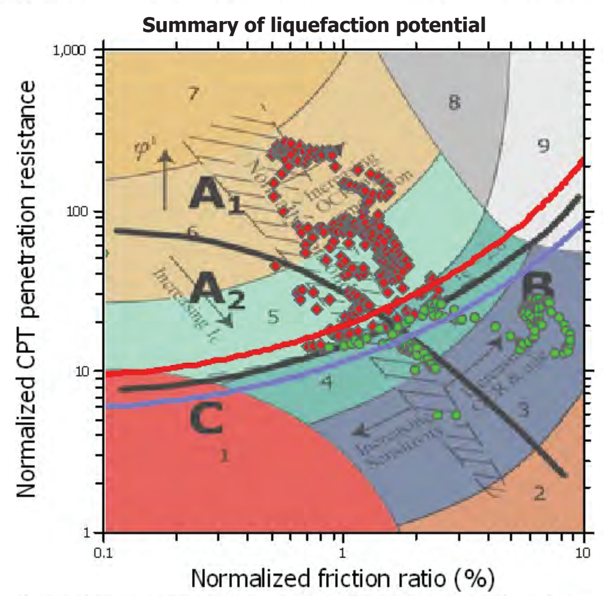
CPT file : B-02

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	1.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.20	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.09	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

:: Liquefaction Potential Index calculation data ::

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
0.07	2.00	0.00	9.99	0.06	0.00	0.13	2.00	0.00	9.98	0.06	0.00
0.20	2.00	0.00	9.97	0.07	0.00	0.26	2.00	0.00	9.96	0.06	0.00
0.33	1.88	0.00	9.95	0.07	0.00	0.39	2.00	0.00	9.94	0.06	0.00
0.46	2.00	0.00	9.93	0.07	0.00	0.52	2.00	0.00	9.92	0.06	0.00
0.59	2.00	0.00	9.91	0.07	0.00	0.66	2.00	0.00	9.90	0.07	0.00
0.72	2.00	0.00	9.89	0.06	0.00	0.79	2.00	0.00	9.88	0.07	0.00
0.85	2.00	0.00	9.87	0.06	0.00	0.92	2.00	0.00	9.86	0.07	0.00
0.98	2.00	0.00	9.85	0.06	0.00	1.05	2.00	0.00	9.84	0.07	0.00
1.12	2.00	0.00	9.83	0.07	0.00	1.18	2.00	0.00	9.82	0.06	0.00
1.25	2.00	0.00	9.81	0.07	0.00	1.31	2.00	0.00	9.80	0.06	0.00
1.38	2.00	0.00	9.79	0.07	0.00	1.44	2.00	0.00	9.78	0.06	0.00
1.51	2.00	0.00	9.77	0.07	0.00	1.57	2.00	0.00	9.76	0.06	0.00
1.64	2.00	0.00	9.75	0.07	0.00	1.71	2.00	0.00	9.74	0.07	0.00
1.77	2.00	0.00	9.73	0.06	0.00	1.84	2.00	0.00	9.72	0.07	0.00
1.90	2.00	0.00	9.71	0.06	0.00	1.97	2.00	0.00	9.70	0.07	0.00
2.03	2.00	0.00	9.69	0.06	0.00	2.10	2.00	0.00	9.68	0.07	0.00
2.16	2.00	0.00	9.67	0.06	0.00	2.23	2.00	0.00	9.66	0.07	0.00
2.30	2.00	0.00	9.65	0.07	0.00	2.36	2.00	0.00	9.64	0.06	0.00
2.43	2.00	0.00	9.63	0.07	0.00	2.49	2.00	0.00	9.62	0.06	0.00
2.56	2.00	0.00	9.61	0.07	0.00	2.62	2.00	0.00	9.60	0.06	0.00
2.69	2.00	0.00	9.59	0.07	0.00	2.76	2.00	0.00	9.58	0.07	0.00
2.82	2.00	0.00	9.57	0.06	0.00	2.89	2.00	0.00	9.56	0.07	0.00
2.95	2.00	0.00	9.55	0.06	0.00	3.02	2.00	0.00	9.54	0.07	0.00
3.08	2.00	0.00	9.53	0.06	0.00	3.15	2.00	0.00	9.52	0.07	0.00
3.21	2.00	0.00	9.51	0.06	0.00	3.28	2.00	0.00	9.50	0.07	0.00
3.35	2.00	0.00	9.49	0.07	0.00	3.41	2.00	0.00	9.48	0.06	0.00
3.48	2.00	0.00	9.47	0.07	0.00	3.54	2.00	0.00	9.46	0.06	0.00
3.61	2.00	0.00	9.45	0.07	0.00	3.67	2.00	0.00	9.44	0.06	0.00
3.74	2.00	0.00	9.43	0.07	0.00	3.80	2.00	0.00	9.42	0.06	0.00
3.87	2.00	0.00	9.41	0.07	0.00	3.94	2.00	0.00	9.40	0.07	0.00
4.00	2.00	0.00	9.39	0.06	0.00	4.07	2.00	0.00	9.38	0.07	0.00
4.13	2.00	0.00	9.37	0.06	0.00	4.20	2.00	0.00	9.36	0.07	0.00
4.26	2.00	0.00	9.35	0.06	0.00	4.33	2.00	0.00	9.34	0.07	0.00
4.40	2.00	0.00	9.33	0.07	0.00	4.46	2.00	0.00	9.32	0.06	0.00
4.53	2.00	0.00	9.31	0.07	0.00	4.59	2.00	0.00	9.30	0.06	0.00
4.66	2.00	0.00	9.29	0.07	0.00	4.72	2.00	0.00	9.28	0.06	0.00
4.79	2.00	0.00	9.27	0.07	0.00	4.85	2.00	0.00	9.26	0.06	0.00
4.92	2.00	0.00	9.25	0.07	0.00	4.99	2.00	0.00	9.24	0.07	0.00
5.05	2.00	0.00	9.23	0.06	0.00	5.12	2.00	0.00	9.22	0.07	0.00
5.18	2.00	0.00	9.21	0.06	0.00	5.25	2.00	0.00	9.20	0.07	0.00
5.31	2.00	0.00	9.19	0.06	0.00	5.38	1.50	0.00	9.18	0.07	0.00
5.44	1.85	0.00	9.17	0.06	0.00	5.51	2.00	0.00	9.16	0.07	0.00
5.58	2.00	0.00	9.15	0.07	0.00	5.64	2.00	0.00	9.14	0.06	0.00
5.71	2.00	0.00	9.13	0.07	0.00	5.77	2.00	0.00	9.12	0.06	0.00
5.84	2.00	0.00	9.11	0.07	0.00	5.90	2.00	0.00	9.10	0.06	0.00
5.97	2.00	0.00	9.09	0.07	0.00	6.04	2.00	0.00	9.08	0.07	0.00
6.10	2.00	0.00	9.07	0.06	0.00	6.17	2.00	0.00	9.06	0.07	0.00
6.23	2.00	0.00	9.05	0.06	0.00	6.30	2.00	0.00	9.04	0.07	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
6.36	2.00	0.00	9.03	0.06	0.00	6.43	2.00	0.00	9.02	0.07	0.00
6.49	2.00	0.00	9.01	0.06	0.00	6.56	2.00	0.00	9.00	0.07	0.00
6.63	2.00	0.00	8.99	0.07	0.00	6.69	2.00	0.00	8.98	0.06	0.00
6.76	2.00	0.00	8.97	0.07	0.00	6.82	2.00	0.00	8.96	0.06	0.00
6.89	2.00	0.00	8.95	0.07	0.00	6.95	2.00	0.00	8.94	0.06	0.00
7.02	2.00	0.00	8.93	0.07	0.00	7.08	2.00	0.00	8.92	0.06	0.00
7.15	2.00	0.00	8.91	0.07	0.00	7.22	2.00	0.00	8.90	0.07	0.00
7.28	2.00	0.00	8.89	0.06	0.00	7.35	2.00	0.00	8.88	0.07	0.00
7.41	2.00	0.00	8.87	0.06	0.00	7.48	2.00	0.00	8.86	0.07	0.00
7.54	2.00	0.00	8.85	0.06	0.00	7.61	2.00	0.00	8.84	0.07	0.00
7.68	2.00	0.00	8.83	0.07	0.00	7.74	2.00	0.00	8.82	0.06	0.00
7.81	2.00	0.00	8.81	0.07	0.00	7.87	2.00	0.00	8.80	0.06	0.00
7.94	2.00	0.00	8.79	0.07	0.00	8.00	2.00	0.00	8.78	0.06	0.00
8.07	2.00	0.00	8.77	0.07	0.00	8.13	2.00	0.00	8.76	0.06	0.00
8.20	2.00	0.00	8.75	0.07	0.00	8.27	2.00	0.00	8.74	0.07	0.00
8.33	2.00	0.00	8.73	0.06	0.00	8.40	2.00	0.00	8.72	0.07	0.00
8.46	2.00	0.00	8.71	0.06	0.00	8.53	2.00	0.00	8.70	0.07	0.00
8.59	2.00	0.00	8.69	0.06	0.00	8.66	2.00	0.00	8.68	0.07	0.00
8.72	2.00	0.00	8.67	0.06	0.00	8.79	2.00	0.00	8.66	0.07	0.00
8.86	2.00	0.00	8.65	0.07	0.00	8.92	2.00	0.00	8.64	0.06	0.00
8.99	2.00	0.00	8.63	0.07	0.00	9.05	2.00	0.00	8.62	0.06	0.00
9.12	2.00	0.00	8.61	0.07	0.00	9.18	2.00	0.00	8.60	0.06	0.00
9.25	2.00	0.00	8.59	0.07	0.00	9.32	2.00	0.00	8.58	0.07	0.00
9.38	2.00	0.00	8.57	0.06	0.00	9.45	2.00	0.00	8.56	0.07	0.00
9.51	2.00	0.00	8.55	0.06	0.00	9.58	2.00	0.00	8.54	0.07	0.00
9.64	2.00	0.00	8.53	0.06	0.00	9.71	2.00	0.00	8.52	0.07	0.00
9.77	2.00	0.00	8.51	0.06	0.00	9.84	2.00	0.00	8.50	0.07	0.00
9.91	2.00	0.00	8.49	0.07	0.00	9.97	2.00	0.00	8.48	0.06	0.00
10.04	2.00	0.00	8.47	0.07	0.00	10.10	2.00	0.00	8.46	0.06	0.00
10.17	2.00	0.00	8.45	0.07	0.00	10.23	2.00	0.00	8.44	0.06	0.00
10.30	2.00	0.00	8.43	0.07	0.00	10.36	2.00	0.00	8.42	0.06	0.00
10.43	2.00	0.00	8.41	0.07	0.00	10.50	2.00	0.00	8.40	0.07	0.00
10.56	2.00	0.00	8.39	0.06	0.00	10.63	2.00	0.00	8.38	0.07	0.00
10.69	2.00	0.00	8.37	0.06	0.00	10.76	2.00	0.00	8.36	0.07	0.00
10.82	2.00	0.00	8.35	0.06	0.00	10.89	2.00	0.00	8.34	0.07	0.00
10.96	2.00	0.00	8.33	0.07	0.00	11.02	2.00	0.00	8.32	0.06	0.00
11.09	2.00	0.00	8.31	0.07	0.00	11.15	2.00	0.00	8.30	0.06	0.00
11.22	2.00	0.00	8.29	0.07	0.00	11.28	2.00	0.00	8.28	0.06	0.00
11.35	2.00	0.00	8.27	0.07	0.00	11.41	2.00	0.00	8.26	0.06	0.00
11.48	2.00	0.00	8.25	0.07	0.00	11.55	2.00	0.00	8.24	0.07	0.00
11.61	2.00	0.00	8.23	0.06	0.00	11.68	2.00	0.00	8.22	0.07	0.00
11.74	2.00	0.00	8.21	0.06	0.00	11.81	2.00	0.00	8.20	0.07	0.00
11.87	2.00	0.00	8.19	0.06	0.00	11.94	2.00	0.00	8.18	0.07	0.00
12.00	2.00	0.00	8.17	0.06	0.00	12.07	2.00	0.00	8.16	0.07	0.00
12.14	2.00	0.00	8.15	0.07	0.00	12.20	2.00	0.00	8.14	0.06	0.00
12.27	2.00	0.00	8.13	0.07	0.00	12.33	2.00	0.00	8.12	0.06	0.00
12.40	1.89	0.00	8.11	0.07	0.00	12.46	1.78	0.00	8.10	0.06	0.00
12.53	1.71	0.00	8.09	0.07	0.00	12.60	1.65	0.00	8.08	0.07	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
12.66	1.66	0.00	8.07	0.06	0.00	12.73	1.76	0.00	8.06	0.07	0.00
12.79	1.87	0.00	8.05	0.06	0.00	12.86	1.97	0.00	8.04	0.07	0.00
12.92	2.00	0.00	8.03	0.06	0.00	12.99	2.00	0.00	8.02	0.07	0.00
13.05	2.00	0.00	8.01	0.06	0.00	13.12	2.00	0.00	8.00	0.07	0.00
13.19	2.00	0.00	7.99	0.07	0.00	13.25	2.00	0.00	7.98	0.06	0.00
13.32	1.93	0.00	7.97	0.07	0.00	13.38	1.78	0.00	7.96	0.06	0.00
13.45	1.65	0.00	7.95	0.07	0.00	13.51	1.59	0.00	7.94	0.06	0.00
13.58	1.57	0.00	7.93	0.07	0.00	13.64	2.00	0.00	7.92	0.06	0.00
13.71	2.00	0.00	7.91	0.07	0.00	13.78	2.00	0.00	7.90	0.07	0.00
13.84	2.00	0.00	7.89	0.06	0.00	13.91	2.00	0.00	7.88	0.07	0.00
13.97	1.58	0.00	7.87	0.06	0.00	14.04	1.52	0.00	7.86	0.07	0.00
14.10	2.00	0.00	7.85	0.06	0.00	14.17	2.00	0.00	7.84	0.07	0.00
14.24	2.00	0.00	7.83	0.07	0.00	14.30	2.00	0.00	7.82	0.06	0.00
14.37	2.00	0.00	7.81	0.07	0.00	14.43	2.00	0.00	7.80	0.06	0.00
14.50	2.00	0.00	7.79	0.07	0.00	14.56	1.31	0.00	7.78	0.06	0.00
14.63	1.29	0.00	7.77	0.07	0.00	14.69	1.27	0.00	7.76	0.06	0.00
14.76	1.26	0.00	7.75	0.07	0.00	14.83	1.25	0.00	7.74	0.07	0.00
14.89	1.24	0.00	7.73	0.06	0.00	14.96	1.22	0.00	7.72	0.07	0.00
15.02	1.23	0.00	7.71	0.06	0.00	15.09	1.26	0.00	7.70	0.07	0.00
15.15	1.73	0.00	7.69	0.06	0.00	15.22	2.00	0.00	7.68	0.07	0.00
15.28	2.00	0.00	7.67	0.06	0.00	15.35	2.00	0.00	7.66	0.07	0.00
15.42	2.00	0.00	7.65	0.07	0.00	15.48	2.00	0.00	7.64	0.06	0.00
15.55	2.00	0.00	7.63	0.07	0.00	15.61	2.00	0.00	7.62	0.06	0.00
15.68	2.00	0.00	7.61	0.07	0.00	15.74	2.00	0.00	7.60	0.06	0.00
15.81	2.00	0.00	7.59	0.07	0.00	15.88	2.00	0.00	7.58	0.07	0.00
15.94	2.00	0.00	7.57	0.06	0.00	16.01	2.00	0.00	7.56	0.07	0.00
16.07	2.00	0.00	7.55	0.06	0.00	16.14	2.00	0.00	7.54	0.07	0.00
16.20	2.00	0.00	7.53	0.06	0.00	16.27	2.00	0.00	7.52	0.07	0.00
16.33	2.00	0.00	7.51	0.06	0.00	16.40	2.00	0.00	7.50	0.07	0.00
16.47	2.00	0.00	7.49	0.07	0.00	16.53	2.00	0.00	7.48	0.06	0.00
16.60	2.00	0.00	7.47	0.07	0.00	16.66	2.00	0.00	7.46	0.06	0.00
16.73	2.00	0.00	7.45	0.07	0.00	16.79	2.00	0.00	7.44	0.06	0.00
16.86	2.00	0.00	7.43	0.07	0.00	16.92	1.96	0.00	7.42	0.06	0.00
16.99	1.33	0.00	7.41	0.07	0.00	17.06	1.24	0.00	7.40	0.07	0.00
17.12	1.29	0.00	7.39	0.06	0.00	17.19	1.38	0.00	7.38	0.07	0.00
17.25	1.40	0.00	7.37	0.06	0.00	17.32	1.56	0.00	7.36	0.07	0.00
17.38	1.82	0.00	7.35	0.06	0.00	17.45	2.00	0.00	7.34	0.07	0.00
17.52	1.88	0.00	7.33	0.07	0.00	17.58	1.48	0.00	7.32	0.06	0.00
17.65	1.23	0.00	7.31	0.07	0.00	17.71	1.33	0.00	7.30	0.06	0.00
17.78	1.29	0.00	7.29	0.07	0.00	17.84	1.29	0.00	7.28	0.06	0.00
17.91	1.18	0.00	7.27	0.07	0.00	17.97	1.23	0.00	7.26	0.06	0.00
18.04	1.23	0.00	7.25	0.07	0.00	18.11	1.25	0.00	7.24	0.07	0.00
18.17	1.27	0.00	7.23	0.06	0.00	18.24	1.29	0.00	7.22	0.07	0.00
18.30	1.30	0.00	7.21	0.06	0.00	18.37	1.31	0.00	7.20	0.07	0.00
18.43	1.34	0.00	7.19	0.06	0.00	18.50	1.36	0.00	7.18	0.07	0.00
18.56	1.36	0.00	7.17	0.06	0.00	18.63	1.36	0.00	7.16	0.07	0.00
18.70	1.37	0.00	7.15	0.07	0.00	18.76	1.36	0.00	7.14	0.06	0.00
18.83	1.34	0.00	7.13	0.07	0.00	18.89	1.34	0.00	7.12	0.06	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
18.96	1.35	0.00	7.11	0.07	0.00	19.02	1.52	0.00	7.10	0.06	0.00
19.09	2.00	0.00	7.09	0.07	0.00	19.16	2.00	0.00	7.08	0.07	0.00
19.22	2.00	0.00	7.07	0.06	0.00	19.29	2.00	0.00	7.06	0.07	0.00
19.35	2.00	0.00	7.05	0.06	0.00	19.42	2.00	0.00	7.04	0.07	0.00
19.48	2.00	0.00	7.03	0.06	0.00	19.55	2.00	0.00	7.02	0.07	0.00
19.61	2.00	0.00	7.01	0.06	0.00	19.68	2.00	0.00	7.00	0.07	0.00
19.75	2.00	0.00	6.99	0.07	0.00	19.81	2.00	0.00	6.98	0.06	0.00
19.88	2.00	0.00	6.97	0.07	0.00	19.94	2.00	0.00	6.96	0.06	0.00
20.01	2.00	0.00	6.95	0.07	0.00	20.07	2.00	0.00	6.94	0.06	0.00
20.14	2.00	0.00	6.93	0.07	0.00	20.20	2.00	0.00	6.92	0.06	0.00
20.27	1.99	0.00	6.91	0.07	0.00	20.34	2.00	0.00	6.90	0.07	0.00
20.40	1.90	0.00	6.89	0.06	0.00	20.47	1.69	0.00	6.88	0.07	0.00
20.53	1.62	0.00	6.87	0.06	0.00	20.60	1.54	0.00	6.86	0.07	0.00
20.66	1.50	0.00	6.85	0.06	0.00	20.73	1.52	0.00	6.84	0.07	0.00
20.80	1.62	0.00	6.83	0.07	0.00	20.86	1.77	0.00	6.82	0.06	0.00
20.93	1.97	0.00	6.81	0.07	0.00	20.99	2.00	0.00	6.80	0.06	0.00
21.06	2.00	0.00	6.79	0.07	0.00	21.12	2.00	0.00	6.78	0.06	0.00
21.19	2.00	0.00	6.77	0.07	0.00	21.25	2.00	0.00	6.76	0.06	0.00
21.32	2.00	0.00	6.75	0.07	0.00	21.39	2.00	0.00	6.74	0.07	0.00
21.45	2.00	0.00	6.73	0.06	0.00	21.52	2.00	0.00	6.72	0.07	0.00
21.58	2.00	0.00	6.71	0.06	0.00	21.65	2.00	0.00	6.70	0.07	0.00
21.71	1.99	0.00	6.69	0.06	0.00	21.78	1.99	0.00	6.68	0.07	0.00
21.84	2.00	0.00	6.67	0.06	0.00	21.91	2.00	0.00	6.66	0.07	0.00
21.98	2.00	0.00	6.65	0.07	0.00	22.04	2.00	0.00	6.64	0.06	0.00
22.11	2.00	0.00	6.63	0.07	0.00	22.17	2.00	0.00	6.62	0.06	0.00
22.24	2.00	0.00	6.61	0.07	0.00	22.30	2.00	0.00	6.60	0.06	0.00
22.37	2.00	0.00	6.59	0.07	0.00	22.44	2.00	0.00	6.58	0.07	0.00
22.50	2.00	0.00	6.57	0.06	0.00	22.57	2.00	0.00	6.56	0.07	0.00
22.63	2.00	0.00	6.55	0.06	0.00	22.70	2.00	0.00	6.54	0.07	0.00
22.76	2.00	0.00	6.53	0.06	0.00	22.83	2.00	0.00	6.52	0.07	0.00
22.89	2.00	0.00	6.51	0.06	0.00	22.96	2.00	0.00	6.50	0.07	0.00
23.03	2.00	0.00	6.49	0.07	0.00	23.09	1.96	0.00	6.48	0.06	0.00
23.16	1.86	0.00	6.47	0.07	0.00	23.22	1.81	0.00	6.46	0.06	0.00
23.29	1.78	0.00	6.45	0.07	0.00	23.35	1.86	0.00	6.44	0.06	0.00
23.42	1.98	0.00	6.43	0.07	0.00	23.48	2.00	0.00	6.42	0.06	0.00
23.55	2.00	0.00	6.41	0.07	0.00	23.62	2.00	0.00	6.40	0.07	0.00
23.68	1.93	0.00	6.39	0.06	0.00	23.75	1.69	0.00	6.38	0.07	0.00
23.81	1.53	0.00	6.37	0.06	0.00	23.88	1.47	0.00	6.36	0.07	0.00
23.94	1.49	0.00	6.35	0.06	0.00	24.01	1.58	0.00	6.34	0.07	0.00
24.08	1.70	0.00	6.33	0.07	0.00	24.14	1.81	0.00	6.32	0.06	0.00
24.21	1.80	0.00	6.31	0.07	0.00	24.27	1.77	0.00	6.30	0.06	0.00
24.34	1.73	0.00	6.29	0.07	0.00	24.40	1.80	0.00	6.28	0.06	0.00
24.47	1.84	0.00	6.27	0.07	0.00	24.53	1.87	0.00	6.26	0.06	0.00
24.60	1.89	0.00	6.25	0.07	0.00	24.67	1.90	0.00	6.24	0.07	0.00
24.73	1.93	0.00	6.23	0.06	0.00	24.80	1.96	0.00	6.22	0.07	0.00
24.86	1.96	0.00	6.21	0.06	0.00	24.93	1.61	0.00	6.20	0.07	0.00
24.99	1.34	0.00	6.19	0.06	0.00	25.06	2.00	0.00	6.18	0.07	0.00
25.12	2.00	0.00	6.17	0.06	0.00						

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI

Overall liquefaction potential: 0.00

LPI = 0.00 - Liquefaction risk very low
LPI between 0.00 and 5.00 - Liquefaction risk low
LPI between 5.00 and 15.00 - Liquefaction risk high
LPI > 15.00 - Liquefaction risk very high

Abbreviations

FS: Calculated factor of safety for test point
F_L: 1 - FS
w_z: Function value of the extend of soil liquefaction according to depth
d_z: Layer thickness (ft)
LPI: Liquefaction potential index value for test point

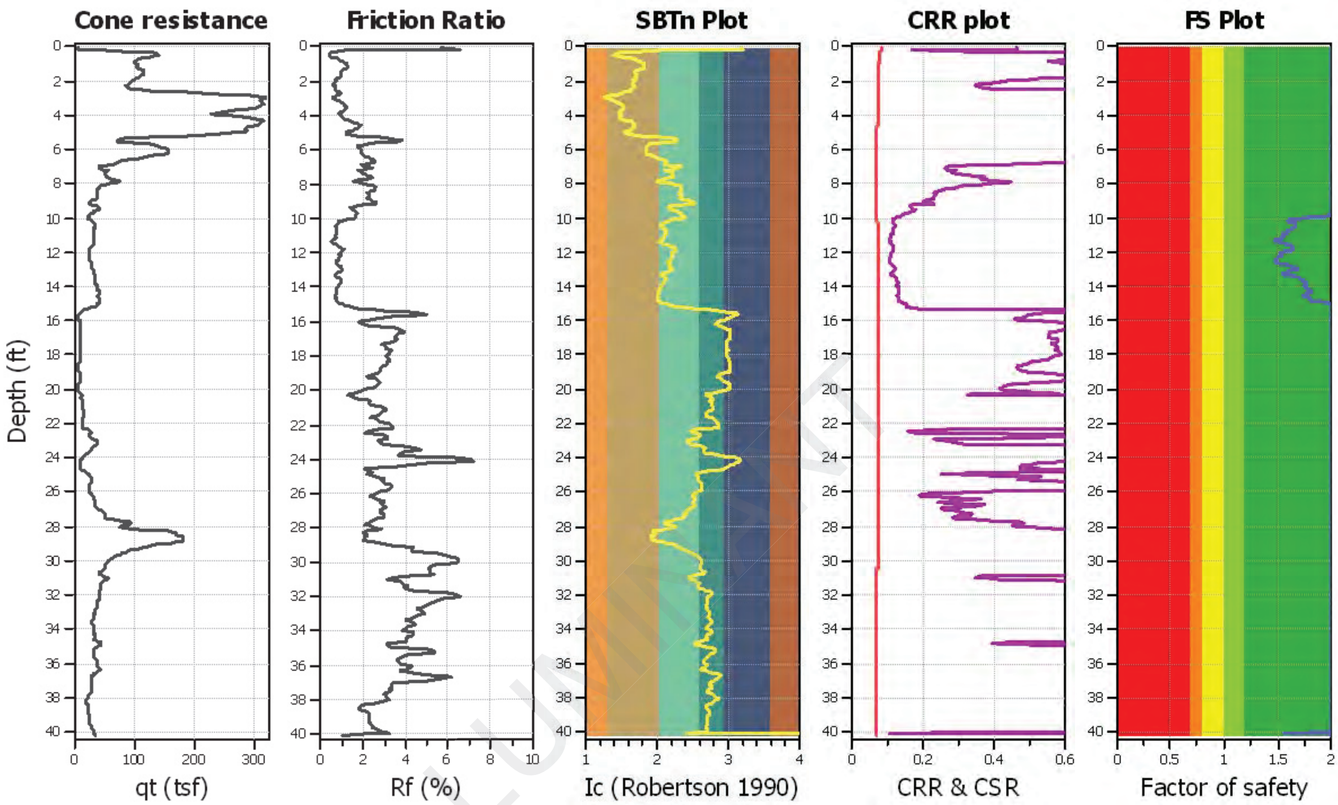
LIQUEFACTION ANALYSIS REPORT

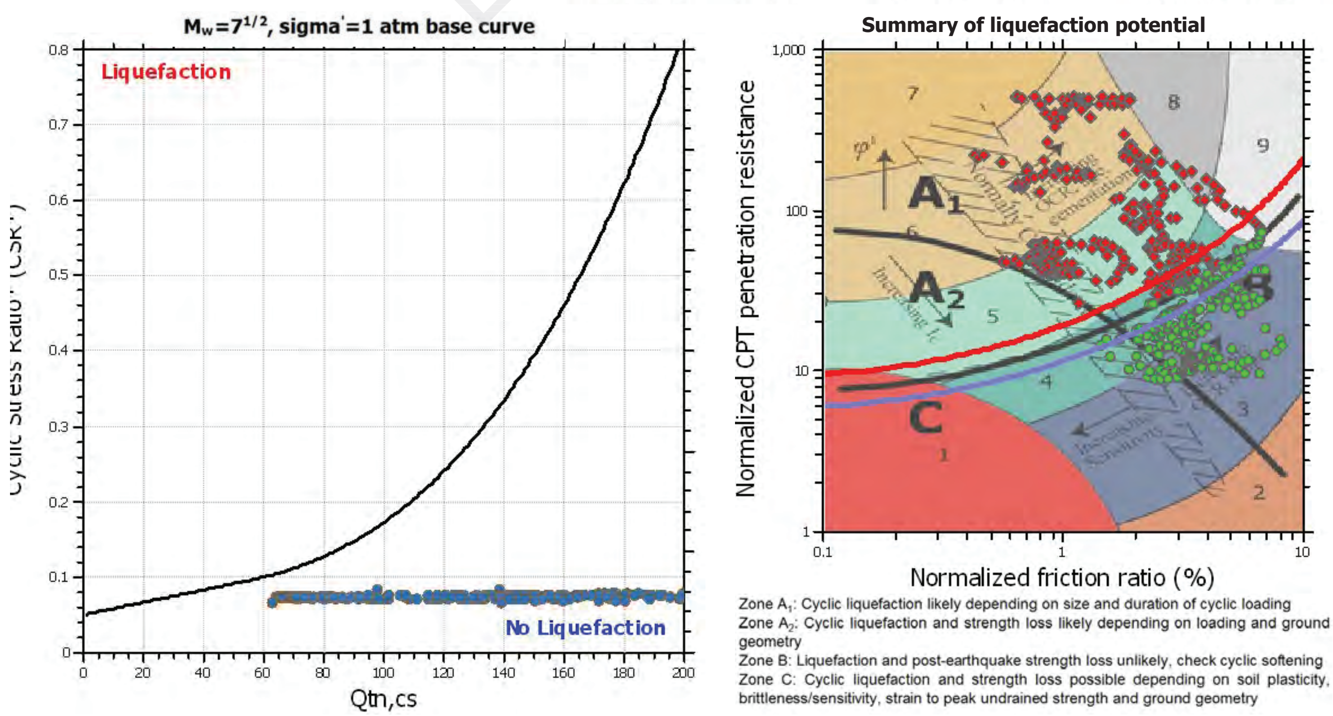
Project title : Martin Lake **Location : PDP-5**

CPT file : B-07

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	1.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.20	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.09	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		





Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

:: Liquefaction Potential Index calculation data ::

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
0.07	2.00	0.00	9.99	0.06	0.00	0.13	2.00	0.00	9.98	0.06	0.00
0.20	2.00	0.00	9.97	0.07	0.00	0.26	2.00	0.00	9.96	0.06	0.00
0.33	2.00	0.00	9.95	0.07	0.00	0.39	2.00	0.00	9.94	0.06	0.00
0.46	2.00	0.00	9.93	0.07	0.00	0.52	2.00	0.00	9.92	0.06	0.00
0.59	2.00	0.00	9.91	0.07	0.00	0.66	2.00	0.00	9.90	0.07	0.00
0.72	2.00	0.00	9.89	0.06	0.00	0.79	2.00	0.00	9.88	0.07	0.00
0.85	2.00	0.00	9.87	0.06	0.00	0.92	2.00	0.00	9.86	0.07	0.00
0.98	2.00	0.00	9.85	0.06	0.00	1.05	2.00	0.00	9.84	0.07	0.00
1.12	2.00	0.00	9.83	0.07	0.00	1.18	2.00	0.00	9.82	0.06	0.00
1.25	2.00	0.00	9.81	0.07	0.00	1.31	2.00	0.00	9.80	0.06	0.00
1.38	2.00	0.00	9.79	0.07	0.00	1.44	2.00	0.00	9.78	0.06	0.00
1.51	2.00	0.00	9.77	0.07	0.00	1.57	2.00	0.00	9.76	0.06	0.00
1.64	2.00	0.00	9.75	0.07	0.00	1.71	2.00	0.00	9.74	0.07	0.00
1.77	2.00	0.00	9.73	0.06	0.00	1.84	2.00	0.00	9.72	0.07	0.00
1.90	2.00	0.00	9.71	0.06	0.00	1.97	2.00	0.00	9.70	0.07	0.00
2.03	2.00	0.00	9.69	0.06	0.00	2.10	2.00	0.00	9.68	0.07	0.00
2.16	2.00	0.00	9.67	0.06	0.00	2.23	2.00	0.00	9.66	0.07	0.00
2.30	2.00	0.00	9.65	0.07	0.00	2.36	2.00	0.00	9.64	0.06	0.00
2.43	2.00	0.00	9.63	0.07	0.00	2.49	2.00	0.00	9.62	0.06	0.00
2.56	2.00	0.00	9.61	0.07	0.00	2.62	2.00	0.00	9.60	0.06	0.00
2.69	2.00	0.00	9.59	0.07	0.00	2.76	2.00	0.00	9.58	0.07	0.00
2.82	2.00	0.00	9.57	0.06	0.00	2.89	2.00	0.00	9.56	0.07	0.00
2.95	2.00	0.00	9.55	0.06	0.00	3.02	2.00	0.00	9.54	0.07	0.00
3.08	2.00	0.00	9.53	0.06	0.00	3.15	2.00	0.00	9.52	0.07	0.00
3.21	2.00	0.00	9.51	0.06	0.00	3.28	2.00	0.00	9.50	0.07	0.00
3.35	2.00	0.00	9.49	0.07	0.00	3.41	2.00	0.00	9.48	0.06	0.00
3.48	2.00	0.00	9.47	0.07	0.00	3.54	2.00	0.00	9.46	0.06	0.00
3.61	2.00	0.00	9.45	0.07	0.00	3.67	2.00	0.00	9.44	0.06	0.00
3.74	2.00	0.00	9.43	0.07	0.00	3.80	2.00	0.00	9.42	0.06	0.00
3.87	2.00	0.00	9.41	0.07	0.00	3.94	2.00	0.00	9.40	0.07	0.00
4.00	2.00	0.00	9.39	0.06	0.00	4.07	2.00	0.00	9.38	0.07	0.00
4.13	2.00	0.00	9.37	0.06	0.00	4.20	2.00	0.00	9.36	0.07	0.00
4.26	2.00	0.00	9.35	0.06	0.00	4.33	2.00	0.00	9.34	0.07	0.00
4.40	2.00	0.00	9.33	0.07	0.00	4.46	2.00	0.00	9.32	0.06	0.00
4.53	2.00	0.00	9.31	0.07	0.00	4.59	2.00	0.00	9.30	0.06	0.00
4.66	2.00	0.00	9.29	0.07	0.00	4.72	2.00	0.00	9.28	0.06	0.00
4.79	2.00	0.00	9.27	0.07	0.00	4.85	2.00	0.00	9.26	0.06	0.00
4.92	2.00	0.00	9.25	0.07	0.00	4.99	2.00	0.00	9.24	0.07	0.00
5.05	2.00	0.00	9.23	0.06	0.00	5.12	2.00	0.00	9.22	0.07	0.00
5.18	2.00	0.00	9.21	0.06	0.00	5.25	2.00	0.00	9.20	0.07	0.00
5.31	2.00	0.00	9.19	0.06	0.00	5.38	2.00	0.00	9.18	0.07	0.00
5.44	2.00	0.00	9.17	0.06	0.00	5.51	2.00	0.00	9.16	0.07	0.00
5.58	2.00	0.00	9.15	0.07	0.00	5.64	2.00	0.00	9.14	0.06	0.00
5.71	2.00	0.00	9.13	0.07	0.00	5.77	2.00	0.00	9.12	0.06	0.00
5.84	2.00	0.00	9.11	0.07	0.00	5.90	2.00	0.00	9.10	0.06	0.00
5.97	2.00	0.00	9.09	0.07	0.00	6.04	2.00	0.00	9.08	0.07	0.00
6.10	2.00	0.00	9.07	0.06	0.00	6.17	2.00	0.00	9.06	0.07	0.00
6.23	2.00	0.00	9.05	0.06	0.00	6.30	2.00	0.00	9.04	0.07	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
6.36	2.00	0.00	9.03	0.06	0.00	6.43	2.00	0.00	9.02	0.07	0.00
6.49	2.00	0.00	9.01	0.06	0.00	6.56	2.00	0.00	9.00	0.07	0.00
6.63	2.00	0.00	8.99	0.07	0.00	6.69	2.00	0.00	8.98	0.06	0.00
6.76	2.00	0.00	8.97	0.07	0.00	6.82	2.00	0.00	8.96	0.06	0.00
6.89	2.00	0.00	8.95	0.07	0.00	6.95	2.00	0.00	8.94	0.06	0.00
7.02	2.00	0.00	8.93	0.07	0.00	7.08	2.00	0.00	8.92	0.06	0.00
7.15	2.00	0.00	8.91	0.07	0.00	7.22	2.00	0.00	8.90	0.07	0.00
7.28	2.00	0.00	8.89	0.06	0.00	7.35	2.00	0.00	8.88	0.07	0.00
7.41	2.00	0.00	8.87	0.06	0.00	7.48	2.00	0.00	8.86	0.07	0.00
7.54	2.00	0.00	8.85	0.06	0.00	7.61	2.00	0.00	8.84	0.07	0.00
7.68	2.00	0.00	8.83	0.07	0.00	7.74	2.00	0.00	8.82	0.06	0.00
7.81	2.00	0.00	8.81	0.07	0.00	7.87	2.00	0.00	8.80	0.06	0.00
7.94	2.00	0.00	8.79	0.07	0.00	8.00	2.00	0.00	8.78	0.06	0.00
8.07	2.00	0.00	8.77	0.07	0.00	8.13	2.00	0.00	8.76	0.06	0.00
8.20	2.00	0.00	8.75	0.07	0.00	8.27	2.00	0.00	8.74	0.07	0.00
8.33	2.00	0.00	8.73	0.06	0.00	8.40	2.00	0.00	8.72	0.07	0.00
8.46	2.00	0.00	8.71	0.06	0.00	8.53	2.00	0.00	8.70	0.07	0.00
8.59	2.00	0.00	8.69	0.06	0.00	8.66	2.00	0.00	8.68	0.07	0.00
8.72	2.00	0.00	8.67	0.06	0.00	8.79	2.00	0.00	8.66	0.07	0.00
8.86	2.00	0.00	8.65	0.07	0.00	8.92	2.00	0.00	8.64	0.06	0.00
8.99	2.00	0.00	8.63	0.07	0.00	9.05	2.00	0.00	8.62	0.06	0.00
9.12	2.00	0.00	8.61	0.07	0.00	9.18	2.00	0.00	8.60	0.06	0.00
9.25	2.00	0.00	8.59	0.07	0.00	9.32	2.00	0.00	8.58	0.07	0.00
9.38	2.00	0.00	8.57	0.06	0.00	9.45	2.00	0.00	8.56	0.07	0.00
9.51	2.00	0.00	8.55	0.06	0.00	9.58	2.00	0.00	8.54	0.07	0.00
9.64	2.00	0.00	8.53	0.06	0.00	9.71	2.00	0.00	8.52	0.07	0.00
9.77	2.00	0.00	8.51	0.06	0.00	9.84	2.00	0.00	8.50	0.07	0.00
9.91	1.91	0.00	8.49	0.07	0.00	9.97	1.81	0.00	8.48	0.06	0.00
10.04	1.70	0.00	8.47	0.07	0.00	10.10	1.61	0.00	8.46	0.06	0.00
10.17	1.60	0.00	8.45	0.07	0.00	10.23	1.61	0.00	8.44	0.06	0.00
10.30	1.66	0.00	8.43	0.07	0.00	10.36	1.67	0.00	8.42	0.06	0.00
10.43	1.67	0.00	8.41	0.07	0.00	10.50	1.67	0.00	8.40	0.07	0.00
10.56	1.65	0.00	8.39	0.06	0.00	10.63	1.63	0.00	8.38	0.07	0.00
10.69	1.62	0.00	8.37	0.06	0.00	10.76	1.60	0.00	8.36	0.07	0.00
10.82	1.60	0.00	8.35	0.06	0.00	10.89	1.59	0.00	8.34	0.07	0.00
10.96	1.55	0.00	8.33	0.07	0.00	11.02	1.54	0.00	8.32	0.06	0.00
11.09	1.55	0.00	8.31	0.07	0.00	11.15	1.55	0.00	8.30	0.06	0.00
11.22	1.50	0.00	8.29	0.07	0.00	11.28	1.46	0.00	8.28	0.06	0.00
11.35	1.47	0.00	8.27	0.07	0.00	11.41	1.51	0.00	8.26	0.06	0.00
11.48	1.57	0.00	8.25	0.07	0.00	11.55	1.60	0.00	8.24	0.07	0.00
11.61	1.63	0.00	8.23	0.06	0.00	11.68	1.62	0.00	8.22	0.07	0.00
11.74	1.64	0.00	8.21	0.06	0.00	11.81	1.64	0.00	8.20	0.07	0.00
11.87	1.62	0.00	8.19	0.06	0.00	11.94	1.57	0.00	8.18	0.07	0.00
12.00	1.55	0.00	8.17	0.06	0.00	12.07	1.53	0.00	8.16	0.07	0.00
12.14	1.54	0.00	8.15	0.07	0.00	12.20	1.53	0.00	8.14	0.06	0.00
12.27	1.51	0.00	8.13	0.07	0.00	12.33	1.49	0.00	8.12	0.06	0.00
12.40	1.48	0.00	8.11	0.07	0.00	12.46	1.47	0.00	8.10	0.06	0.00
12.53	1.48	0.00	8.09	0.07	0.00	12.60	1.48	0.00	8.08	0.07	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
12.66	1.52	0.00	8.07	0.06	0.00	12.73	1.55	0.00	8.06	0.07	0.00
12.79	1.61	0.00	8.05	0.06	0.00	12.86	1.65	0.00	8.04	0.07	0.00
12.92	1.68	0.00	8.03	0.06	0.00	12.99	1.69	0.00	8.02	0.07	0.00
13.05	1.65	0.00	8.01	0.06	0.00	13.12	1.60	0.00	8.00	0.07	0.00
13.19	1.55	0.00	7.99	0.07	0.00	13.25	1.54	0.00	7.98	0.06	0.00
13.32	1.55	0.00	7.97	0.07	0.00	13.38	1.61	0.00	7.96	0.06	0.00
13.45	1.68	0.00	7.95	0.07	0.00	13.51	1.72	0.00	7.94	0.06	0.00
13.58	1.73	0.00	7.93	0.07	0.00	13.64	1.74	0.00	7.92	0.06	0.00
13.71	1.75	0.00	7.91	0.07	0.00	13.78	1.78	0.00	7.90	0.07	0.00
13.84	1.76	0.00	7.89	0.06	0.00	13.91	1.76	0.00	7.88	0.07	0.00
13.97	1.76	0.00	7.87	0.06	0.00	14.04	1.77	0.00	7.86	0.07	0.00
14.10	1.78	0.00	7.85	0.06	0.00	14.17	1.78	0.00	7.84	0.07	0.00
14.24	1.81	0.00	7.83	0.07	0.00	14.30	1.83	0.00	7.82	0.06	0.00
14.37	1.82	0.00	7.81	0.07	0.00	14.43	1.77	0.00	7.80	0.06	0.00
14.50	1.74	0.00	7.79	0.07	0.00	14.56	1.75	0.00	7.78	0.06	0.00
14.63	1.78	0.00	7.77	0.07	0.00	14.69	1.81	0.00	7.76	0.06	0.00
14.76	1.81	0.00	7.75	0.07	0.00	14.83	1.83	0.00	7.74	0.07	0.00
14.89	1.90	0.00	7.73	0.06	0.00	14.96	2.00	0.00	7.72	0.07	0.00
15.02	2.00	0.00	7.71	0.06	0.00	15.09	2.00	0.00	7.70	0.07	0.00
15.15	2.00	0.00	7.69	0.06	0.00	15.22	2.00	0.00	7.68	0.07	0.00
15.28	2.00	0.00	7.67	0.06	0.00	15.35	2.00	0.00	7.66	0.07	0.00
15.42	2.00	0.00	7.65	0.07	0.00	15.48	2.00	0.00	7.64	0.06	0.00
15.55	2.00	0.00	7.63	0.07	0.00	15.61	2.00	0.00	7.62	0.06	0.00
15.68	2.00	0.00	7.61	0.07	0.00	15.74	2.00	0.00	7.60	0.06	0.00
15.81	2.00	0.00	7.59	0.07	0.00	15.88	2.00	0.00	7.58	0.07	0.00
15.94	2.00	0.00	7.57	0.06	0.00	16.01	2.00	0.00	7.56	0.07	0.00
16.07	2.00	0.00	7.55	0.06	0.00	16.14	2.00	0.00	7.54	0.07	0.00
16.20	2.00	0.00	7.53	0.06	0.00	16.27	2.00	0.00	7.52	0.07	0.00
16.33	2.00	0.00	7.51	0.06	0.00	16.40	2.00	0.00	7.50	0.07	0.00
16.47	2.00	0.00	7.49	0.07	0.00	16.53	2.00	0.00	7.48	0.06	0.00
16.60	2.00	0.00	7.47	0.07	0.00	16.66	2.00	0.00	7.46	0.06	0.00
16.73	2.00	0.00	7.45	0.07	0.00	16.79	2.00	0.00	7.44	0.06	0.00
16.86	2.00	0.00	7.43	0.07	0.00	16.92	2.00	0.00	7.42	0.06	0.00
16.99	2.00	0.00	7.41	0.07	0.00	17.06	2.00	0.00	7.40	0.07	0.00
17.12	2.00	0.00	7.39	0.06	0.00	17.19	2.00	0.00	7.38	0.07	0.00
17.25	2.00	0.00	7.37	0.06	0.00	17.32	2.00	0.00	7.36	0.07	0.00
17.38	2.00	0.00	7.35	0.06	0.00	17.45	2.00	0.00	7.34	0.07	0.00
17.52	2.00	0.00	7.33	0.07	0.00	17.58	2.00	0.00	7.32	0.06	0.00
17.65	2.00	0.00	7.31	0.07	0.00	17.71	2.00	0.00	7.30	0.06	0.00
17.78	2.00	0.00	7.29	0.07	0.00	17.84	2.00	0.00	7.28	0.06	0.00
17.91	2.00	0.00	7.27	0.07	0.00	17.97	2.00	0.00	7.26	0.06	0.00
18.04	2.00	0.00	7.25	0.07	0.00	18.11	2.00	0.00	7.24	0.07	0.00
18.17	2.00	0.00	7.23	0.06	0.00	18.24	2.00	0.00	7.22	0.07	0.00
18.30	2.00	0.00	7.21	0.06	0.00	18.37	2.00	0.00	7.20	0.07	0.00
18.43	2.00	0.00	7.19	0.06	0.00	18.50	2.00	0.00	7.18	0.07	0.00
18.56	2.00	0.00	7.17	0.06	0.00	18.63	2.00	0.00	7.16	0.07	0.00
18.70	2.00	0.00	7.15	0.07	0.00	18.76	2.00	0.00	7.14	0.06	0.00
18.83	2.00	0.00	7.13	0.07	0.00	18.89	2.00	0.00	7.12	0.06	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
18.96	2.00	0.00	7.11	0.07	0.00	19.02	2.00	0.00	7.10	0.06	0.00
19.09	2.00	0.00	7.09	0.07	0.00	19.16	2.00	0.00	7.08	0.07	0.00
19.22	2.00	0.00	7.07	0.06	0.00	19.29	2.00	0.00	7.06	0.07	0.00
19.35	2.00	0.00	7.05	0.06	0.00	19.42	2.00	0.00	7.04	0.07	0.00
19.48	2.00	0.00	7.03	0.06	0.00	19.55	2.00	0.00	7.02	0.07	0.00
19.61	2.00	0.00	7.01	0.06	0.00	19.68	2.00	0.00	7.00	0.07	0.00
19.75	2.00	0.00	6.99	0.07	0.00	19.81	2.00	0.00	6.98	0.06	0.00
19.88	2.00	0.00	6.97	0.07	0.00	19.94	2.00	0.00	6.96	0.06	0.00
20.01	2.00	0.00	6.95	0.07	0.00	20.07	2.00	0.00	6.94	0.06	0.00
20.14	2.00	0.00	6.93	0.07	0.00	20.20	2.00	0.00	6.92	0.06	0.00
20.27	2.00	0.00	6.91	0.07	0.00	20.34	2.00	0.00	6.90	0.07	0.00
20.40	2.00	0.00	6.89	0.06	0.00	20.47	2.00	0.00	6.88	0.07	0.00
20.53	2.00	0.00	6.87	0.06	0.00	20.60	2.00	0.00	6.86	0.07	0.00
20.66	2.00	0.00	6.85	0.06	0.00	20.73	2.00	0.00	6.84	0.07	0.00
20.80	2.00	0.00	6.83	0.07	0.00	20.86	2.00	0.00	6.82	0.06	0.00
20.93	2.00	0.00	6.81	0.07	0.00	20.99	2.00	0.00	6.80	0.06	0.00
21.06	2.00	0.00	6.79	0.07	0.00	21.12	2.00	0.00	6.78	0.06	0.00
21.19	2.00	0.00	6.77	0.07	0.00	21.25	2.00	0.00	6.76	0.06	0.00
21.32	2.00	0.00	6.75	0.07	0.00	21.39	2.00	0.00	6.74	0.07	0.00
21.45	2.00	0.00	6.73	0.06	0.00	21.52	2.00	0.00	6.72	0.07	0.00
21.58	2.00	0.00	6.71	0.06	0.00	21.65	2.00	0.00	6.70	0.07	0.00
21.71	2.00	0.00	6.69	0.06	0.00	21.78	2.00	0.00	6.68	0.07	0.00
21.84	2.00	0.00	6.67	0.06	0.00	21.91	2.00	0.00	6.66	0.07	0.00
21.98	2.00	0.00	6.65	0.07	0.00	22.04	2.00	0.00	6.64	0.06	0.00
22.11	2.00	0.00	6.63	0.07	0.00	22.17	2.00	0.00	6.62	0.06	0.00
22.24	2.00	0.00	6.61	0.07	0.00	22.30	2.00	0.00	6.60	0.06	0.00
22.37	2.00	0.00	6.59	0.07	0.00	22.44	2.00	0.00	6.58	0.07	0.00
22.50	2.00	0.00	6.57	0.06	0.00	22.57	2.00	0.00	6.56	0.07	0.00
22.63	2.00	0.00	6.55	0.06	0.00	22.70	2.00	0.00	6.54	0.07	0.00
22.76	2.00	0.00	6.53	0.06	0.00	22.83	2.00	0.00	6.52	0.07	0.00
22.89	2.00	0.00	6.51	0.06	0.00	22.96	2.00	0.00	6.50	0.07	0.00
23.03	2.00	0.00	6.49	0.07	0.00	23.09	2.00	0.00	6.48	0.06	0.00
23.16	2.00	0.00	6.47	0.07	0.00	23.22	2.00	0.00	6.46	0.06	0.00
23.29	2.00	0.00	6.45	0.07	0.00	23.35	2.00	0.00	6.44	0.06	0.00
23.42	2.00	0.00	6.43	0.07	0.00	23.48	2.00	0.00	6.42	0.06	0.00
23.55	2.00	0.00	6.41	0.07	0.00	23.62	2.00	0.00	6.40	0.07	0.00
23.68	2.00	0.00	6.39	0.06	0.00	23.75	2.00	0.00	6.38	0.07	0.00
23.81	2.00	0.00	6.37	0.06	0.00	23.88	2.00	0.00	6.36	0.07	0.00
23.94	2.00	0.00	6.35	0.06	0.00	24.01	2.00	0.00	6.34	0.07	0.00
24.08	2.00	0.00	6.33	0.07	0.00	24.14	2.00	0.00	6.32	0.06	0.00
24.21	2.00	0.00	6.31	0.07	0.00	24.27	2.00	0.00	6.30	0.06	0.00
24.34	2.00	0.00	6.29	0.07	0.00	24.40	2.00	0.00	6.28	0.06	0.00
24.47	2.00	0.00	6.27	0.07	0.00	24.53	2.00	0.00	6.26	0.06	0.00
24.60	2.00	0.00	6.25	0.07	0.00	24.67	2.00	0.00	6.24	0.07	0.00
24.73	2.00	0.00	6.23	0.06	0.00	24.80	2.00	0.00	6.22	0.07	0.00
24.86	2.00	0.00	6.21	0.06	0.00	24.93	2.00	0.00	6.20	0.07	0.00
24.99	2.00	0.00	6.19	0.06	0.00	25.06	2.00	0.00	6.18	0.07	0.00
25.12	2.00	0.00	6.17	0.06	0.00	25.19	2.00	0.00	6.16	0.07	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
25.26	2.00	0.00	6.15	0.07	0.00	25.32	2.00	0.00	6.14	0.06	0.00
25.39	2.00	0.00	6.13	0.07	0.00	25.45	2.00	0.00	6.12	0.06	0.00
25.52	2.00	0.00	6.11	0.07	0.00	25.58	2.00	0.00	6.10	0.06	0.00
25.65	2.00	0.00	6.09	0.07	0.00	25.72	2.00	0.00	6.08	0.07	0.00
25.78	2.00	0.00	6.07	0.06	0.00	25.85	2.00	0.00	6.06	0.07	0.00
25.91	2.00	0.00	6.05	0.06	0.00	25.98	2.00	0.00	6.04	0.07	0.00
26.04	2.00	0.00	6.03	0.06	0.00	26.11	2.00	0.00	6.02	0.07	0.00
26.17	2.00	0.00	6.01	0.06	0.00	26.24	2.00	0.00	6.00	0.07	0.00
26.31	2.00	0.00	5.99	0.07	0.00	26.37	2.00	0.00	5.98	0.06	0.00
26.44	2.00	0.00	5.97	0.07	0.00	26.50	2.00	0.00	5.96	0.06	0.00
26.57	2.00	0.00	5.95	0.07	0.00	26.63	2.00	0.00	5.94	0.06	0.00
26.70	2.00	0.00	5.93	0.07	0.00	26.76	2.00	0.00	5.92	0.06	0.00
26.83	2.00	0.00	5.91	0.07	0.00	26.90	2.00	0.00	5.90	0.07	0.00
26.96	2.00	0.00	5.89	0.06	0.00	27.03	2.00	0.00	5.88	0.07	0.00
27.09	2.00	0.00	5.87	0.06	0.00	27.16	2.00	0.00	5.86	0.07	0.00
27.22	2.00	0.00	5.85	0.06	0.00	27.29	2.00	0.00	5.84	0.07	0.00
27.36	2.00	0.00	5.83	0.07	0.00	27.42	2.00	0.00	5.82	0.06	0.00
27.49	2.00	0.00	5.81	0.07	0.00	27.55	2.00	0.00	5.80	0.06	0.00
27.62	2.00	0.00	5.79	0.07	0.00	27.68	2.00	0.00	5.78	0.06	0.00
27.75	2.00	0.00	5.77	0.07	0.00	27.81	2.00	0.00	5.76	0.06	0.00
27.88	2.00	0.00	5.75	0.07	0.00	27.95	2.00	0.00	5.74	0.07	0.00
28.01	2.00	0.00	5.73	0.06	0.00	28.08	2.00	0.00	5.72	0.07	0.00
28.14	2.00	0.00	5.71	0.06	0.00	28.21	2.00	0.00	5.70	0.07	0.00
28.27	2.00	0.00	5.69	0.06	0.00	28.34	2.00	0.00	5.68	0.07	0.00
28.40	2.00	0.00	5.67	0.06	0.00	28.47	2.00	0.00	5.66	0.07	0.00
28.54	2.00	0.00	5.65	0.07	0.00	28.60	2.00	0.00	5.64	0.06	0.00
28.67	2.00	0.00	5.63	0.07	0.00	28.73	2.00	0.00	5.62	0.06	0.00
28.80	2.00	0.00	5.61	0.07	0.00	28.86	2.00	0.00	5.60	0.06	0.00
28.93	2.00	0.00	5.59	0.07	0.00	29.00	2.00	0.00	5.58	0.07	0.00
29.06	2.00	0.00	5.57	0.06	0.00	29.13	2.00	0.00	5.56	0.07	0.00
29.19	2.00	0.00	5.55	0.06	0.00	29.26	2.00	0.00	5.54	0.07	0.00
29.32	2.00	0.00	5.53	0.06	0.00	29.39	2.00	0.00	5.52	0.07	0.00
29.45	2.00	0.00	5.51	0.06	0.00	29.52	2.00	0.00	5.50	0.07	0.00
29.59	2.00	0.00	5.49	0.07	0.00	29.65	2.00	0.00	5.48	0.06	0.00
29.72	2.00	0.00	5.47	0.07	0.00	29.78	2.00	0.00	5.46	0.06	0.00
29.85	2.00	0.00	5.45	0.07	0.00	29.91	2.00	0.00	5.44	0.06	0.00
29.98	2.00	0.00	5.43	0.07	0.00	30.04	2.00	0.00	5.42	0.06	0.00
30.11	2.00	0.00	5.41	0.07	0.00	30.18	2.00	0.00	5.40	0.07	0.00
30.24	2.00	0.00	5.39	0.06	0.00	30.31	2.00	0.00	5.38	0.07	0.00
30.37	2.00	0.00	5.37	0.06	0.00	30.44	2.00	0.00	5.36	0.07	0.00
30.50	2.00	0.00	5.35	0.06	0.00	30.57	2.00	0.00	5.34	0.07	0.00
30.64	2.00	0.00	5.33	0.07	0.00	30.70	2.00	0.00	5.32	0.06	0.00
30.77	2.00	0.00	5.31	0.07	0.00	30.83	2.00	0.00	5.30	0.06	0.00
30.90	2.00	0.00	5.29	0.07	0.00	30.96	2.00	0.00	5.28	0.06	0.00
31.03	2.00	0.00	5.27	0.07	0.00	31.09	2.00	0.00	5.26	0.06	0.00
31.16	2.00	0.00	5.25	0.07	0.00	31.23	2.00	0.00	5.24	0.07	0.00
31.29	2.00	0.00	5.23	0.06	0.00	31.36	2.00	0.00	5.22	0.07	0.00
31.42	2.00	0.00	5.21	0.06	0.00	31.49	2.00	0.00	5.20	0.07	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
31.55	2.00	0.00	5.19	0.06	0.00	31.62	2.00	0.00	5.18	0.07	0.00
31.68	2.00	0.00	5.17	0.06	0.00	31.75	2.00	0.00	5.16	0.07	0.00
31.82	2.00	0.00	5.15	0.07	0.00	31.88	2.00	0.00	5.14	0.06	0.00
31.95	2.00	0.00	5.13	0.07	0.00	32.01	2.00	0.00	5.12	0.06	0.00
32.08	2.00	0.00	5.11	0.07	0.00	32.14	2.00	0.00	5.10	0.06	0.00
32.21	2.00	0.00	5.09	0.07	0.00	32.28	2.00	0.00	5.08	0.07	0.00
32.34	2.00	0.00	5.07	0.06	0.00	32.41	2.00	0.00	5.06	0.07	0.00
32.47	2.00	0.00	5.05	0.06	0.00	32.54	2.00	0.00	5.04	0.07	0.00
32.60	2.00	0.00	5.03	0.06	0.00	32.67	2.00	0.00	5.02	0.07	0.00
32.73	2.00	0.00	5.01	0.06	0.00	32.80	2.00	0.00	5.00	0.07	0.00
32.87	2.00	0.00	4.99	0.07	0.00	32.93	2.00	0.00	4.98	0.06	0.00
33.00	2.00	0.00	4.97	0.07	0.00	33.06	2.00	0.00	4.96	0.06	0.00
33.13	2.00	0.00	4.95	0.07	0.00	33.19	2.00	0.00	4.94	0.06	0.00
33.26	2.00	0.00	4.93	0.07	0.00	33.32	2.00	0.00	4.92	0.06	0.00
33.39	2.00	0.00	4.91	0.07	0.00	33.46	2.00	0.00	4.90	0.07	0.00
33.52	2.00	0.00	4.89	0.06	0.00	33.59	2.00	0.00	4.88	0.07	0.00
33.65	2.00	0.00	4.87	0.06	0.00	33.72	2.00	0.00	4.86	0.07	0.00
33.78	2.00	0.00	4.85	0.06	0.00	33.85	2.00	0.00	4.84	0.07	0.00
33.92	2.00	0.00	4.83	0.07	0.00	33.98	2.00	0.00	4.82	0.06	0.00
34.05	2.00	0.00	4.81	0.07	0.00	34.11	2.00	0.00	4.80	0.06	0.00
34.18	2.00	0.00	4.79	0.07	0.00	34.24	2.00	0.00	4.78	0.06	0.00
34.31	2.00	0.00	4.77	0.07	0.00	34.37	2.00	0.00	4.76	0.06	0.00
34.44	2.00	0.00	4.75	0.07	0.00	34.51	2.00	0.00	4.74	0.07	0.00
34.57	2.00	0.00	4.73	0.06	0.00	34.64	2.00	0.00	4.72	0.07	0.00
34.70	2.00	0.00	4.71	0.06	0.00	34.77	2.00	0.00	4.70	0.07	0.00
34.83	2.00	0.00	4.69	0.06	0.00	34.90	2.00	0.00	4.68	0.07	0.00
34.96	2.00	0.00	4.67	0.06	0.00	35.03	2.00	0.00	4.66	0.07	0.00
35.10	2.00	0.00	4.65	0.07	0.00	35.16	2.00	0.00	4.64	0.06	0.00
35.23	2.00	0.00	4.63	0.07	0.00	35.29	2.00	0.00	4.62	0.06	0.00
35.36	2.00	0.00	4.61	0.07	0.00	35.42	2.00	0.00	4.60	0.06	0.00
35.49	2.00	0.00	4.59	0.07	0.00	35.56	2.00	0.00	4.58	0.07	0.00
35.62	2.00	0.00	4.57	0.06	0.00	35.69	2.00	0.00	4.56	0.07	0.00
35.75	2.00	0.00	4.55	0.06	0.00	35.82	2.00	0.00	4.54	0.07	0.00
35.88	2.00	0.00	4.53	0.06	0.00	35.95	2.00	0.00	4.52	0.07	0.00
36.01	2.00	0.00	4.51	0.06	0.00	36.08	2.00	0.00	4.50	0.07	0.00
36.15	2.00	0.00	4.49	0.07	0.00	36.21	2.00	0.00	4.48	0.06	0.00
36.28	2.00	0.00	4.47	0.07	0.00	36.34	2.00	0.00	4.46	0.06	0.00
36.41	2.00	0.00	4.45	0.07	0.00	36.47	2.00	0.00	4.44	0.06	0.00
36.54	2.00	0.00	4.43	0.07	0.00	36.60	2.00	0.00	4.42	0.06	0.00
36.67	2.00	0.00	4.41	0.07	0.00	36.74	2.00	0.00	4.40	0.07	0.00
36.80	2.00	0.00	4.39	0.06	0.00	36.87	2.00	0.00	4.38	0.07	0.00
36.93	2.00	0.00	4.37	0.06	0.00	37.00	2.00	0.00	4.36	0.07	0.00
37.06	2.00	0.00	4.35	0.06	0.00	37.13	2.00	0.00	4.34	0.07	0.00
37.20	2.00	0.00	4.33	0.07	0.00	37.26	2.00	0.00	4.32	0.06	0.00
37.33	2.00	0.00	4.31	0.07	0.00	37.39	2.00	0.00	4.30	0.06	0.00
37.46	2.00	0.00	4.29	0.07	0.00	37.52	2.00	0.00	4.28	0.06	0.00
37.59	2.00	0.00	4.27	0.07	0.00	37.65	2.00	0.00	4.26	0.06	0.00
37.72	2.00	0.00	4.25	0.07	0.00	37.79	2.00	0.00	4.24	0.07	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
37.85	2.00	0.00	4.23	0.06	0.00	37.92	2.00	0.00	4.22	0.07	0.00
37.98	2.00	0.00	4.21	0.06	0.00	38.05	2.00	0.00	4.20	0.07	0.00
38.11	2.00	0.00	4.19	0.06	0.00	38.18	2.00	0.00	4.18	0.07	0.00
38.24	2.00	0.00	4.17	0.06	0.00	38.31	2.00	0.00	4.16	0.07	0.00
38.38	2.00	0.00	4.15	0.07	0.00	38.44	2.00	0.00	4.14	0.06	0.00
38.51	2.00	0.00	4.13	0.07	0.00	38.57	2.00	0.00	4.12	0.06	0.00
38.64	2.00	0.00	4.11	0.07	0.00	38.70	2.00	0.00	4.10	0.06	0.00
38.77	2.00	0.00	4.09	0.07	0.00	38.84	2.00	0.00	4.08	0.07	0.00
38.90	2.00	0.00	4.07	0.06	0.00	38.97	2.00	0.00	4.06	0.07	0.00
39.03	2.00	0.00	4.05	0.06	0.00	39.10	2.00	0.00	4.04	0.07	0.00
39.16	2.00	0.00	4.03	0.06	0.00	39.23	2.00	0.00	4.02	0.07	0.00
39.29	2.00	0.00	4.01	0.06	0.00	39.36	2.00	0.00	4.00	0.07	0.00
39.43	2.00	0.00	3.99	0.07	0.00	39.49	2.00	0.00	3.98	0.06	0.00
39.56	2.00	0.00	3.97	0.07	0.00	39.62	2.00	0.00	3.96	0.06	0.00
39.69	2.00	0.00	3.95	0.07	0.00	39.75	2.00	0.00	3.94	0.06	0.00
39.82	2.00	0.00	3.93	0.07	0.00	39.88	2.00	0.00	3.92	0.06	0.00
39.95	2.00	0.00	3.91	0.07	0.00	40.02	2.00	0.00	3.90	0.07	0.00
40.08	1.57	0.00	3.89	0.06	0.00	40.15	2.00	0.00	3.88	0.07	0.00
40.21	2.00	0.00	3.87	0.06	0.00						

Overall liquefaction potential: 0.00

LPI = 0.00 - Liquefaction risk very low
LPI between 0.00 and 5.00 - Liquefaction risk low
LPI between 5.00 and 15.00 - Liquefaction risk high
LPI > 15.00 - Liquefaction risk very high

Abbreviations

FS: Calculated factor of safety for test point
F_L: 1 - FS
w_z: Function value of the extend of soil liquefaction according to depth
d_z: Layer thickness (ft)
LPI: Liquefaction potential index value for test point

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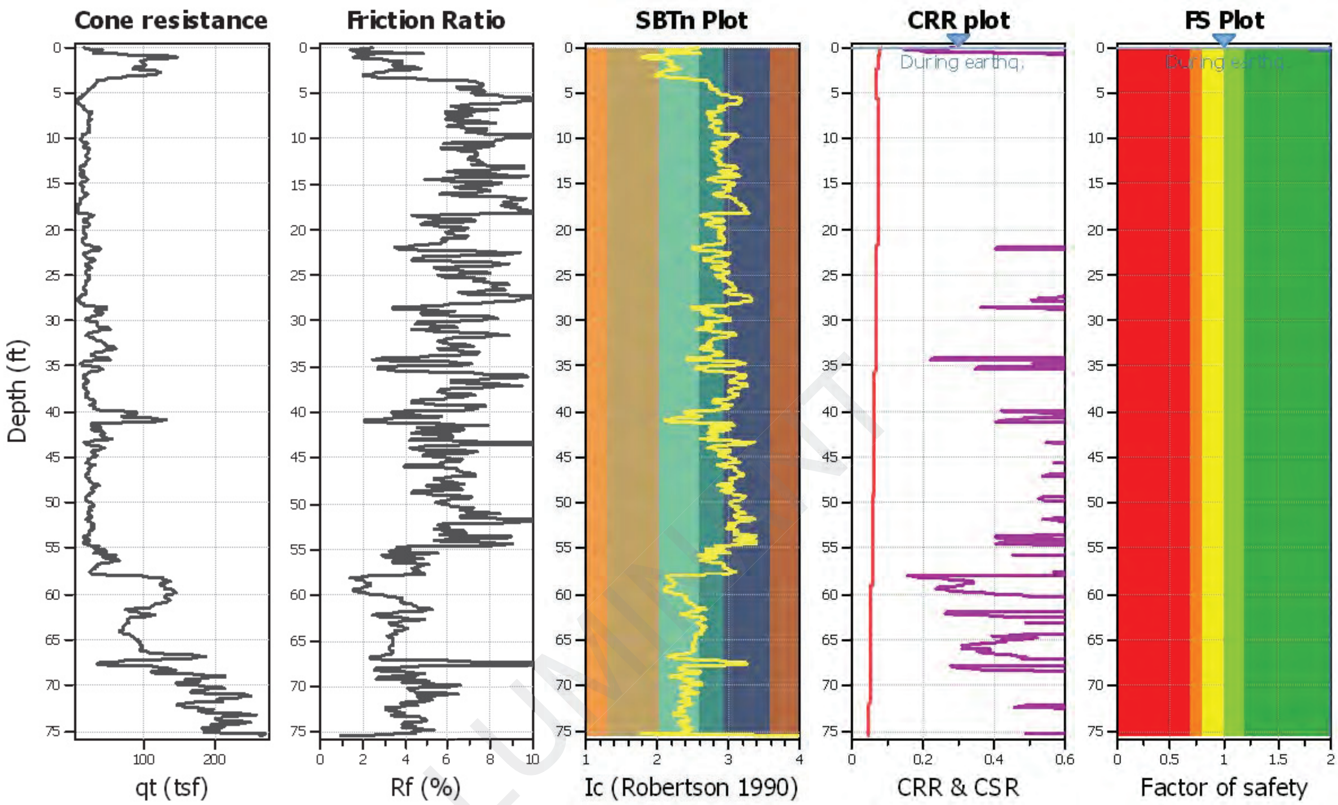
LIQUEFACTION ANALYSIS REPORT

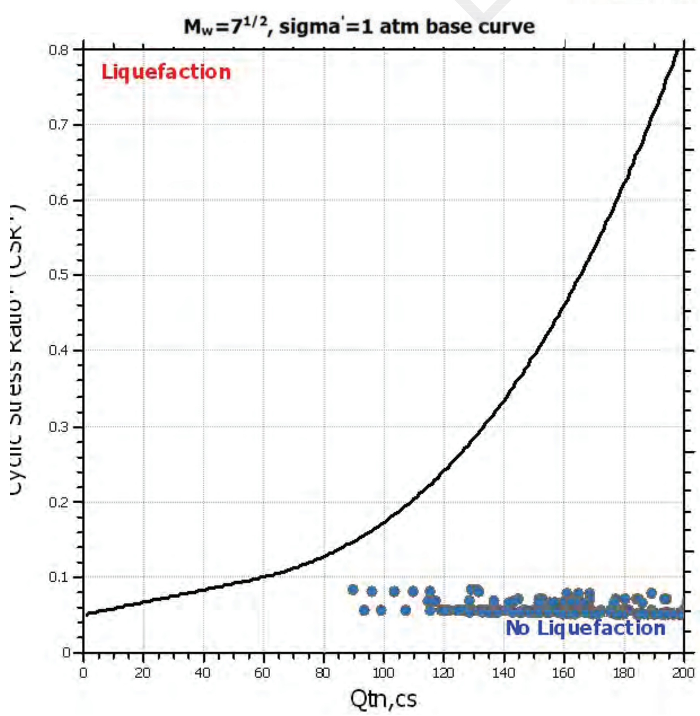
Project title : Martin Lake **Location : PDP-5**

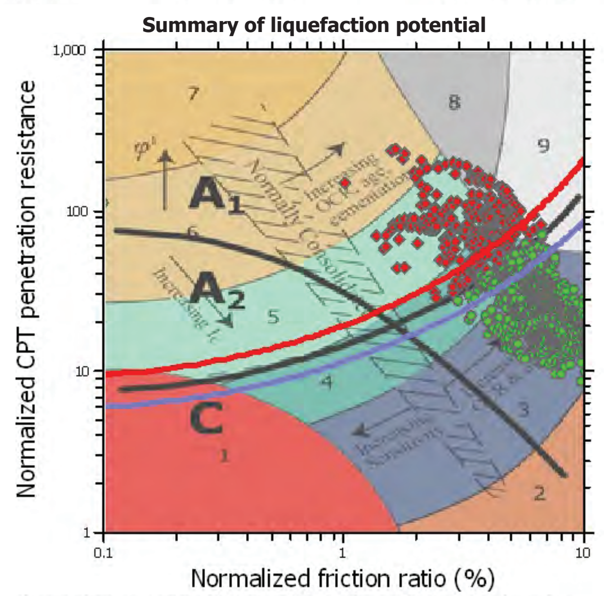
CPT file : B-12

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	1.00 ft	Use fill:	No	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	0.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.20	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.09	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

:: Liquefaction Potential Index calculation data ::

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
0.07	2.00	0.00	9.99	0.06	0.00	0.13	2.00	0.00	9.98	0.06	0.00
0.20	1.80	0.00	9.97	0.07	0.00	0.26	2.00	0.00	9.96	0.06	0.00
0.33	2.00	0.00	9.95	0.07	0.00	0.39	2.00	0.00	9.94	0.06	0.00
0.46	2.00	0.00	9.93	0.07	0.00	0.52	2.00	0.00	9.92	0.06	0.00
0.59	2.00	0.00	9.91	0.07	0.00	0.66	2.00	0.00	9.90	0.07	0.00
0.72	2.00	0.00	9.89	0.06	0.00	0.79	2.00	0.00	9.88	0.07	0.00
0.85	2.00	0.00	9.87	0.06	0.00	0.92	2.00	0.00	9.86	0.07	0.00
0.98	2.00	0.00	9.85	0.06	0.00	1.05	2.00	0.00	9.84	0.07	0.00
1.12	2.00	0.00	9.83	0.07	0.00	1.18	2.00	0.00	9.82	0.06	0.00
1.25	2.00	0.00	9.81	0.07	0.00	1.31	2.00	0.00	9.80	0.06	0.00
1.38	2.00	0.00	9.79	0.07	0.00	1.44	2.00	0.00	9.78	0.06	0.00
1.51	2.00	0.00	9.77	0.07	0.00	1.57	2.00	0.00	9.76	0.06	0.00
1.64	2.00	0.00	9.75	0.07	0.00	1.71	2.00	0.00	9.74	0.07	0.00
1.77	2.00	0.00	9.73	0.06	0.00	1.84	2.00	0.00	9.72	0.07	0.00
1.90	2.00	0.00	9.71	0.06	0.00	1.97	2.00	0.00	9.70	0.07	0.00
2.03	2.00	0.00	9.69	0.06	0.00	2.10	2.00	0.00	9.68	0.07	0.00
2.16	2.00	0.00	9.67	0.06	0.00	2.23	2.00	0.00	9.66	0.07	0.00
2.30	2.00	0.00	9.65	0.07	0.00	2.36	2.00	0.00	9.64	0.06	0.00
2.43	2.00	0.00	9.63	0.07	0.00	2.49	2.00	0.00	9.62	0.06	0.00
2.56	2.00	0.00	9.61	0.07	0.00	2.62	2.00	0.00	9.60	0.06	0.00
2.69	2.00	0.00	9.59	0.07	0.00	2.76	2.00	0.00	9.58	0.07	0.00
2.82	2.00	0.00	9.57	0.06	0.00	2.89	2.00	0.00	9.56	0.07	0.00
2.95	2.00	0.00	9.55	0.06	0.00	3.02	2.00	0.00	9.54	0.07	0.00
3.08	2.00	0.00	9.53	0.06	0.00	3.15	2.00	0.00	9.52	0.07	0.00
3.21	2.00	0.00	9.51	0.06	0.00	3.28	2.00	0.00	9.50	0.07	0.00
3.35	2.00	0.00	9.49	0.07	0.00	3.41	2.00	0.00	9.48	0.06	0.00
3.48	2.00	0.00	9.47	0.07	0.00	3.54	2.00	0.00	9.46	0.06	0.00
3.61	2.00	0.00	9.45	0.07	0.00	3.67	2.00	0.00	9.44	0.06	0.00
3.74	2.00	0.00	9.43	0.07	0.00	3.80	2.00	0.00	9.42	0.06	0.00
3.87	2.00	0.00	9.41	0.07	0.00	3.94	2.00	0.00	9.40	0.07	0.00
4.00	2.00	0.00	9.39	0.06	0.00	4.07	2.00	0.00	9.38	0.07	0.00
4.13	2.00	0.00	9.37	0.06	0.00	4.20	2.00	0.00	9.36	0.07	0.00
4.26	2.00	0.00	9.35	0.06	0.00	4.33	2.00	0.00	9.34	0.07	0.00
4.40	2.00	0.00	9.33	0.07	0.00	4.46	2.00	0.00	9.32	0.06	0.00
4.53	2.00	0.00	9.31	0.07	0.00	4.59	2.00	0.00	9.30	0.06	0.00
4.66	2.00	0.00	9.29	0.07	0.00	4.72	2.00	0.00	9.28	0.06	0.00
4.79	2.00	0.00	9.27	0.07	0.00	4.85	2.00	0.00	9.26	0.06	0.00
4.92	2.00	0.00	9.25	0.07	0.00	4.99	2.00	0.00	9.24	0.07	0.00
5.05	2.00	0.00	9.23	0.06	0.00	5.12	2.00	0.00	9.22	0.07	0.00
5.18	2.00	0.00	9.21	0.06	0.00	5.25	2.00	0.00	9.20	0.07	0.00
5.31	2.00	0.00	9.19	0.06	0.00	5.38	2.00	0.00	9.18	0.07	0.00
5.44	2.00	0.00	9.17	0.06	0.00	5.51	2.00	0.00	9.16	0.07	0.00
5.58	2.00	0.00	9.15	0.07	0.00	5.64	2.00	0.00	9.14	0.06	0.00
5.71	2.00	0.00	9.13	0.07	0.00	5.77	2.00	0.00	9.12	0.06	0.00
5.84	2.00	0.00	9.11	0.07	0.00	5.90	2.00	0.00	9.10	0.06	0.00
5.97	2.00	0.00	9.09	0.07	0.00	6.04	2.00	0.00	9.08	0.07	0.00
6.10	2.00	0.00	9.07	0.06	0.00	6.17	2.00	0.00	9.06	0.07	0.00
6.23	2.00	0.00	9.05	0.06	0.00	6.30	2.00	0.00	9.04	0.07	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
6.36	2.00	0.00	9.03	0.06	0.00	6.43	2.00	0.00	9.02	0.07	0.00
6.49	2.00	0.00	9.01	0.06	0.00	6.56	2.00	0.00	9.00	0.07	0.00
6.63	2.00	0.00	8.99	0.07	0.00	6.69	2.00	0.00	8.98	0.06	0.00
6.76	2.00	0.00	8.97	0.07	0.00	6.82	2.00	0.00	8.96	0.06	0.00
6.89	2.00	0.00	8.95	0.07	0.00	6.95	2.00	0.00	8.94	0.06	0.00
7.02	2.00	0.00	8.93	0.07	0.00	7.08	2.00	0.00	8.92	0.06	0.00
7.15	2.00	0.00	8.91	0.07	0.00	7.22	2.00	0.00	8.90	0.07	0.00
7.28	2.00	0.00	8.89	0.06	0.00	7.35	2.00	0.00	8.88	0.07	0.00
7.41	2.00	0.00	8.87	0.06	0.00	7.48	2.00	0.00	8.86	0.07	0.00
7.54	2.00	0.00	8.85	0.06	0.00	7.61	2.00	0.00	8.84	0.07	0.00
7.68	2.00	0.00	8.83	0.07	0.00	7.74	2.00	0.00	8.82	0.06	0.00
7.81	2.00	0.00	8.81	0.07	0.00	7.87	2.00	0.00	8.80	0.06	0.00
7.94	2.00	0.00	8.79	0.07	0.00	8.00	2.00	0.00	8.78	0.06	0.00
8.07	2.00	0.00	8.77	0.07	0.00	8.13	2.00	0.00	8.76	0.06	0.00
8.20	2.00	0.00	8.75	0.07	0.00	8.27	2.00	0.00	8.74	0.07	0.00
8.33	2.00	0.00	8.73	0.06	0.00	8.40	2.00	0.00	8.72	0.07	0.00
8.46	2.00	0.00	8.71	0.06	0.00	8.53	2.00	0.00	8.70	0.07	0.00
8.59	2.00	0.00	8.69	0.06	0.00	8.66	2.00	0.00	8.68	0.07	0.00
8.72	2.00	0.00	8.67	0.06	0.00	8.79	2.00	0.00	8.66	0.07	0.00
8.86	2.00	0.00	8.65	0.07	0.00	8.92	2.00	0.00	8.64	0.06	0.00
8.99	2.00	0.00	8.63	0.07	0.00	9.05	2.00	0.00	8.62	0.06	0.00
9.12	2.00	0.00	8.61	0.07	0.00	9.18	2.00	0.00	8.60	0.06	0.00
9.25	2.00	0.00	8.59	0.07	0.00	9.32	2.00	0.00	8.58	0.07	0.00
9.38	2.00	0.00	8.57	0.06	0.00	9.45	2.00	0.00	8.56	0.07	0.00
9.51	2.00	0.00	8.55	0.06	0.00	9.58	2.00	0.00	8.54	0.07	0.00
9.64	2.00	0.00	8.53	0.06	0.00	9.71	2.00	0.00	8.52	0.07	0.00
9.77	2.00	0.00	8.51	0.06	0.00	9.84	2.00	0.00	8.50	0.07	0.00
9.91	2.00	0.00	8.49	0.07	0.00	9.97	2.00	0.00	8.48	0.06	0.00
10.04	2.00	0.00	8.47	0.07	0.00	10.10	2.00	0.00	8.46	0.06	0.00
10.17	2.00	0.00	8.45	0.07	0.00	10.23	2.00	0.00	8.44	0.06	0.00
10.30	2.00	0.00	8.43	0.07	0.00	10.36	2.00	0.00	8.42	0.06	0.00
10.43	2.00	0.00	8.41	0.07	0.00	10.50	2.00	0.00	8.40	0.07	0.00
10.56	2.00	0.00	8.39	0.06	0.00	10.63	2.00	0.00	8.38	0.07	0.00
10.69	2.00	0.00	8.37	0.06	0.00	10.76	2.00	0.00	8.36	0.07	0.00
10.82	2.00	0.00	8.35	0.06	0.00	10.89	2.00	0.00	8.34	0.07	0.00
10.96	2.00	0.00	8.33	0.07	0.00	11.02	2.00	0.00	8.32	0.06	0.00
11.09	2.00	0.00	8.31	0.07	0.00	11.15	2.00	0.00	8.30	0.06	0.00
11.22	2.00	0.00	8.29	0.07	0.00	11.28	2.00	0.00	8.28	0.06	0.00
11.35	2.00	0.00	8.27	0.07	0.00	11.41	2.00	0.00	8.26	0.06	0.00
11.48	2.00	0.00	8.25	0.07	0.00	11.55	2.00	0.00	8.24	0.07	0.00
11.61	2.00	0.00	8.23	0.06	0.00	11.68	2.00	0.00	8.22	0.07	0.00
11.74	2.00	0.00	8.21	0.06	0.00	11.81	2.00	0.00	8.20	0.07	0.00
11.87	2.00	0.00	8.19	0.06	0.00	11.94	2.00	0.00	8.18	0.07	0.00
12.00	2.00	0.00	8.17	0.06	0.00	12.07	2.00	0.00	8.16	0.07	0.00
12.14	2.00	0.00	8.15	0.07	0.00	12.20	2.00	0.00	8.14	0.06	0.00
12.27	2.00	0.00	8.13	0.07	0.00	12.33	2.00	0.00	8.12	0.06	0.00
12.40	2.00	0.00	8.11	0.07	0.00	12.46	2.00	0.00	8.10	0.06	0.00
12.53	2.00	0.00	8.09	0.07	0.00	12.60	2.00	0.00	8.08	0.07	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
12.66	2.00	0.00	8.07	0.06	0.00	12.73	2.00	0.00	8.06	0.07	0.00
12.79	2.00	0.00	8.05	0.06	0.00	12.86	2.00	0.00	8.04	0.07	0.00
12.92	2.00	0.00	8.03	0.06	0.00	12.99	2.00	0.00	8.02	0.07	0.00
13.05	2.00	0.00	8.01	0.06	0.00	13.12	2.00	0.00	8.00	0.07	0.00
13.19	2.00	0.00	7.99	0.07	0.00	13.25	2.00	0.00	7.98	0.06	0.00
13.32	2.00	0.00	7.97	0.07	0.00	13.38	2.00	0.00	7.96	0.06	0.00
13.45	2.00	0.00	7.95	0.07	0.00	13.51	2.00	0.00	7.94	0.06	0.00
13.58	2.00	0.00	7.93	0.07	0.00	13.64	2.00	0.00	7.92	0.06	0.00
13.71	2.00	0.00	7.91	0.07	0.00	13.78	2.00	0.00	7.90	0.07	0.00
13.84	2.00	0.00	7.89	0.06	0.00	13.91	2.00	0.00	7.88	0.07	0.00
13.97	2.00	0.00	7.87	0.06	0.00	14.04	2.00	0.00	7.86	0.07	0.00
14.10	2.00	0.00	7.85	0.06	0.00	14.17	2.00	0.00	7.84	0.07	0.00
14.24	2.00	0.00	7.83	0.07	0.00	14.30	2.00	0.00	7.82	0.06	0.00
14.37	2.00	0.00	7.81	0.07	0.00	14.43	2.00	0.00	7.80	0.06	0.00
14.50	2.00	0.00	7.79	0.07	0.00	14.56	2.00	0.00	7.78	0.06	0.00
14.63	2.00	0.00	7.77	0.07	0.00	14.69	2.00	0.00	7.76	0.06	0.00
14.76	2.00	0.00	7.75	0.07	0.00	14.83	2.00	0.00	7.74	0.07	0.00
14.89	2.00	0.00	7.73	0.06	0.00	14.96	2.00	0.00	7.72	0.07	0.00
15.02	2.00	0.00	7.71	0.06	0.00	15.09	2.00	0.00	7.70	0.07	0.00
15.15	2.00	0.00	7.69	0.06	0.00	15.22	2.00	0.00	7.68	0.07	0.00
15.28	2.00	0.00	7.67	0.06	0.00	15.35	2.00	0.00	7.66	0.07	0.00
15.42	2.00	0.00	7.65	0.07	0.00	15.48	2.00	0.00	7.64	0.06	0.00
15.55	2.00	0.00	7.63	0.07	0.00	15.61	2.00	0.00	7.62	0.06	0.00
15.68	2.00	0.00	7.61	0.07	0.00	15.74	2.00	0.00	7.60	0.06	0.00
15.81	2.00	0.00	7.59	0.07	0.00	15.88	2.00	0.00	7.58	0.07	0.00
15.94	2.00	0.00	7.57	0.06	0.00	16.01	2.00	0.00	7.56	0.07	0.00
16.07	2.00	0.00	7.55	0.06	0.00	16.14	2.00	0.00	7.54	0.07	0.00
16.20	2.00	0.00	7.53	0.06	0.00	16.27	2.00	0.00	7.52	0.07	0.00
16.33	2.00	0.00	7.51	0.06	0.00	16.40	2.00	0.00	7.50	0.07	0.00
16.47	2.00	0.00	7.49	0.07	0.00	16.53	2.00	0.00	7.48	0.06	0.00
16.60	2.00	0.00	7.47	0.07	0.00	16.66	2.00	0.00	7.46	0.06	0.00
16.73	2.00	0.00	7.45	0.07	0.00	16.79	2.00	0.00	7.44	0.06	0.00
16.86	2.00	0.00	7.43	0.07	0.00	16.92	2.00	0.00	7.42	0.06	0.00
16.99	2.00	0.00	7.41	0.07	0.00	17.06	2.00	0.00	7.40	0.07	0.00
17.12	2.00	0.00	7.39	0.06	0.00	17.19	2.00	0.00	7.38	0.07	0.00
17.25	2.00	0.00	7.37	0.06	0.00	17.32	2.00	0.00	7.36	0.07	0.00
17.38	2.00	0.00	7.35	0.06	0.00	17.45	2.00	0.00	7.34	0.07	0.00
17.52	2.00	0.00	7.33	0.07	0.00	17.58	2.00	0.00	7.32	0.06	0.00
17.65	2.00	0.00	7.31	0.07	0.00	17.71	2.00	0.00	7.30	0.06	0.00
17.78	2.00	0.00	7.29	0.07	0.00	17.84	2.00	0.00	7.28	0.06	0.00
17.91	2.00	0.00	7.27	0.07	0.00	17.97	2.00	0.00	7.26	0.06	0.00
18.04	2.00	0.00	7.25	0.07	0.00	18.11	2.00	0.00	7.24	0.07	0.00
18.17	2.00	0.00	7.23	0.06	0.00	18.24	2.00	0.00	7.22	0.07	0.00
18.30	2.00	0.00	7.21	0.06	0.00	18.37	2.00	0.00	7.20	0.07	0.00
18.43	2.00	0.00	7.19	0.06	0.00	18.50	2.00	0.00	7.18	0.07	0.00
18.56	2.00	0.00	7.17	0.06	0.00	18.63	2.00	0.00	7.16	0.07	0.00
18.70	2.00	0.00	7.15	0.07	0.00	18.76	2.00	0.00	7.14	0.06	0.00
18.83	2.00	0.00	7.13	0.07	0.00	18.89	2.00	0.00	7.12	0.06	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
18.96	2.00	0.00	7.11	0.07	0.00	19.02	2.00	0.00	7.10	0.06	0.00
19.09	2.00	0.00	7.09	0.07	0.00	19.16	2.00	0.00	7.08	0.07	0.00
19.22	2.00	0.00	7.07	0.06	0.00	19.29	2.00	0.00	7.06	0.07	0.00
19.35	2.00	0.00	7.05	0.06	0.00	19.42	2.00	0.00	7.04	0.07	0.00
19.48	2.00	0.00	7.03	0.06	0.00	19.55	2.00	0.00	7.02	0.07	0.00
19.61	2.00	0.00	7.01	0.06	0.00	19.68	2.00	0.00	7.00	0.07	0.00
19.75	2.00	0.00	6.99	0.07	0.00	19.81	2.00	0.00	6.98	0.06	0.00
19.88	2.00	0.00	6.97	0.07	0.00	19.94	2.00	0.00	6.96	0.06	0.00
20.01	2.00	0.00	6.95	0.07	0.00	20.07	2.00	0.00	6.94	0.06	0.00
20.14	2.00	0.00	6.93	0.07	0.00	20.20	2.00	0.00	6.92	0.06	0.00
20.27	2.00	0.00	6.91	0.07	0.00	20.34	2.00	0.00	6.90	0.07	0.00
20.40	2.00	0.00	6.89	0.06	0.00	20.47	2.00	0.00	6.88	0.07	0.00
20.53	2.00	0.00	6.87	0.06	0.00	20.60	2.00	0.00	6.86	0.07	0.00
20.66	2.00	0.00	6.85	0.06	0.00	20.73	2.00	0.00	6.84	0.07	0.00
20.80	2.00	0.00	6.83	0.07	0.00	20.86	2.00	0.00	6.82	0.06	0.00
20.93	2.00	0.00	6.81	0.07	0.00	20.99	2.00	0.00	6.80	0.06	0.00
21.06	2.00	0.00	6.79	0.07	0.00	21.12	2.00	0.00	6.78	0.06	0.00
21.19	2.00	0.00	6.77	0.07	0.00	21.25	2.00	0.00	6.76	0.06	0.00
21.32	2.00	0.00	6.75	0.07	0.00	21.39	2.00	0.00	6.74	0.07	0.00
21.45	2.00	0.00	6.73	0.06	0.00	21.52	2.00	0.00	6.72	0.07	0.00
21.58	2.00	0.00	6.71	0.06	0.00	21.65	2.00	0.00	6.70	0.07	0.00
21.71	2.00	0.00	6.69	0.06	0.00	21.78	2.00	0.00	6.68	0.07	0.00
21.84	2.00	0.00	6.67	0.06	0.00	21.91	2.00	0.00	6.66	0.07	0.00
21.98	2.00	0.00	6.65	0.07	0.00	22.04	2.00	0.00	6.64	0.06	0.00
22.11	2.00	0.00	6.63	0.07	0.00	22.17	2.00	0.00	6.62	0.06	0.00
22.24	2.00	0.00	6.61	0.07	0.00	22.30	2.00	0.00	6.60	0.06	0.00
22.37	2.00	0.00	6.59	0.07	0.00	22.44	2.00	0.00	6.58	0.07	0.00
22.50	2.00	0.00	6.57	0.06	0.00	22.57	2.00	0.00	6.56	0.07	0.00
22.63	2.00	0.00	6.55	0.06	0.00	22.70	2.00	0.00	6.54	0.07	0.00
22.76	2.00	0.00	6.53	0.06	0.00	22.83	2.00	0.00	6.52	0.07	0.00
22.89	2.00	0.00	6.51	0.06	0.00	22.96	2.00	0.00	6.50	0.07	0.00
23.03	2.00	0.00	6.49	0.07	0.00	23.09	2.00	0.00	6.48	0.06	0.00
23.16	2.00	0.00	6.47	0.07	0.00	23.22	2.00	0.00	6.46	0.06	0.00
23.29	2.00	0.00	6.45	0.07	0.00	23.35	2.00	0.00	6.44	0.06	0.00
23.42	2.00	0.00	6.43	0.07	0.00	23.48	2.00	0.00	6.42	0.06	0.00
23.55	2.00	0.00	6.41	0.07	0.00	23.62	2.00	0.00	6.40	0.07	0.00
23.68	2.00	0.00	6.39	0.06	0.00	23.75	2.00	0.00	6.38	0.07	0.00
23.81	2.00	0.00	6.37	0.06	0.00	23.88	2.00	0.00	6.36	0.07	0.00
23.94	2.00	0.00	6.35	0.06	0.00	24.01	2.00	0.00	6.34	0.07	0.00
24.08	2.00	0.00	6.33	0.07	0.00	24.14	2.00	0.00	6.32	0.06	0.00
24.21	2.00	0.00	6.31	0.07	0.00	24.27	2.00	0.00	6.30	0.06	0.00
24.34	2.00	0.00	6.29	0.07	0.00	24.40	2.00	0.00	6.28	0.06	0.00
24.47	2.00	0.00	6.27	0.07	0.00	24.53	2.00	0.00	6.26	0.06	0.00
24.60	2.00	0.00	6.25	0.07	0.00	24.67	2.00	0.00	6.24	0.07	0.00
24.73	2.00	0.00	6.23	0.06	0.00	24.80	2.00	0.00	6.22	0.07	0.00
24.86	2.00	0.00	6.21	0.06	0.00	24.93	2.00	0.00	6.20	0.07	0.00
24.99	2.00	0.00	6.19	0.06	0.00	25.06	2.00	0.00	6.18	0.07	0.00
25.12	2.00	0.00	6.17	0.06	0.00	25.19	2.00	0.00	6.16	0.07	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
25.26	2.00	0.00	6.15	0.07	0.00	25.32	2.00	0.00	6.14	0.06	0.00
25.39	2.00	0.00	6.13	0.07	0.00	25.45	2.00	0.00	6.12	0.06	0.00
25.52	2.00	0.00	6.11	0.07	0.00	25.58	2.00	0.00	6.10	0.06	0.00
25.65	2.00	0.00	6.09	0.07	0.00	25.72	2.00	0.00	6.08	0.07	0.00
25.78	2.00	0.00	6.07	0.06	0.00	25.85	2.00	0.00	6.06	0.07	0.00
25.91	2.00	0.00	6.05	0.06	0.00	25.98	2.00	0.00	6.04	0.07	0.00
26.04	2.00	0.00	6.03	0.06	0.00	26.11	2.00	0.00	6.02	0.07	0.00
26.17	2.00	0.00	6.01	0.06	0.00	26.24	2.00	0.00	6.00	0.07	0.00
26.31	2.00	0.00	5.99	0.07	0.00	26.37	2.00	0.00	5.98	0.06	0.00
26.44	2.00	0.00	5.97	0.07	0.00	26.50	2.00	0.00	5.96	0.06	0.00
26.57	2.00	0.00	5.95	0.07	0.00	26.63	2.00	0.00	5.94	0.06	0.00
26.70	2.00	0.00	5.93	0.07	0.00	26.76	2.00	0.00	5.92	0.06	0.00
26.83	2.00	0.00	5.91	0.07	0.00	26.90	2.00	0.00	5.90	0.07	0.00
26.96	2.00	0.00	5.89	0.06	0.00	27.03	2.00	0.00	5.88	0.07	0.00
27.09	2.00	0.00	5.87	0.06	0.00	27.16	2.00	0.00	5.86	0.07	0.00
27.22	2.00	0.00	5.85	0.06	0.00	27.29	2.00	0.00	5.84	0.07	0.00
27.36	2.00	0.00	5.83	0.07	0.00	27.42	2.00	0.00	5.82	0.06	0.00
27.49	2.00	0.00	5.81	0.07	0.00	27.55	2.00	0.00	5.80	0.06	0.00
27.62	2.00	0.00	5.79	0.07	0.00	27.68	2.00	0.00	5.78	0.06	0.00
27.75	2.00	0.00	5.77	0.07	0.00	27.81	2.00	0.00	5.76	0.06	0.00
27.88	2.00	0.00	5.75	0.07	0.00	27.95	2.00	0.00	5.74	0.07	0.00
28.01	2.00	0.00	5.73	0.06	0.00	28.08	2.00	0.00	5.72	0.07	0.00
28.14	2.00	0.00	5.71	0.06	0.00	28.21	2.00	0.00	5.70	0.07	0.00
28.27	2.00	0.00	5.69	0.06	0.00	28.34	2.00	0.00	5.68	0.07	0.00
28.40	2.00	0.00	5.67	0.06	0.00	28.47	2.00	0.00	5.66	0.07	0.00
28.54	2.00	0.00	5.65	0.07	0.00	28.60	2.00	0.00	5.64	0.06	0.00
28.67	2.00	0.00	5.63	0.07	0.00	28.73	2.00	0.00	5.62	0.06	0.00
28.80	2.00	0.00	5.61	0.07	0.00	28.86	2.00	0.00	5.60	0.06	0.00
28.93	2.00	0.00	5.59	0.07	0.00	29.00	2.00	0.00	5.58	0.07	0.00
29.06	2.00	0.00	5.57	0.06	0.00	29.13	2.00	0.00	5.56	0.07	0.00
29.19	2.00	0.00	5.55	0.06	0.00	29.26	2.00	0.00	5.54	0.07	0.00
29.32	2.00	0.00	5.53	0.06	0.00	29.39	2.00	0.00	5.52	0.07	0.00
29.45	2.00	0.00	5.51	0.06	0.00	29.52	2.00	0.00	5.50	0.07	0.00
29.59	2.00	0.00	5.49	0.07	0.00	29.65	2.00	0.00	5.48	0.06	0.00
29.72	2.00	0.00	5.47	0.07	0.00	29.78	2.00	0.00	5.46	0.06	0.00
29.85	2.00	0.00	5.45	0.07	0.00	29.91	2.00	0.00	5.44	0.06	0.00
29.98	2.00	0.00	5.43	0.07	0.00	30.04	2.00	0.00	5.42	0.06	0.00
30.11	2.00	0.00	5.41	0.07	0.00	30.18	2.00	0.00	5.40	0.07	0.00
30.24	2.00	0.00	5.39	0.06	0.00	30.31	2.00	0.00	5.38	0.07	0.00
30.37	2.00	0.00	5.37	0.06	0.00	30.44	2.00	0.00	5.36	0.07	0.00
30.50	2.00	0.00	5.35	0.06	0.00	30.57	2.00	0.00	5.34	0.07	0.00
30.64	2.00	0.00	5.33	0.07	0.00	30.70	2.00	0.00	5.32	0.06	0.00
30.77	2.00	0.00	5.31	0.07	0.00	30.83	2.00	0.00	5.30	0.06	0.00
30.90	2.00	0.00	5.29	0.07	0.00	30.96	2.00	0.00	5.28	0.06	0.00
31.03	2.00	0.00	5.27	0.07	0.00	31.09	2.00	0.00	5.26	0.06	0.00
31.16	2.00	0.00	5.25	0.07	0.00	31.23	2.00	0.00	5.24	0.07	0.00
31.29	2.00	0.00	5.23	0.06	0.00	31.36	2.00	0.00	5.22	0.07	0.00
31.42	2.00	0.00	5.21	0.06	0.00	31.49	2.00	0.00	5.20	0.07	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
31.55	2.00	0.00	5.19	0.06	0.00	31.62	2.00	0.00	5.18	0.07	0.00
31.68	2.00	0.00	5.17	0.06	0.00	31.75	2.00	0.00	5.16	0.07	0.00
31.82	2.00	0.00	5.15	0.07	0.00	31.88	2.00	0.00	5.14	0.06	0.00
31.95	2.00	0.00	5.13	0.07	0.00	32.01	2.00	0.00	5.12	0.06	0.00
32.08	2.00	0.00	5.11	0.07	0.00	32.14	2.00	0.00	5.10	0.06	0.00
32.21	2.00	0.00	5.09	0.07	0.00	32.28	2.00	0.00	5.08	0.07	0.00
32.34	2.00	0.00	5.07	0.06	0.00	32.41	2.00	0.00	5.06	0.07	0.00
32.47	2.00	0.00	5.05	0.06	0.00	32.54	2.00	0.00	5.04	0.07	0.00
32.60	2.00	0.00	5.03	0.06	0.00	32.67	2.00	0.00	5.02	0.07	0.00
32.73	2.00	0.00	5.01	0.06	0.00	32.80	2.00	0.00	5.00	0.07	0.00
32.87	2.00	0.00	4.99	0.07	0.00	32.93	2.00	0.00	4.98	0.06	0.00
33.00	2.00	0.00	4.97	0.07	0.00	33.06	2.00	0.00	4.96	0.06	0.00
33.13	2.00	0.00	4.95	0.07	0.00	33.19	2.00	0.00	4.94	0.06	0.00
33.26	2.00	0.00	4.93	0.07	0.00	33.32	2.00	0.00	4.92	0.06	0.00
33.39	2.00	0.00	4.91	0.07	0.00	33.46	2.00	0.00	4.90	0.07	0.00
33.52	2.00	0.00	4.89	0.06	0.00	33.59	2.00	0.00	4.88	0.07	0.00
33.65	2.00	0.00	4.87	0.06	0.00	33.72	2.00	0.00	4.86	0.07	0.00
33.78	2.00	0.00	4.85	0.06	0.00	33.85	2.00	0.00	4.84	0.07	0.00
33.92	2.00	0.00	4.83	0.07	0.00	33.98	2.00	0.00	4.82	0.06	0.00
34.05	2.00	0.00	4.81	0.07	0.00	34.11	2.00	0.00	4.80	0.06	0.00
34.18	2.00	0.00	4.79	0.07	0.00	34.24	2.00	0.00	4.78	0.06	0.00
34.31	2.00	0.00	4.77	0.07	0.00	34.37	2.00	0.00	4.76	0.06	0.00
34.44	2.00	0.00	4.75	0.07	0.00	34.51	2.00	0.00	4.74	0.07	0.00
34.57	2.00	0.00	4.73	0.06	0.00	34.64	2.00	0.00	4.72	0.07	0.00
34.70	2.00	0.00	4.71	0.06	0.00	34.77	2.00	0.00	4.70	0.07	0.00
34.83	2.00	0.00	4.69	0.06	0.00	34.90	2.00	0.00	4.68	0.07	0.00
34.96	2.00	0.00	4.67	0.06	0.00	35.03	2.00	0.00	4.66	0.07	0.00
35.10	2.00	0.00	4.65	0.07	0.00	35.16	2.00	0.00	4.64	0.06	0.00
35.23	2.00	0.00	4.63	0.07	0.00	35.29	2.00	0.00	4.62	0.06	0.00
35.36	2.00	0.00	4.61	0.07	0.00	35.42	2.00	0.00	4.60	0.06	0.00
35.49	2.00	0.00	4.59	0.07	0.00	35.56	2.00	0.00	4.58	0.07	0.00
35.62	2.00	0.00	4.57	0.06	0.00	35.69	2.00	0.00	4.56	0.07	0.00
35.75	2.00	0.00	4.55	0.06	0.00	35.82	2.00	0.00	4.54	0.07	0.00
35.88	2.00	0.00	4.53	0.06	0.00	35.95	2.00	0.00	4.52	0.07	0.00
36.01	2.00	0.00	4.51	0.06	0.00	36.08	2.00	0.00	4.50	0.07	0.00
36.15	2.00	0.00	4.49	0.07	0.00	36.21	2.00	0.00	4.48	0.06	0.00
36.28	2.00	0.00	4.47	0.07	0.00	36.34	2.00	0.00	4.46	0.06	0.00
36.41	2.00	0.00	4.45	0.07	0.00	36.47	2.00	0.00	4.44	0.06	0.00
36.54	2.00	0.00	4.43	0.07	0.00	36.60	2.00	0.00	4.42	0.06	0.00
36.67	2.00	0.00	4.41	0.07	0.00	36.74	2.00	0.00	4.40	0.07	0.00
36.80	2.00	0.00	4.39	0.06	0.00	36.87	2.00	0.00	4.38	0.07	0.00
36.93	2.00	0.00	4.37	0.06	0.00	37.00	2.00	0.00	4.36	0.07	0.00
37.06	2.00	0.00	4.35	0.06	0.00	37.13	2.00	0.00	4.34	0.07	0.00
37.20	2.00	0.00	4.33	0.07	0.00	37.26	2.00	0.00	4.32	0.06	0.00
37.33	2.00	0.00	4.31	0.07	0.00	37.39	2.00	0.00	4.30	0.06	0.00
37.46	2.00	0.00	4.29	0.07	0.00	37.52	2.00	0.00	4.28	0.06	0.00
37.59	2.00	0.00	4.27	0.07	0.00	37.65	2.00	0.00	4.26	0.06	0.00
37.72	2.00	0.00	4.25	0.07	0.00	37.79	2.00	0.00	4.24	0.07	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
37.85	2.00	0.00	4.23	0.06	0.00	37.92	2.00	0.00	4.22	0.07	0.00
37.98	2.00	0.00	4.21	0.06	0.00	38.05	2.00	0.00	4.20	0.07	0.00
38.11	2.00	0.00	4.19	0.06	0.00	38.18	2.00	0.00	4.18	0.07	0.00
38.24	2.00	0.00	4.17	0.06	0.00	38.31	2.00	0.00	4.16	0.07	0.00
38.38	2.00	0.00	4.15	0.07	0.00	38.44	2.00	0.00	4.14	0.06	0.00
38.51	2.00	0.00	4.13	0.07	0.00	38.57	2.00	0.00	4.12	0.06	0.00
38.64	2.00	0.00	4.11	0.07	0.00	38.70	2.00	0.00	4.10	0.06	0.00
38.77	2.00	0.00	4.09	0.07	0.00	38.84	2.00	0.00	4.08	0.07	0.00
38.90	2.00	0.00	4.07	0.06	0.00	38.97	2.00	0.00	4.06	0.07	0.00
39.03	2.00	0.00	4.05	0.06	0.00	39.10	2.00	0.00	4.04	0.07	0.00
39.16	2.00	0.00	4.03	0.06	0.00	39.23	2.00	0.00	4.02	0.07	0.00
39.29	2.00	0.00	4.01	0.06	0.00	39.36	2.00	0.00	4.00	0.07	0.00
39.43	2.00	0.00	3.99	0.07	0.00	39.49	2.00	0.00	3.98	0.06	0.00
39.56	2.00	0.00	3.97	0.07	0.00	39.62	2.00	0.00	3.96	0.06	0.00
39.69	2.00	0.00	3.95	0.07	0.00	39.75	2.00	0.00	3.94	0.06	0.00
39.82	2.00	0.00	3.93	0.07	0.00	39.88	2.00	0.00	3.92	0.06	0.00
39.95	2.00	0.00	3.91	0.07	0.00	40.02	2.00	0.00	3.90	0.07	0.00
40.08	2.00	0.00	3.89	0.06	0.00	40.15	2.00	0.00	3.88	0.07	0.00
40.21	2.00	0.00	3.87	0.06	0.00	40.28	2.00	0.00	3.86	0.07	0.00
40.34	2.00	0.00	3.85	0.06	0.00	40.41	2.00	0.00	3.84	0.07	0.00
40.48	2.00	0.00	3.83	0.07	0.00	40.54	2.00	0.00	3.82	0.06	0.00
40.61	2.00	0.00	3.81	0.07	0.00	40.67	2.00	0.00	3.80	0.06	0.00
40.74	2.00	0.00	3.79	0.07	0.00	40.80	2.00	0.00	3.78	0.06	0.00
40.87	2.00	0.00	3.77	0.07	0.00	40.93	2.00	0.00	3.76	0.06	0.00
41.00	2.00	0.00	3.75	0.07	0.00	41.07	2.00	0.00	3.74	0.07	0.00
41.13	2.00	0.00	3.73	0.06	0.00	41.20	2.00	0.00	3.72	0.07	0.00
41.26	2.00	0.00	3.71	0.06	0.00	41.33	2.00	0.00	3.70	0.07	0.00
41.39	2.00	0.00	3.69	0.06	0.00	41.46	2.00	0.00	3.68	0.07	0.00
41.52	2.00	0.00	3.67	0.06	0.00	41.59	2.00	0.00	3.66	0.07	0.00
41.66	2.00	0.00	3.65	0.07	0.00	41.72	2.00	0.00	3.64	0.06	0.00
41.79	2.00	0.00	3.63	0.07	0.00	41.85	2.00	0.00	3.62	0.06	0.00
41.92	2.00	0.00	3.61	0.07	0.00	41.98	2.00	0.00	3.60	0.06	0.00
42.05	2.00	0.00	3.59	0.07	0.00	42.12	2.00	0.00	3.58	0.07	0.00
42.18	2.00	0.00	3.57	0.06	0.00	42.25	2.00	0.00	3.56	0.07	0.00
42.31	2.00	0.00	3.55	0.06	0.00	42.38	2.00	0.00	3.54	0.07	0.00
42.44	2.00	0.00	3.53	0.06	0.00	42.51	2.00	0.00	3.52	0.07	0.00
42.57	2.00	0.00	3.51	0.06	0.00	42.64	2.00	0.00	3.50	0.07	0.00
42.71	2.00	0.00	3.49	0.07	0.00	42.77	2.00	0.00	3.48	0.06	0.00
42.84	2.00	0.00	3.47	0.07	0.00	42.90	2.00	0.00	3.46	0.06	0.00
42.97	2.00	0.00	3.45	0.07	0.00	43.03	2.00	0.00	3.44	0.06	0.00
43.10	2.00	0.00	3.43	0.07	0.00	43.16	2.00	0.00	3.42	0.06	0.00
43.23	2.00	0.00	3.41	0.07	0.00	43.30	2.00	0.00	3.40	0.07	0.00
43.36	2.00	0.00	3.39	0.06	0.00	43.43	2.00	0.00	3.38	0.07	0.00
43.49	2.00	0.00	3.37	0.06	0.00	43.56	2.00	0.00	3.36	0.07	0.00
43.62	2.00	0.00	3.35	0.06	0.00	43.69	2.00	0.00	3.34	0.07	0.00
43.76	2.00	0.00	3.33	0.07	0.00	43.82	2.00	0.00	3.32	0.06	0.00
43.89	2.00	0.00	3.31	0.07	0.00	43.95	2.00	0.00	3.30	0.06	0.00
44.02	2.00	0.00	3.29	0.07	0.00	44.08	2.00	0.00	3.28	0.06	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
44.15	2.00	0.00	3.27	0.07	0.00	44.21	2.00	0.00	3.26	0.06	0.00
44.28	2.00	0.00	3.25	0.07	0.00	44.35	2.00	0.00	3.24	0.07	0.00
44.41	2.00	0.00	3.23	0.06	0.00	44.48	2.00	0.00	3.22	0.07	0.00
44.54	2.00	0.00	3.21	0.06	0.00	44.61	2.00	0.00	3.20	0.07	0.00
44.67	2.00	0.00	3.19	0.06	0.00	44.74	2.00	0.00	3.18	0.07	0.00
44.80	2.00	0.00	3.17	0.06	0.00	44.87	2.00	0.00	3.16	0.07	0.00
44.94	2.00	0.00	3.15	0.07	0.00	45.00	2.00	0.00	3.14	0.06	0.00
45.07	2.00	0.00	3.13	0.07	0.00	45.13	2.00	0.00	3.12	0.06	0.00
45.20	2.00	0.00	3.11	0.07	0.00	45.26	2.00	0.00	3.10	0.06	0.00
45.33	2.00	0.00	3.09	0.07	0.00	45.40	2.00	0.00	3.08	0.07	0.00
45.46	2.00	0.00	3.07	0.06	0.00	45.53	2.00	0.00	3.06	0.07	0.00
45.59	2.00	0.00	3.05	0.06	0.00	45.66	2.00	0.00	3.04	0.07	0.00
45.72	2.00	0.00	3.03	0.06	0.00	45.79	2.00	0.00	3.02	0.07	0.00
45.85	2.00	0.00	3.01	0.06	0.00	45.92	2.00	0.00	3.00	0.07	0.00
45.99	2.00	0.00	2.99	0.07	0.00	46.05	2.00	0.00	2.98	0.06	0.00
46.12	2.00	0.00	2.97	0.07	0.00	46.18	2.00	0.00	2.96	0.06	0.00
46.25	2.00	0.00	2.95	0.07	0.00	46.31	2.00	0.00	2.94	0.06	0.00
46.38	2.00	0.00	2.93	0.07	0.00	46.45	2.00	0.00	2.92	0.07	0.00
46.51	2.00	0.00	2.91	0.06	0.00	46.58	2.00	0.00	2.90	0.07	0.00
46.64	2.00	0.00	2.89	0.06	0.00	46.71	2.00	0.00	2.88	0.07	0.00
46.77	2.00	0.00	2.87	0.06	0.00	46.84	2.00	0.00	2.86	0.07	0.00
46.90	2.00	0.00	2.85	0.06	0.00	46.97	2.00	0.00	2.84	0.07	0.00
47.04	2.00	0.00	2.83	0.07	0.00	47.10	2.00	0.00	2.82	0.06	0.00
47.17	2.00	0.00	2.81	0.07	0.00	47.23	2.00	0.00	2.80	0.06	0.00
47.30	2.00	0.00	2.79	0.07	0.00	47.36	2.00	0.00	2.78	0.06	0.00
47.43	2.00	0.00	2.77	0.07	0.00	47.49	2.00	0.00	2.76	0.06	0.00
47.56	2.00	0.00	2.75	0.07	0.00	47.63	2.00	0.00	2.74	0.07	0.00
47.69	2.00	0.00	2.73	0.06	0.00	47.76	2.00	0.00	2.72	0.07	0.00
47.82	2.00	0.00	2.71	0.06	0.00	47.89	2.00	0.00	2.70	0.07	0.00
47.95	2.00	0.00	2.69	0.06	0.00	48.02	2.00	0.00	2.68	0.07	0.00
48.09	2.00	0.00	2.67	0.07	0.00	48.15	2.00	0.00	2.66	0.06	0.00
48.22	2.00	0.00	2.65	0.07	0.00	48.28	2.00	0.00	2.64	0.06	0.00
48.35	2.00	0.00	2.63	0.07	0.00	48.41	2.00	0.00	2.62	0.06	0.00
48.48	2.00	0.00	2.61	0.07	0.00	48.54	2.00	0.00	2.60	0.06	0.00
48.61	2.00	0.00	2.59	0.07	0.00	48.68	2.00	0.00	2.58	0.07	0.00
48.74	2.00	0.00	2.57	0.06	0.00	48.81	2.00	0.00	2.56	0.07	0.00
48.87	2.00	0.00	2.55	0.06	0.00	48.94	2.00	0.00	2.54	0.07	0.00
49.00	2.00	0.00	2.53	0.06	0.00	49.07	2.00	0.00	2.52	0.07	0.00
49.13	2.00	0.00	2.51	0.06	0.00	49.20	2.00	0.00	2.50	0.07	0.00
49.27	2.00	0.00	2.49	0.07	0.00	49.33	2.00	0.00	2.48	0.06	0.00
49.40	2.00	0.00	2.47	0.07	0.00	49.46	2.00	0.00	2.46	0.06	0.00
49.53	2.00	0.00	2.45	0.07	0.00	49.59	2.00	0.00	2.44	0.06	0.00
49.66	2.00	0.00	2.43	0.07	0.00	49.73	2.00	0.00	2.42	0.07	0.00
49.79	2.00	0.00	2.41	0.06	0.00	49.86	2.00	0.00	2.40	0.07	0.00
49.92	2.00	0.00	2.39	0.06	0.00	49.99	2.00	0.00	2.38	0.07	0.00
50.05	2.00	0.00	2.37	0.06	0.00	50.12	2.00	0.00	2.36	0.07	0.00
50.18	2.00	0.00	2.35	0.06	0.00	50.25	2.00	0.00	2.34	0.07	0.00
50.32	2.00	0.00	2.33	0.07	0.00	50.38	2.00	0.00	2.32	0.06	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
50.45	2.00	0.00	2.31	0.07	0.00	50.51	2.00	0.00	2.30	0.06	0.00
50.58	2.00	0.00	2.29	0.07	0.00	50.64	2.00	0.00	2.28	0.06	0.00
50.71	2.00	0.00	2.27	0.07	0.00	50.77	2.00	0.00	2.26	0.06	0.00
50.84	2.00	0.00	2.25	0.07	0.00	50.91	2.00	0.00	2.24	0.07	0.00
50.97	2.00	0.00	2.23	0.06	0.00	51.04	2.00	0.00	2.22	0.07	0.00
51.10	2.00	0.00	2.21	0.06	0.00	51.17	2.00	0.00	2.20	0.07	0.00
51.23	2.00	0.00	2.19	0.06	0.00	51.30	2.00	0.00	2.18	0.07	0.00
51.37	2.00	0.00	2.17	0.07	0.00	51.43	2.00	0.00	2.16	0.06	0.00
51.50	2.00	0.00	2.15	0.07	0.00	51.56	2.00	0.00	2.14	0.06	0.00
51.63	2.00	0.00	2.13	0.07	0.00	51.69	2.00	0.00	2.12	0.06	0.00
51.76	2.00	0.00	2.11	0.07	0.00	51.82	2.00	0.00	2.10	0.06	0.00
51.89	2.00	0.00	2.09	0.07	0.00	51.96	2.00	0.00	2.08	0.07	0.00
52.02	2.00	0.00	2.07	0.06	0.00	52.09	2.00	0.00	2.06	0.07	0.00
52.15	2.00	0.00	2.05	0.06	0.00	52.22	2.00	0.00	2.04	0.07	0.00
52.28	2.00	0.00	2.03	0.06	0.00	52.35	2.00	0.00	2.02	0.07	0.00
52.41	2.00	0.00	2.01	0.06	0.00	52.48	2.00	0.00	2.00	0.07	0.00
52.55	2.00	0.00	1.99	0.07	0.00	52.61	2.00	0.00	1.98	0.06	0.00
52.68	2.00	0.00	1.97	0.07	0.00	52.74	2.00	0.00	1.96	0.06	0.00
52.81	2.00	0.00	1.95	0.07	0.00	52.87	2.00	0.00	1.94	0.06	0.00
52.94	2.00	0.00	1.93	0.07	0.00	53.01	2.00	0.00	1.92	0.07	0.00
53.07	2.00	0.00	1.91	0.06	0.00	53.14	2.00	0.00	1.90	0.07	0.00
53.20	2.00	0.00	1.89	0.06	0.00	53.27	2.00	0.00	1.88	0.07	0.00
53.33	2.00	0.00	1.87	0.06	0.00	53.40	2.00	0.00	1.86	0.07	0.00
53.46	2.00	0.00	1.85	0.06	0.00	53.53	2.00	0.00	1.84	0.07	0.00
53.60	2.00	0.00	1.83	0.07	0.00	53.66	2.00	0.00	1.82	0.06	0.00
53.73	2.00	0.00	1.81	0.07	0.00	53.79	2.00	0.00	1.80	0.06	0.00
53.86	2.00	0.00	1.79	0.07	0.00	53.92	2.00	0.00	1.78	0.06	0.00
53.99	2.00	0.00	1.77	0.07	0.00	54.05	2.00	0.00	1.76	0.06	0.00
54.12	2.00	0.00	1.75	0.07	0.00	54.19	2.00	0.00	1.74	0.07	0.00
54.25	2.00	0.00	1.73	0.06	0.00	54.32	2.00	0.00	1.72	0.07	0.00
54.38	2.00	0.00	1.71	0.06	0.00	54.45	2.00	0.00	1.70	0.07	0.00
54.51	2.00	0.00	1.69	0.06	0.00	54.58	2.00	0.00	1.68	0.07	0.00
54.65	2.00	0.00	1.67	0.07	0.00	54.71	2.00	0.00	1.66	0.06	0.00
54.78	2.00	0.00	1.65	0.07	0.00	54.84	2.00	0.00	1.64	0.06	0.00
54.91	2.00	0.00	1.63	0.07	0.00	54.97	2.00	0.00	1.62	0.06	0.00
55.04	2.00	0.00	1.61	0.07	0.00	55.10	2.00	0.00	1.60	0.06	0.00
55.17	2.00	0.00	1.59	0.07	0.00	55.24	2.00	0.00	1.58	0.07	0.00
55.30	2.00	0.00	1.57	0.06	0.00	55.37	2.00	0.00	1.56	0.07	0.00
55.43	2.00	0.00	1.55	0.06	0.00	55.50	2.00	0.00	1.54	0.07	0.00
55.56	2.00	0.00	1.53	0.06	0.00	55.63	2.00	0.00	1.52	0.07	0.00
55.69	2.00	0.00	1.51	0.06	0.00	55.76	2.00	0.00	1.50	0.07	0.00
55.83	2.00	0.00	1.49	0.07	0.00	55.89	2.00	0.00	1.48	0.06	0.00
55.96	2.00	0.00	1.47	0.07	0.00	56.02	2.00	0.00	1.46	0.06	0.00
56.09	2.00	0.00	1.45	0.07	0.00	56.15	2.00	0.00	1.44	0.06	0.00
56.22	2.00	0.00	1.43	0.07	0.00	56.29	2.00	0.00	1.42	0.07	0.00
56.35	2.00	0.00	1.41	0.06	0.00	56.42	2.00	0.00	1.40	0.07	0.00
56.48	2.00	0.00	1.39	0.06	0.00	56.55	2.00	0.00	1.38	0.07	0.00
56.61	2.00	0.00	1.37	0.06	0.00	56.68	2.00	0.00	1.36	0.07	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
56.74	2.00	0.00	1.35	0.06	0.00	56.81	2.00	0.00	1.34	0.07	0.00
56.88	2.00	0.00	1.33	0.07	0.00	56.94	2.00	0.00	1.32	0.06	0.00
57.01	2.00	0.00	1.31	0.07	0.00	57.07	2.00	0.00	1.30	0.06	0.00
57.14	2.00	0.00	1.29	0.07	0.00	57.20	2.00	0.00	1.28	0.06	0.00
57.27	2.00	0.00	1.27	0.07	0.00	57.33	2.00	0.00	1.26	0.06	0.00
57.40	2.00	0.00	1.25	0.07	0.00	57.47	2.00	0.00	1.24	0.07	0.00
57.53	2.00	0.00	1.23	0.06	0.00	57.60	2.00	0.00	1.22	0.07	0.00
57.66	2.00	0.00	1.21	0.06	0.00	57.73	2.00	0.00	1.20	0.07	0.00
57.79	2.00	0.00	1.19	0.06	0.00	57.86	2.00	0.00	1.18	0.07	0.00
57.93	2.00	0.00	1.17	0.07	0.00	57.99	2.00	0.00	1.16	0.06	0.00
58.06	2.00	0.00	1.15	0.07	0.00	58.12	2.00	0.00	1.14	0.06	0.00
58.19	2.00	0.00	1.13	0.07	0.00	58.25	2.00	0.00	1.12	0.06	0.00
58.32	2.00	0.00	1.11	0.07	0.00	58.38	2.00	0.00	1.10	0.06	0.00
58.45	2.00	0.00	1.09	0.07	0.00	58.52	2.00	0.00	1.08	0.07	0.00
58.58	2.00	0.00	1.07	0.06	0.00	58.65	2.00	0.00	1.06	0.07	0.00
58.71	2.00	0.00	1.05	0.06	0.00	58.78	2.00	0.00	1.04	0.07	0.00
58.84	2.00	0.00	1.03	0.06	0.00	58.91	2.00	0.00	1.02	0.07	0.00
58.97	2.00	0.00	1.01	0.06	0.00	59.04	2.00	0.00	1.00	0.07	0.00
59.11	2.00	0.00	0.99	0.07	0.00	59.17	2.00	0.00	0.98	0.06	0.00
59.24	2.00	0.00	0.97	0.07	0.00	59.30	2.00	0.00	0.96	0.06	0.00
59.37	2.00	0.00	0.95	0.07	0.00	59.43	2.00	0.00	0.94	0.06	0.00
59.50	2.00	0.00	0.93	0.07	0.00	59.57	2.00	0.00	0.92	0.07	0.00
59.63	2.00	0.00	0.91	0.06	0.00	59.70	2.00	0.00	0.90	0.07	0.00
59.76	2.00	0.00	0.89	0.06	0.00	59.83	2.00	0.00	0.88	0.07	0.00
59.89	2.00	0.00	0.87	0.06	0.00	59.96	2.00	0.00	0.86	0.07	0.00
60.02	2.00	0.00	0.85	0.06	0.00	60.09	2.00	0.00	0.84	0.07	0.00
60.16	2.00	0.00	0.83	0.07	0.00	60.22	2.00	0.00	0.82	0.06	0.00
60.29	2.00	0.00	0.81	0.07	0.00	60.35	2.00	0.00	0.80	0.06	0.00
60.42	2.00	0.00	0.79	0.07	0.00	60.48	2.00	0.00	0.78	0.06	0.00
60.55	2.00	0.00	0.77	0.07	0.00	60.61	2.00	0.00	0.76	0.06	0.00
60.68	2.00	0.00	0.75	0.07	0.00	60.75	2.00	0.00	0.74	0.07	0.00
60.81	2.00	0.00	0.73	0.06	0.00	60.88	2.00	0.00	0.72	0.07	0.00
60.94	2.00	0.00	0.71	0.06	0.00	61.01	2.00	0.00	0.70	0.07	0.00
61.07	2.00	0.00	0.69	0.06	0.00	61.14	2.00	0.00	0.68	0.07	0.00
61.21	2.00	0.00	0.67	0.07	0.00	61.27	2.00	0.00	0.66	0.06	0.00
61.34	2.00	0.00	0.65	0.07	0.00	61.40	2.00	0.00	0.64	0.06	0.00
61.47	2.00	0.00	0.63	0.07	0.00	61.53	2.00	0.00	0.62	0.06	0.00
61.60	2.00	0.00	0.61	0.07	0.00	61.66	2.00	0.00	0.60	0.06	0.00
61.73	2.00	0.00	0.59	0.07	0.00	61.80	2.00	0.00	0.58	0.07	0.00
61.86	2.00	0.00	0.57	0.06	0.00	61.93	2.00	0.00	0.56	0.07	0.00
61.99	2.00	0.00	0.55	0.06	0.00	62.06	2.00	0.00	0.54	0.07	0.00
62.12	2.00	0.00	0.53	0.06	0.00	62.19	2.00	0.00	0.52	0.07	0.00
62.25	2.00	0.00	0.51	0.06	0.00	62.32	2.00	0.00	0.50	0.07	0.00
62.39	2.00	0.00	0.49	0.07	0.00	62.45	2.00	0.00	0.48	0.06	0.00
62.52	2.00	0.00	0.47	0.07	0.00	62.58	2.00	0.00	0.46	0.06	0.00
62.65	2.00	0.00	0.45	0.07	0.00	62.71	2.00	0.00	0.44	0.06	0.00
62.78	2.00	0.00	0.43	0.07	0.00	62.85	2.00	0.00	0.42	0.07	0.00
62.91	2.00	0.00	0.41	0.06	0.00	62.98	2.00	0.00	0.40	0.07	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
63.04	2.00	0.00	0.39	0.06	0.00	63.11	2.00	0.00	0.38	0.07	0.00
63.17	2.00	0.00	0.37	0.06	0.00	63.24	2.00	0.00	0.36	0.07	0.00
63.30	2.00	0.00	0.35	0.06	0.00	63.37	2.00	0.00	0.34	0.07	0.00
63.44	2.00	0.00	0.33	0.07	0.00	63.50	2.00	0.00	0.32	0.06	0.00
63.57	2.00	0.00	0.31	0.07	0.00	63.63	2.00	0.00	0.30	0.06	0.00
63.70	2.00	0.00	0.29	0.07	0.00	63.76	2.00	0.00	0.28	0.06	0.00
63.83	2.00	0.00	0.27	0.07	0.00	63.89	2.00	0.00	0.26	0.06	0.00
63.96	2.00	0.00	0.25	0.07	0.00	64.03	2.00	0.00	0.24	0.07	0.00
64.09	2.00	0.00	0.23	0.06	0.00	64.16	2.00	0.00	0.22	0.07	0.00
64.22	2.00	0.00	0.21	0.06	0.00	64.29	2.00	0.00	0.20	0.07	0.00
64.35	2.00	0.00	0.19	0.06	0.00	64.42	2.00	0.00	0.18	0.07	0.00
64.49	2.00	0.00	0.17	0.07	0.00	64.55	2.00	0.00	0.16	0.06	0.00
64.62	2.00	0.00	0.15	0.07	0.00	64.68	2.00	0.00	0.14	0.06	0.00
64.75	2.00	0.00	0.13	0.07	0.00	64.81	2.00	0.00	0.12	0.06	0.00
64.88	2.00	0.00	0.11	0.07	0.00	64.94	2.00	0.00	0.10	0.06	0.00
65.01	2.00	0.00	0.09	0.07	0.00	65.08	2.00	0.00	0.08	0.07	0.00
65.14	2.00	0.00	0.07	0.06	0.00	65.21	2.00	0.00	0.06	0.07	0.00
65.27	2.00	0.00	0.05	0.06	0.00	65.34	2.00	0.00	0.04	0.07	0.00
65.40	2.00	0.00	0.03	0.06	0.00	65.47	2.00	0.00	0.02	0.07	0.00
65.53	2.00	0.00	0.01	0.06	0.00	65.60	2.00	0.00	0.00	0.07	0.00
65.67	2.00	0.00	0.00	0.00	0.00	65.73	2.00	0.00	0.00	0.00	0.00
65.80	2.00	0.00	0.00	0.00	0.00	65.86	2.00	0.00	0.00	0.00	0.00
65.93	2.00	0.00	0.00	0.00	0.00	65.99	2.00	0.00	0.00	0.00	0.00
66.06	2.00	0.00	0.00	0.00	0.00	66.13	2.00	0.00	0.00	0.00	0.00
66.19	2.00	0.00	0.00	0.00	0.00	66.26	2.00	0.00	0.00	0.00	0.00
66.32	2.00	0.00	0.00	0.00	0.00	66.39	2.00	0.00	0.00	0.00	0.00
66.45	2.00	0.00	0.00	0.00	0.00	66.52	2.00	0.00	0.00	0.00	0.00
66.58	2.00	0.00	0.00	0.00	0.00	66.65	2.00	0.00	0.00	0.00	0.00
66.72	2.00	0.00	0.00	0.00	0.00	66.78	2.00	0.00	0.00	0.00	0.00
66.85	2.00	0.00	0.00	0.00	0.00	66.91	2.00	0.00	0.00	0.00	0.00
66.98	2.00	0.00	0.00	0.00	0.00	67.04	2.00	0.00	0.00	0.00	0.00
67.11	2.00	0.00	0.00	0.00	0.00	67.17	2.00	0.00	0.00	0.00	0.00
67.24	2.00	0.00	0.00	0.00	0.00	67.31	2.00	0.00	0.00	0.00	0.00
67.37	2.00	0.00	0.00	0.00	0.00	67.44	2.00	0.00	0.00	0.00	0.00
67.50	2.00	0.00	0.00	0.00	0.00	67.57	2.00	0.00	0.00	0.00	0.00
67.63	2.00	0.00	0.00	0.00	0.00	67.70	2.00	0.00	0.00	0.00	0.00
67.77	2.00	0.00	0.00	0.00	0.00	67.83	2.00	0.00	0.00	0.00	0.00
67.90	2.00	0.00	0.00	0.00	0.00	67.96	2.00	0.00	0.00	0.00	0.00
68.03	2.00	0.00	0.00	0.00	0.00	68.09	2.00	0.00	0.00	0.00	0.00
68.16	2.00	0.00	0.00	0.00	0.00	68.22	2.00	0.00	0.00	0.00	0.00
68.29	2.00	0.00	0.00	0.00	0.00	68.36	2.00	0.00	0.00	0.00	0.00
68.42	2.00	0.00	0.00	0.00	0.00	68.49	2.00	0.00	0.00	0.00	0.00
68.55	2.00	0.00	0.00	0.00	0.00	68.62	2.00	0.00	0.00	0.00	0.00
68.68	2.00	0.00	0.00	0.00	0.00	68.75	2.00	0.00	0.00	0.00	0.00
68.81	2.00	0.00	0.00	0.00	0.00	68.88	2.00	0.00	0.00	0.00	0.00
68.95	2.00	0.00	0.00	0.00	0.00	69.01	2.00	0.00	0.00	0.00	0.00
69.08	2.00	0.00	0.00	0.00	0.00	69.14	2.00	0.00	0.00	0.00	0.00
69.21	2.00	0.00	0.00	0.00	0.00	69.27	2.00	0.00	0.00	0.00	0.00

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI
69.34	2.00	0.00	0.00	0.00	0.00	69.41	2.00	0.00	0.00	0.00	0.00
69.47	2.00	0.00	0.00	0.00	0.00	69.54	2.00	0.00	0.00	0.00	0.00
69.60	2.00	0.00	0.00	0.00	0.00	69.67	2.00	0.00	0.00	0.00	0.00
69.73	2.00	0.00	0.00	0.00	0.00	69.80	2.00	0.00	0.00	0.00	0.00
69.86	2.00	0.00	0.00	0.00	0.00	69.93	2.00	0.00	0.00	0.00	0.00
70.00	2.00	0.00	0.00	0.00	0.00	70.06	2.00	0.00	0.00	0.00	0.00
70.13	2.00	0.00	0.00	0.00	0.00	70.19	2.00	0.00	0.00	0.00	0.00
70.26	2.00	0.00	0.00	0.00	0.00	70.32	2.00	0.00	0.00	0.00	0.00
70.39	2.00	0.00	0.00	0.00	0.00	70.45	2.00	0.00	0.00	0.00	0.00
70.52	2.00	0.00	0.00	0.00	0.00	70.59	2.00	0.00	0.00	0.00	0.00
70.65	2.00	0.00	0.00	0.00	0.00	70.72	2.00	0.00	0.00	0.00	0.00
70.78	2.00	0.00	0.00	0.00	0.00	70.85	2.00	0.00	0.00	0.00	0.00
70.91	2.00	0.00	0.00	0.00	0.00	70.98	2.00	0.00	0.00	0.00	0.00
71.05	2.00	0.00	0.00	0.00	0.00	71.11	2.00	0.00	0.00	0.00	0.00
71.18	2.00	0.00	0.00	0.00	0.00	71.24	2.00	0.00	0.00	0.00	0.00
71.31	2.00	0.00	0.00	0.00	0.00	71.37	2.00	0.00	0.00	0.00	0.00
71.44	2.00	0.00	0.00	0.00	0.00	71.50	2.00	0.00	0.00	0.00	0.00
71.57	2.00	0.00	0.00	0.00	0.00	71.64	2.00	0.00	0.00	0.00	0.00
71.70	2.00	0.00	0.00	0.00	0.00	71.77	2.00	0.00	0.00	0.00	0.00
71.83	2.00	0.00	0.00	0.00	0.00	71.90	2.00	0.00	0.00	0.00	0.00
71.96	2.00	0.00	0.00	0.00	0.00	72.03	2.00	0.00	0.00	0.00	0.00
72.09	2.00	0.00	0.00	0.00	0.00	72.16	2.00	0.00	0.00	0.00	0.00
72.23	2.00	0.00	0.00	0.00	0.00	72.29	2.00	0.00	0.00	0.00	0.00
72.36	2.00	0.00	0.00	0.00	0.00	72.42	2.00	0.00	0.00	0.00	0.00
72.49	2.00	0.00	0.00	0.00	0.00	72.55	2.00	0.00	0.00	0.00	0.00
72.62	2.00	0.00	0.00	0.00	0.00	72.69	2.00	0.00	0.00	0.00	0.00
72.75	2.00	0.00	0.00	0.00	0.00	72.82	2.00	0.00	0.00	0.00	0.00
72.88	2.00	0.00	0.00	0.00	0.00	72.95	2.00	0.00	0.00	0.00	0.00
73.01	2.00	0.00	0.00	0.00	0.00	73.08	2.00	0.00	0.00	0.00	0.00
73.14	2.00	0.00	0.00	0.00	0.00	73.21	2.00	0.00	0.00	0.00	0.00
73.28	2.00	0.00	0.00	0.00	0.00	73.34	2.00	0.00	0.00	0.00	0.00
73.41	2.00	0.00	0.00	0.00	0.00	73.47	2.00	0.00	0.00	0.00	0.00
73.54	2.00	0.00	0.00	0.00	0.00	73.60	2.00	0.00	0.00	0.00	0.00
73.67	2.00	0.00	0.00	0.00	0.00	73.73	2.00	0.00	0.00	0.00	0.00
73.80	2.00	0.00	0.00	0.00	0.00	73.87	2.00	0.00	0.00	0.00	0.00
73.93	2.00	0.00	0.00	0.00	0.00	74.00	2.00	0.00	0.00	0.00	0.00
74.06	2.00	0.00	0.00	0.00	0.00	74.13	2.00	0.00	0.00	0.00	0.00
74.19	2.00	0.00	0.00	0.00	0.00	74.26	2.00	0.00	0.00	0.00	0.00
74.32	2.00	0.00	0.00	0.00	0.00	74.39	2.00	0.00	0.00	0.00	0.00
74.46	2.00	0.00	0.00	0.00	0.00	74.52	2.00	0.00	0.00	0.00	0.00
74.59	2.00	0.00	0.00	0.00	0.00	74.65	2.00	0.00	0.00	0.00	0.00
74.72	2.00	0.00	0.00	0.00	0.00	74.78	2.00	0.00	0.00	0.00	0.00
74.85	2.00	0.00	0.00	0.00	0.00	74.92	2.00	0.00	0.00	0.00	0.00
74.98	2.00	0.00	0.00	0.00	0.00	75.05	2.00	0.00	0.00	0.00	0.00
75.11	2.00	0.00	0.00	0.00	0.00	75.18	2.00	0.00	0.00	0.00	0.00
75.24	2.00	0.00	0.00	0.00	0.00	75.31	2.00	0.00	0.00	0.00	0.00
75.37	2.00	0.00	0.00	0.00	0.00	75.44	2.00	0.00	0.00	0.00	0.00
75.51	2.00	0.00	0.00	0.00	0.00						

:: Liquefaction Potential Index calculation data :: (continued)

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI

Overall liquefaction potential: 0.00

LPI = 0.00 - Liquefaction risk very low
LPI between 0.00 and 5.00 - Liquefaction risk low
LPI between 5.00 and 15.00 - Liquefaction risk high
LPI > 15.00 - Liquefaction risk very high

Abbreviations

FS: Calculated factor of safety for test point
F_L: 1 - FS
w_z: Function value of the extend of soil liquefaction according to depth
d_z: Layer thickness (ft)
LPI: Liquefaction potential index value for test point

Procedure for the evaluation of soil liquefaction resistance, NCEER (1998)

Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. The procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart[1]:

q_c : tip resistance, f_s : sleeve friction
σ_{vo}, σ_{vo}' : in-situ vertical total and effective stress
units : all in kPa

initial stress exponent[a] : n = 1.0 and calculate Q, F, and I_c
if $I_c \le 1.64$, $n = 0.5$
if $1.64 < I_c < 3.30$, $n = (I_c - 1.64)0.3 + 0.5$
if $I_c \ge 3.30$, $n = 1.0$
iterate until the change in n, $\Delta n < 0.01$
if $\sigma_{vo}' > 300$ kPa, let n = 1.0 for all soils

[a]updated from Robertson and Wride (1998)

$$C_n = \left(\frac{100}{\sigma_{vo}'}\right)^n$$

$$Q = \frac{(q_c - \sigma_{vo})}{100} \cdot C_n \qquad F = \frac{f_s}{(q_c - \sigma_{vo})} \cdot 100$$

$$I_c = \sqrt{\left[(3.47 - \log Q)^2 + (1.22 + \log F)^2\right]}$$

if $I_c \le 1.64$, $K_c = 1.0$
if $1.64 < I_c < 2.60$, $K_c = -0.403 I_c^4 + 5.581 I_c^3 - 21.63 I_c^2 + 33.75 I_c - 17.88$
if $I_c \ge 2.60$, evaluate using other criteria; likely nonliquefiable if F > 1%
<u>BUT</u>, if $1.64 < I_c < 2.36$ <u>and</u> F < 0.5%, set $K_c = 1.0$

$$(q_{c1N})_{cs} = K_c Q$$

$$CRR_{7.5} = 93 \cdot \left[\frac{(q_{c1N})_{cs}}{1000}\right]^3 + 0.08, \text{ if } 50 \le (q_{c1N})_{cs} < 160$$

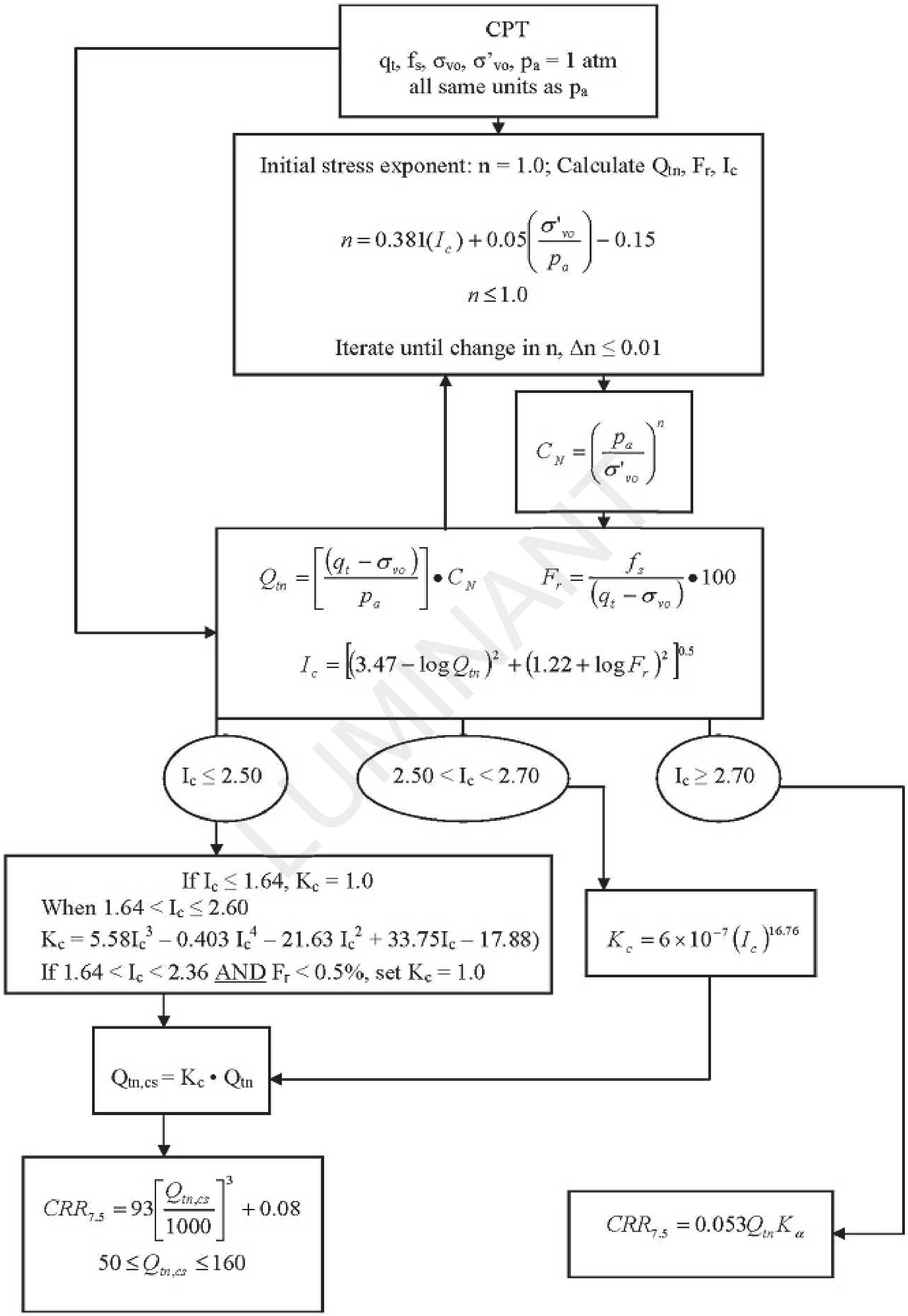
$$CRR_{7.5} = 0.833 \cdot \left[\frac{(q_{c1N})_{cs}}{1000}\right] + 0.05, \text{ if } (q_{c1N})_{cs} < 50$$

if $I_c \ge 2.60$, evaluate using other criteria; likely nonliquifiable if F > 1%

[1] "Estimating liquefaction-induced ground settlements from CPT for level ground", G. Zhang, P.K. Robertson, and R.W.I. Brachman

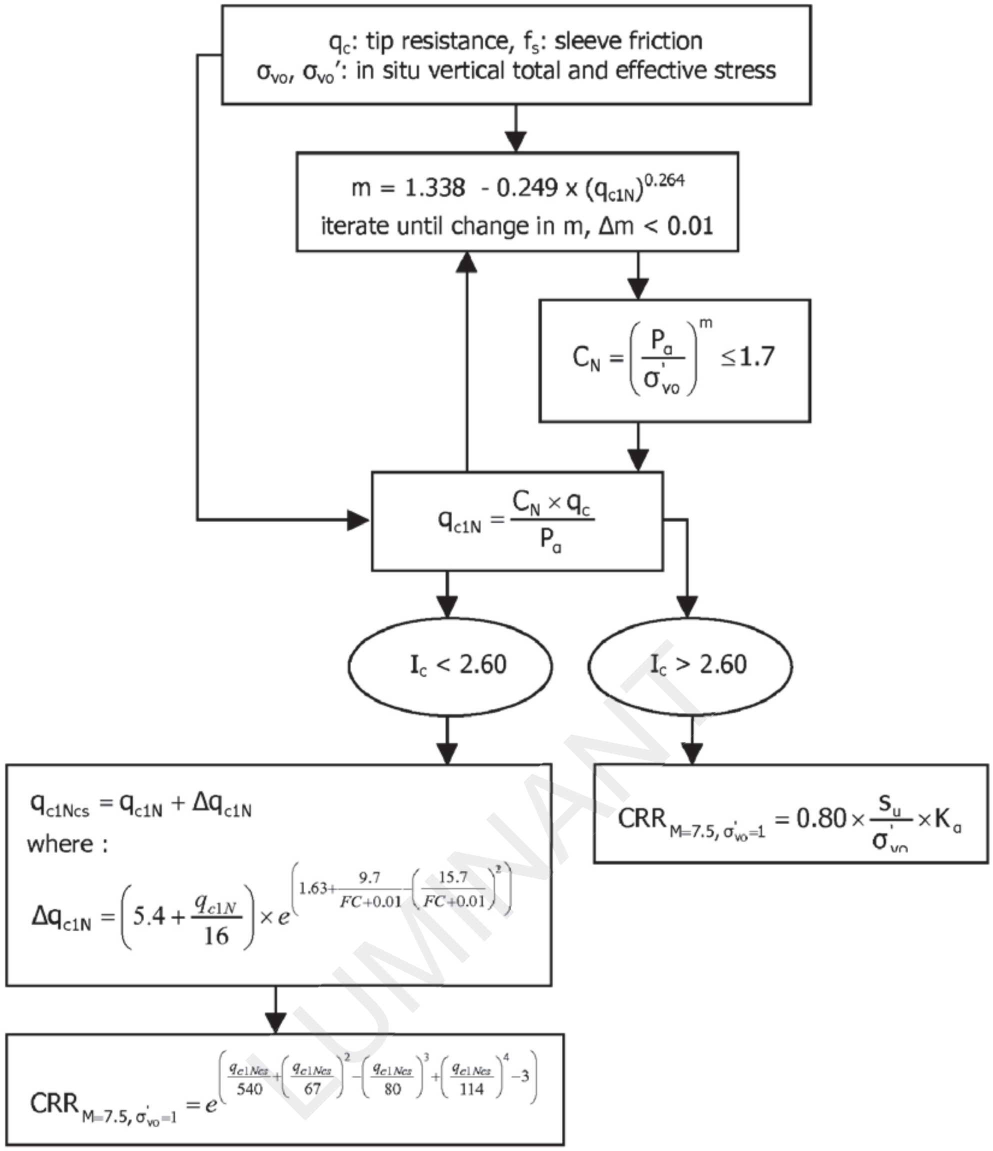
Procedure for the evaluation of soil liquefaction resistance (all soils), Robertson (2010)

Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. This procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart[1]:

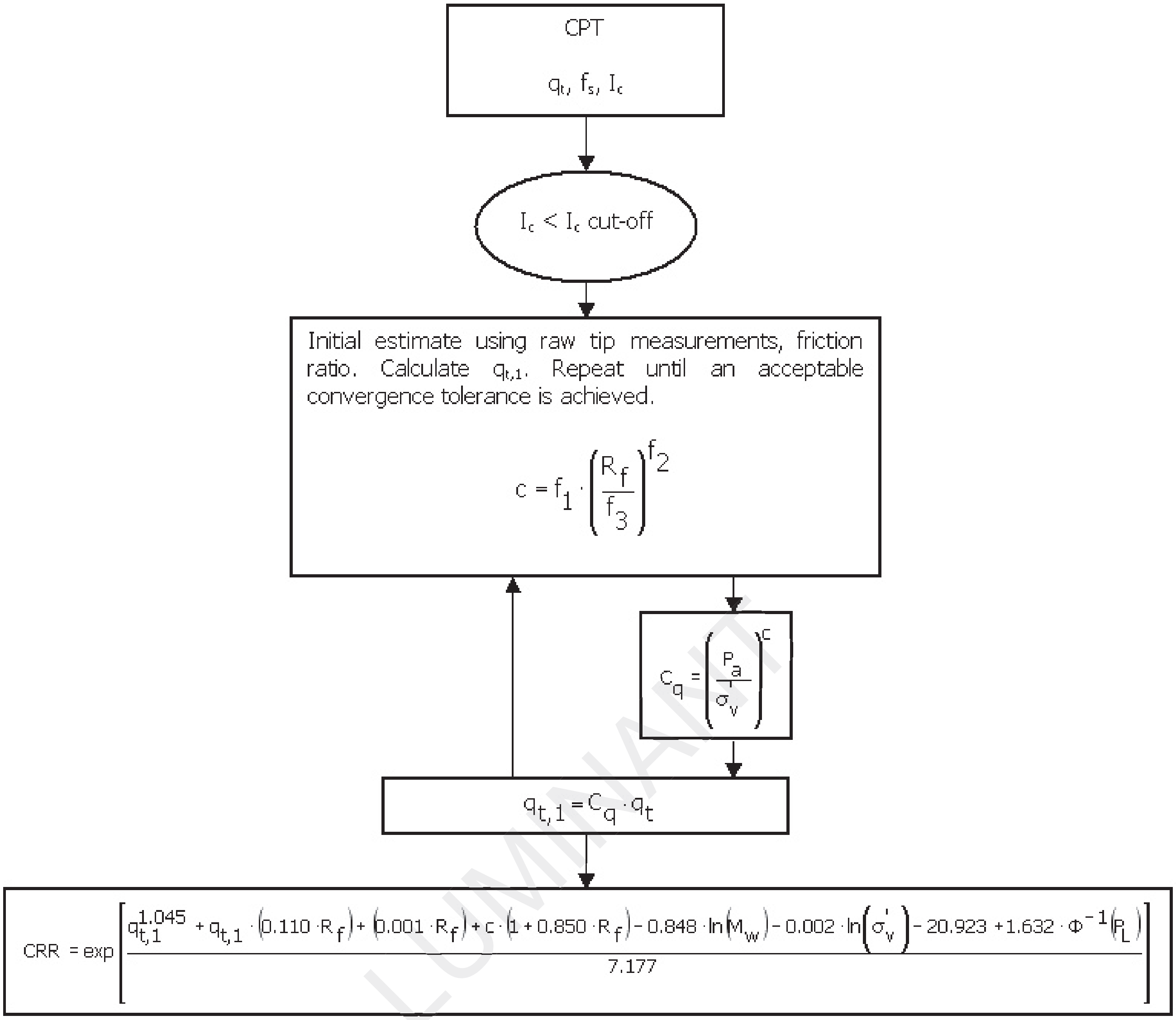


[1] P.K. Robertson, 2009. "Performance based earthquake design using the CPT", Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering – from case history to practice, IS-Tokyo, June 2009

Procedure for the evaluation of soil liquefaction resistance, Idriss & Boulanger (2008)



Procedure for the evaluation of soil liquefaction resistance (sandy soils), Moss et al. (2006)



Procedure for the evaluation of soil liquefaction resistance, Boulanger & Idriss(2014)

$$FS_{liq} = \frac{CRR_{M=7.5,\sigma'_v=1atm}}{CSR_{M=7.5,\sigma'_v=1atm}}$$

$$CSR_{M=7.5,\sigma'_v=1atm} = 0.65\frac{\sigma_v}{\sigma'_v}\frac{a_{\max}}{g}r_d\frac{1}{MSF}\frac{1}{K_\sigma}$$

$$r_d = \exp\left[\alpha(z)+\beta(z)\cdot M\right]$$

$$\alpha(z) = -1.012 - 1.126\sin\left(\frac{z}{11.73}+5.133\right)$$

$$\beta(z) = 0.106 + 0.118\sin\left(\frac{z}{11.28}+5.142\right)$$

$$K_\sigma = 1 - C_\sigma \ln\left(\frac{\sigma'_v}{P_a}\right) \leq 1.1$$

$$C_\sigma = \frac{1}{37.3 - 8.27\left(q_{c1Ncs}\right)^{0.264}} \leq 0.3$$

$$MSF = 1 + \left(MSF_{max} - 1\right)\left(8.64\exp\left(\frac{-M}{4}\right) - 1.325\right)$$

$$MSF_{max} = 1.09 + \left(\frac{q_{C1Ncs}}{180}\right)^3 \leq 2.2$$

σ'_v *and* σ_v *at start of earthquake shaking*

$$CRR_{M=7.5,\sigma'_v=1atm} = \exp\left(\frac{q_{c1Ncs}}{113} + \left(\frac{q_{c1Ncs}}{1000}\right)^2 - \left(\frac{q_{c1Ncs}}{140}\right)^3 + \left(\frac{q_{c1Ncs}}{137}\right)^4 - 2.80\right)$$

$$q_{c1Ncs} = q_{c1N} + \Delta q_{c1N}$$

$$\Delta q_{c1N} = \left(11.9 + \frac{q_{c1N}}{14.6}\right)\exp\left(1.63 - \frac{9.7}{FC+2} - \left(\frac{15.7}{FC+2}\right)^2\right)$$

$$q_{c1N} = C_{Ne}\frac{q_c}{P_a}$$

$$C_{Ne} = \left(\frac{P_a}{\sigma'_v}\right)^m \leq 1.7$$

$$m = 1.338 - 0.249\left(q_{c1Ncs}\right)^{0.264} \quad with \quad 0.264 \leq m \leq 0.782$$

$$FC = 80\left(I_C + C_{FC}\right) - 137 \quad with \quad 0\% \leq FC \leq 100\%$$

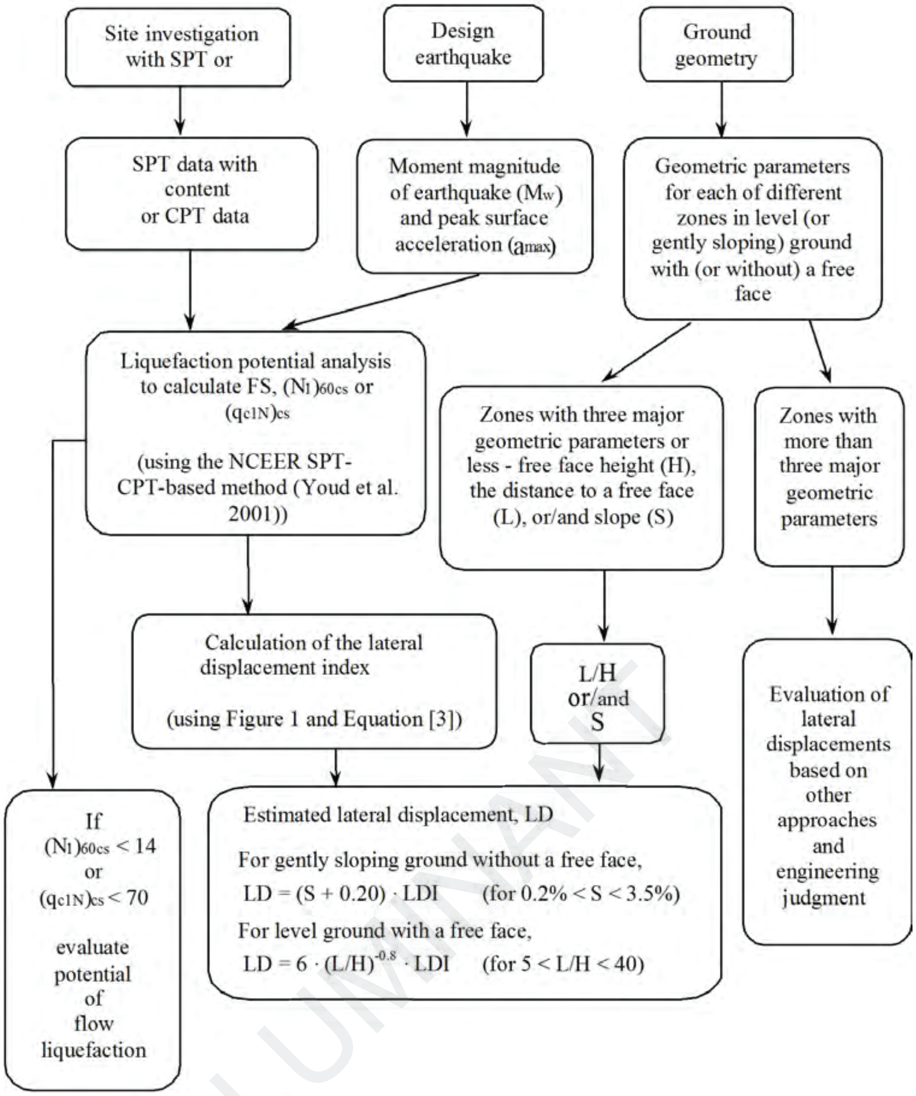
$$I_c = \left[\left(3.47 - \log(Q)\right)^2 + \left(1.22 + \log(F)\right)^2\right]^{0.5}$$

$$Q = \left(\frac{q_c - \sigma_{vc}}{P_a}\right)\left(\frac{P_a}{\sigma'_{vc}}\right)^n \quad with\ 0.5 \leq n \leq 1.0\ per\ Robertson\ \&\ Wride\ (1998)$$

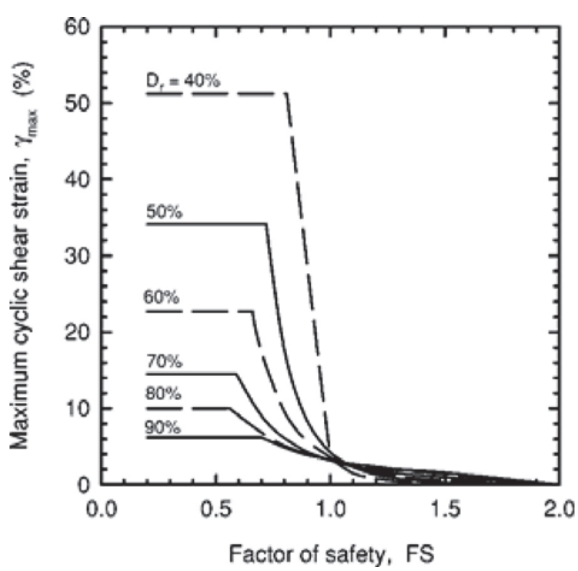
$$F = \left(\frac{f_s}{q_c - \sigma_{vc}}\right)\cdot 100\%$$

σ'_v *at time of CPT sounding*

Procedure for the evaluation of liquefaction-induced lateral spreading displacements



[1] Flow chart illustrating major steps in estimating liquefaction-induced lateral spreading displacements using the proposed approach



[1] **Figure 1**

$$LDI = \int_0^{Z_{max}} \gamma_{max}\, dz$$

[1] **Equation [3]**

[1] "Estimating liquefaction-induced ground settlements from CPT for level ground", G. Zhang, P.K. Robertson, and R.W.I. Brachman

Procedure for the estimation of seismic induced settlements in dry sands

Average shear stress, τ_{av}

$$\tau_{av} = CSR^{*} \cdot \sigma_{v0}' = 0.65 \cdot \frac{\alpha_{max}}{g} \cdot \sigma_{v0} \cdot \tau_{a}$$

↓

Estimate small shear strain modulus, G_0

$$G_0 = 0.0188 \cdot \left[10^{(0.55 I_c - 1.68)}\right] \cdot (q_t - \sigma_v)$$

↓

Estimate shear strain amplitude, γ
(based on Pradel (1998))

$$\gamma = \left[\frac{1 + \alpha \cdot e^{bR}}{1 + \alpha}\right] \cdot R \cdot 100\ (\%)$$

$$R = \frac{\tau_{av}}{G_0} \text{ (Note } \tau_{av} \text{ and } G_0 \text{ same units)}$$

$$\alpha = 0.0389 \cdot \left(\frac{\sigma_v}{p_a}\right) + 0.124$$

$$b = 6400 \cdot \left(\frac{\sigma_v}{p_a}\right)$$

↓

Estimate volumetric strain in 15 cycles

$$\varepsilon_{vol(15)} = \gamma \cdot \left[\frac{(N_1)_{60,cs}}{20}\right]^{-1.20}$$

$$(N_1)_{60,cs} = \frac{Q_{tn,cs}}{8.5 \cdot \left[1 - \frac{I_c}{4.6}\right]}$$

↓

Volumetric strain in design earthquake

$$\Sigma_{vol} = \varepsilon_{vol(15)} \cdot \left[\frac{N_c}{15}\right]^{0.45}$$

$$N_c = (M - 4)^{2.17}$$

↓

Seismic settlement, s

$$s = 2 \cdot \int_0^{GWT} \Sigma_{vol} \cdot dz$$

Robertson, P.K. and Lisheng, S., 2010, "Estimation of seismic compression in dry soils using the CPT" FIFTH INTERNATIONAL CONFERENCE ON RECENT ADVANCES IN GEOTECHNICAL EARTHQUAKE ENGINEERING AND SOIL DYNAMICS, Symposium in honor of professor I. M. Idriss, San Diego, CA

Liquefaction Potential Index (LPI) calculation procedure

Calculation of the Liquefaction Potential Index (LPI) is used to interpret the liquefaction assessment calculations in terms of severity over depth. The calculation procedure is based on the methology developed by Iwasaki (1982) and is adopted by AFPS.

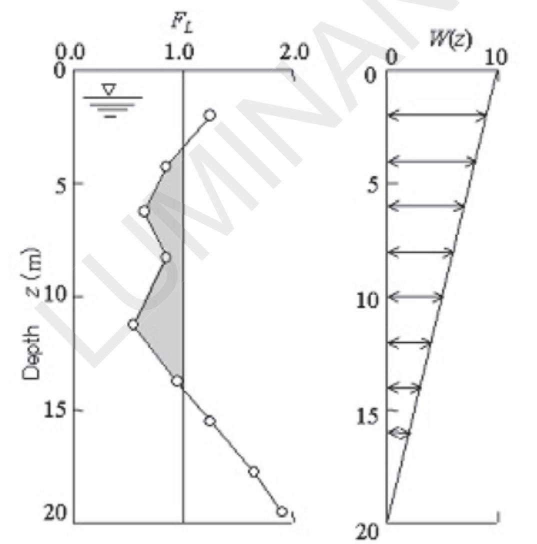
To estimate the severity of liquefaction extent at a given site, LPI is calculated based on the following equation:

$$\textbf{LPI} = \int_{0}^{20} (10 - 0{,}5_{Z}) \times F_{L} \times d_{z}$$

where:
F_L = 1 - F.S. when F.S. less than 1
F_L = 0 when F.S. greater than 1
z depth of measurment in meters

Values of LPI range between zero (0) when no test point is characterized as liquefiable and 100 when all points are characterized as susceptible to liquefaction. Iwasaki proposed four (4) discrete categories based on the numeric value of LPI:

- LPI = 0 : Liquefaction risk is very low
- 0 < LPI <= 5 : Liquefaction risk is low
- 5 < LPI <= 15 : Liquefaction risk is high
- LPI > 15 : Liquefaction risk is very high



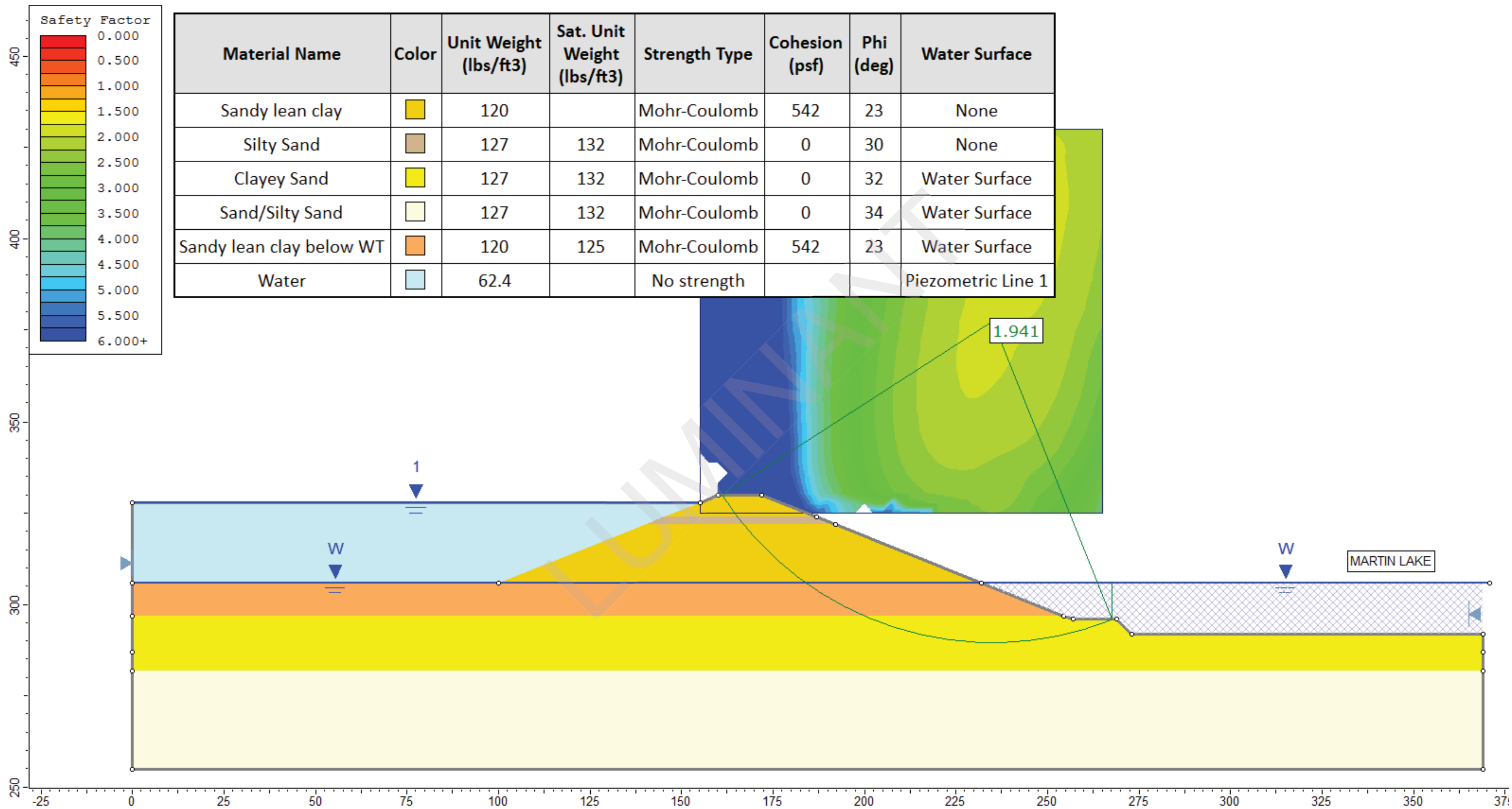
Graphical presentation of the LPI calculation procedure

References

- Lunne, T., Robertson, P.K., and Powell, J.J.M 1997. Cone penetration testing in geotechnical practice, E & FN Spon Routledge, 352 p, ISBN 0-7514-0393-8.
- Boulanger, R.W. and Idriss, I. M., 2007. Evaluation of Cyclic Softening in Silts and Clays. ASCE Journal of Geotechnical and Geoenvironmental Engineering June, Vol. 133, No. 6 pp 641-652
- Boulanger, R.W. and Idriss, I. M., 2014. CPT AND SPT BASED LIQUEFACTION TRIGGERING PROCEDURES. DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING COLLEGE OF ENGINEERING UNIVERSITY OF CALIFORNIA AT DAVIS
- Robertson, P.K. and Cabal, K.L., 2007, Guide to Cone Penetration Testing for Geotechnical Engineering. Available at no cost at http://www.geologismiki.gr/
- Robertson, P.K. 1990. Soil classification using the cone penetration test. Canadian Geotechnical Journal, 27 (1), 151-8.
- Robertson, P.K. and Wride, C.E., 1998. Cyclic Liquefaction and its Evaluation based on the CPT Canadian Geotechnical Journal, 1998, Vol. 35, August.
- Youd, T.L., Idriss, I.M., Andrus, R.D., Arango, I., Castro, G., Christian, J.T., Dobry, R., Finn, W.D.L., Harder, L.F., Hynes, M.E., Ishihara, K., Koester, J., Liao, S., Marcuson III, W.F., Martin, G.R., Mitchell, J.K., Moriwaki, Y., Power, M.S., Robertson, P.K., Seed, R., and Stokoe, K.H., Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshop on Evaluation of Liquefaction Resistance of Soils, ASCE, Journal of Geotechnical & Geoenvironmental Engineering, Vol. 127, October, pp 817-833
- Zhang, G., Robertson. P.K., Brachman, R., 2002, Estimating Liquefaction Induced Ground Settlements from the CPT, Canadian Geotechnical Journal, 39: pp 1168-1180
- Zhang, G., Robertson. P.K., Brachman, R., 2004, Estimating Liquefaction Induced Lateral Displacements using the SPT and CPT, ASCE, Journal of Geotechnical & Geoenvironmental Engineering, Vol. 130, No. 8, 861-871
- Pradel, D., 1998, Procedure to Evaluate Earthquake-Induced Settlements in Dry Sandy Soils, ASCE, Journal of Geotechnical & Geoenvironmental Engineering, Vol. 124, No. 4, 364-368
- Iwasaki, T., 1986, Soil liquefaction studies in Japan: state-of-the-art, Soil Dynamics and Earthquake Engineering, Vol. 5, No. 1, 2-70
- Papathanassiou G., 2008, LPI-based approach for calibrating the severity of liquefaction-induced failures and for assessing the probability of liquefaction surface evidence, Eng. Geol. 96:94–104
- P.K. Robertson, 2009, Interpretation of Cone Penetration Tests - a unified approach., Canadian Geotechnical Journal, Vol. 46, No. 11, pp 1337-1355
- P.K. Robertson, 2009. "Performance based earthquake design using the CPT", Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering - from case history to practice, IS-Tokyo, June 2009
- Robertson, P.K. and Lisheng, S., 2010, "Estimation of seismic compression in dry soils using the CPT" FIFTH INTERNATIONAL CONFERENCE ON RECENT ADVANCES IN GEOTECHNICAL EARTHQUAKE ENGINEERING AND SOIL DYNAMICS, *Symposium in honor of professor I. M. Idriss,* SAN diego, CA
- R. E. S. Moss, R. B. Seed, R. E. Kayen, J. P. Stewart, A. Der Kiureghian, K. O. Cetin, CPT-Based Probabilistic and Deterministic Assessment of In Situ Seismic Soil Liquefaction Potential, Journal of Geotechnical and Geoenvironmental Engineering, Vol. 132, No. 8, August 1, 2006
- I. M. Idriss and R. W. Boulanger, 2008. Soil liquefaction during earthquakes, Earthquake Engineering Research Institute MNO-12

APPENDIX D

SLOPE STABILITY ANALYSIS RESULTS

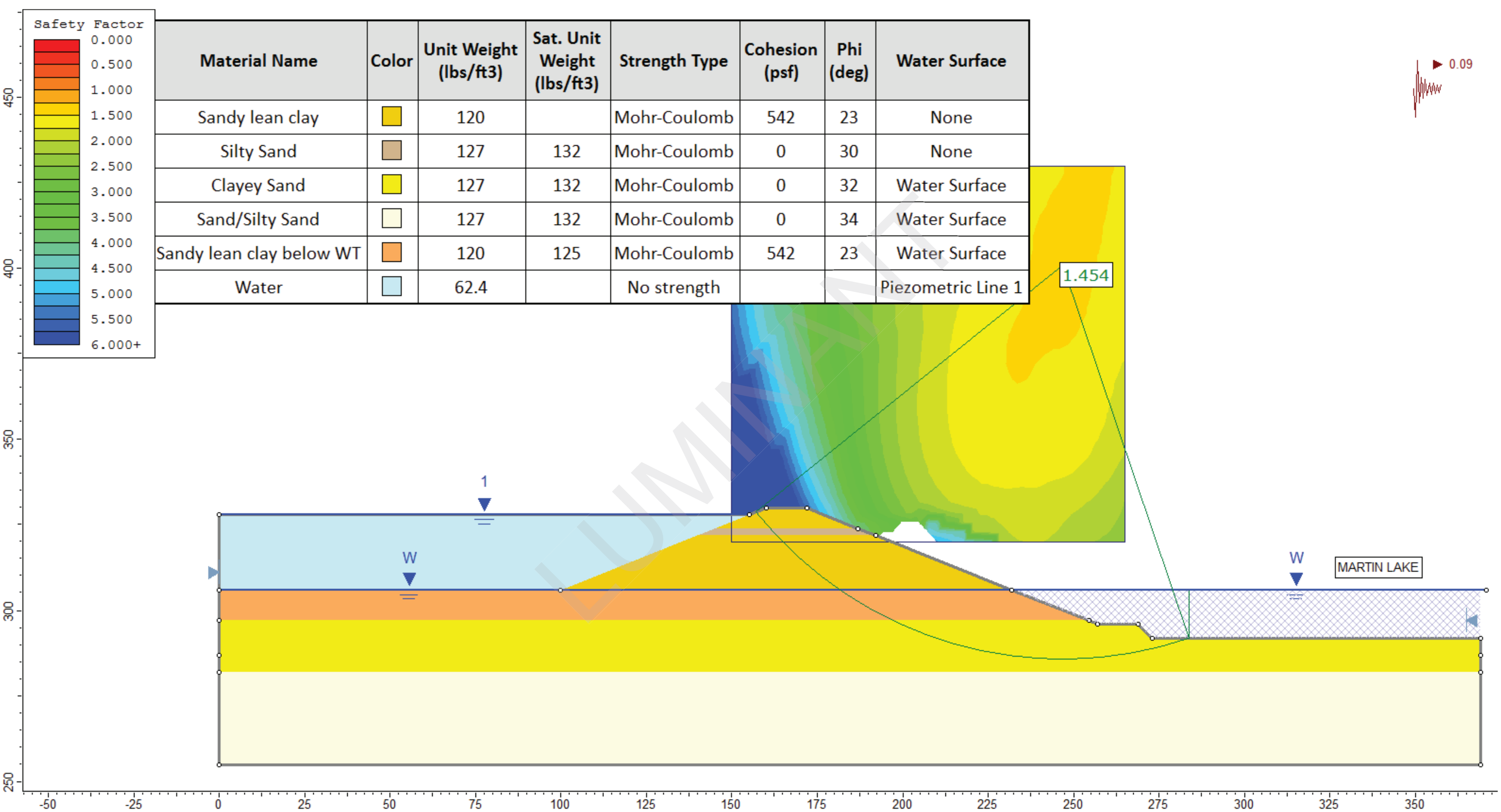


Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Sandy lean clay		120		Mohr-Coulomb	542	23	None
Silty Sand		127	132	Mohr-Coulomb	0	30	None
Clayey Sand		127	132	Mohr-Coulomb	0	32	Water Surface
Sand/Silty Sand		127	132	Mohr-Coulomb	0	34	Water Surface
Sandy lean clay below WT		120	125	Mohr-Coulomb	542	23	Water Surface
Water		62.4		No strength			Piezometric Line 1

FIGURE **C.1**

Results of Stability Analysis – BAP–SP: A–A' – Case 1a

Stability and Safety Factor Assessment, Martin Lake SES



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Sandy lean clay		120		Mohr-Coulomb	542	23	None
Silty Sand		127	132	Mohr-Coulomb	0	30	None
Clayey Sand		127	132	Mohr-Coulomb	0	32	Water Surface
Sand/Silty Sand		127	132	Mohr-Coulomb	0	34	Water Surface
Sandy lean clay below WT		120	125	Mohr-Coulomb	542	23	Water Surface
Water		62.4		No strength			Piezometric Line 1

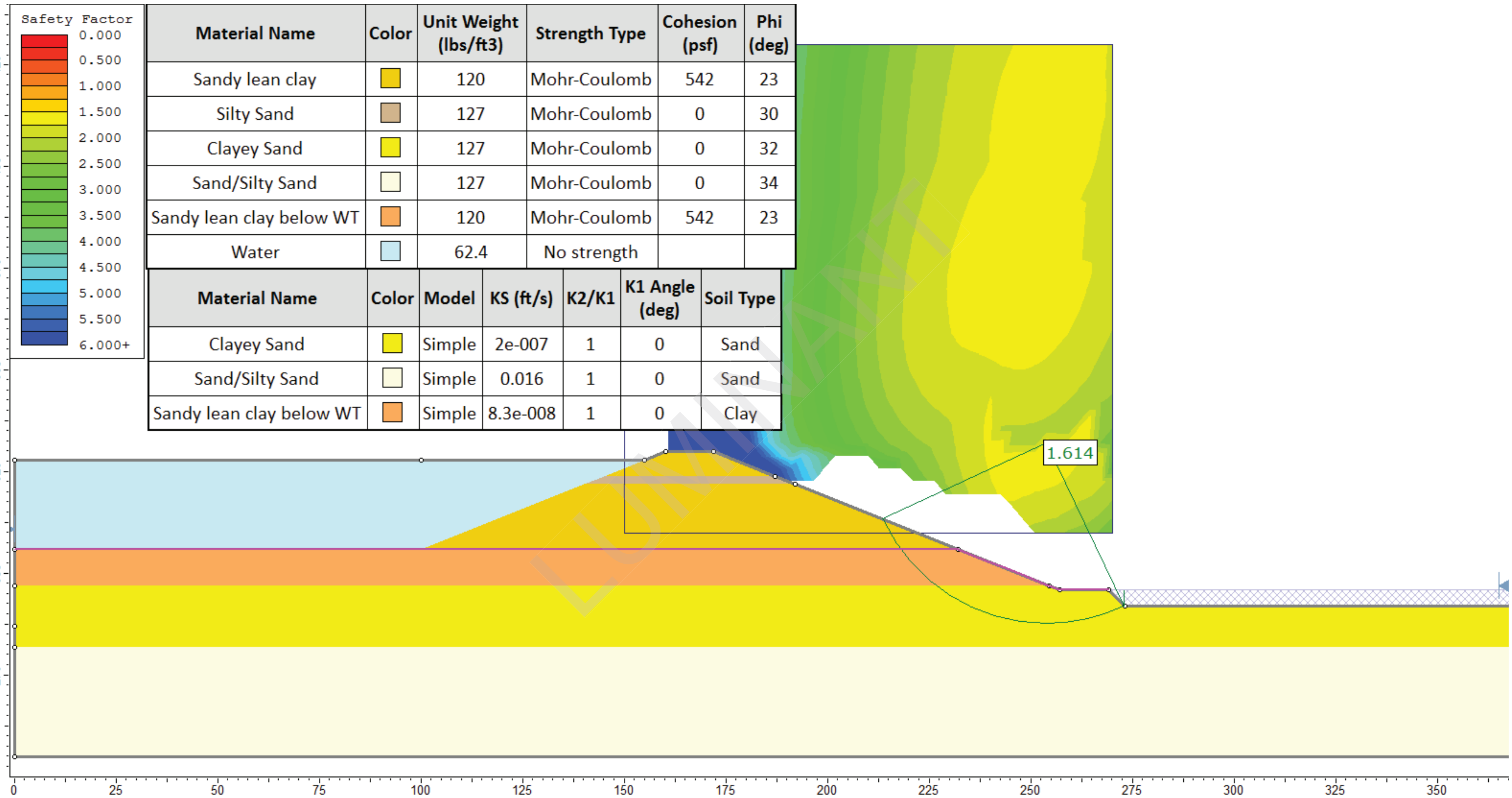
FIGURE **C.2**

Results of Stability Analysis – BAP–SP: A–A' – Case 1b

Stability and Safety Factor Assessment, Martin Lake SES

164816402

Golder Associates



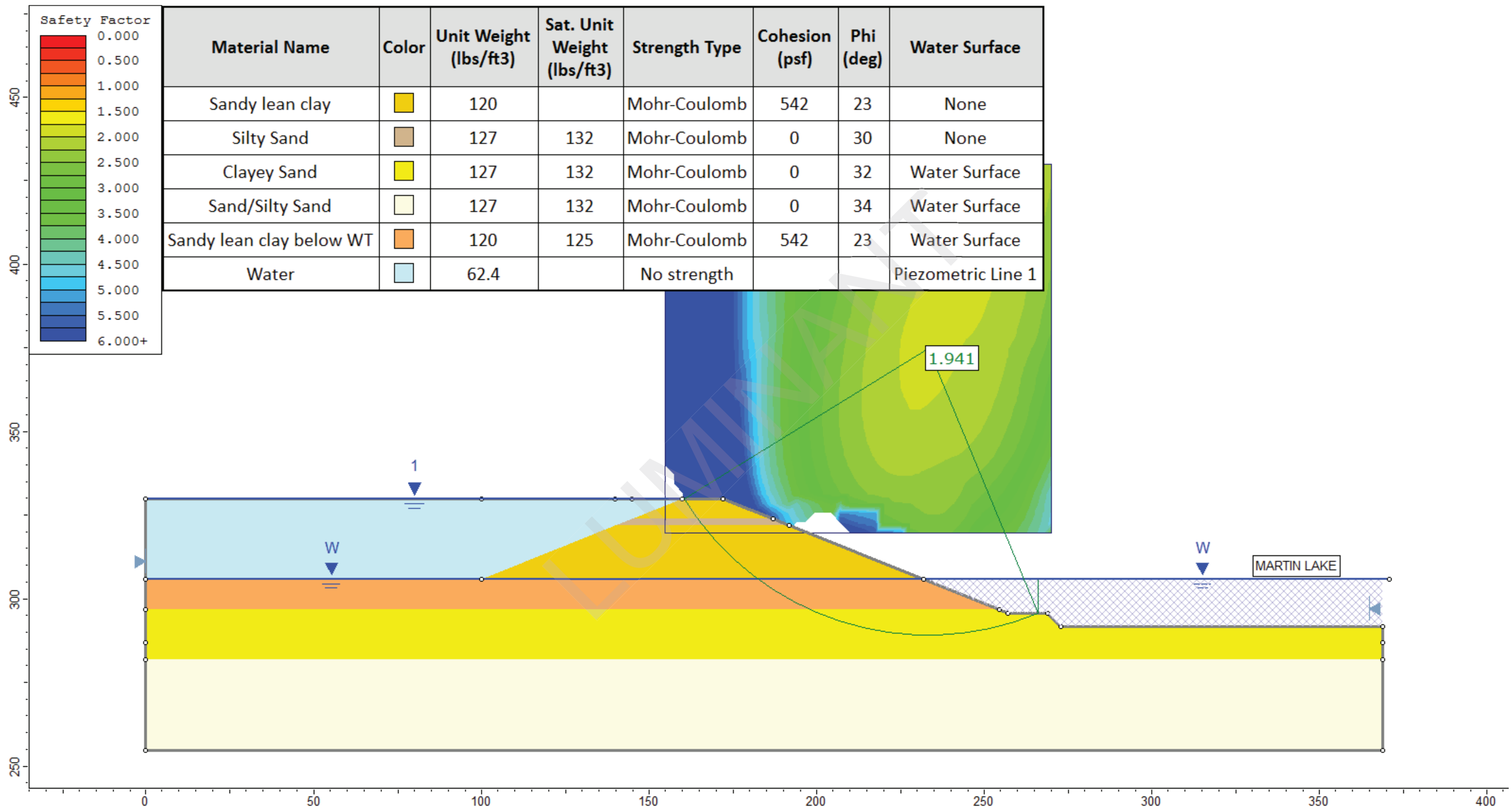
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Sandy lean clay		120	Mohr-Coulomb	542	23
Silty Sand		127	Mohr-Coulomb	0	30
Clayey Sand		127	Mohr-Coulomb	0	32
Sand/Silty Sand		127	Mohr-Coulomb	0	34
Sandy lean clay below WT		120	Mohr-Coulomb	542	23
Water		62.4	No strength		

Material Name	Color	Model	KS (ft/s)	K2/K1	K1 Angle (deg)	Soil Type
Clayey Sand		Simple	2e-007	1	0	Sand
Sand/Silty Sand		Simple	0.016	1	0	Sand
Sandy lean clay below WT		Simple	8.3e-008	1	0	Clay

FIGURE **C.3**

Results of Stability Analysis – BAP–SP: A–A' – Case 1c

Stability and Safety Factor Assessment, Martin Lake SES



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Sandy lean clay		120		Mohr-Coulomb	542	23	None
Silty Sand		127	132	Mohr-Coulomb	0	30	None
Clayey Sand		127	132	Mohr-Coulomb	0	32	Water Surface
Sand/Silty Sand		127	132	Mohr-Coulomb	0	34	Water Surface
Sandy lean clay below WT		120	125	Mohr-Coulomb	542	23	Water Surface
Water		62.4		No strength			Piezometric Line 1

FIGURE **C.4**

Results of Stability Analysis – BAP–SP: A–A' – Case 2a

Stability and Safety Factor Assessment, Martin Lake SES

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Sandy lean clay		120		Mohr-Coulomb	542	23	None
Silty Sand		127	132	Mohr-Coulomb	0	30	None
Clayey Sand		127	132	Mohr-Coulomb	0	32	Water Surface
Sand/Silty Sand		127	132	Mohr-Coulomb	0	34	Water Surface
Sandy lean clay below WT		120	125	Mohr-Coulomb	542	23	Water Surface
Water		62.4		No strength			Piezometric Line 1

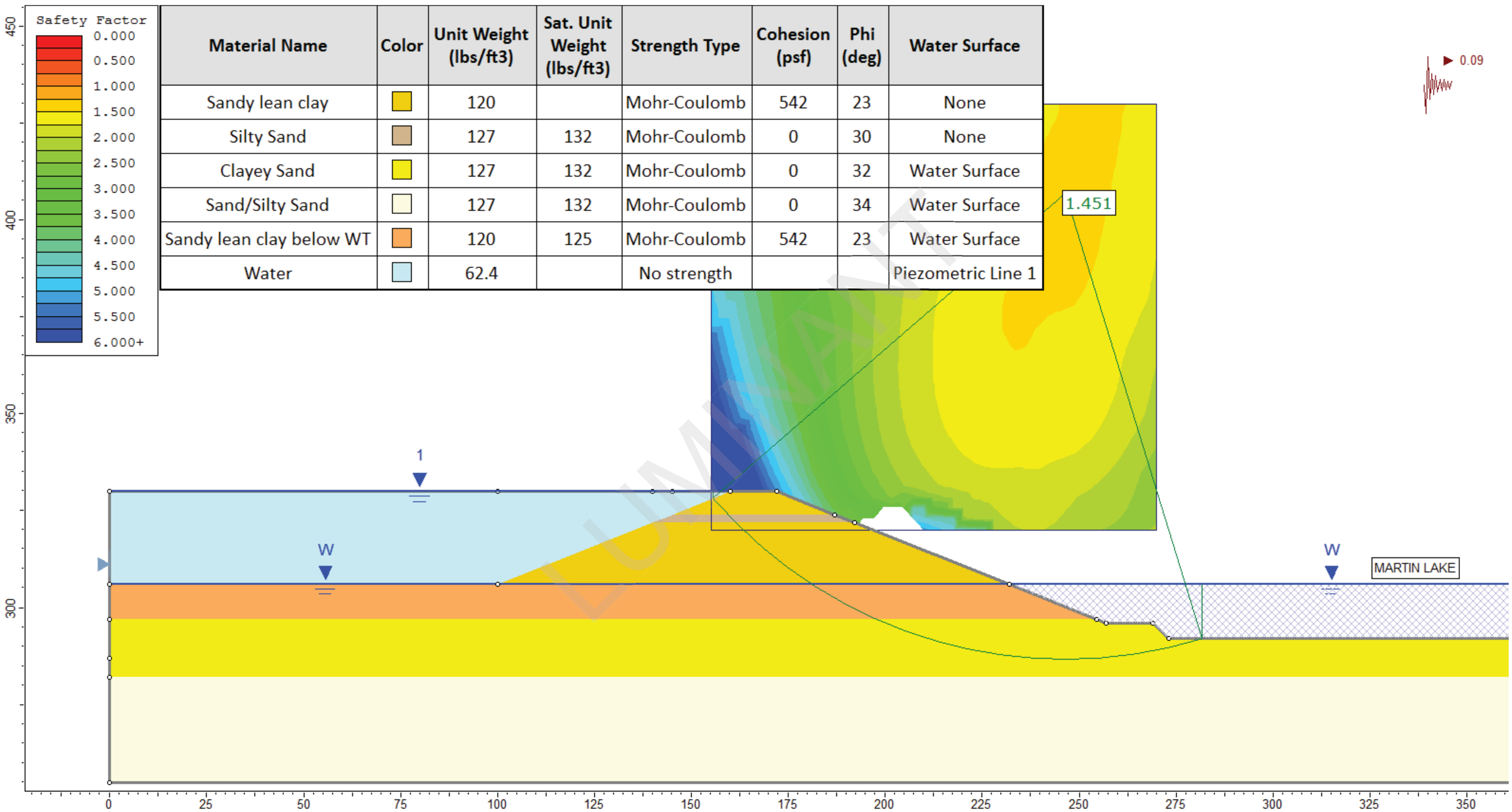
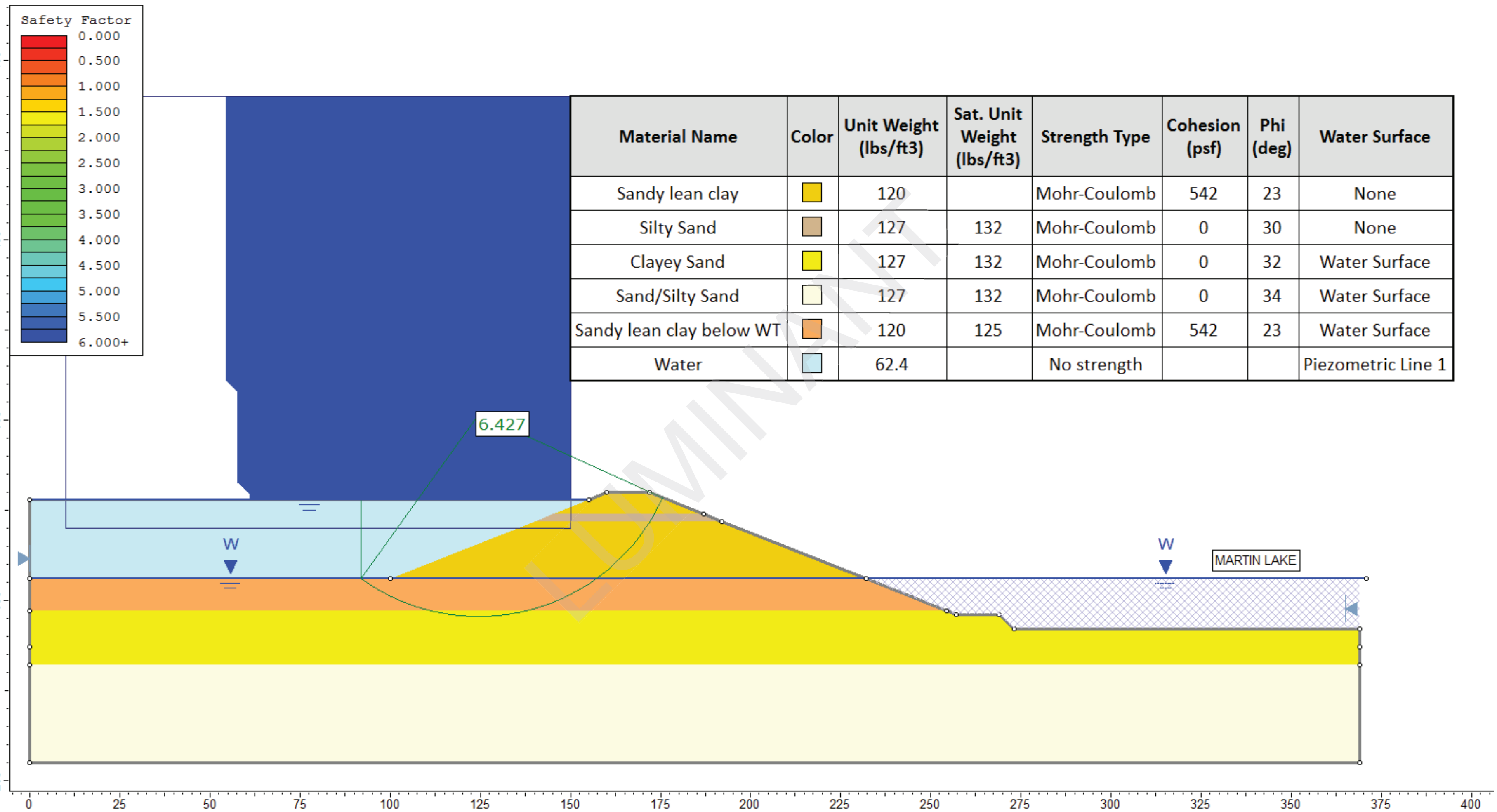


FIGURE **C.5**

Results of Stability Analysis – BAP–SP: A–A' – Case 2b

Stability and Safety Factor Assessment, Martin Lake SES

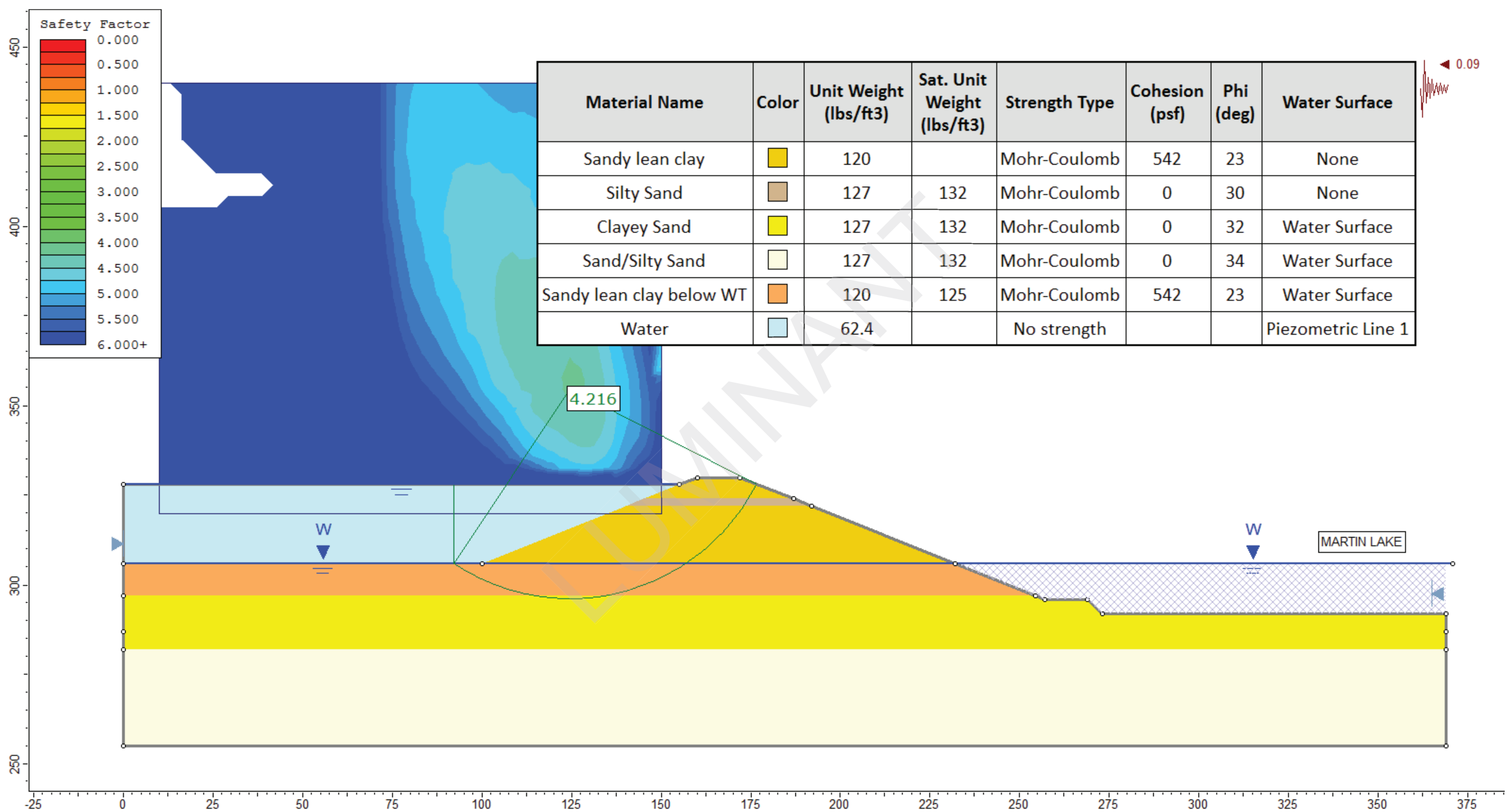


Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Sandy lean clay		120		Mohr-Coulomb	542	23	None
Silty Sand		127	132	Mohr-Coulomb	0	30	None
Clayey Sand		127	132	Mohr-Coulomb	0	32	Water Surface
Sand/Silty Sand		127	132	Mohr-Coulomb	0	34	Water Surface
Sandy lean clay below WT		120	125	Mohr-Coulomb	542	23	Water Surface
Water		62.4		No strength			Piezometric Line 1

FIGURE **C.6**

Results of Stability Analysis – BAP–SP: A–A' – Case 3a

Stability and Safety Factor Assessment, Martin Lake SES

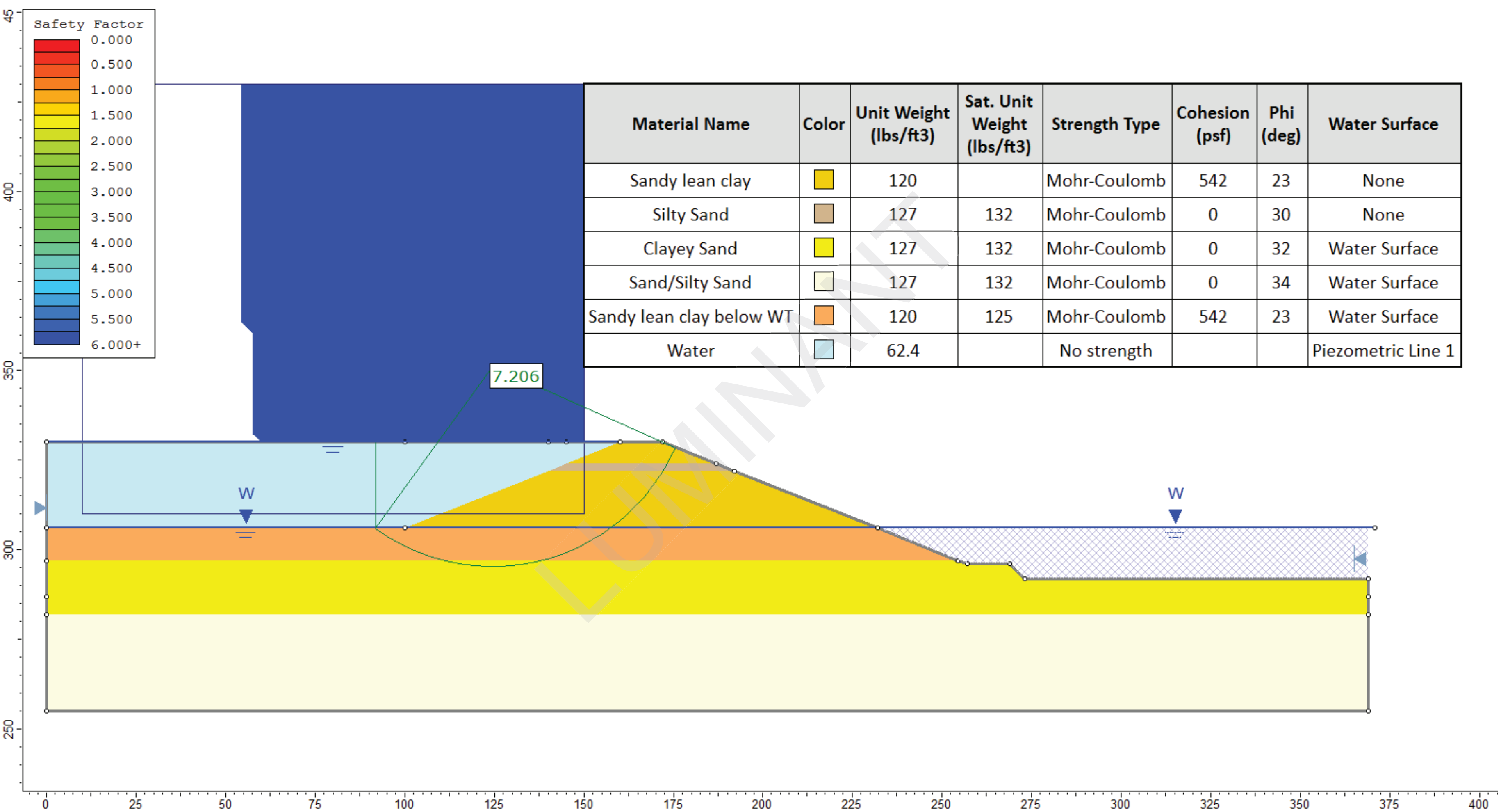


Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Sandy lean clay		120		Mohr-Coulomb	542	23	None
Silty Sand		127	132	Mohr-Coulomb	0	30	None
Clayey Sand		127	132	Mohr-Coulomb	0	32	Water Surface
Sand/Silty Sand		127	132	Mohr-Coulomb	0	34	Water Surface
Sandy lean clay below WT		120	125	Mohr-Coulomb	542	23	Water Surface
Water		62.4		No strength			Piezometric Line 1

FIGURE **C.7**

Results of Stability Analysis – BAP–SP: A–A' – Case 3b

Stability and Safety Factor Assessment, Martin Lake SES

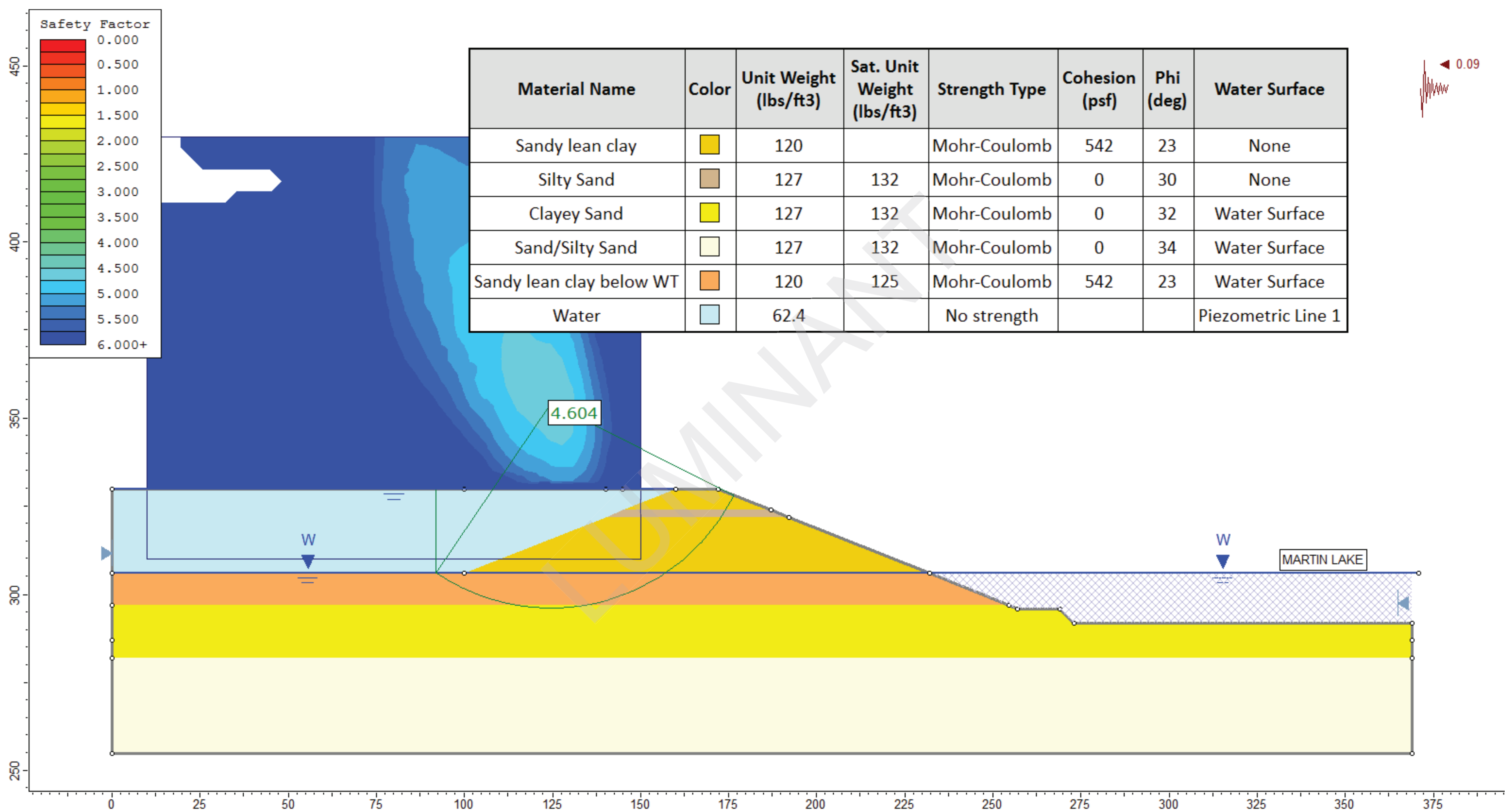


Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Sandy lean clay		120		Mohr-Coulomb	542	23	None
Silty Sand		127	132	Mohr-Coulomb	0	30	None
Clayey Sand		127	132	Mohr-Coulomb	0	32	Water Surface
Sand/Silty Sand		127	132	Mohr-Coulomb	0	34	Water Surface
Sandy lean clay below WT		120	125	Mohr-Coulomb	542	23	Water Surface
Water		62.4		No strength			Piezometric Line 1

FIGURE **C.8**

Results of Stability Analysis – BAP–SP: A–A' – Case 4a

Stability and Safety Factor Assessment, Martin Lake SES

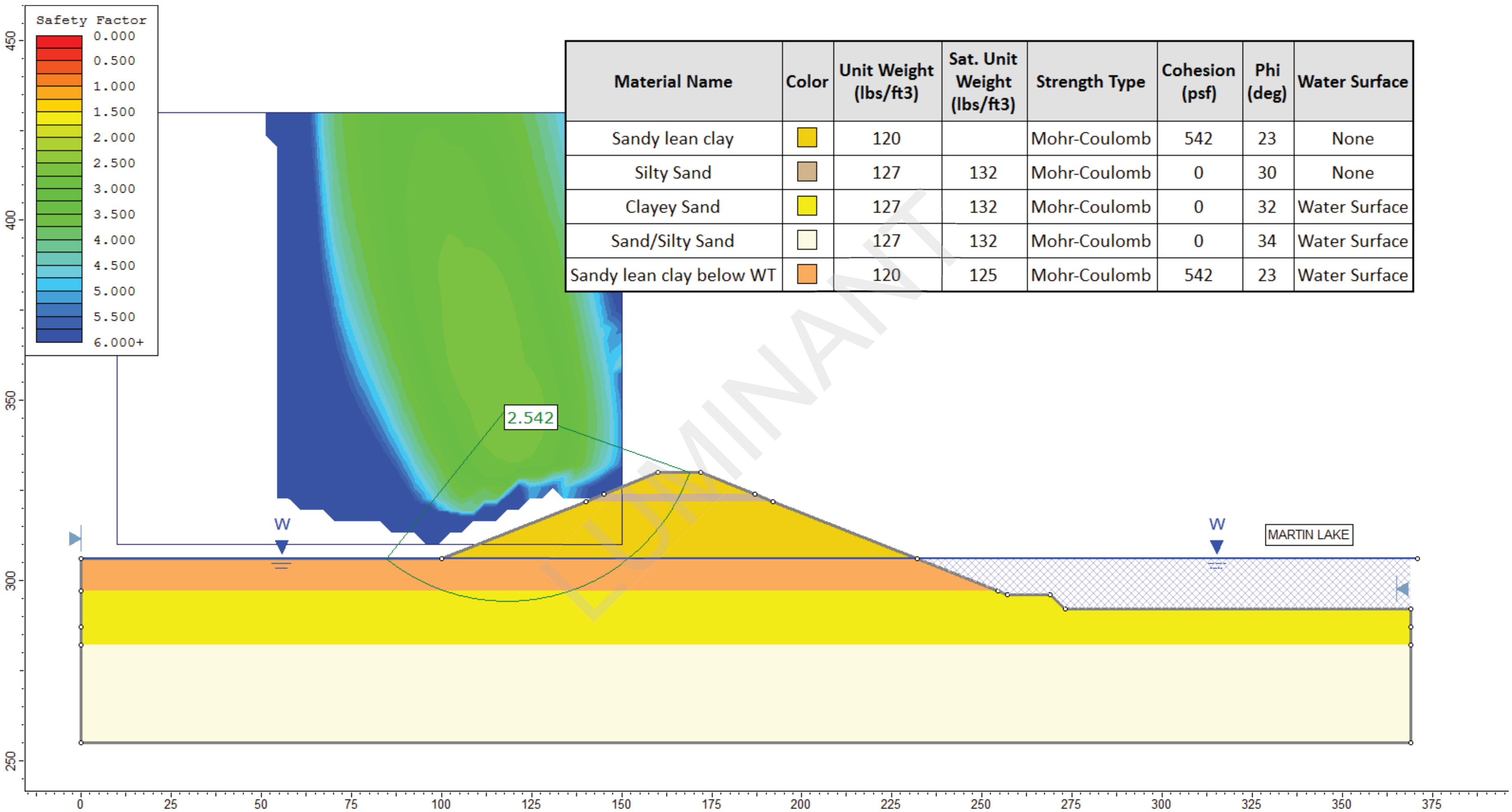


Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Sandy lean clay		120		Mohr-Coulomb	542	23	None
Silty Sand		127	132	Mohr-Coulomb	0	30	None
Clayey Sand		127	132	Mohr-Coulomb	0	32	Water Surface
Sand/Silty Sand		127	132	Mohr-Coulomb	0	34	Water Surface
Sandy lean clay below WT		120	125	Mohr-Coulomb	542	23	Water Surface
Water		62.4		No strength			Piezometric Line 1

FIGURE **C.9**

Results of Stability Analysis – BAP–SP: A–A' – Case 4b

Stability and Safety Factor Assessment, Martin Lake SES

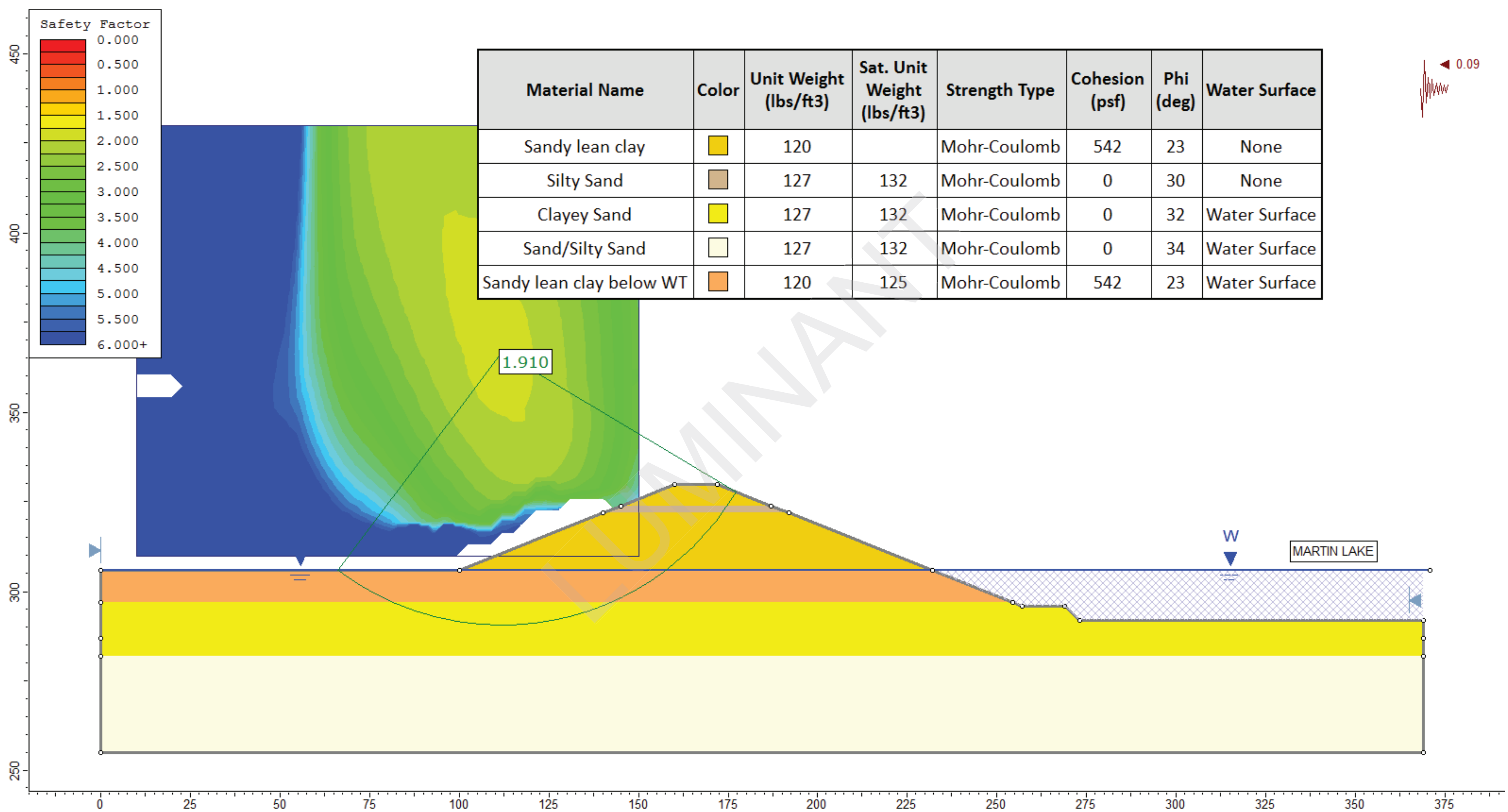


Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Sandy lean clay		120		Mohr-Coulomb	542	23	None
Silty Sand		127	132	Mohr-Coulomb	0	30	None
Clayey Sand		127	132	Mohr-Coulomb	0	32	Water Surface
Sand/Silty Sand		127	132	Mohr-Coulomb	0	34	Water Surface
Sandy lean clay below WT		120	125	Mohr-Coulomb	542	23	Water Surface

FIGURE **C.10**

Results of Stability Analysis – BAP–SP: A–A' – Case 5a

Stability and Safety Factor Assessment, Martin Lake SES

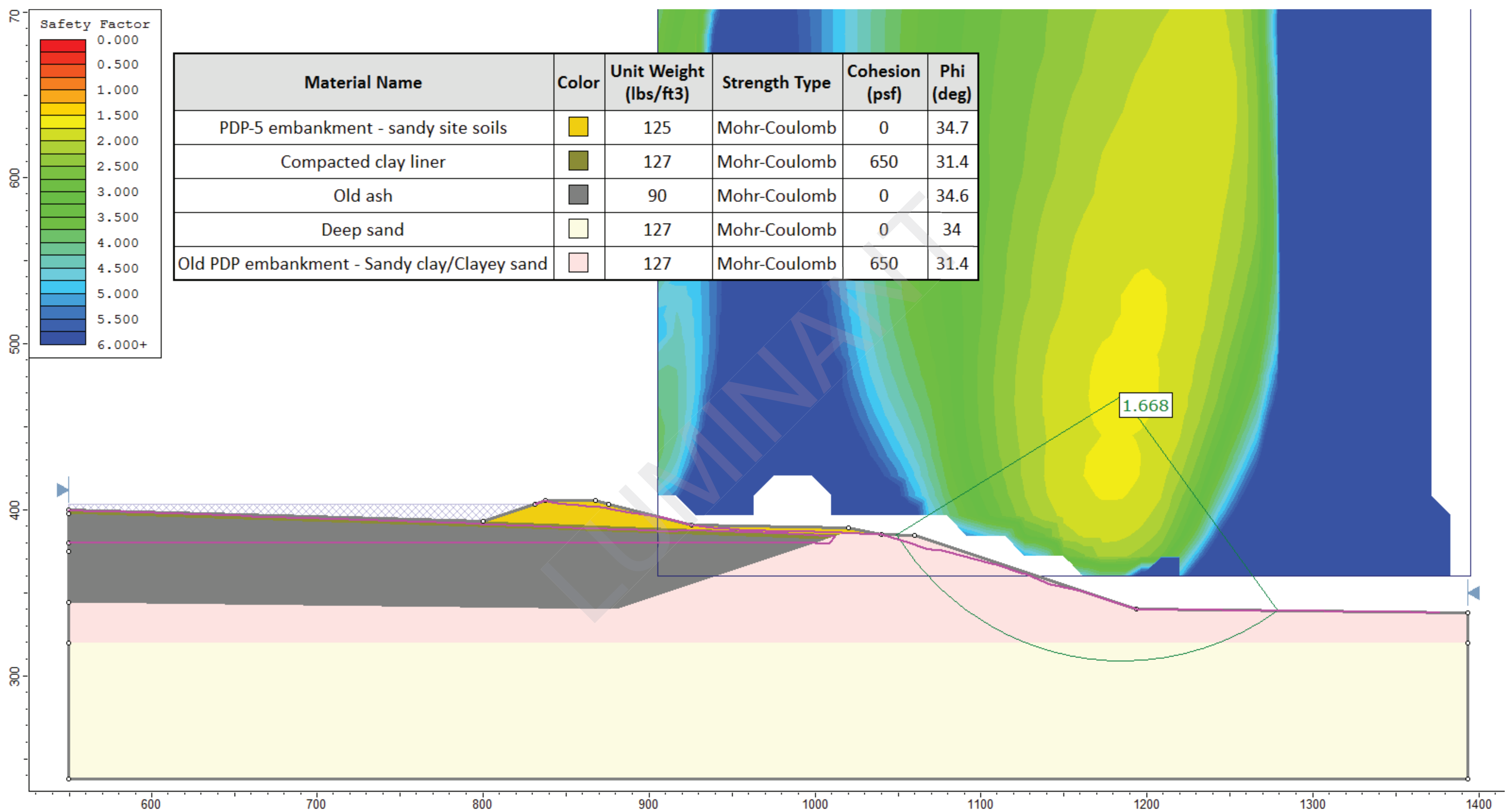


Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Sandy lean clay		120		Mohr-Coulomb	542	23	None
Silty Sand		127	132	Mohr-Coulomb	0	30	None
Clayey Sand		127	132	Mohr-Coulomb	0	32	Water Surface
Sand/Silty Sand		127	132	Mohr-Coulomb	0	34	Water Surface
Sandy lean clay below WT		120	125	Mohr-Coulomb	542	23	Water Surface

FIGURE **C.11**

Results of Stability Analysis – BAP–SP: A–A' – Case 5b

Stability and Safety Factor Assessment, Martin Lake SES

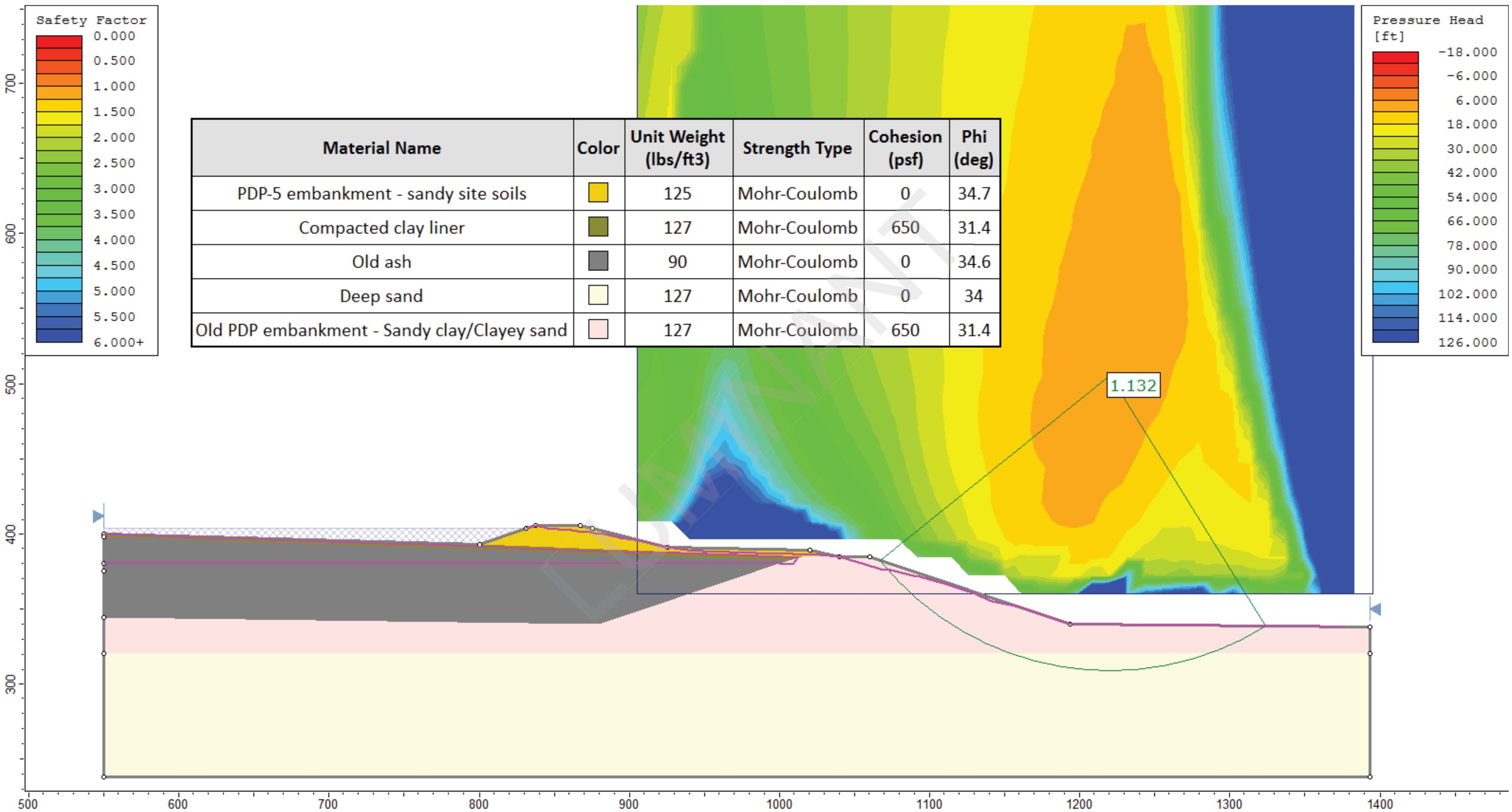


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
PDP-5 embankment - sandy site soils		125	Mohr-Coulomb	0	34.7
Compacted clay liner		127	Mohr-Coulomb	650	31.4
Old ash		90	Mohr-Coulomb	0	34.6
Deep sand		127	Mohr-Coulomb	0	34
Old PDP embankment - Sandy clay/Clayey sand		127	Mohr-Coulomb	650	31.4

FIGURE **C.12**

Results of Stability Analysis – PDP5: B–B' – Case 1a

Stability and Safety Factor Assessment, Martin Lake SES

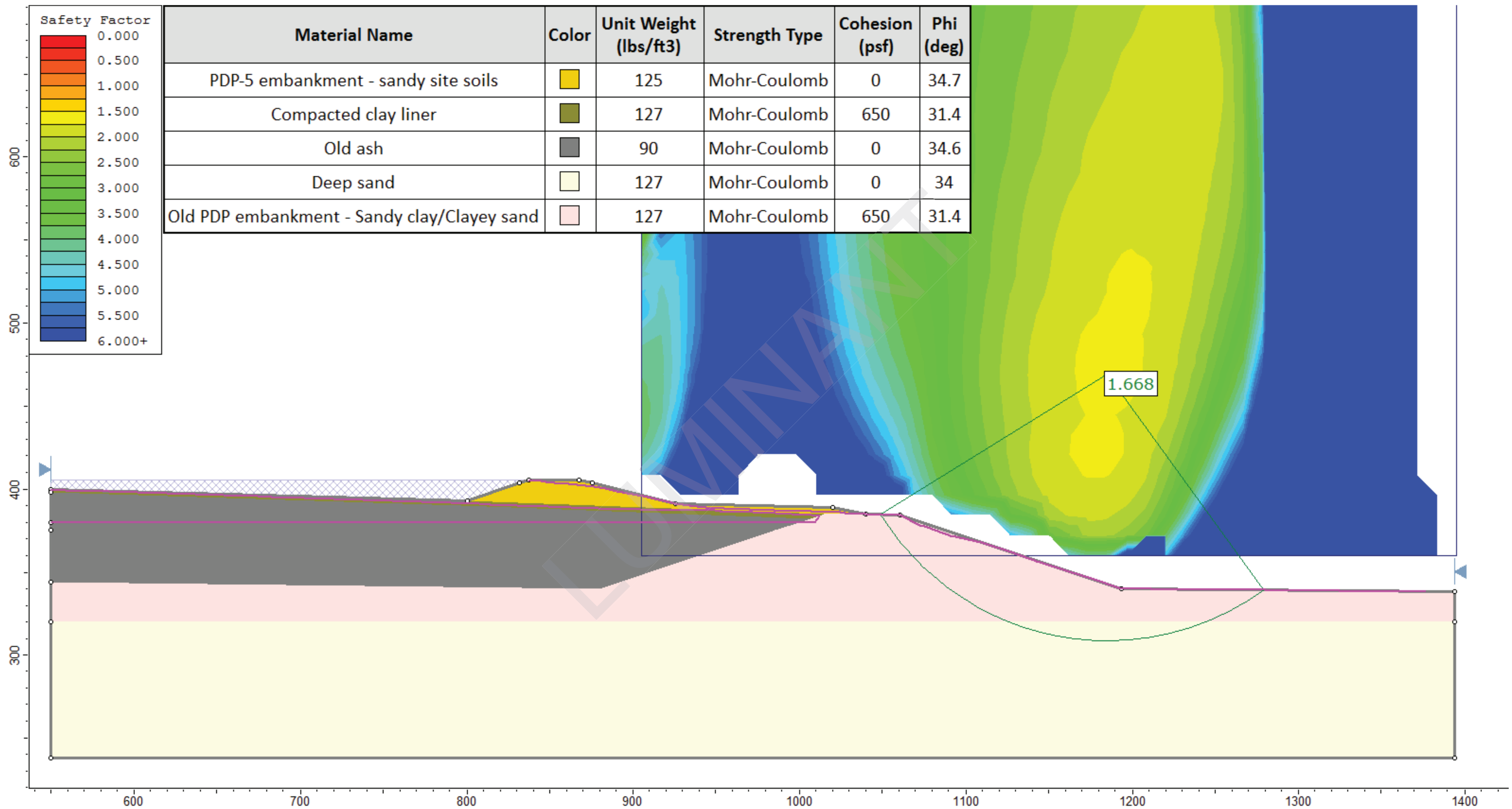


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
PDP-5 embankment - sandy site soils		125	Mohr-Coulomb	0	34.7
Compacted clay liner		127	Mohr-Coulomb	650	31.4
Old ash		90	Mohr-Coulomb	0	34.6
Deep sand		127	Mohr-Coulomb	0	34
Old PDP embankment - Sandy clay/Clayey sand		127	Mohr-Coulomb	650	31.4

FIGURE **C.13**

Results of Stability Analysis – PDP5: B–B' – Case 1b

Stability and Safety Factor Assessment, Martin Lake SES

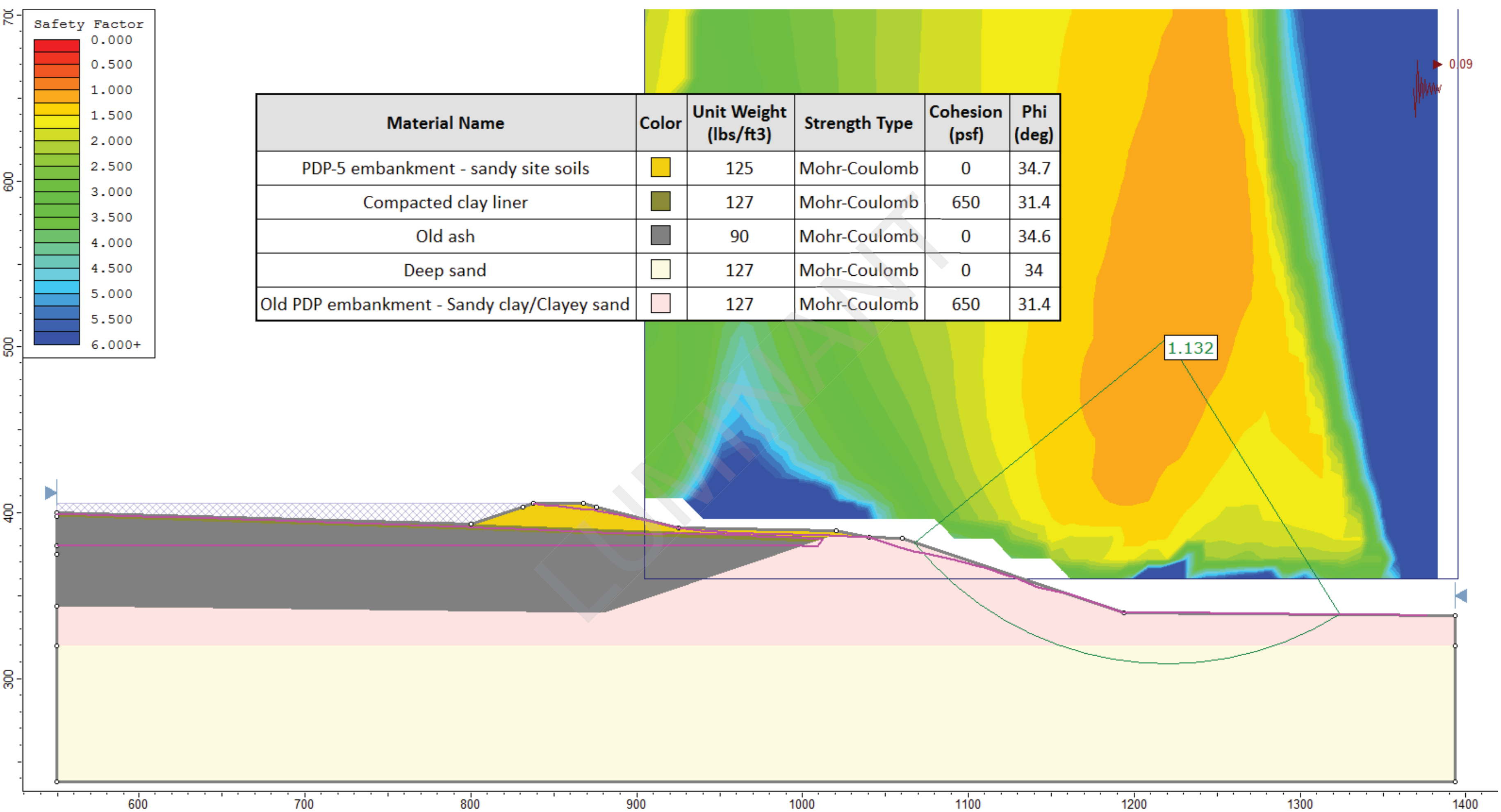


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
PDP-5 embankment - sandy site soils		125	Mohr-Coulomb	0	34.7
Compacted clay liner		127	Mohr-Coulomb	650	31.4
Old ash		90	Mohr-Coulomb	0	34.6
Deep sand		127	Mohr-Coulomb	0	34
Old PDP embankment - Sandy clay/Clayey sand		127	Mohr-Coulomb	650	31.4

FIGURE **C.14**

Results of Stability Analysis – PDP5: B–B' – Case 2a

Stability and Safety Factor Assessment, Martin Lake SES

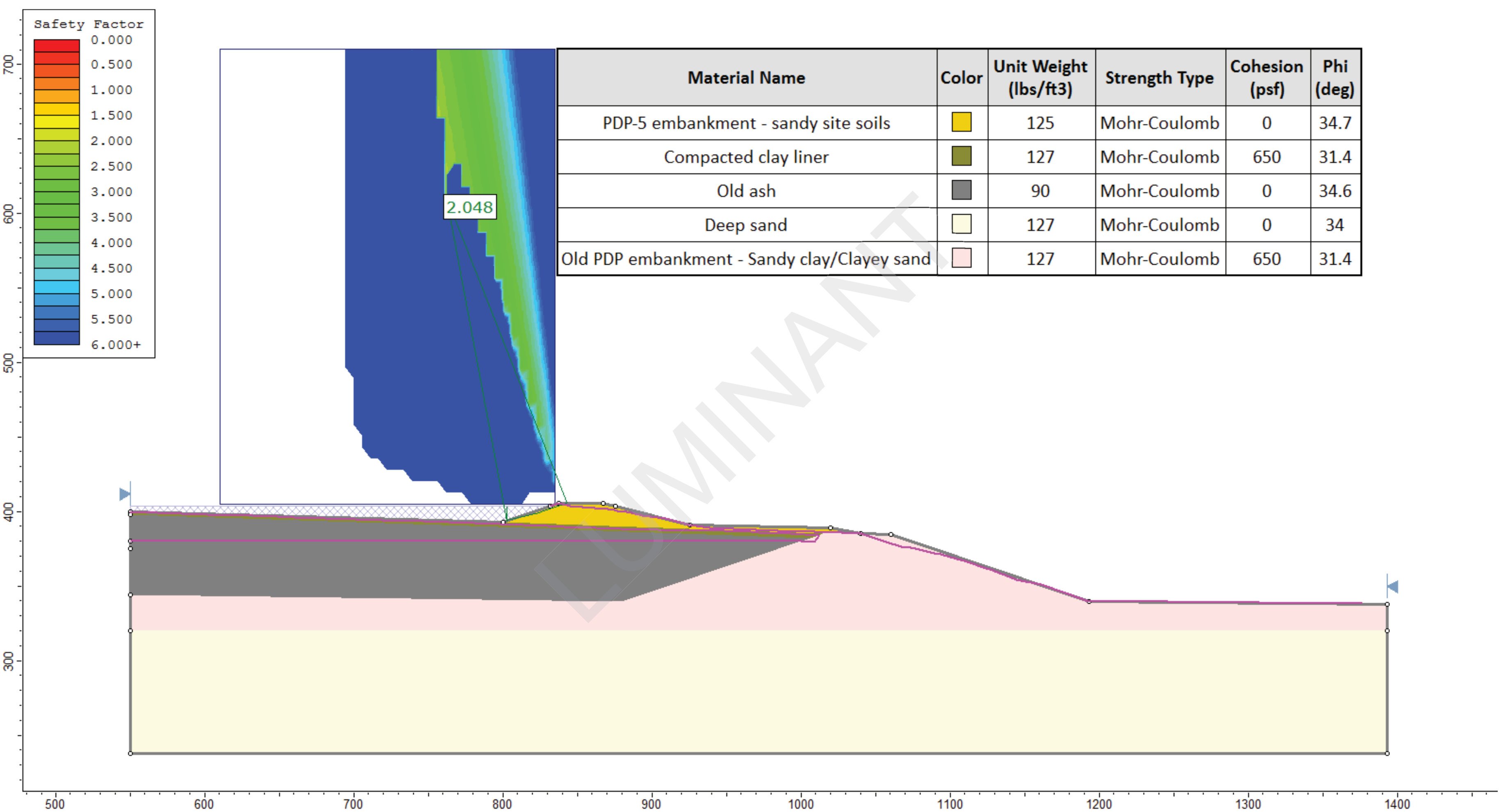


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
PDP-5 embankment - sandy site soils		125	Mohr-Coulomb	0	34.7
Compacted clay liner		127	Mohr-Coulomb	650	31.4
Old ash		90	Mohr-Coulomb	0	34.6
Deep sand		127	Mohr-Coulomb	0	34
Old PDP embankment - Sandy clay/Clayey sand		127	Mohr-Coulomb	650	31.4

FIGURE **C.15**

Results of Stability Analysis – PDP5: B–B' – Case 2b

Stability and Safety Factor Assessment, Martin Lake SES

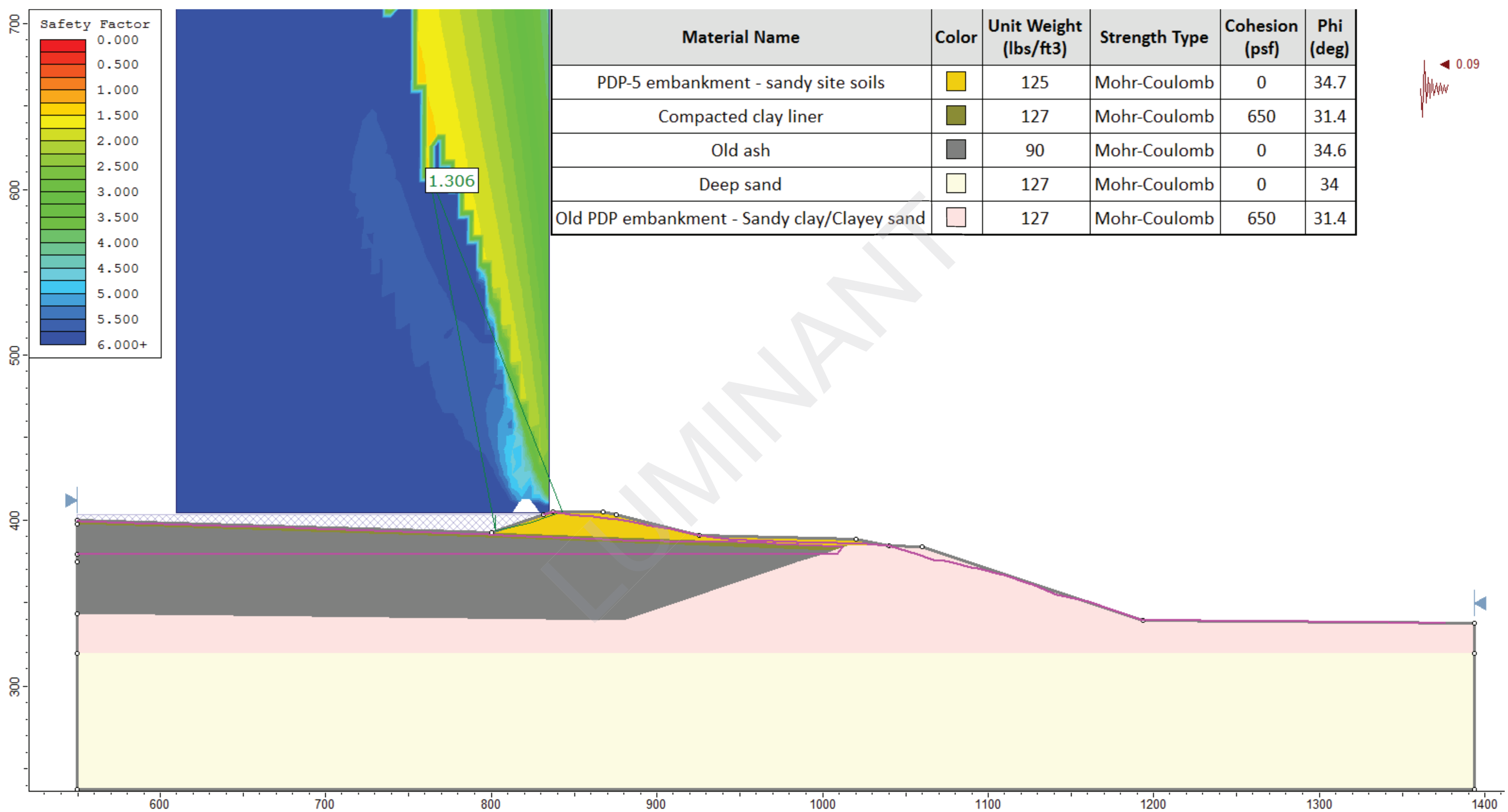


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
PDP-5 embankment - sandy site soils		125	Mohr-Coulomb	0	34.7
Compacted clay liner		127	Mohr-Coulomb	650	31.4
Old ash		90	Mohr-Coulomb	0	34.6
Deep sand		127	Mohr-Coulomb	0	34
Old PDP embankment - Sandy clay/Clayey sand		127	Mohr-Coulomb	650	31.4

FIGURE **C.16**

Results of Stability Analysis – PDP5: B–B' – Case 3a

Stability and Safety Factor Assessment, Martin Lake SES

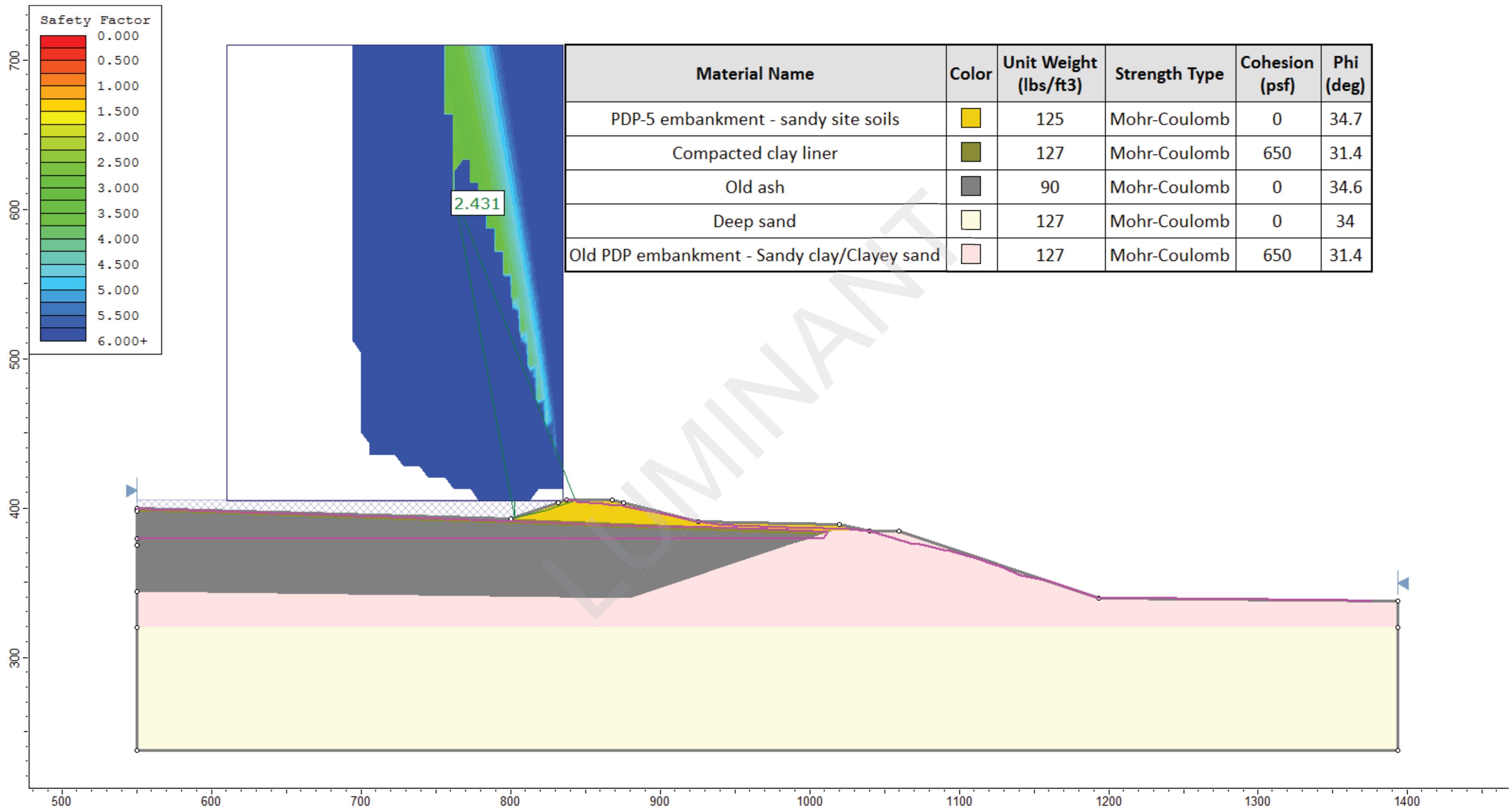


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
PDP-5 embankment - sandy site soils		125	Mohr-Coulomb	0	34.7
Compacted clay liner		127	Mohr-Coulomb	650	31.4
Old ash		90	Mohr-Coulomb	0	34.6
Deep sand		127	Mohr-Coulomb	0	34
Old PDP embankment - Sandy clay/Clayey sand		127	Mohr-Coulomb	650	31.4

FIGURE **C.17**

Results of Stability Analysis – PDP5: B–B' – Case 3b

Stability and Safety Factor Assessment, Martin Lake SES

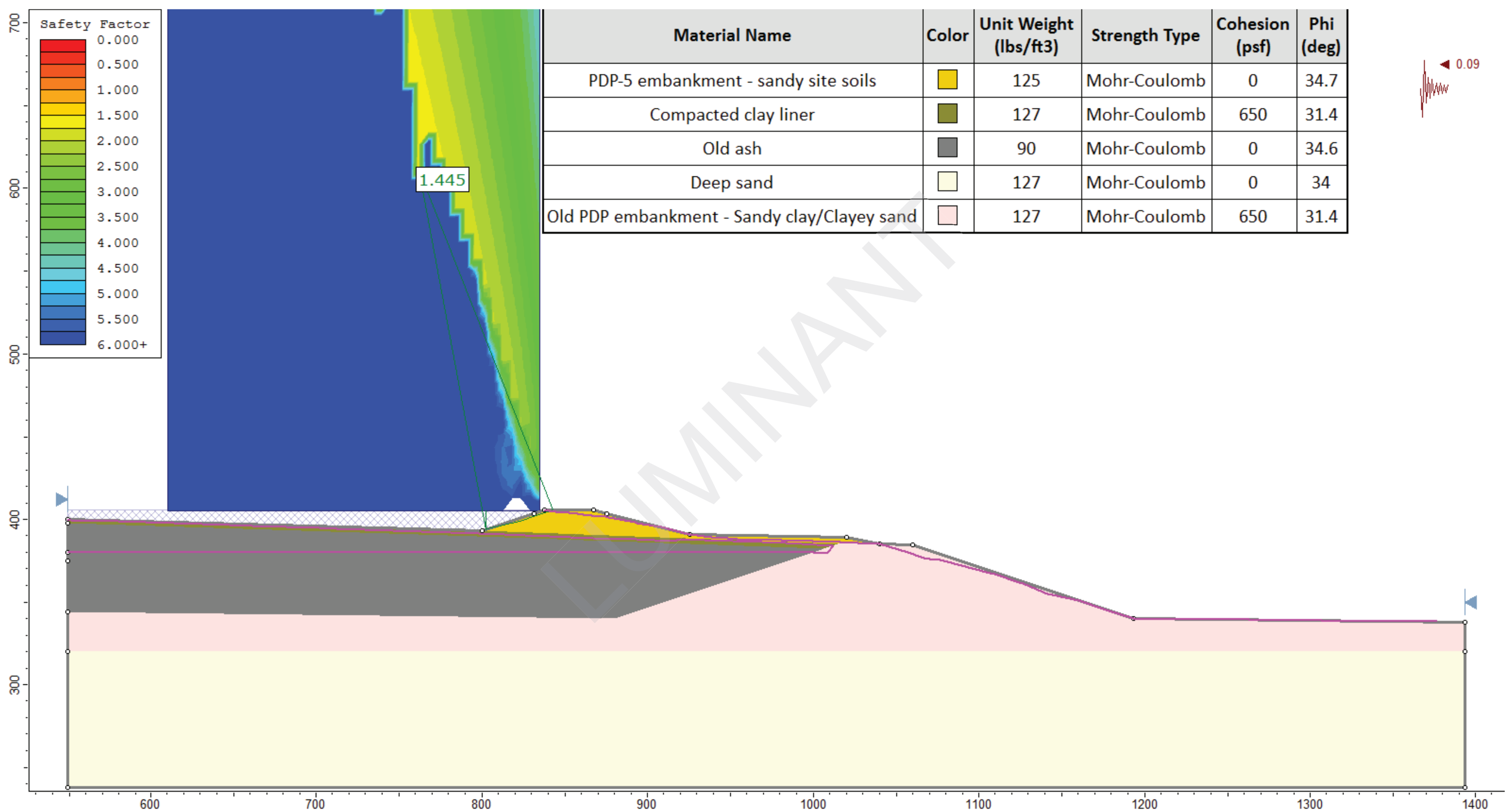


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
PDP-5 embankment - sandy site soils		125	Mohr-Coulomb	0	34.7
Compacted clay liner		127	Mohr-Coulomb	650	31.4
Old ash		90	Mohr-Coulomb	0	34.6
Deep sand		127	Mohr-Coulomb	0	34
Old PDP embankment - Sandy clay/Clayey sand		127	Mohr-Coulomb	650	31.4

FIGURE **C.18**

Results of Stability Analysis – PDP5: B–B' – Case 4a

Stability and Safety Factor Assessment, Martin Lake SES

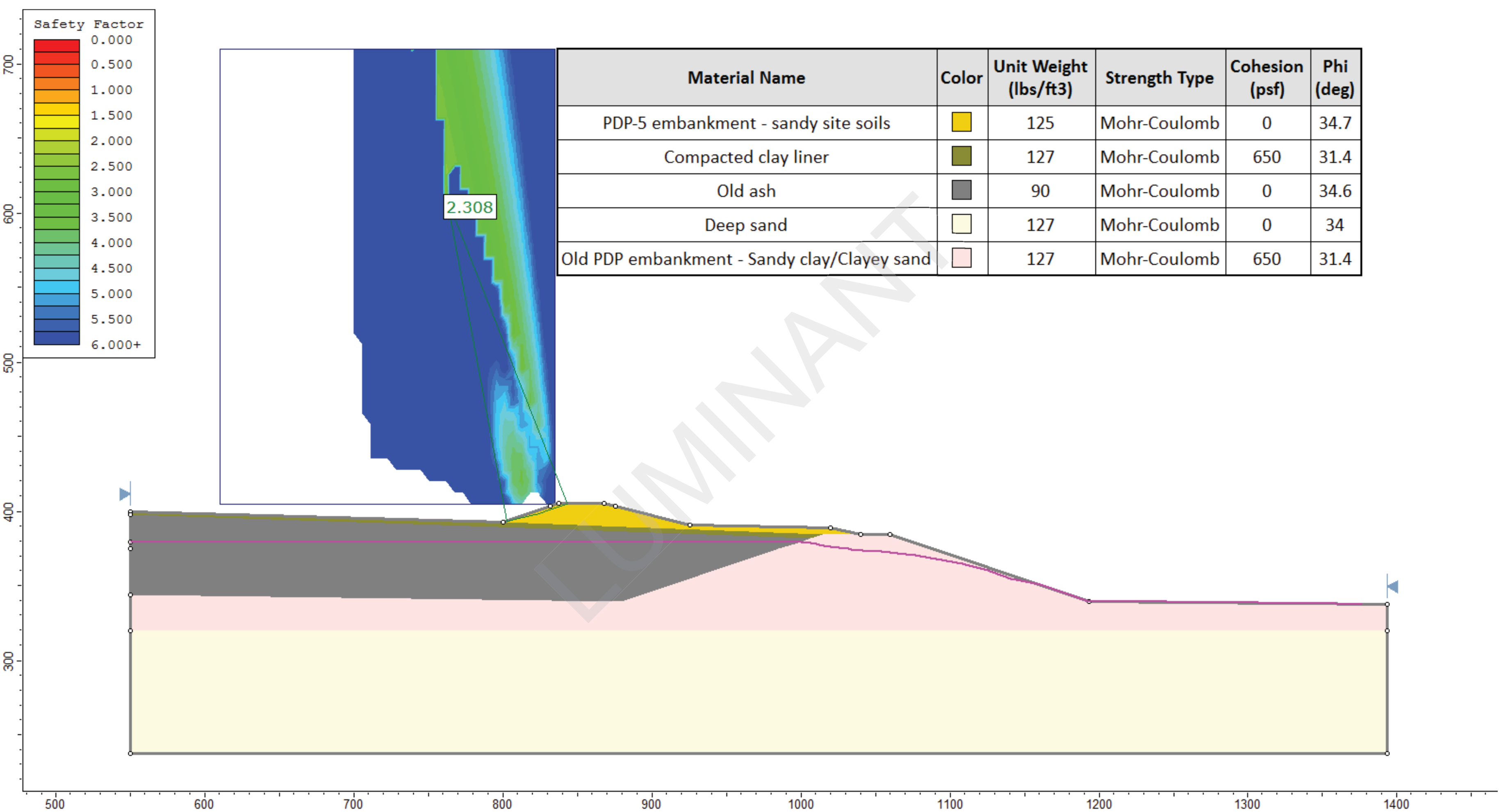


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
PDP-5 embankment - sandy site soils		125	Mohr-Coulomb	0	34.7
Compacted clay liner		127	Mohr-Coulomb	650	31.4
Old ash		90	Mohr-Coulomb	0	34.6
Deep sand		127	Mohr-Coulomb	0	34
Old PDP embankment - Sandy clay/Clayey sand		127	Mohr-Coulomb	650	31.4

FIGURE **C.19**

Results of Stability Analysis – PDP5: B–B' – Case 4b

Stability and Safety Factor Assessment, Martin Lake SES

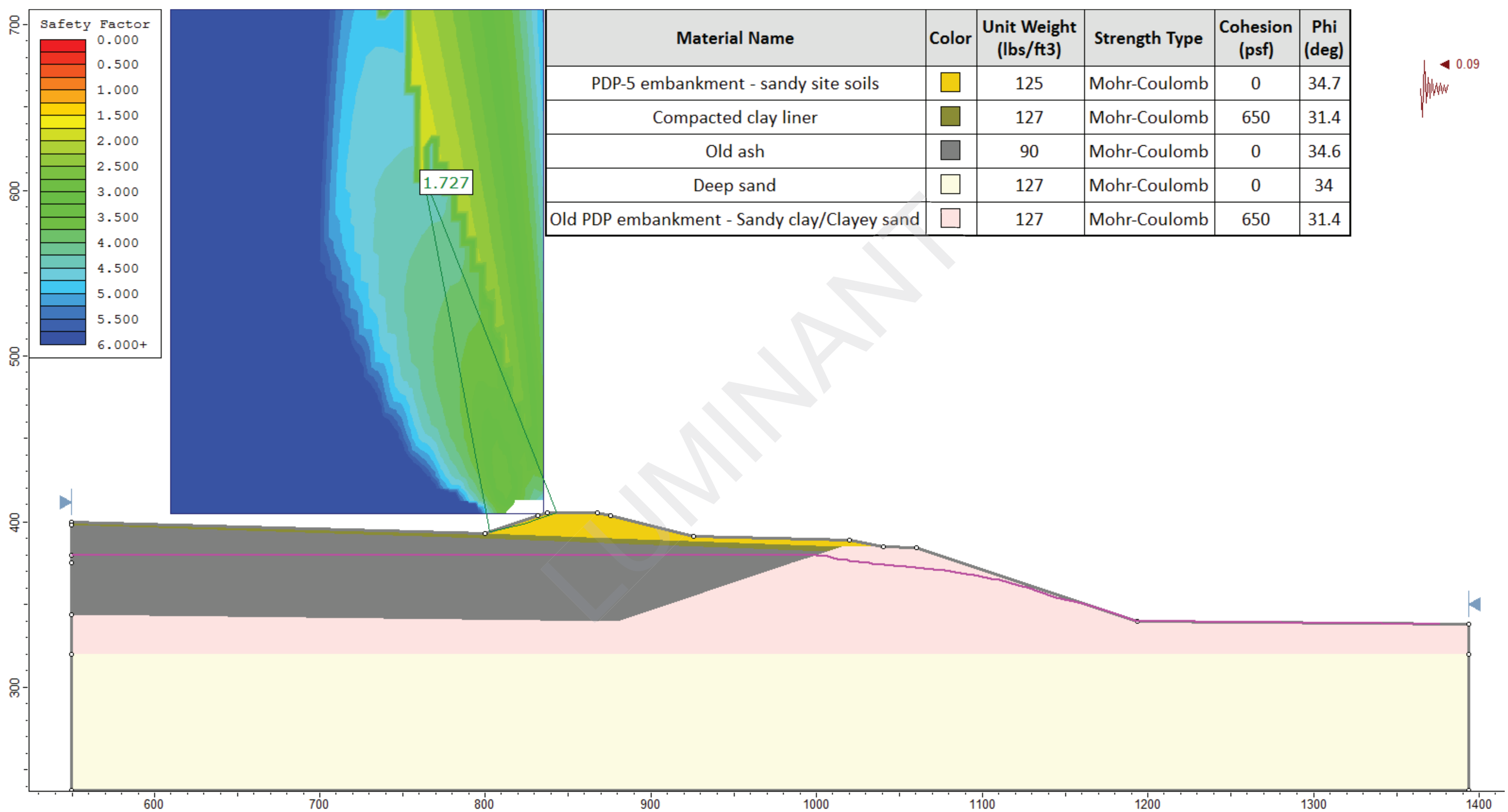


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
PDP-5 embankment - sandy site soils		125	Mohr-Coulomb	0	34.7
Compacted clay liner		127	Mohr-Coulomb	650	31.4
Old ash		90	Mohr-Coulomb	0	34.6
Deep sand		127	Mohr-Coulomb	0	34
Old PDP embankment - Sandy clay/Clayey sand		127	Mohr-Coulomb	650	31.4

FIGURE **C.20**

Results of Stability Analysis – PDP5: B–B' – Case 5a

Stability and Safety Factor Assessment, Martin Lake SES



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
PDP-5 embankment - sandy site soils		125	Mohr-Coulomb	0	34.7
Compacted clay liner		127	Mohr-Coulomb	650	31.4
Old ash		90	Mohr-Coulomb	0	34.6
Deep sand		127	Mohr-Coulomb	0	34
Old PDP embankment - Sandy clay/Clayey sand		127	Mohr-Coulomb	650	31.4

FIGURE **C.21**

Results of Stability Analysis – PDP5: B–B' – Case 5b

Stability and Safety Factor Assessment, Martin Lake SES

Established in 1960, Golder Associates is a global, employee-owned organization that helps clients find sustainable solutions to the challenges of finite resources, energy and water supply and management, waste management, urbanization, and climate change. We provide a wide range of independent consulting, design, and construction services in our specialist areas of earth, environment, and energy. By building strong relationships and meeting the needs of clients, our people have created one of the most trusted professional services organizations in the world.

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Golder Associates

Engineering Earth's Development, Preserving Earth's Integrity

APPENDIX F10 - A-1 AREA LANDFILL GROUNDWATER MONITORING SYSTEM CERTIFICATION

COAL COMBUSTION RESIDUAL RULE
GROUNDWATER MONITORING SYSTEM CERTIFICATION

MARTIN LAKE STEAM ELECTRIC STATION
A1 AREA LANDFILL
RUSK COUNTY, TEXAS

OCTOBER 16, 2017

Prepared For:

Luminant Generation Company, LLC
6555 Sierra Drive
Irving, TX 75039

Prepared By:

Pastor, Behling & Wheeler, LLC
2201 Double Creek Drive, Suite 4004
Round Rock, Texas 78664
Texas Engineering Firm No. 4760

October 16, 2017

PROFESSIONAL CERTIFICATION

This document and all attachments were prepared by Pastor, Behling & Wheeler, LLC under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I hereby certify that the groundwater monitoring system installed at the referenced facility has been designed and constructed to meet the requirements of Section 257.91 of the CCR Rule.

Patrick J. Behling, P.E.
Principal Engineer
PASTOR, BEHLING & WHEELER, LLC

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1.0 INTRODUCTION

Luminant Power (Luminant) operates the Martin Lake Steam Electric Station (MLSES) located approximately 5 miles southeast of Tatum, Rusk County, Texas (Figure 1). The MLSES consists of three coal/lignite-fired power generation units. Coal Combustion Residuals (CCRs) including fly ash, bottom ash and gypsum are generated as part of the MLSES unit operations. Currently, CCRs generated at the MLSES are transported off-site for beneficial use by third-parties or are managed by Luminant in surface impoundments located on the MLSES property or the A1 Area Landfill located approximately 2.5 miles east of the MLSES. Three CCR Units have been identified within the MLSES operations, the Ash Pond Area (the West Ash Pond (WAP) East Ash Pond (EAP), and the New Scrubber Pond), Permanent Disposal Pond 5 (PDP 5), and A1 Area Landfill. This report discusses the A1 Area Landfill (the Site).

The CCR Rule (40 CFR 257 Subpart D - *Standards for the Receipt of Coal Combustion Residuals in Landfills and Surface Impoundments*) has been promulgated by the EPA to regulate the management and disposal of CCRs as solid waste under Resource Conservation and Recovery Act (RCRA) Subtitle D. The final CCR Rule was published in the Federal Register on April 17, 2015. The effective date of the CCR Rule was October 19, 2015.

The CCR Rule establishes national minimum criteria for existing and new CCR landfills, existing and new CCR surface impoundments, and lateral expansions to landfills/impoundments. Pastor, Behling & Wheeler, LLC (PBW) was retained by Luminant to evaluate and certify the groundwater monitoring system at the Site in accordance with Section 257.91 of the CCR Rule.

1.1 Description of A1 Area Landfill

The A1 Area Landfill and adjacent A1 Area Landfill Expansion (collectively referred to as the A1 Area Landfill) are located at the Beckville Lignite Mine, approximately 2.5 miles southeast of the MLSES power units, on the opposite side of Martin Lake from the MLSES (Figure 2). CCRs generated at the MLSES, including fly ash and bottom ash, are transported and managed/disposed of by Luminant in the A1 Area Landfill. The A1 Area Landfill was constructed within a mined-out area of the Beckville Lignite Mine, and is surrounded and underlain by spoil material that was previously excavated during lignite mining operations. The A1 Area Landfill is considered an existing CCR unit under the CCR Rule.

1.2 CCR Unit Groundwater Monitoring System Requirements

Section 257.91 of the CCR Rule indicates that existing CCR landfills and surface impoundments be provided with a groundwater monitoring system that consists of sufficient wells, installed at appropriate location and depths, to yield groundwater samples from the uppermost aquifer that meet the following criteria:

- Accurately represent the quality of background groundwater that has not been affected by leakage from a CCR unit; and
- Accurately represent the quality of groundwater passing the waste boundary of the CCR unit. The downgradient monitoring system must be installed at the waste boundary to ensure detection of groundwater contamination in the uppermost aquifer. All potential contaminant pathways must be monitored.

The specific configuration of the groundwater monitoring system must be determined based on site-specific technical information that must include aquifer thickness, groundwater flow rate, groundwater flow direction (including seasonal and temporal fluctuation in groundwater flow), saturated and unsaturated geologic units and fill materials that overly the uppermost aquifer, materials comprising the uppermost aquifer, and materials comprising the confining unit defining the lower boundary of the upmost aquifer, including, but not limited to, thickness, stratigraphy, lithology, hydraulic conductivities, porosities, and effective porosities.

At a minimum, the monitoring system must consist of at least one upgradient and three downgradient monitoring wells, and any additional monitoring wells necessary to accurately represent the quality of the background groundwater that has not been affected by leakage from the CCR unit and the quality of groundwater passing the waste boundary of the CCR unit. Multi-unit groundwater monitoring systems are allowed but must be equally as capable of detecting monitored constituents at the waste boundary of a CCR unit as individual groundwater monitoring wells.

Monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated and packed with gravel or sand, where necessary, to enable collection of groundwater samples. The annular space above the sampling depth must be sealed to prevent contamination of samples and the groundwater. There must be documentation in the operating record of the design, installation, development, and decommissioning of any monitoring wells, piezometers and other measurement, sampling, and analytical devices. The qualified engineer must have access to and must review this documentation as part of the groundwater monitoring system certification.

2.0 GROUNDWATER MONITORING SYSTEM EVALUATION

2.1 A1 Area Landfill Groundwater Monitoring System

The CCR groundwater monitoring well system at the Site consists of eleven monitoring wells (BMW-11AR, BMW-18, BMW-19, BMW-20, BMW-21, BMW-22, BMW-23, BMW-24, BMW-26, BMW-27, and BMW-28) that are each screened in the uppermost aquifer at the Site. The locations of the CCR monitoring wells are shown on Figure 2. Well construction information and survey data for the CCR wells are summarized in Table 1, CCR monitoring well logs are presented in Appendix A, and photographs of the CCR wells are presented in Appendix B.

2.2 Local Geology and Hydrogeology

The Site is located in the outcrop area of the Eocene-aged Wilcox Group (Barnes, 1965). PBW reviewed current and historical soil boring logs, monitoring well completion documentation, and historical reports to describe the geologic and hydrogeologic conditions at the A1 Area Landfill. Geologic cross sections were constructed through this area using this data. Cross section locations are presented on Figure 3 and the cross sections are presented on Figures 4, 5, 6, and 7.

The A1 Area Landfill is constructed within spoil material that was excavated during lignite mining operations at the Beckville Lignite Mine. Available lithologic descriptions of the spoil material indicate that it primarily consists of a heterogenous mixture of clay and sand with trace imbedded fragments of lignite. The spoil depth generally increases to the northwest. The spoil/native contact in the southeastern portion of the A1 Area Landfill was encountered at depths ranging from 9 feet bgs to 70 feet bgs (BMW-, while the spoil/native contact in the northwestern portion of the A1 Area Landfill was encountered at depths ranging from 90 feet bgs to 150 feet bgs. Native material encountered below the spoil zone consisted of lignite or native, silty clay. The A1 Area Landfill groundwater monitoring wells are all completed within the spoil zone.

2.3 Groundwater Potentiometric Surface Elevations

Eight background groundwater monitoring events were performed using the A1 Area Landfill CCR monitoring well system. Static water levels measured during the background monitoring period indicated water elevations ranging from 318.19 feet above mean sea level (amsl) to 386.98 feet amsl, and depths to water ranging from 1.77 feet bgs to 55.02 feet bgs (Table 2). Groundwater potentiometric surface maps based on data collected during the background monitoring period are presented in Appendix C.

Groundwater elevations were generally highest on the north side of the landfill, with an inferred groundwater flow direction radially outward from the north side of the landfill. Based on the inferred groundwater flow direction, the location of each CCR monitoring well relative to the A1 Area Landfill is as follows:

Upgradient Wells	Downgradient Wells
BMW-11A-R	BMW-18 BMW-19 BMW-20 BMW-21 BMW-22 BMW-23 BMW-24 BMW-26 BMW-27 BMW-28

2.4 Uppermost Aquifer Hydraulic Conductivity Testing

PBW performed slug tests at monitoring wells BMW-21, BMW-23, and BMW-24 on October 7, 2015 to evaluate groundwater linear flow velocities at the uppermost aquifer at the Site. Slug test data and time-head change plots used to calculate hydraulic conductivities and transmissivities of the uppermost aquifer are provided in Appendix D. A summary of these hydraulic properties is presented in Table 3. The average hydraulic conductivities for the wells ranged from 9.55×10^{-5} cm/sec (well BMW-24) to 1.53×10^{-3} cm/sec (well BMW-23), with a geometric mean for the test wells of 3.05×10^{-4} cm/sec.

2.5 Conclusions

The CCR groundwater monitoring well system at the A1 Landfill complies with Section 257.91 of the CCR Rule. This conclusion is supported by the following as described in detail in previous sections of this report:

- Eleven monitoring wells are included in the CCR groundwater monitoring system – one upgradient monitoring well and ten downgradient monitoring wells.

- Each monitoring well is screened in the uppermost aquifer at the Site. Samples collected from upgradient monitoring wells will be representative of the quality of background groundwater that has not been affected by leakage from the CCR unit and samples collected from downgradient wells will ensure detection of groundwater contamination in the uppermost aquifer from the CCR unit.

- The monitoring wells are constructed with appropriate well casing to maintain the integrity of the monitoring well borehole and with slotted well screens to enable collection of groundwater samples. In addition, the annular space above the well screen is appropriately sealed to prevent contamination of groundwater samples from surface sources.

- Appropriate documentation exists concerning the design, installation, and development of the monitoring wells.

3.0 REFERENCES

Barnes, Virgil E., 1965. Geologic Atlas of Texas, Tyler Sheet. Texas Bureau of Economic Geology.

Tables

TABLE 1
WELL CONSTRUCTION SUMMARY
A1 AREA LANDFILL

Well ID	Date Installed	Northing	Easting	Ground Elevation (ft amsl)	TOC Elevation (ft amsl)	Top of Screen (ft bgs)	Bottom of Screen (ft bgs)	Screen Length (ft)	Total Design Depth (ft bgs)	Casing Diameter (in)
BMW-11AR	2012	221220	2919014	423.37	426.05	119	139	20	139	4
BMW-18	9/29/15	216951	2915600	355.50	357.83	100	120	20	120	2
BMW-19	10/7/15	219535	2918071	397.47	400.69	25	45	20	45	2
BMW-20	10/8/15	219167	2923996	354.67	357.51	10	30	20	30	2
BMW-21	9/27/15	217793	2923479	347.87	350.98	20	40	20	40	2
BMW-22	9/27/15	216298	2924360	329.53	332.30	20	40	20	40	2
BMW-23	9/28/15	215105	2923180	339.43	341.90	15	35	20	35	2
BMW-24	9/28/15	213874	2921447	344.70	347.07	20	40	20	40	2
BMW-26	8/31/16	221187	2921307	365.96	369.44	20	30	10	30	4
BMW-27	9/1/16	220024	2922347	373.46	376.25	20	30	10	30	4
BMW-28	10/27/16	215307	2917356	371.27	373.21	40	60	20	60	2

Notes:
1. Abbreviations: ft - feet; amsl - above mean sea level; bgs - below ground surface.

TABLE 2
GROUNDWATER ELEVATION SUMMARY
A1 AREA LANDFILL

Well ID	TOC Elevation (ft amsl)	Date	Depth to Water (ft btoc)	Water Elevation (ft amsl)
BMW-11AR	426.05	10/30/15	43.79	382.26
		12/30/15	43.11	382.94
		02/24/16	41.77	384.28
		04/07/16	40.49	385.56
		06/08/16	39.26	386.79
		08/11/16	39.24	386.81
		10/25/16	39.07	386.98
		12/13/16	40.57	385.48
BMW-18	357.83	10/30/15	33.40	324.43
		12/30/15	32.16	325.67
		02/24/16	29.49	328.34
		04/07/16	28.98	328.85
		06/08/16	28.04	329.79
		08/11/16	28.19	329.64
		10/25/16	28.31	329.52
		12/13/16	29.88	327.95
BMW-19	400.69	10/30/15	21.42	379.27
		12/30/15	20.14	380.55
		02/24/16	20.41	380.28
		04/07/16	19.56	381.13
		06/08/16	19.22	381.47
		08/11/16	20.84	379.85
		10/25/16	20.33	380.36
		12/13/16	24.11	376.58
BMW-20	357.51	10/30/15	8.56	348.95
		12/30/15	8.81	348.70
		02/24/16	8.96	348.55
		04/07/16	9.24	348.27
		06/08/16	8.81	348.70
		08/11/16	8.52	348.99
		10/25/16	8.36	349.15
		12/13/16	10.21	347.30
BMW-21	350.98	10/30/15	5.23	345.75
		12/30/15	4.09	346.89
		02/24/16	3.83	347.15
		04/07/16	3.93	347.05
		06/08/16	3.34	347.64
		08/11/16	4.56	346.42
		10/25/16	3.84	347.14
		12/13/16	6.89	344.09
BMW-22	332.30	10/30/15	7.11	325.19
		12/30/15	6.17	326.13
		02/24/16	5.74	326.56
		04/07/16	7.33	324.97
		06/08/16	6.91	325.39
		08/11/16	5.96	326.34
		10/25/16	6.07	326.23
		12/13/16	7.86	324.44

TABLE 2
GROUNDWATER ELEVATION SUMMARY
A1 AREA LANDFILL

Well ID	TOC Elevation (ft amsl)	Date	Depth to Water (ft btoc)	Water Elevation (ft amsl)
BMW-23	341.90	10/30/15	16.47	325.43
		12/30/15	15.34	326.56
		02/24/16	14.78	327.12
		04/07/16	13.98	327.92
		06/08/16	11.72	330.18
		08/11/16	15.21	326.69
		10/25/16	15.51	326.39
		12/13/16	17.56	324.34
BMW-24	347.07	10/30/15	14.26	332.81
		12/30/15	12.09	334.98
		02/24/16	12.11	334.96
		04/07/16	12.03	335.04
		06/08/16	11.22	335.85
		08/11/16	12.73	334.34
		10/25/16	12.72	334.35
		12/13/16	14.27	332.80
BMW-26	369.44	9/13/16	1.77	367.67
		10/25/16	2.39	367.05
		12/13/16	4.02	365.42
		1/23/17	2.21	367.23
		2/23/17	2.67	366.77
		3/24/17	2.46	366.98
		4/24/17	2.24	367.20
		5/25/17	2.13	367.31
		6/29/17	2.12	367.32
BMW-27	376.25	9/13/16	2.12	374.13
		10/25/16	2.46	373.79
		12/13/16	4.11	372.14
		1/23/17	2.51	373.74
		2/23/17	2.84	373.41
		3/24/17	2.67	373.58
		4/24/17	3.07	373.18
		5/25/17	2.67	373.58
		6/29/17	2.24	374.01
BMW-28	373.21	12/13/16	55.02	318.19
		1/23/17	45.94	327.27
		2/23/17	39.97	333.24
		3/24/17	39.82	333.39
		4/24/17	36.81	336.40
		5/25/17	34.91	338.30
		6/29/17	33.85	339.36
		8/1/17	41.96	331.25

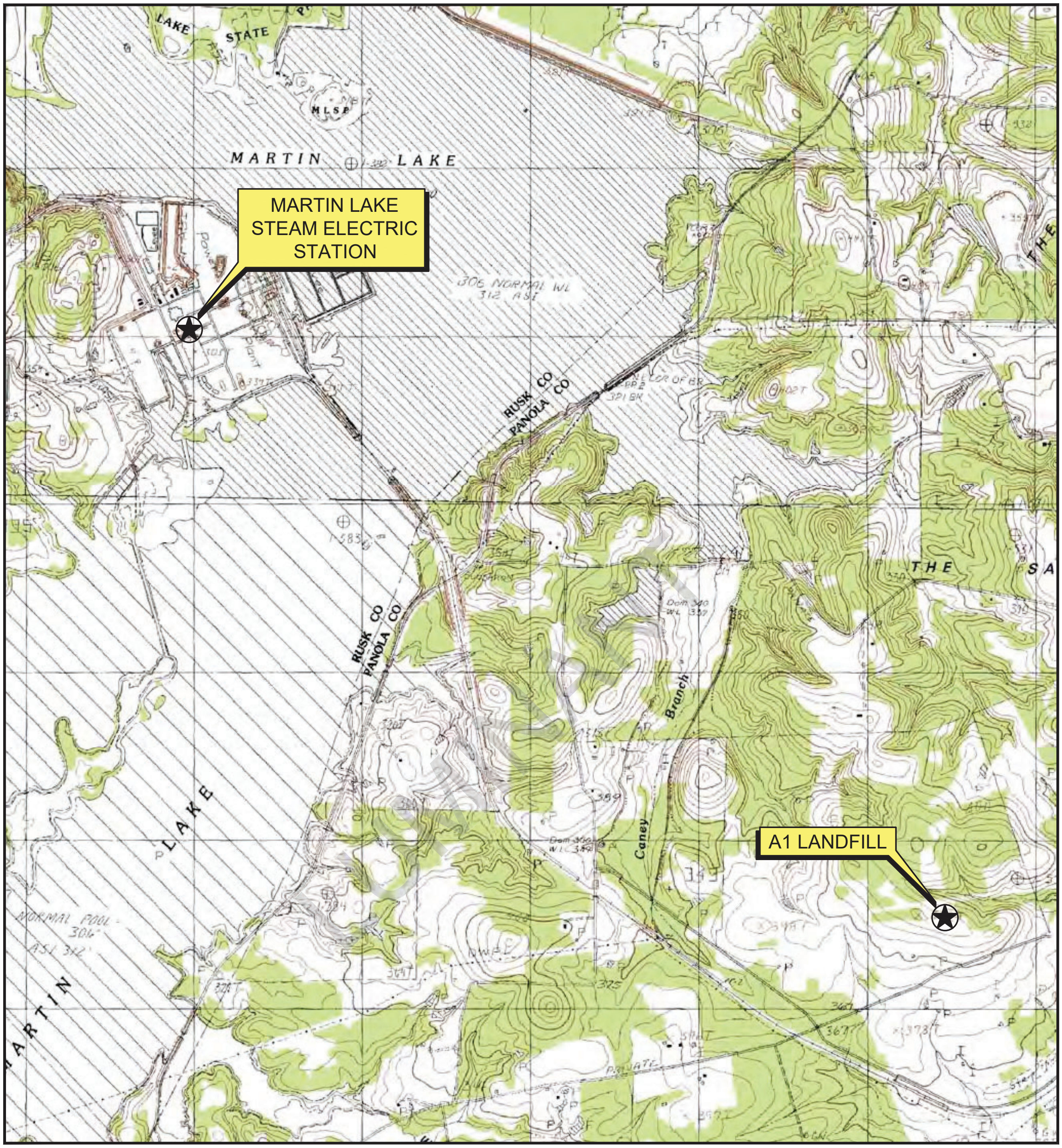
Notes:
1. Abbreviations: ft - feet; amsl - above mean sea level; bgs - below ground surface; toc - top of casing; btoc - below top of casing.

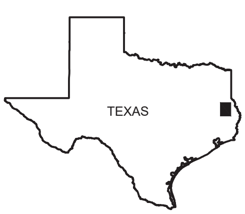
TABLE 3
SUMMARY OF AQUIFER TEST RESULTS
A1 AREA LANDFILL

Well ID	Test Type	Aquifer Type	Analysis Method	Saturated Thickness (feet)	Results	
					T (cm^2/sec)	K (cm/sec)
PDP 5						
A1 Area Landfill						
BMW-21	Slug-In	Confined	Bouwer-Rice	10	6.24E-02	2.05E-04
BMW-21	Slug-Out	Confined	Bouwer-Rice	10	5.64E-02	1.85E-04
				Mean	**5.94E-02**	**1.95E-04**
BMW-23	Slug-In	Semi-Confined to Confined	Bouwer-Rice	15	8.00E-01	1.75E-03
BMW-23	Slug-Out	Semi-Confined to Confined	Bouwer-Rice	15	5.97E-01	1.31E-03
				Mean	**6.98E-01**	**1.53E-03**
BMW-24	Slug-In	Confined	Bouwer-Rice	5	1.30E-02	8.52E-05
BMW-24	Slug-Out	Confined	Bouwer-Rice	5	1.61E-02	1.06E-04
				Mean	**1.46E-02**	**9.55E-05**
				Geometric Mean for All A1 Area Landfill Tests	**8.45E-02**	**3.05E-04**

Notes:
1. Abbreviations: T - transmissivity; K - hydraulic conductivity.

Figures





QUADRANGLE LOCATION

N

Scale in Feet

0 1500 3000

SOURCE:
Base map from www.tnris.gov, Tatum, TX 7.5 min. USGS quadrangle dated 1983.

MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

Figure 1

A1 AREA LANDFILL SITE LOCATION MAP

PROJECT: 5123B	BY: AJD	REVISIONS
DATE: JUNE, 2015	CHECKED: PJB	

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CONSULTING ENGINEERS AND SCIENTISTS

EXPLANATION

CCR Monitoring Well

MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

Figure 2

A1 AREA LANDFILL DETAILED SITE MAP

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

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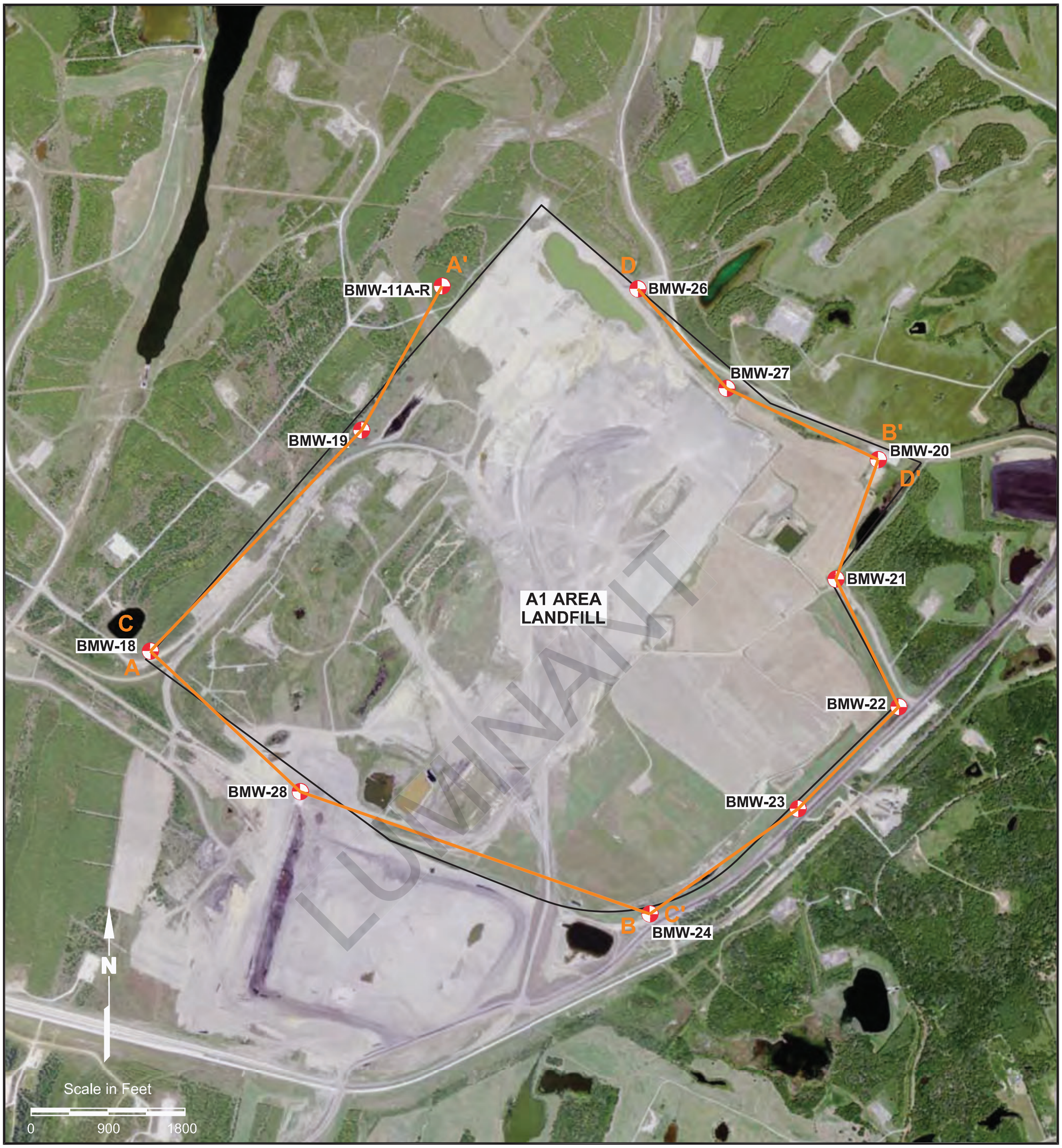
SOURCE:
Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.



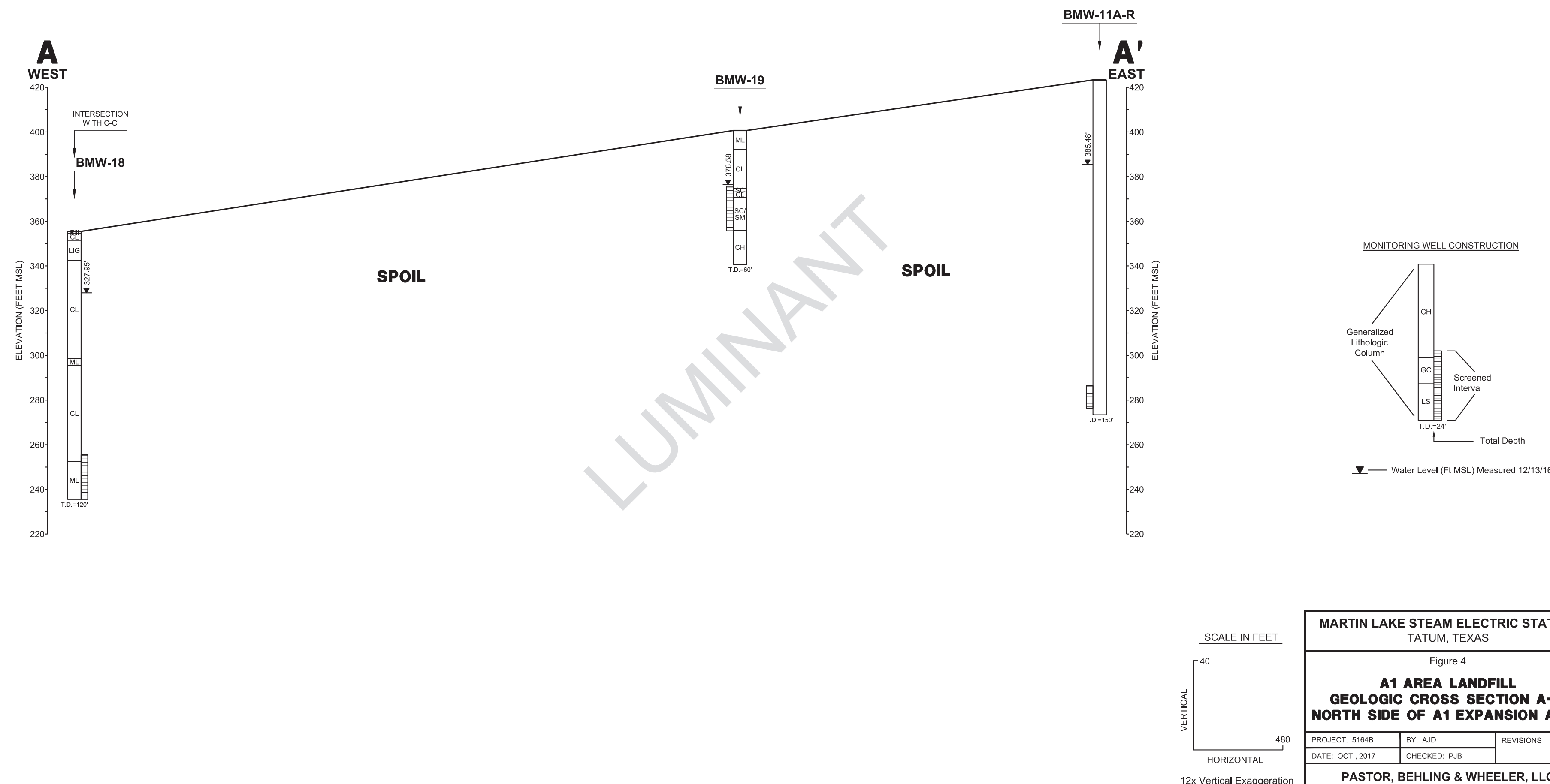
EXPLANATION

CCR Monitoring Well

A____A' Geologic Cross Section Location Lines

MARTIN LAKE STEAM ELECTRIC STATION TATUM, TEXAS		
Figure 3 **A1 AREA LANDFILL CROSS SECTION LOCATION MAP**		
PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	
PASTOR, BEHLING & WHEELER, LLC CONSULTING ENGINEERS AND SCIENTISTS		

SOURCE:
Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.



MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

Figure 4

A1 AREA LANDFILL
GEOLOGIC CROSS SECTION A-A'
NORTH SIDE OF A1 EXPANSION AREA

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: OCT., 2017	CHECKED: PJB	

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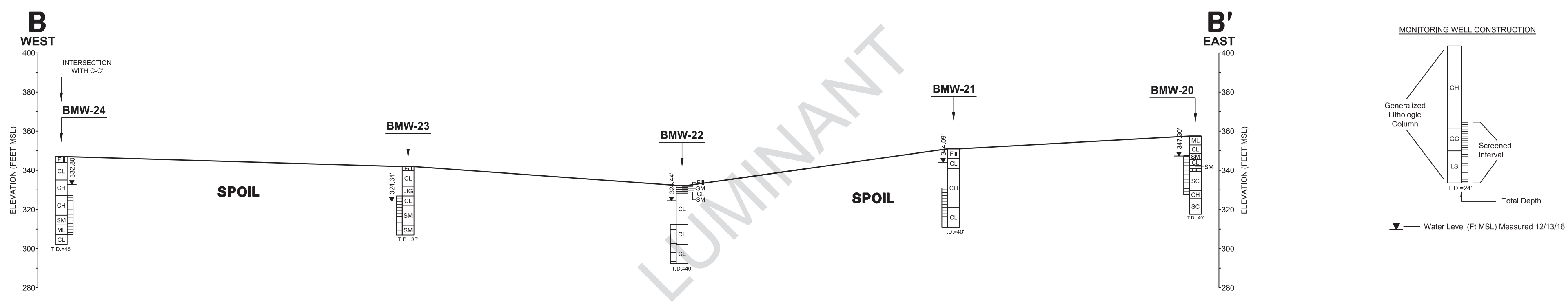

MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

Figure 5

A1 AREA LANDFILL
GEOLOGIC CROSS SECTION B-B'
SOUTH SIDE OF A1 LANDFILL

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: OCT., 2017	CHECKED: PJB	

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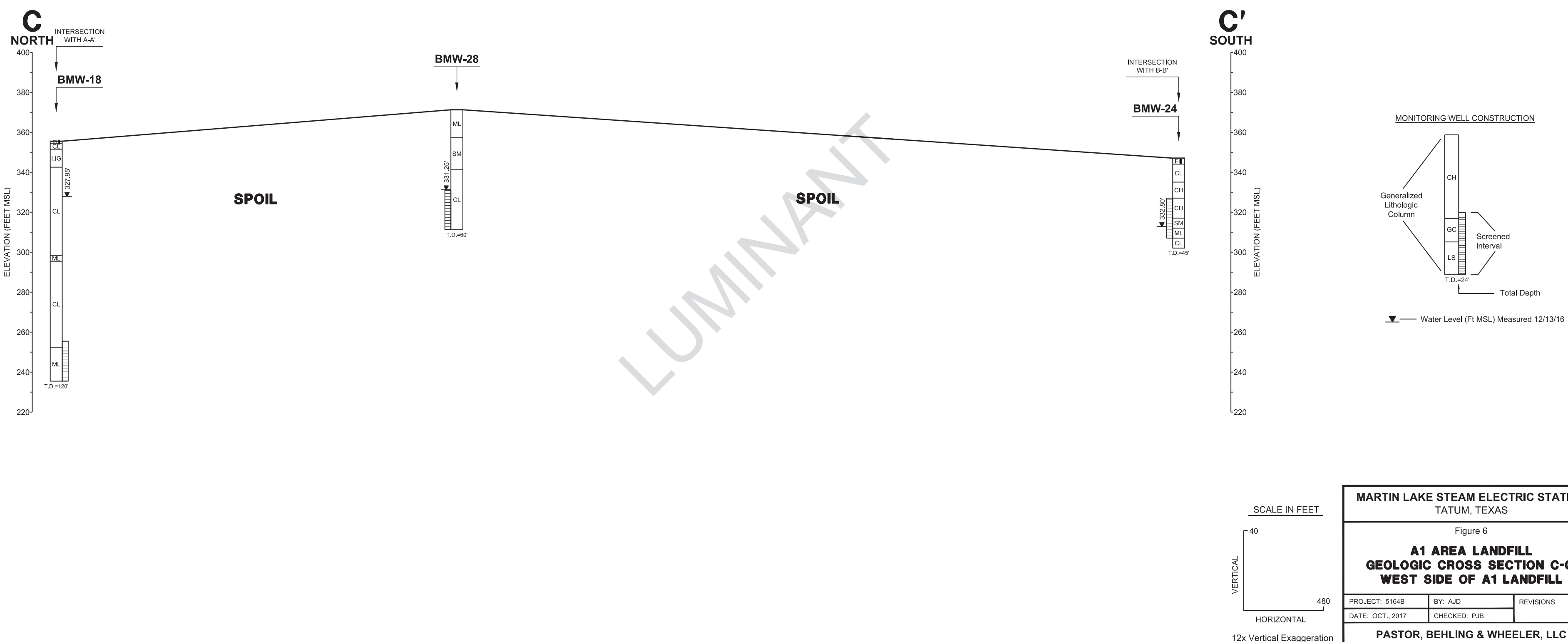

MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

Figure 6

A1 AREA LANDFILL
GEOLOGIC CROSS SECTION C-C'
WEST SIDE OF A1 LANDFILL

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: OCT., 2017	CHECKED: PJB	

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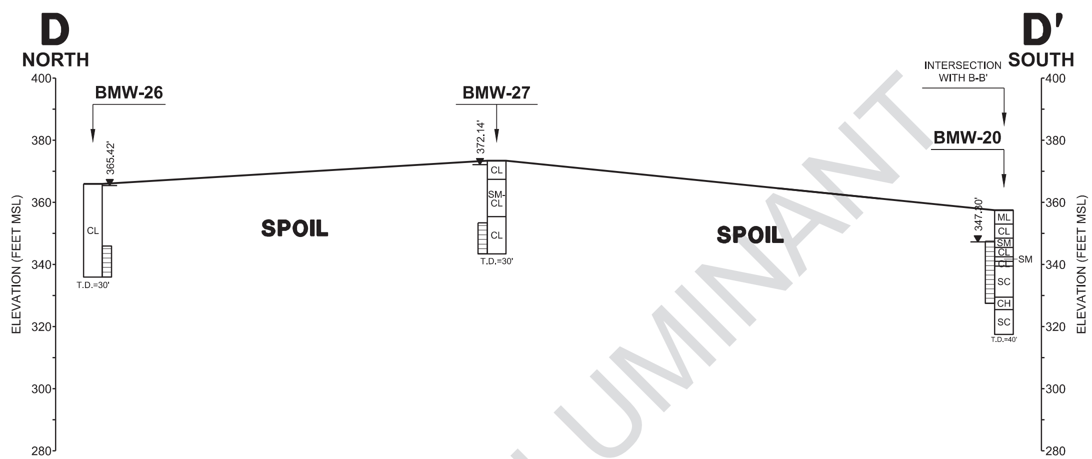

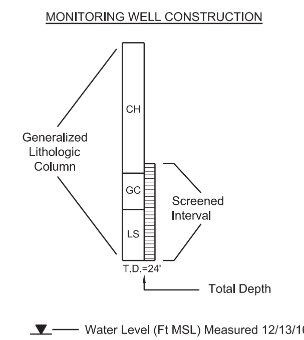

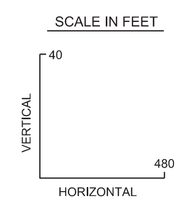

12x Vertical Exaggeration

MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

Figure 7

A1 AREA LANDFILL
GEOLOGIC CROSS SECTION D-D′
EAST SIDE OF A1 LANDFILL

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: OCT., 2017	CHECKED: PJB	

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Appendix A

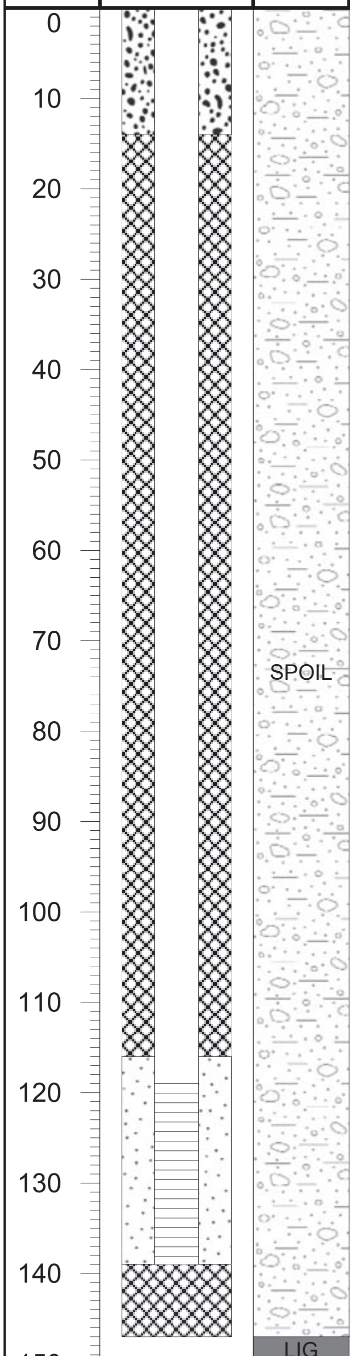
CCR Monitoring Well Logs

Luminant

Log of Boring: BMW-11AR

Beckville Mine Beckville, TX	Completion Date:	5/24/12	Drilling Method:	Mud Rotary
	Drilling Company:	Diversified	Borehole Diameter (in.):	10
	Driller:	Ed Noble	Total Depth (ft):	147
PBW Project No. 1793	Driller's License:	5031M	Northing:	
	Field Supervisor:	R. McClure/S. Berry	Easting:	
	Sampling Method:	Cuttings	Ground Elev. (ft AMSL):	

Depth (ft)	Well Materials	USCS	Lithologic Description
0		SPOIL	(0.0 - 147.0) MINE SPOIL, clay/silty clay, dark brownish gray, abundant red and orange clay/silty clay fragments from 0.0-10.0', abundant lignite fragments from 0.0-147.0', soft, medium plasticity. Trace red and orange clay/silty clay fragments from 10.0-147.0'.
147		LIG	(147.0 - 150.0) LIGNITE, black.



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Notes:

TOC Elevation (ft AMSL):

Centralizers located at 124.0' and 137.0'. Lithology taken at 150.0' pilot hole.

Annular Materials

(0.0 - 14.0) Concrete
(14.0 - 116.0) Bentonite Grout
(116.0 - 139.0) 20/40 Silica Sand
(139.0 -147.0) Cuttings

Well Materials

(+3.0 - 119.0) Casing, 4" Sch 40 FJT PVC
(119.0 - 139.0) Screen, 4" Sch 40 FJT PVC, 0.01 slot

Luminant

Log of Boring: BMW-18

Martin Lake Steam Electric Station Tatum, TX	Completion Date:	9/29/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	120
PBW Project No. 5164B	Driller's License:	5814M	TOC Elevation (ft. AMSL):	357.833
	Logged By:	Jeremiah Bihl	Northing:	
	Sampling Method:	4"x10' Core barrel	Easting:	

Depth (ft)	Recovery (ft/ft)
0–10	10.0/10.0
10–20	5.0/10.0
20–30	10.0/10.0
30–40	10.0/10.0
40–50	10.0/10.0
50–60	10.0/10.0
60–70	10.0/10.0
70–80	10.0/10.0
80–90	10.0/10.0
90–100	10.0/10.0
100–110	10.0/10.0
110–120	10.0/10.0

USCS	Lithologic Description
FILL	(0 - 1) Top soil, light brown, rocks (1-3 cm) present
CL	(1 - 4) CLAY, dark gray to black with pale tan mottling, dry, firm, brittle
LIG	(4 - 13) LIGNITE with clay, dark grey to black, dry to moist, soft, brittle, angular, low plasticity
CL	(13 - 57) Silty CLAY, dark gray to dark brown with red and yellow mottling, dry, soft to firm, crumbly, medium plasticity, color change to tan at 30', coal seam at 32' (black, dry to moist, soft), pieces of lignite present, color change to gray to dark gray at 35'
ML	(57 - 60) Clayey SILT, light brown to tan, moist, soft, low plasticity, lignite seam at 59'
CL	(60 - 81) Silty CLAY, black to gray, dry, soft to firm, low plasticity, crumbly, 6" dry white gravel layer at 69', 4" light brown silty sand layer at 81'
CL	(81 - 103) Silty CLAY, light gray, dry to moist, soft, low to medium plasticity, crumbly, rubber tire pieces at 89', hard lignite seam at 90' (hard, dry, black, firm), streaks of black (91'- 94'), becomes hard at 94', light to dark gray (94'-103')
ML	(103 - 106) Clayey SILT, gray, very moist, soft, medium plasticity
ML	(106 - 120) Clayey SILT, gray to dark gray, dry, firm, low plasticity

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Notes:
1. This log should not be used separately from the report to which it is attached.
2. All logged material is mine spoil.

Well Materials
(0-100) Casing, 2" Sch 40 FJT PVC
(100-120) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-96') Grout
(96'-98') Bentonite pellets
(98'-110') 20/40 sand

Luminant

Log of Boring: BMW-19

Martin Lake Steam Electric Station Tatum, TX	Completion Date:	10/7/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	60
PBW Project No. 5164B	Driller's License:	5814M	TOC Elevation (ft. AMSL):	400.685
	Logged By:	Nolan Townsend	Northing:	
	Sampling Method:	4"x10' Core barrel	Easting:	

Depth (ft)	Well Materials	Recovery (ft/ft)	USCS	Lithologic Description
0 – 8.5		9.2/10.0	ML	(0 - 8.5) Sandy SILT with clay, light brown to brownish yellow, dry to slightly mosit, soft, low plasticity, more clay content below ~1.0', trace black lignite fragments - dry, firm to hard, brittle, friable, sharp basal contact
8.5 – 26		4.2/10.0 9.7/10.0	CL	(8.5 - 26) Sandy CLAY, yellowish brown, gray after 9.5', trace to moderate orange-yellow mottling, dry to moist, firm, low plasticity, trace black lignite fragments, very fine sand, sharp basal contact
26 – 27.5			SC	(26 - 27.5) Clayey SAND, gray to yellowish brown, very moist to wet, soft, low plasticity, very fine sand, sharp basal conact
27.5 – 30			CL	(27.5 - 30) Sandy CLAY, gray to yellowish brown, trace to moderate orange mottling, moist to very moist, soft to firm, moderate plasticity, very fine sand, small lignite seam 29.7'-30.0', brittle and friable, dry, black, hard, sharp basal contact
30 – 44.7		10.0/10.0	SC/SM	(30 - 44.7) Clayey silty SAND - sandy CLAY, brownish yellow to gray to greenish gray, trace orange mottling, abundant orange mottling 37.5'-38.5' and 42'-44.7', very moist to wet, soft to firm, moderate to high plasicity, very fine sand
44.7 – 60		7.2/10.0 10.0/10.0	CH	(44.7 - 60) Sandy CLAY, greenish gray to gray, trace orange-red mottling, dry to moist, firm, moderate to high plasticity, trace black lignite fragments, abundant orange and red mottling 56.0'-59.5'

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Notes:
1. This log should not be used separately from the report to which it is attached.
2. Hole collapsed - drilled back down to 45' with 6" casing to set well.
3. All logged material is mine spoil.

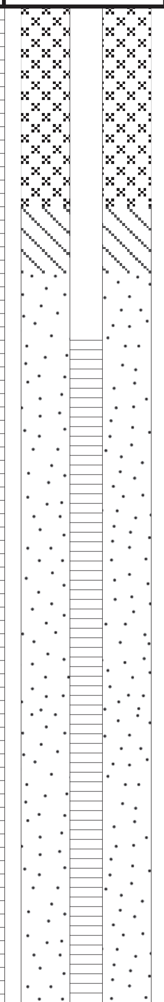
Well Materials
(0-25) Casing, 2" Sch 40 FJT PVC
(25-45) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-21') Grout
(21'-23') Bentonite pellets
(23'-45') 20/40 sand

Luminant

Log of Boring: BMW-20

Martin Lake Steam Electric Station Tatum, TX	Completion Date:	10/8/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	40
	Driller's License:	5814M	TOC Elevation (ft. AMSL):	357.512
PBW Project No. 5164B	Logged By:	Nolan Townsend	Northing:	
	Sampling Method:	4"x10' Core barrel	Easting:	



Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0 - 4.5	9.5/10.0	ML	(0 - 4.5) Sandy SILT with clay, brownish yellow to gray, trace to moderate orange mottling near 4.0', dry, soft, low plasticity, very fine sand
4.5 - 9		CL	(4.5 - 9) CLAY with trace sand lenses, gray with trace to moderate orange/yellow mottling, dry to slightly moist, firm to hard, low to moderate plasticity, trace calcareous precipitates, sharp basal contact
9 - 12	9.8/10.0	SM	(9 - 12) Slightly silty SAND, yellowish orange to tan, moist to very moist, slightly unconsolidated, moderate to high plasticity, very fine sand, moderately to well sorted, mostly quarts with ~5-10% lithic fragments, clay content present 10'-12', dark gray, sharp basal contact
12 - 15		CL	(12 - 15) CLAY, slightly sandy, gray to dark gray, dry to slihgtly moist, firm to hard, low to moderate plasticity, trace black lignite fragments, sandy lenses, trace orange mottling
15 - 16.5		SM	(15 - 16.5) Silty SAND with clay, tan to yellowish orange, moist to very moist, moderately consolidated, medium to high plasticity, very fine sand
16.5 - 18		CL	(16.5 - 18) CLAY as above, dry to moist, firm to hard, moderate plasticity
18 - 28	10.0/10.0	SC	(18 - 28) Clayey SAND, reddish orange and gray, very moist, wet at 20.0', moderately consolidated, moderate to high plasticity, clay composition increases and decreases throughout, very fine sand, becomes gray at 28.0' and more clay content
28 - 32		CH	(28 - 32) Sandy CLAY, gray, trace orange mottling, moist to very moist, firm, moderate to high plasticity, locally sandy lenses/interbeds, trace lignitic fragments (black)
32 - 40	10.0/10.0	SC	(32 - 40) Clayey SAND, reddish orange with gray clay, very moist to wet, moderately consolidated, moderate to high plasticity, very fine sand, localized small sandy clay seams, trace lignite fragments

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Notes:
1. This log should not be used separately from the report to which it is attached.
2. All logged material is mine spoil.

Well Materials
(0-10) Casing, 2" Sch 40 FJT PVC
(10-30) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-6') Grout
(6'-8') Bentonite pellets
(8'-30') 20/40 sand

Luminant

Log of Boring: BMW-21

Martin Lake Steam Electric Station
Tatum, TX

PBW Project No. 5164B

Completion Date:	9/27/2015	Drilling Method:	Sonic
Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
Driller:	Timmy Beach	Total Depth (ft):	40
Driller's License:	5814M	TOC Elevation (ft. AMSL):	350.976
Logged By:	Jeremiah Bihl	Northing:	
Sampling Method:	4"x10' Core barrel	Easting:	

Depth (ft)	Well Materials	Recovery (ft/ft)	USCS	Lithologic Description
0 - 5		10.0/10.1	FILL	(0 - 5) Top soil, sandy with small amounts of clay, tan/brown, moist, soft, low plasticity
5 - 10			CL	(5 - 10) Sandy CLAY, dark gray to black, moist, soft, low to medium plasticity, trace amounts of lignite, clay content increases with depth
10 - 30		10.0/10.0 10.0/10.0	CH	(10 - 30) CLAY with angular lignite, light gray, moist, soft, high plasticity, 1'-thick lignite layer at 25', hardness increases from 26' to 30'
30 - 40		10.0/10.0	CL	(30 - 40) CLAY with angular lignite pieces, wet, soft with increasing hardness with depth, medium plasticity, water present at 30', moisture decreases at 35'

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Notes:
1. This log should not be used separately from the report to which it is attached.
2. All logged material is mine spoil.

Well Materials
(0-20) Casing, 2" Sch 40 FJT PVC
(20-40) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-16') Grout
(16'-18') Bentonite pellets
(18'-40') 20/40 sand

Luminant

Log of Boring: BMW-22

Martin Lake Steam Electric Station
Tatum, TX

PBW Project No. 5164B

Completion Date:	9/27/2015	Drilling Method:	Sonic
Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
Driller:	Timmy Beach	Total Depth (ft):	40
Driller's License:	5814M	TOC Elevation (ft. AMSL):	332.304
Logged By:	Jeremiah Bihl	Northing:	
Sampling Method:	4"x10' Core barrel	Easting:	

Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0 - 1	10.0/10.0	FILL	(0 - 1) Top soil, light brown
1 - 2		SM	(1 - 2) Sandy silty soil with pieces of rock, light brown, abundant organics
2 - 3		CL	(2 - 3) CLAY, yellow-reddish
3 - 4		SM	(3 - 4) Sandy silty soil with pieces of rock, light brown/tan, abundant organics
4 - 20	10.0/10.0 (10-20)	CL	(4 - 20) CLAY, dark gray, lignite present (angular), color change to light gray to yellow clay with some red mottling at 6', firm, moist, medium plasticity, color change to tan at 10', moist and soft lignite layer (12'-13'), hard and lignite layer (angular pieces) at 13'
20 - 30	10.0/10.0	CL	(20 - 30) Sandy CLAY, light gray, moist, soft, medium plasticity, moisture content decreases with depth, hardness increases with depth, plasticity decreases with depth
30 - 40	10.0/10.0	CL	(30 - 40) Sandy CLAY, light gray, wet, soft, hardness increases with depth

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Notes:
1. This log should not be used separately from the report to which it is attached.
2. All logged material is mine spoil.

Well Materials
(0-20) Casing, 2" Sch 40 FJT PVC
(20-40) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-16') Grout
(16'-18') Bentonite pellets
(18'-40') 20/40 sand

Luminant

Log of Boring: BMW-23

Martin Lake Steam Electric Station Tatum, TX	Completion Date:	9/28/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	35
PBW Project No. 5164B	Driller's License:	5814M	TOC Elevation (ft. AMSL):	341.903
	Logged By:	Jeremiah Bihl	Northing:	
	Sampling Method:	4"x10' Core barrel	Easting:	

Depth (ft)	Well Materials	Recovery (ft/ft)	USCS	Lithologic Description
0 - 2		10.0/10.0	FILL	(0 - 2) Top soil, sandy silty CLAY, moist, soft, light brown
2 - 10			CL	(2 - 10) CLAY, light gray to pale yellow, some sand present, soft, moist, low plasticity, color change to brown at 5'
10 - 15		10.0/10.0	LIG	(10 - 15) LIGNITE, black, soft, moist, crumbly, sharp contact
15 - 20			CL	(15 - 20) CLAY, dark gray and light tan, dry, hard, medium plasticity
20 - 30		10.0/10.0	SM	(20 - 30) Silty SAND with small amounts of clay, moist, soft, low plasticity, small seams of lignite, clay content increases with depth (20'-30')
30 - 35		10.0/10.0		(30 - 35) Silty SAND, light gray, wet, very soft, low plasticity, some clay content at 32', sand lenses present

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Notes:
1. This log should not be used separately from the report to which it is attached.
2. All logged material is mine spoil.

Well Materials
(0-15) Casing, 2" Sch 40 FJT PVC
(15-35) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-11') Grout
(11'-13') Bentonite pellets
(13'-35') 20/40 sand

Luminant

Log of Boring: BMW-24

Martin Lake Steam Electric Station
Tatum, TX

PBW Project No. 5164B

Completion Date:	9/28/2015	Drilling Method:	Sonic
Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
Driller:	Timmy Beach	Total Depth (ft):	45
Driller's License:	5814M	TOC Elevation (ft. AMSL):	347.074
Logged By:	Jeremiah Bihl	Northing:	
Sampling Method:	4"x10' Core barrel	Easting:	

Depth (ft)	Well Materials	Recovery (ft/ft)	USCS	Lithologic Description
0			FILL	(0 - 3) Top soil, brown, moist, roots present
				(3 - 4) CLAY, light brown with yellow and orange mottling, dry, soft, low plasticity
4		10.0/10.0		(4 - 6) CLAY with some silt, tan to yellow/gray, moist, firm, medium plasticity
8			CL	(6 - 12) CLAY, black with lignite pieces (0.2-1 cm), dry, soft, low plasticity, sharp contact
12				
16		10.0/10.0		(12 - 20) CLAY, dark gray with yellow and red mottling, dry, hard, medium to high plasticity
20			CH	
24		10.0/10.0		(20 - 30) Silty CLAY, light gray to gray, yellow and red mottling, moist, very soft, high plasticity, pieces of lignite present, decreasing silt content with depth and becomes harder, more brittle, and dry (28'-30'), increase in red, yellow, and black mottling at 28'
28				
32			SM	(30 - 35) Silty SAND, gray, wet, soft, low plasticity, subangular to rounded
36		10.0/10.0	ML	(35 - 40) Clayey SILT, dry, firm, low plasticity, silt content decreases with depth
40		10.0/10.0	CL	(40 - 45) Silty CLAY, light gray, dry, firm, low plasticity
44				
48				

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Notes:
1. This log should not be used separately from the report to which it is attached.
2. All logged material is mine spoil.

Well Materials
(0-20) Casing, 2" Sch 40 FJT PVC
(20-40) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-16') Grout
(16'-18') Bentonite pellets
(18'-40') 20/40 sand

LUMINANT	Log of Boring: BMW-26

A-1 AREA LANDFILL TATUM. TEXAS	Completion Date	8-31-16	Drilling Method	HS Auger
	Drilling Company:	Walker-Hill Env	Borehole Diameter (in)	10 25"
	Driller:	Jeremy Thornhill	Total Depth (ft)	30 0'
PBW PROJECT No : 5164-F	Driller's License:	NA	Northing	221187 022
	Field Supervisor:	RKS	Easting:	2921306 755
	Sampling Method:	5'Macrocore Sampler	Ground Elev (ft AMSL)	365 958

Depth (ft)	Well Materials	PID (ppm-v)	(ft/ft) Recovery	USCS	Lithologic Description
0–5			5/5	CL	0 0-12 0 - Clay with silt and lignite fragments, dark gray-black, soft, moist, low plasticity Wet at 4 0'
5–10			5/5		
10–15			5/5	CL	12 0-20 0 - Silty clay, dark brown, saturated, low plasticity
15–20			5/5		
20–25			5/5	CL	20 0-30 0 - Silty clay, fine grained, dark brown, saturated, low plasticity
25–30			5/5		

PBW
Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr , Suite 4004
Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446

Notes:

1. All logged material is mine spoil.

Depth (bgs)	Well Materials	Depth (bgs)	Annular Materials
0' - 20'	Casing, 4" Sch 40 PVC, FJT	0' - 5'	Grout
20' - 30'	Screen, 4" Sch 40 PVC, 010 Slot	5' - 15'	Bentonite Pellet Seal
		15' - 30'	20/40 Sand

LUMINANT	Log of Boring: BMW-27

A-1 AREA LANDFILL TATUM, TEXAS	Completion Date:	9-1-16	Drilling Method:	HS Auger
	Drilling Company:	Walker-Hill Env.	Borehole Diameter (in.):	10 25"
	Driller:	Jeremy Thornhill	Total Depth (ft):	30 0'
PBW PROJECT No.: 5164-F	Driller's License:	NA	Northing:	220024 389
	Field Supervisor:	RKS	Easting:	2922347 297
	Sampling Method:	5'Macrocore Sampler	Ground Elev (ft AMSL):	373 463

Depth (ft)	Well Materials	PID (ppm-v)	Recovery (ft/ft)	USCS	Lithologic Description
0 – 6			5/5	CL	0.0-6.0 - Clay with silt and fine sand, dark gray, soft, moist, low plasticity Wet at 5 0'
6 – 18			5/5 5/5 5/5	SM-CL	6 0-18 0 - Silty sand with clay, brown, soft, moist
18 – 30			5/5 5/5	CL	18.0-30.0 - Silty clay with lignite, dark brown-gray, wet, low plasticity

PBW
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Round Rock, TX 78664
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Notes:
1. All logged material is mine spoil.

Depth (bgs)	Well Materials	Depth (bgs)	Annular Materials
0' - 20'	Casing, 4" Sch 40 PVC, FJT	0' - 16'	Grout
20' - 30'	Screen, 4" Sch 40 PVC, 010 Slot	16' - 18'	Bentonite Pellet Seal
		18' - 30'	20/40 Sand

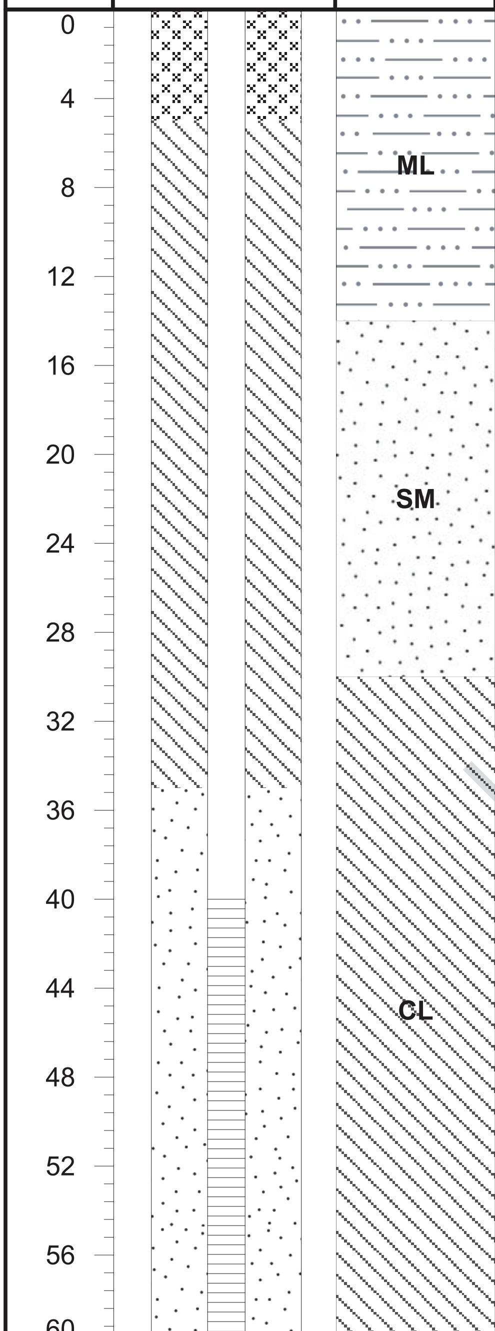
Luminant

Log of Boring: BMW-28

A-1 Area Landfill
Tatum, TX

PBW Project No. 5164F

Completion Date:	10/27/2016	Drilling Method:	HSA
Drilling Company:	ETTL	Borehole Diameter (in.):	10.25
Driller:	Tommy Cook	Total Depth (ft):	60
Driller's License:	2853	TOC Elevation (ft. AMSL):	373.208
Logged By:	Jeremiah Bihl	Northing:	
Sampling Method:	4"x10' Core barrel	Easting:	



Depth (ft)	USCS	Lithologic Description
0 - 14	ML	(0 - 14) Clayey SILT (spoil), black to brown, some pieces of coal, moist, low plasticity.
14 - 30	SM	(14 - 30) SAND with silt and small amounts of clay (spoil), some coal pieces, black, soft, dry, low plasticity.
30 - 60	CL	(30 - 60) CLAY with some silt (spoil), pieces of coal, soft, black to dark gray, dry, low plasticity, possible sandstone/siltstone boulder at 40'.

PBW
Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446

Notes:
1. This log should not be used separately from the report to which it is attached.
2. All logged material is mine spoil.

Well Materials
(0-40) Casing, 2" Sch 40 FJT PVC
(40-60) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-5') Grout
(5'-35') Bentonite pellets
(35'-60') 20/40 sand

Appendix B

Photographs of CCR Groundwater Monitoring Wells

Appendix B – Photographs of CCR Groundwater Monitoring Wells
A1 Area Landfill

Photograph 1: BMW-18

Photograph 2: BMW-19

Appendix B – Photographs of CCR Groundwater Monitoring Wells
A1 Area Landfill

Photograph 3: BMW-20

Photograph 4: BMW-21

Appendix B – Photographs of CCR Groundwater Monitoring Wells
A1 Area Landfill

Photograph 5: BMW-22

Photograph 6: BMW-23

Appendix B – Photographs of CCR Groundwater Monitoring Wells
A1 Area Landfill

Photograph 7: BMW-24

Photograph 8: BMW-26

Appendix B – Photographs of CCR Groundwater Monitoring Wells
A1 Area Landfill

Photograph 9: BMW-27

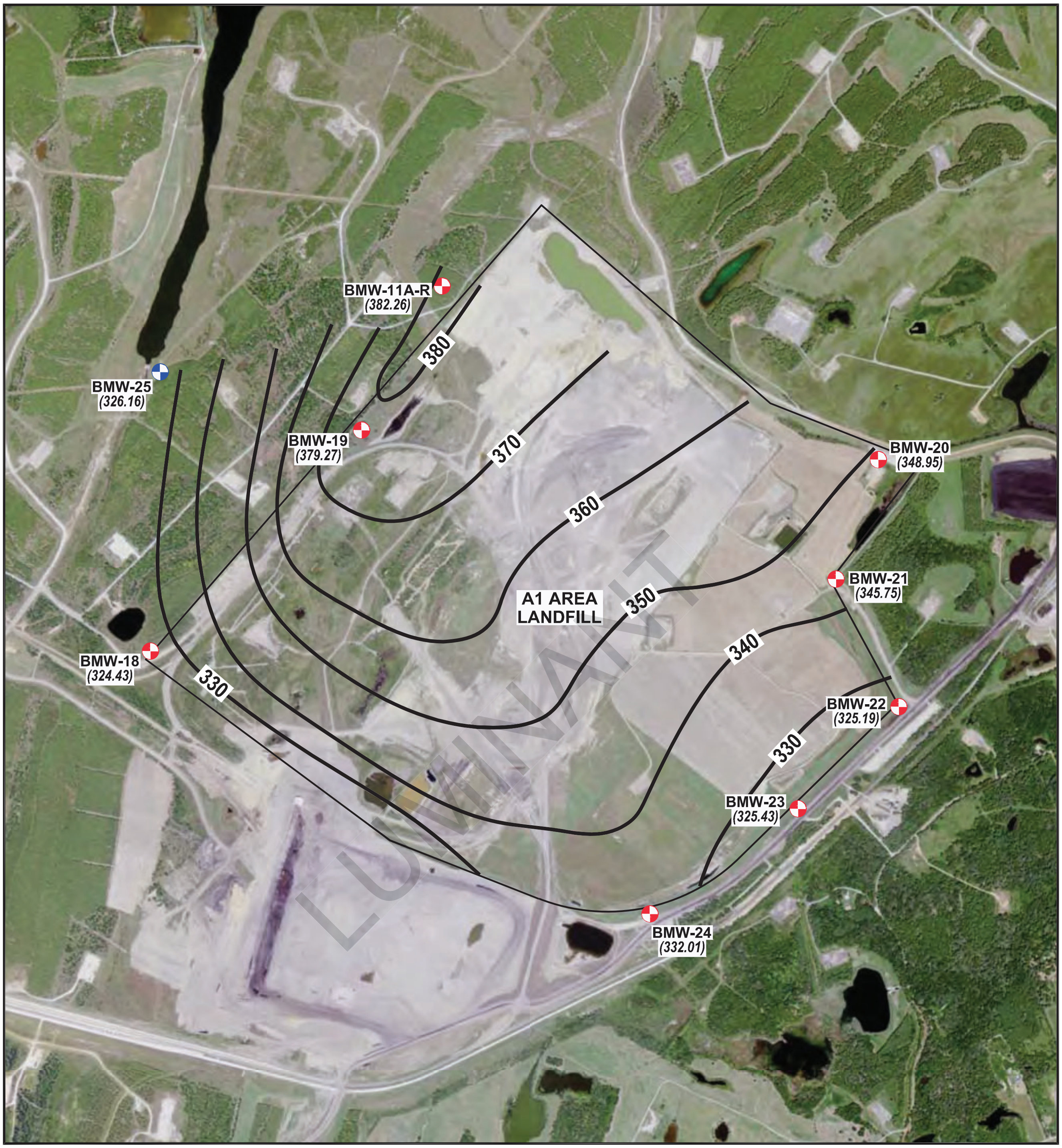
Photograph 10: BMW-28

Appendix B – Photographs of CCR Groundwater Monitoring Wells
A1 Area Landfill

Photograph 11: BMW-11-AR

Appendix C

Groundwater Potentiometric Surface Maps



EXPLANATION

CCR Monitoring Well Location

Non-CCR Monitoring Well Used to Further Evaluate Groundwater Flow Direction

(358.02) Groundwater Potentiometric Surface (ft. MSL)

— 360 — Groundwater Potentiometric Surface Contour (C.I. = 10 ft.)

N

Scale in Feet

0 900 1800

SOURCE:
Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

MARTIN LAKE STEAM ELECTRIC STATION

TATUM, TEXAS

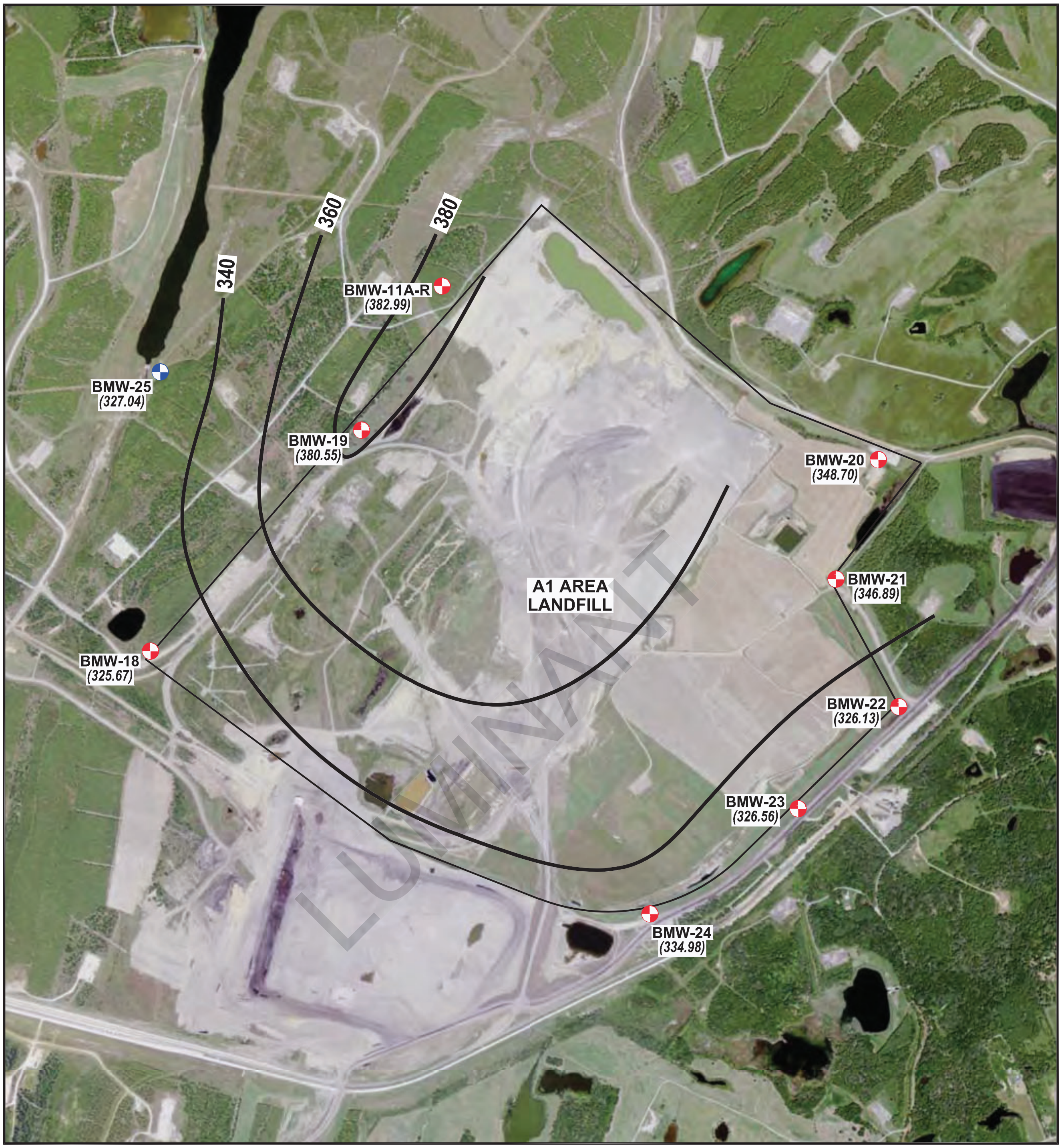
Figure 1

A1 AREA LANDFILL GROUNDWATER POTENTIOMETRIC SURFACE MAP OCTOBER 30, 2015

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC

CONSULTING ENGINEERS AND SCIENTISTS



EXPLANATION

- CCR Monitoring Well Location
- Non-CCR Monitoring Well Used to Further Evaluate Groundwater Flow Direction
- *(358.02)* Groundwater Potentiometric Surface (ft. MSL)
- **— 360 —** Groundwater Potentiometric Surface Contour (C.I. = 20 ft.)

N

Scale in Feet

0 900 1800

SOURCE:
Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

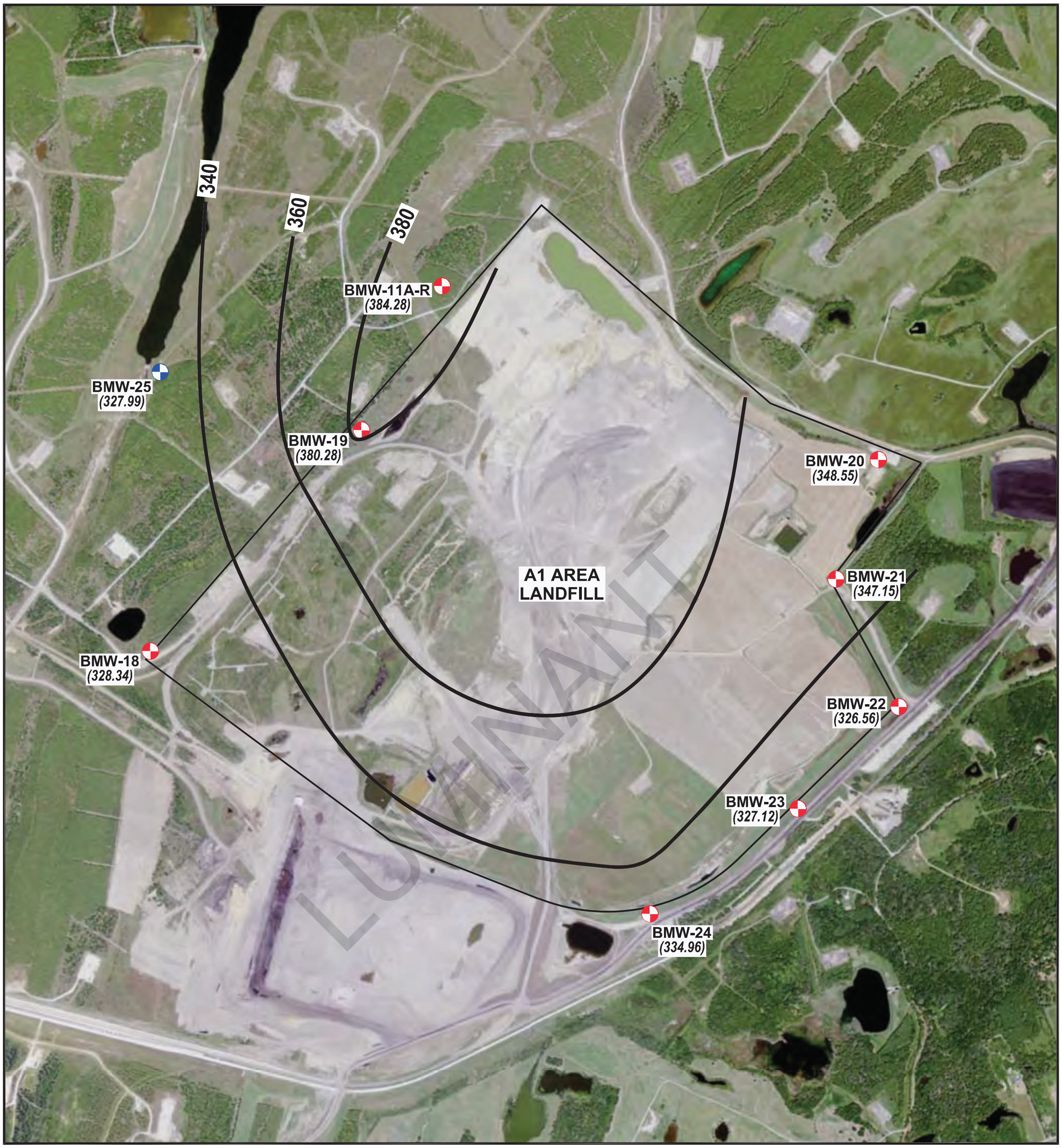
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

Figure 2

A1 AREA LANDFILL GROUNDWATER POTENTIOMETRIC SURFACE MAP DEC. 30, 2015

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS



EXPLANATION

- CCR Monitoring Well Location
- Non-CCR Monitoring Well Used to Further Evaluate Groundwater Flow Direction
- (358.02) Groundwater Potentiometric Surface (ft. MSL)
- 360 Groundwater Potentiometric Surface Contour (C.I. = 20 ft.)

N

Scale in Feet

0 900 1800

SOURCE:
Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

Figure 3

A1 AREA LANDFILL GROUNDWATER POTENTIOMETRIC SURFACE MAP FEB. 24, 2016

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS

EXPLANATION

CCR Monitoring Well Location

Non-CCR Monitoring Well Used to Further Evaluate Groundwater Flow Direction

(358.02) Groundwater Potentiometric Surface (ft. MSL)

— 360 — Groundwater Potentiometric Surface Contour (C.I. = 20 ft.)

N

Scale in Feet

0 900 1800

SOURCE:
Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

Figure 4

A1 AREA LANDFILL GROUNDWATER POTENTIOMETRIC SURFACE MAP APRIL 7, 2016

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS

EXPLANATION

CCR Monitoring Well Location

Non-CCR Monitoring Well Used to Further Evaluate Groundwater Flow Direction

(358.02) Groundwater Potentiometric Surface (ft. MSL)

— 360 — Groundwater Potentiometric Surface Contour (C.I. = 20 ft.)

N

Scale in Feet

0 900 1800

SOURCE:
Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

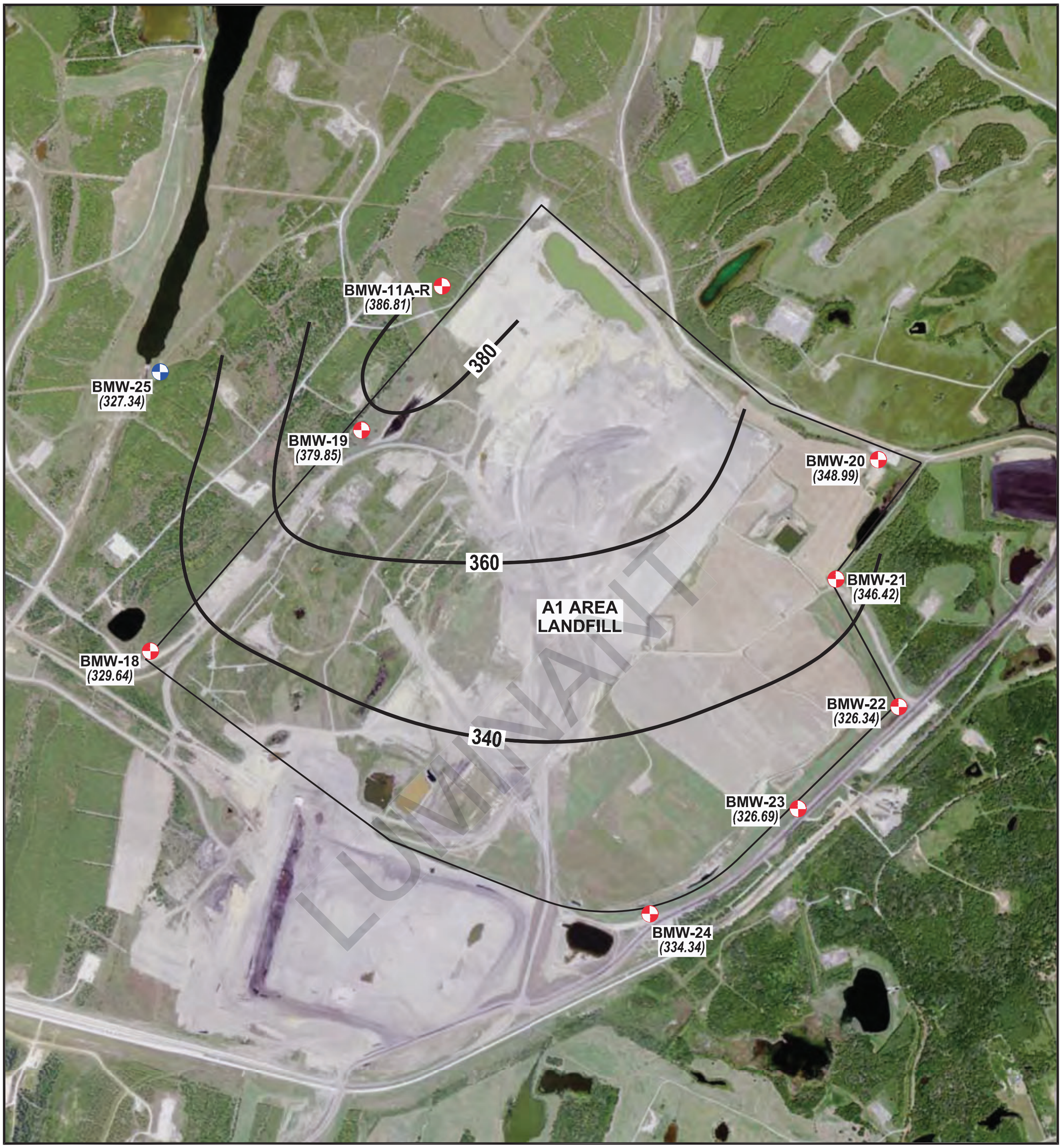
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

Figure 5

A1 AREA LANDFILL GROUNDWATER POTENTIOMETRIC SURFACE MAP JUNE 6, 2016

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS



EXPLANATION

CCR Monitoring Well Location

Non-CCR Monitoring Well Used to Further Evaluate Groundwater Flow Direction

(358.02) Groundwater Potentiometric Surface (ft. MSL)

— 360 — Groundwater Potentiometric Surface Contour (C.I. = 20 ft.)

N

Scale in Feet

0 900 1800

SOURCE:
Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

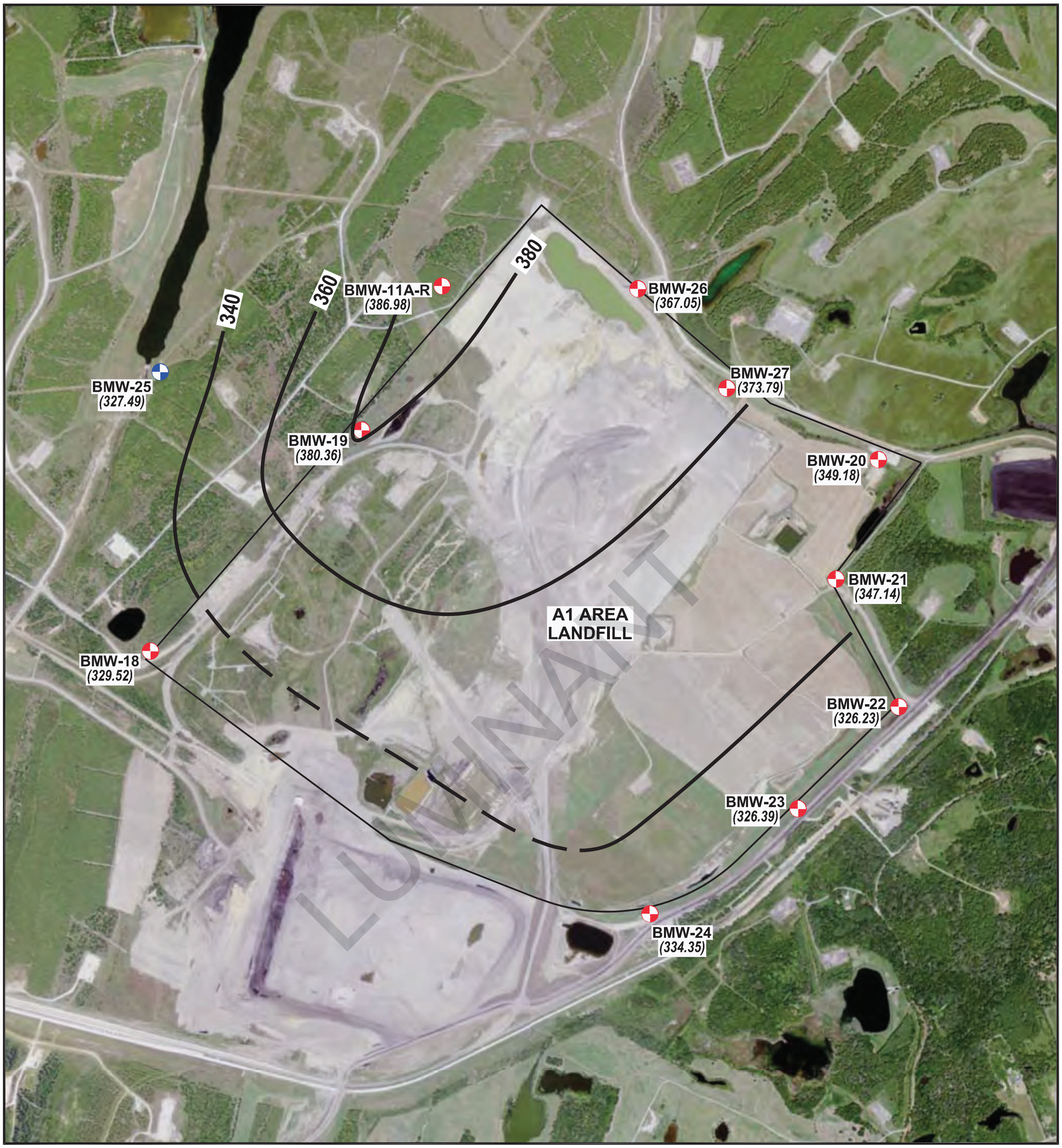
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

Figure 6

A1 AREA LANDFILL GROUNDWATER POTENTIOMETRIC SURFACE MAP AUGUST 11, 2016

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS



EXPLANATION

CCR Monitoring Well Location

Non-CCR Monitoring Well Used to Further Evaluate Groundwater Flow Direction

(358.02) Groundwater Potentiometric Surface (ft. MSL)

— 360 — Groundwater Potentiometric Surface Contour (C.I. = 20 ft.)

N

Scale in Feet

0 900 1800

SOURCE:
Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

Figure 7

A1 AREA LANDFILL GROUNDWATER POTENTIOMETRIC SURFACE MAP OCTOBER 25, 2016

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS

EXPLANATION

CCR Monitoring Well Location

Non-CCR Monitoring Well Used to Further Evaluate Groundwater Flow Direction

(358.02) Groundwater Potentiometric Surface (ft. MSL)

— 360 — Groundwater Potentiometric Surface Contour (C.I. = 20 ft.)

N

Scale in Feet

0 900 1800

SOURCE:
Imagery from www.tnris.gov, Rusk County, aerial photographs, 2012.

MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

Figure 8

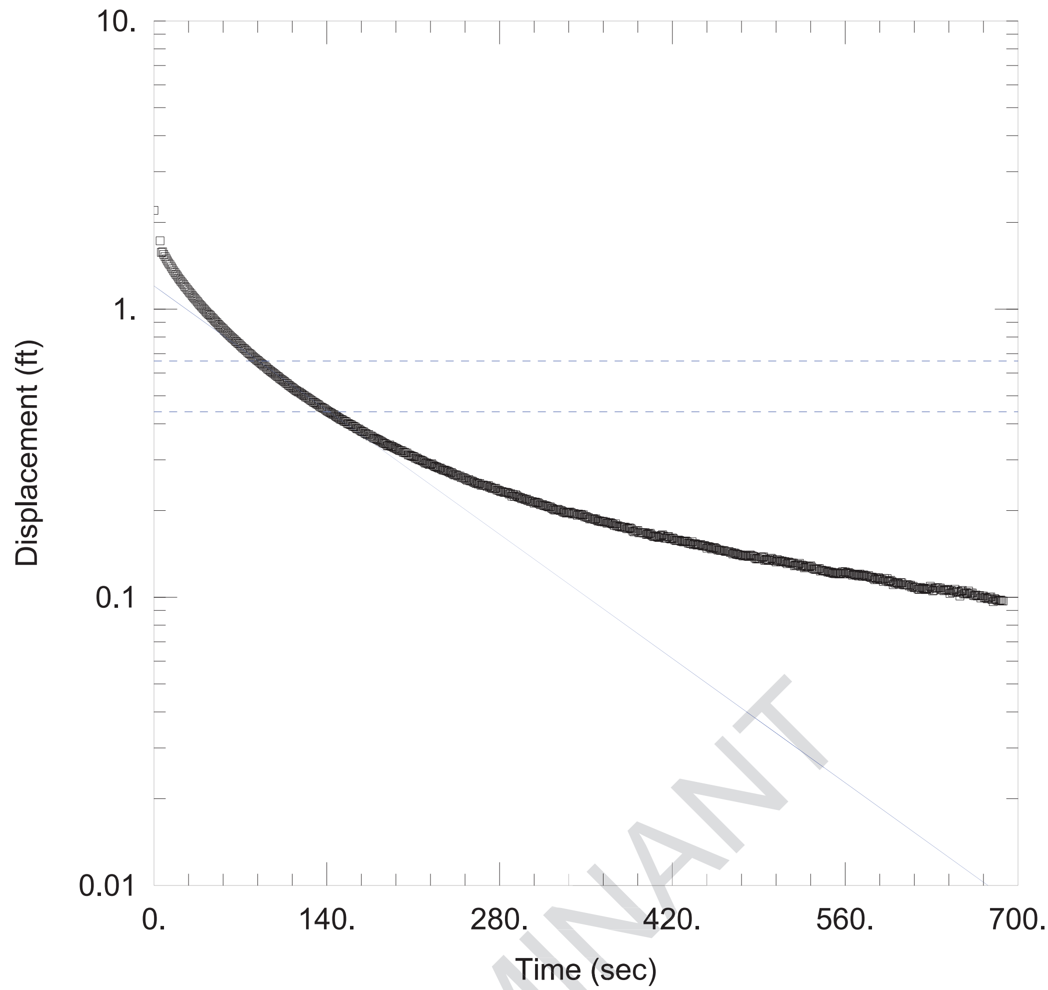
A1 AREA LANDFILL GROUNDWATER POTENTIOMETRIC SURFACE MAP DECEMBER 13, 2016

PROJECT: 5164B	BY: AJD	REVISIONS
DATE: SEPT., 2017	CHECKED: PJB	

PASTOR, BEHLING & WHEELER, LLC
CONSULTING ENGINEERS AND SCIENTISTS

Appendix D

Aquifer Test Data



WELL TEST ANALYSIS

Data Set: J:\...\BMW-21 Slug IN.aqt
Date: 12/16/15 Time: 10:22:24

PROJECT INFORMATION

Company: PBW
Client: Luminant
Project: 5164-B
Location: Beckville Mine
Test Well: BMW-21
Test Date: 9-22-2015

AQUIFER DATA

Saturated Thickness: 10. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BMW-21)

Initial Displacement: 2.2 ft Static Water Column Height: 38.08 ft
Total Well Penetration Depth: 10. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.27 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice
K = 0.0002046 cm/sec y0 = 1.204 ft

Data Set: J:\5164 - Luminant CCR Well Installation and GW Sampling\5164-B_Martin Lake\Slug Tests\A1 LF\Aqtes
Date: 12/16/15
Time: 10:24:36

PROJECT INFORMATION

Company: PBW
Client: Luminant
Project: 5164-B
Location: Beckville Mine
Test Date: 9-22-2015
Test Well: BMW-21

AQUIFER DATA

Saturated Thickness: 10. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: BMW-21

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.2 ft
Static Water Column Height: 38.08 ft
Casing Radius: 0.083 ft
Well Radius: 0.27 ft
Well Skin Radius: 0.27 ft
Screen Length: 10. ft
Total Well Penetration Depth: 10. ft

No. of Observations: 685

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	0.	347.	0.1923
5.	1.725	348.	0.193
6.	1.573	349.	0.1901
7.	1.58	350.	0.1904
8.	1.547	351.	0.1894
9.	1.52	352.	0.1889
10.	1.493	353.	0.187
11.	1.468	354.	0.1876
12.	1.444	355.	0.1868
13.	1.424	356.	0.1872
14.	1.401	357.	0.186
15.	1.38	358.	0.1871
16.	1.356	359.	0.1848
17.	1.338	360.	0.1838
18.	1.319	361.	0.1843
19.	1.302	362.	0.1833
20.	1.282	363.	0.1829
21.	1.265	364.	0.1835
22.	1.249	365.	0.1823
23.	1.233	366.	0.1825
24.	1.218	367.	0.1806
25.	1.201	368.	0.1809
26.	1.187	369.	0.1811
27.	1.172	370.	0.1813
28.	1.156	371.	0.1799
29.	1.143	372.	0.1792
30.	1.129	373.	0.1775
31.	1.114	374.	0.1798
32.	1.101	375.	0.1769
33.	1.09	376.	0.1771

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
34.	1.076	377.	0.1757
35.	1.064	378.	0.1758
36.	1.05	379.	0.1751
37.	1.039	380.	0.1753
38.	1.028	381.	0.175
39.	1.016	382.	0.1749
40.	1.005	383.	0.1729
41.	0.994	384.	0.1729
42.	0.9826	385.	0.1741
43.	0.9714	386.	0.1736
44.	0.962	387.	0.1724
45.	0.9552	388.	0.1698
46.	0.9466	389.	0.1687
47.	0.9345	390.	0.1699
48.	0.9261	391.	0.1701
49.	0.9153	392.	0.1704
50.	0.9058	393.	0.1674
51.	0.8976	394.	0.1678
52.	0.8867	395.	0.1678
53.	0.8794	396.	0.1675
54.	0.8698	397.	0.167
55.	0.8616	398.	0.1676
56.	0.8539	399.	0.165
57.	0.844	400.	0.1657
58.	0.8371	401.	0.166
59.	0.8284	402.	0.1667
60.	0.8203	403.	0.1646
61.	0.8126	404.	0.1633
62.	0.8052	405.	0.1623
63.	0.7972	406.	0.163
64.	0.7909	407.	0.1624
65.	0.7837	408.	0.1617
66.	0.7748	409.	0.1612
67.	0.7694	410.	0.1632
68.	0.7622	411.	0.1637
69.	0.7567	412.	0.1648
70.	0.7481	413.	0.1629
71.	0.7415	414.	0.1602
72.	0.7337	415.	0.1607
73.	0.7293	416.	0.162
74.	0.7219	417.	0.1624
75.	0.7163	418.	0.1597
76.	0.7086	419.	0.1591
77.	0.7023	420.	0.1607
78.	0.6981	421.	0.1597
79.	0.6922	422.	0.1579
80.	0.6841	423.	0.1572
81.	0.6792	424.	0.1574
82.	0.6738	425.	0.158
83.	0.6673	426.	0.1573
84.	0.6634	427.	0.1563
85.	0.6582	428.	0.1563
86.	0.6521	429.	0.1556
87.	0.6465	430.	0.1561
88.	0.6426	431.	0.1568
89.	0.6351	432.	0.1555
90.	0.6336	433.	0.1539
91.	0.6276	434.	0.154
92.	0.6202	435.	0.1535
93.	0.617	436.	0.1557
94.	0.6114	437.	0.1522
95.	0.6065	438.	0.1533
96.	0.603	439.	0.1532
97.	0.5984	440.	0.1516
98.	0.5934	441.	0.1518
99.	0.5885	442.	0.1522

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
100.	0.5843	443.	0.1524
101.	0.5809	444.	0.1507
102.	0.5748	445.	0.151
103.	0.5707	446.	0.1512
104.	0.5673	447.	0.1502
105.	0.5629	448.	0.1481
106.	0.5594	449.	0.15
107.	0.5537	450.	0.1496
108.	0.5511	451.	0.1489
109.	0.5452	452.	0.147
110.	0.5423	453.	0.1484
111.	0.5374	454.	0.1488
112.	0.5339	455.	0.1478
113.	0.5305	456.	0.1469
114.	0.5259	457.	0.1458
115.	0.5217	458.	0.146
116.	0.5192	459.	0.1454
117.	0.5159	460.	0.1454
118.	0.5144	461.	0.1451
119.	0.5101	462.	0.145
120.	0.5068	463.	0.1442
121.	0.503	464.	0.144
122.	0.5	465.	0.144
123.	0.4949	466.	0.144
124.	0.4944	467.	0.143
125.	0.4898	468.	0.1429
126.	0.4869	469.	0.1414
127.	0.4834	470.	0.1425
128.	0.4805	471.	0.142
129.	0.4759	472.	0.1408
130.	0.4748	473.	0.141
131.	0.4715	474.	0.1402
132.	0.4679	475.	0.1401
133.	0.4662	476.	0.1403
134.	0.4616	477.	0.1392
135.	0.4576	478.	0.1391
136.	0.4561	479.	0.1395
137.	0.4535	480.	0.1396
138.	0.4516	481.	0.1386
139.	0.4476	482.	0.1387
140.	0.4445	483.	0.1402
141.	0.4411	484.	0.1393
142.	0.4393	485.	0.1391
143.	0.4368	486.	0.1385
144.	0.4348	487.	0.1369
145.	0.4315	488.	0.1359
146.	0.4303	489.	0.1361
147.	0.4265	490.	0.1357
148.	0.4235	491.	0.1358
149.	0.421	492.	0.138
150.	0.4181	493.	0.1374
151.	0.4152	494.	0.1381
152.	0.414	495.	0.1341
153.	0.4116	496.	0.135
154.	0.4083	497.	0.1356
155.	0.4074	498.	0.1343
156.	0.4054	499.	0.1347
157.	0.4006	500.	0.1365
158.	0.4	501.	0.1356
159.	0.3979	502.	0.1339
160.	0.3965	503.	0.1339
161.	0.3925	504.	0.1326
162.	0.3916	505.	0.1351
163.	0.3898	506.	0.1338
164.	0.386	507.	0.1342
165.	0.384	508.	0.1327

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
166.	0.3832	509.	0.1336
167.	0.3799	510.	0.133
168.	0.3771	511.	0.133
169.	0.3758	512.	0.132
170.	0.3748	513.	0.1307
171.	0.3709	514.	0.1326
172.	0.3695	515.	0.1317
173.	0.3668	516.	0.1309
174.	0.3671	517.	0.1315
175.	0.3628	518.	0.1314
176.	0.3628	519.	0.1286
177.	0.3599	520.	0.1293
178.	0.3569	521.	0.1294
179.	0.3563	522.	0.1299
180.	0.3544	523.	0.131
181.	0.3528	524.	0.1279
182.	0.3516	525.	0.1292
183.	0.349	526.	0.1287
184.	0.3479	527.	0.1264
185.	0.345	528.	0.1273
186.	0.3432	529.	0.1279
187.	0.3418	530.	0.1277
188.	0.3398	531.	0.1277
189.	0.3356	532.	0.1286
190.	0.3357	533.	0.1271
191.	0.3377	534.	0.1257
192.	0.3344	535.	0.1254
193.	0.3335	536.	0.1248
194.	0.3317	537.	0.1249
195.	0.3297	538.	0.1253
196.	0.3286	539.	0.1258
197.	0.3269	540.	0.1232
198.	0.3251	541.	0.1242
199.	0.3231	542.	0.1236
200.	0.3225	543.	0.1232
201.	0.3221	544.	0.1231
202.	0.3183	545.	0.1236
203.	0.3183	546.	0.1221
204.	0.3169	547.	0.1226
205.	0.3164	548.	0.1218
206.	0.3122	549.	0.1222
207.	0.3117	550.	0.1211
208.	0.31	551.	0.1211
209.	0.3088	552.	0.1206
210.	0.3082	553.	0.1219
211.	0.3068	554.	0.1207
212.	0.3036	555.	0.1206
213.	0.304	556.	0.1206
214.	0.3014	557.	0.1213
215.	0.2998	558.	0.1226
216.	0.2994	559.	0.1204
217.	0.2979	560.	0.1224
218.	0.2968	561.	0.1214
219.	0.2947	562.	0.1217
220.	0.292	563.	0.1217
221.	0.2926	564.	0.1207
222.	0.2909	565.	0.1204
223.	0.2891	566.	0.1192
224.	0.289	567.	0.1202
225.	0.2909	568.	0.12
226.	0.2874	569.	0.1192
227.	0.2852	570.	0.1201
228.	0.2839	571.	0.1184
229.	0.2833	572.	0.1203
230.	0.2818	573.	0.1193
231.	0.2804	574.	0.1181

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
232.	0.2807	575.	0.1196
233.	0.2786	576.	0.1191
234.	0.2768	577.	0.1181
235.	0.276	578.	0.118
236.	0.2761	579.	0.1189
237.	0.2744	580.	0.1176
238.	0.2737	581.	0.1171
239.	0.2724	582.	0.1174
240.	0.2702	583.	0.116
241.	0.2711	584.	0.115
242.	0.2686	585.	0.1165
243.	0.2664	586.	0.1154
244.	0.266	587.	0.117
245.	0.2658	588.	0.1157
246.	0.2638	589.	0.1152
247.	0.2633	590.	0.1151
248.	0.2632	591.	0.1134
249.	0.2601	592.	0.1162
250.	0.2602	593.	0.1143
251.	0.2596	594.	0.116
252.	0.2586	595.	0.1131
253.	0.2561	596.	0.1138
254.	0.2546	597.	0.1145
255.	0.2561	598.	0.1131
256.	0.2536	599.	0.1105
257.	0.2533	600.	0.1122
258.	0.2526	601.	0.1119
259.	0.2508	602.	0.1125
260.	0.2501	603.	0.1116
261.	0.248	604.	0.1109
262.	0.2488	605.	0.1124
263.	0.247	606.	0.1122
264.	0.2483	607.	0.1106
265.	0.2447	608.	0.1104
266.	0.2454	609.	0.1106
267.	0.245	610.	0.1105
268.	0.2444	611.	0.1104
269.	0.2441	612.	0.1094
270.	0.2424	613.	0.1102
271.	0.244	614.	0.1084
272.	0.2407	615.	0.1092
273.	0.241	616.	0.1079
274.	0.2385	617.	0.108
275.	0.2385	618.	0.1081
276.	0.2379	619.	0.1068
277.	0.2387	620.	0.1064
278.	0.2354	621.	0.1082
279.	0.2351	622.	0.107
280.	0.2342	623.	0.1077
281.	0.2325	624.	0.1072
282.	0.2329	625.	0.1063
283.	0.2318	626.	0.1065
284.	0.2311	627.	0.1075
285.	0.2313	628.	0.1067
286.	0.2309	629.	0.1092
287.	0.23	630.	0.1078
288.	0.2281	631.	0.1052
289.	0.2286	632.	0.1057
290.	0.2243	633.	0.1078
291.	0.2276	634.	0.1074
292.	0.224	635.	0.1079
293.	0.2269	636.	0.1076
294.	0.2249	637.	0.1077
295.	0.2229	638.	0.1062
296.	0.2224	639.	0.1062
297.	0.2217	640.	0.1053

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
298.	0.2197	641.	0.1061
299.	0.2203	642.	0.106
300.	0.2191	643.	0.1066
301.	0.2182	644.	0.1056
302.	0.219	645.	0.1031
303.	0.2163	646.	0.1055
304.	0.2166	647.	0.1039
305.	0.2151	648.	0.105
306.	0.2147	649.	0.1066
307.	0.2146	650.	0.1044
308.	0.2121	651.	0.1051
309.	0.2138	652.	0.1038
310.	0.2126	653.	0.1009
311.	0.2129	654.	0.1048
312.	0.2115	655.	0.1056
313.	0.2097	656.	0.1027
314.	0.2097	657.	0.1029
315.	0.2095	658.	0.1039
316.	0.208	659.	0.1032
317.	0.2078	660.	0.1051
318.	0.2074	661.	0.1025
319.	0.2063	662.	0.1035
320.	0.2055	663.	0.1034
321.	0.2059	664.	0.1013
322.	0.2041	665.	0.1012
323.	0.2031	666.	0.1019
324.	0.2013	667.	0.1011
325.	0.2008	668.	0.1014
326.	0.2006	669.	0.1013
327.	0.202	670.	0.0994
328.	0.2009	671.	0.1009
329.	0.2002	672.	0.1009
330.	0.1999	673.	0.0995
331.	0.1985	674.	0.1
332.	0.1971	675.	0.0988
333.	0.1975	676.	0.0991
334.	0.1958	677.	0.1001
335.	0.1961	678.	0.1002
336.	0.1964	679.	0.0982
337.	0.1975	680.	0.0966
338.	0.1969	681.	0.0989
339.	0.1943	682.	0.0983
340.	0.1954	683.	0.0977
341.	0.1948	684.	0.0973
342.	0.1943	685.	0.0974
343.	0.1924	686.	0.0978
344.	0.1943	687.	0.0972
345.	0.1936	688.	0.0971
346.	0.1939		

SOLUTION

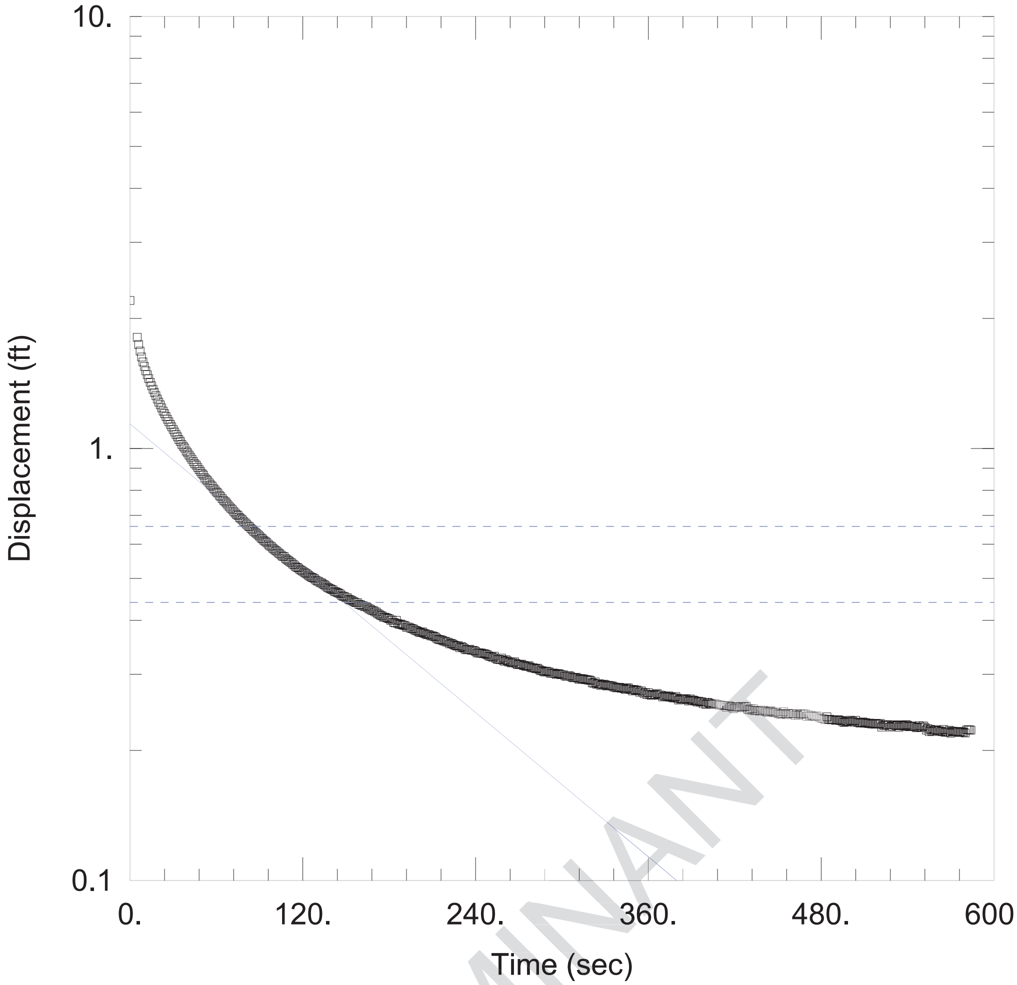
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.748

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0002046	cm/sec
y0	1.204	ft

T = K*b = 0.06235 cm²/sec



SLUG OUT

Data Set: J:\...\BMW-21 Slug OUT.aqt
Date: 12/16/15 Time: 10:22:40

PROJECT INFORMATION

Company: PBW
Client: Luminant
Project: 5164-B
Location: Beckville Mine
Test Well: BMW-21
Test Date: 9-22-2015

AQUIFER DATA

Saturated Thickness: 10. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BMW-21)

Initial Displacement: 2.2 ft Static Water Column Height: 38.08 ft
Total Well Penetration Depth: 10. ft Screen Length: 10. ft
Casing Radius: 0.083 ft Well Radius: 0.27 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.0001849 cm/sec y0 = 1.14 ft

Data Set: J:\5164 - Luminant CCR Well Installation and GW Sampling\5164-B_Martin Lake\Slug Tests\A1 LF\Aqtes
Title: Slug OUT
Date: 12/16/15
Time: 10:24:27

PROJECT INFORMATION

Company: PBW
Client: Luminant
Project: 5164-B
Location: Beckville Mine
Test Date: 9-22-2015
Test Well: BMW-21

AQUIFER DATA

Saturated Thickness: 10. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: BMW-21

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.2 ft
Static Water Column Height: 38.08 ft
Casing Radius: 0.083 ft
Well Radius: 0.27 ft
Well Skin Radius: 0.27 ft
Screen Length: 10. ft
Total Well Penetration Depth: 10. ft

No. of Observations: 581

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	0.	295.	0.3014
5.	1.809	296.	0.2997
6.	1.74	297.	0.3012
7.	1.68	298.	0.301
8.	1.628	299.	0.2999
9.	1.585	300.	0.2994
10.	1.548	301.	0.2992
11.	1.511	302.	0.2976
12.	1.48	303.	0.2969
13.	1.451	304.	0.2972
14.	1.423	305.	0.2978
15.	1.396	306.	0.2968
16.	1.37	307.	0.2952
17.	1.347	308.	0.2944
18.	1.325	309.	0.295
19.	1.301	310.	0.2953
20.	1.281	311.	0.2938
21.	1.262	312.	0.2919
22.	1.241	313.	0.2934
23.	1.22	314.	0.2926
24.	1.203	315.	0.2927
25.	1.185	316.	0.2918
26.	1.168	317.	0.2918
27.	1.152	318.	0.291
28.	1.136	319.	0.291
29.	1.122	320.	0.2902
30.	1.107	321.	0.2868
31.	1.091	322.	0.286
32.	1.078	323.	0.288

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
33.	1.064	324.	0.2846
34.	1.049	325.	0.2851
35.	1.037	326.	0.2854
36.	1.022	327.	0.2828
37.	1.012	328.	0.284
38.	1.002	329.	0.2846
39.	0.9864	330.	0.2842
40.	0.9767	331.	0.2819
41.	0.9654	332.	0.2829
42.	0.9543	333.	0.2827
43.	0.9438	334.	0.2821
44.	0.9317	335.	0.282
45.	0.9221	336.	0.2803
46.	0.9145	337.	0.2803
47.	0.9036	338.	0.2792
48.	0.8933	339.	0.2799
49.	0.8844	340.	0.2801
50.	0.8746	341.	0.2787
51.	0.8674	342.	0.2788
52.	0.8542	343.	0.2778
53.	0.8472	344.	0.2768
54.	0.8417	345.	0.2786
55.	0.8322	346.	0.279
56.	0.8236	347.	0.2773
57.	0.8178	348.	0.2766
58.	0.8082	349.	0.2745
59.	0.8018	350.	0.2767
60.	0.7934	351.	0.2753
61.	0.7889	352.	0.2761
62.	0.7789	353.	0.2748
63.	0.7735	354.	0.2727
64.	0.7656	355.	0.2747
65.	0.7583	356.	0.2727
66.	0.7532	357.	0.2707
67.	0.7472	358.	0.2723
68.	0.7396	359.	0.2692
69.	0.7331	360.	0.272
70.	0.7273	361.	0.2693
71.	0.7221	362.	0.2682
72.	0.7151	363.	0.2696
73.	0.7086	364.	0.2693
74.	0.7028	365.	0.2697
75.	0.6996	366.	0.2708
76.	0.6921	367.	0.2683
77.	0.6881	368.	0.2685
78.	0.6831	369.	0.2684
79.	0.6772	370.	0.2658
80.	0.6724	371.	0.267
81.	0.6679	372.	0.2668
82.	0.6617	373.	0.2666
83.	0.659	374.	0.2674
84.	0.6526	375.	0.2656
85.	0.6481	376.	0.2658
86.	0.6426	377.	0.2644
87.	0.6392	378.	0.2648
88.	0.6349	379.	0.2665
89.	0.6306	380.	0.2642
90.	0.6264	381.	0.2616
91.	0.6204	382.	0.263
92.	0.6173	383.	0.2631
93.	0.612	384.	0.2632
94.	0.6092	385.	0.2627
95.	0.6054	386.	0.2637
96.	0.6002	387.	0.2619
97.	0.5954	388.	0.2602
98.	0.5936	389.	0.2631

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
99.	0.5881	390.	0.2613
100.	0.5845	391.	0.2615
101.	0.5808	392.	0.2609
102.	0.5782	393.	0.2601
103.	0.573	394.	0.2586
104.	0.5701	395.	0.2601
105.	0.5664	396.	0.2587
106.	0.5623	397.	0.2592
107.	0.5624	398.	0.2564
108.	0.5562	399.	0.2585
109.	0.5526	400.	0.2556
110.	0.5503	401.	0.2585
111.	0.5464	402.	0.2575
112.	0.5442	403.	0.2563
113.	0.54	404.	0.2561
114.	0.5373	405.	0.2556
115.	0.5323	406.	0.257
116.	0.5303	407.	0.2561
117.	0.5287	408.	0.2557
118.	0.524	409.	0.254
119.	0.5223	410.	0.2552
120.	0.5198	411.	0.2543
121.	0.5167	412.	0.2541
122.	0.5142	413.	0.2534
123.	0.5117	414.	0.252
124.	0.5082	415.	0.2537
125.	0.5058	416.	0.2537
126.	0.5033	417.	0.253
127.	0.5019	418.	0.2524
128.	0.4999	419.	0.2499
129.	0.4957	420.	0.2513
130.	0.4934	421.	0.2522
131.	0.4923	422.	0.2525
132.	0.4891	423.	0.2513
133.	0.4882	424.	0.2529
134.	0.4856	425.	0.2509
135.	0.4834	426.	0.2527
136.	0.4805	427.	0.2522
137.	0.4773	428.	0.2531
138.	0.4753	429.	0.2487
139.	0.4736	430.	0.2481
140.	0.4714	431.	0.25
141.	0.4703	432.	0.2476
142.	0.4664	433.	0.2496
143.	0.4655	434.	0.2468
144.	0.4638	435.	0.2477
145.	0.4622	436.	0.2477
146.	0.4605	437.	0.2466
147.	0.4564	438.	0.2478
148.	0.4545	439.	0.2476
149.	0.4543	440.	0.2477
150.	0.4511	441.	0.2462
151.	0.4509	442.	0.2456
152.	0.4472	443.	0.2447
153.	0.446	444.	0.2465
154.	0.445	445.	0.2472
155.	0.4428	446.	0.2455
156.	0.4408	447.	0.2446
157.	0.4393	448.	0.2453
158.	0.4393	449.	0.2454
159.	0.4354	450.	0.2428
160.	0.4352	451.	0.2432
161.	0.4325	452.	0.2424
162.	0.4323	453.	0.2438
163.	0.4301	454.	0.2456
164.	0.4304	455.	0.2433

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
165.	0.4279	456.	0.2416
166.	0.4249	457.	0.244
167.	0.4245	458.	0.2433
168.	0.4215	459.	0.2431
169.	0.4216	460.	0.2428
170.	0.4186	461.	0.2428
171.	0.418	462.	0.241
172.	0.4146	463.	0.243
173.	0.4133	464.	0.2411
174.	0.4108	465.	0.2426
175.	0.4097	466.	0.2426
176.	0.407	467.	0.243
177.	0.4068	468.	0.243
178.	0.4058	469.	0.2432
179.	0.4044	470.	0.24
180.	0.4034	471.	0.2421
181.	0.4004	472.	0.2402
182.	0.4005	473.	0.2415
183.	0.396	474.	0.2401
184.	0.3946	475.	0.2402
185.	0.4001	476.	0.2391
186.	0.3933	477.	0.2405
187.	0.3916	478.	0.2396
188.	0.3921	479.	0.2379
189.	0.3907	480.	0.2375
190.	0.3896	481.	0.237
191.	0.3893	482.	0.2364
192.	0.3857	483.	0.2353
193.	0.386	484.	0.2392
194.	0.3857	485.	0.2357
195.	0.3831	486.	0.2362
196.	0.383	487.	0.2354
197.	0.3817	488.	0.2355
198.	0.3795	489.	0.2356
199.	0.3787	490.	0.2348
200.	0.3772	491.	0.2349
201.	0.3753	492.	0.2356
202.	0.3748	493.	0.2345
203.	0.3761	494.	0.2346
204.	0.3735	495.	0.2327
205.	0.3726	496.	0.2322
206.	0.3704	497.	0.2334
207.	0.3712	498.	0.2328
208.	0.3701	499.	0.2337
209.	0.3681	500.	0.235
210.	0.3681	501.	0.2337
211.	0.3673	502.	0.2337
212.	0.3661	503.	0.2326
213.	0.3634	504.	0.2348
214.	0.3614	505.	0.2321
215.	0.3611	506.	0.2321
216.	0.3606	507.	0.2314
217.	0.3596	508.	0.2322
218.	0.358	509.	0.2328
219.	0.3577	510.	0.2313
220.	0.3562	511.	0.232
221.	0.3559	512.	0.2309
222.	0.353	513.	0.2308
223.	0.354	514.	0.2314
224.	0.3526	515.	0.2301
225.	0.3509	516.	0.2307
226.	0.3499	517.	0.2302
227.	0.3488	518.	0.231
228.	0.3492	519.	0.2299
229.	0.3457	520.	0.2299
230.	0.3481	521.	0.2309

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
231.	0.3465	522.	0.2264
232.	0.3449	523.	0.2288
233.	0.3418	524.	0.2285
234.	0.3427	525.	0.2293
235.	0.3429	526.	0.2291
236.	0.3427	527.	0.2294
237.	0.3409	528.	0.2265
238.	0.3409	529.	0.2277
239.	0.3403	530.	0.2292
240.	0.3389	531.	0.2291
241.	0.336	532.	0.2281
242.	0.3368	533.	0.2288
243.	0.3359	534.	0.2263
244.	0.336	535.	0.2286
245.	0.3349	536.	0.2292
246.	0.3349	537.	0.2278
247.	0.3341	538.	0.2276
248.	0.3333	539.	0.2294
249.	0.3309	540.	0.2287
250.	0.3302	541.	0.2268
251.	0.3298	542.	0.2276
252.	0.3281	543.	0.2276
253.	0.3304	544.	0.2269
254.	0.3268	545.	0.2269
255.	0.3249	546.	0.2257
256.	0.3247	547.	0.2258
257.	0.3246	548.	0.2283
258.	0.3271	549.	0.2262
259.	0.3235	550.	0.2264
260.	0.3214	551.	0.2279
261.	0.3243	552.	0.2263
262.	0.3224	553.	0.2229
263.	0.3201	554.	0.2247
264.	0.3211	555.	0.2211
265.	0.3189	556.	0.2238
266.	0.319	557.	0.2211
267.	0.3207	558.	0.2224
268.	0.3181	559.	0.2229
269.	0.3159	560.	0.2233
270.	0.3166	561.	0.222
271.	0.3157	562.	0.2222
272.	0.3166	563.	0.2212
273.	0.3144	564.	0.2212
274.	0.3145	565.	0.2235
275.	0.3129	566.	0.2201
276.	0.3136	567.	0.221
277.	0.314	568.	0.2205
278.	0.3117	569.	0.2226
279.	0.3105	570.	0.2192
280.	0.3108	571.	0.2216
281.	0.3099	572.	0.2214
282.	0.309	573.	0.2208
283.	0.3099	574.	0.2206
284.	0.3081	575.	0.2212
285.	0.3061	576.	0.2199
286.	0.3059	577.	0.2211
287.	0.3046	578.	0.2203
288.	0.3038	579.	0.2204
289.	0.3052	580.	0.2194
290.	0.3041	581.	0.2231
291.	0.304	582.	0.2234
292.	0.3015	583.	0.2232
293.	0.3015	584.	0.2228
294.	0.302		

SOLUTION

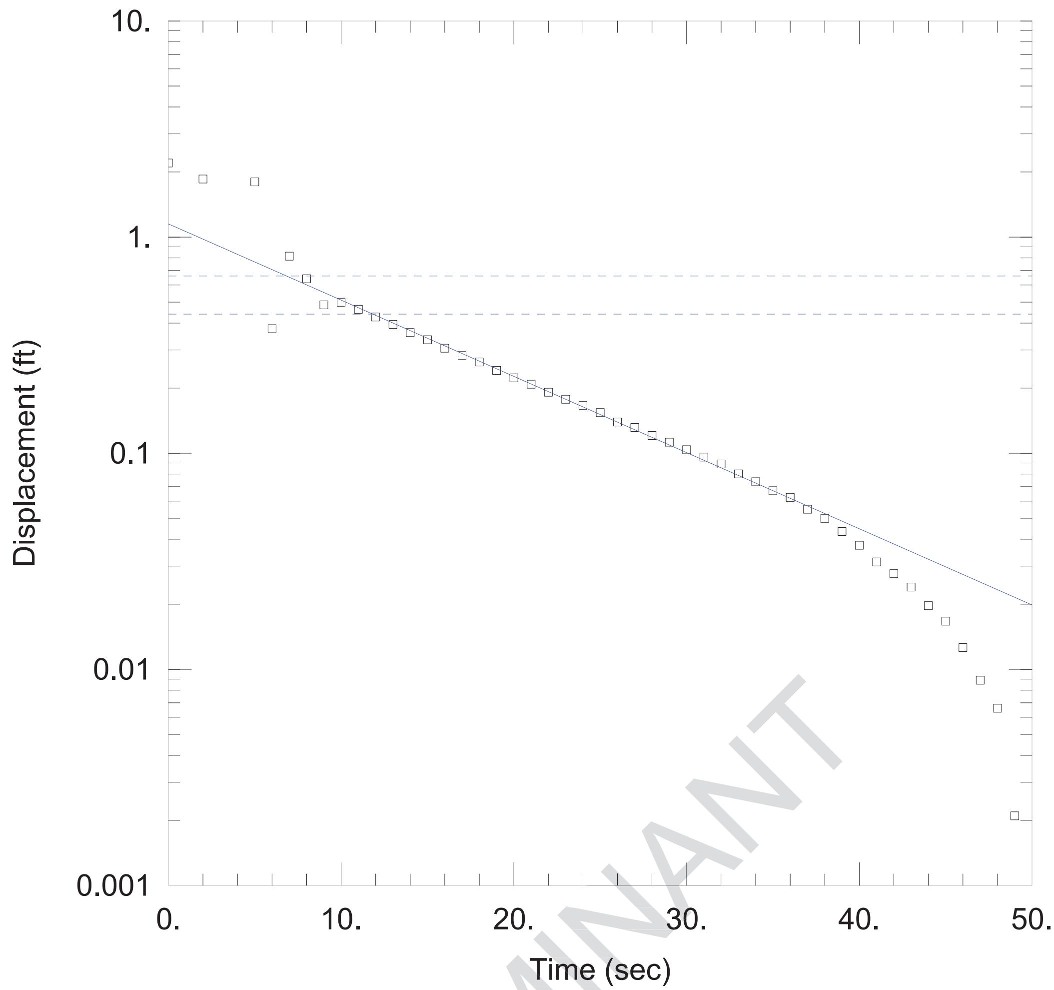
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.748

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0001849	cm/sec
y0	1.14	ft

T = K*b = 0.05637 cm²/sec



WELL TEST ANALYSIS

Data Set: J:\...\BMW-23 Slug IN.aqt
Date: 12/16/15 Time: 10:22:50

PROJECT INFORMATION

Company: PBW
Client: Luminant
Project: 5164-B
Location: Beckville Mine
Test Well: BMW-23
Test Date: 9-22-2015

AQUIFER DATA

Saturated Thickness: 15. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BMW-23)

Initial Displacement: 2.2 ft Static Water Column Height: 21.76 ft
Total Well Penetration Depth: 15. ft Screen Length: 15. ft
Casing Radius: 0.083 ft Well Radius: 0.27 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice
K = 0.00175 cm/sec y0 = 1.15 ft

Data Set: J:\5164 - Luminant CCR Well Installation and GW Sampling\5164-B_Martin Lake\Slug Tests\A1 LF\Aqtes
Date: 12/16/15
Time: 10:24:14

PROJECT INFORMATION

Company: PBW
Client: Luminant
Project: 5164-B
Location: Beckville Mine
Test Date: 9-22-2015
Test Well: BMW-23

AQUIFER DATA

Saturated Thickness: 15. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: BMW-23

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.2 ft
Static Water Column Height: 21.76 ft
Casing Radius: 0.083 ft
Well Radius: 0.27 ft
Well Skin Radius: 0.27 ft
Screen Length: 15. ft
Total Well Penetration Depth: 15. ft

No. of Observations: 48

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	0.	27.	0.1315
2.	1.854	28.	0.1208
5.	1.8	29.	0.1124
6.	0.3769	30.	0.1038
7.	0.8153	31.	0.0959
8.	0.6414	32.	0.0891
9.	0.4853	33.	0.0802
10.	0.4989	34.	0.0738
11.	0.4631	35.	0.067
12.	0.4267	36.	0.0624
13.	0.3941	37.	0.055
14.	0.3618	38.	0.0499
15.	0.3346	39.	0.0434
16.	0.3059	40.	0.0375
17.	0.2828	41.	0.0314
18.	0.264	42.	0.0277
19.	0.2415	43.	0.024
20.	0.2231	44.	0.0197
21.	0.2085	45.	0.0167
22.	0.1915	46.	0.0126
23.	0.1775	47.	0.0089
24.	0.1664	48.	0.0066
25.	0.1541	49.	0.0021
26.	0.1393	50.	0.

SOLUTION

Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice

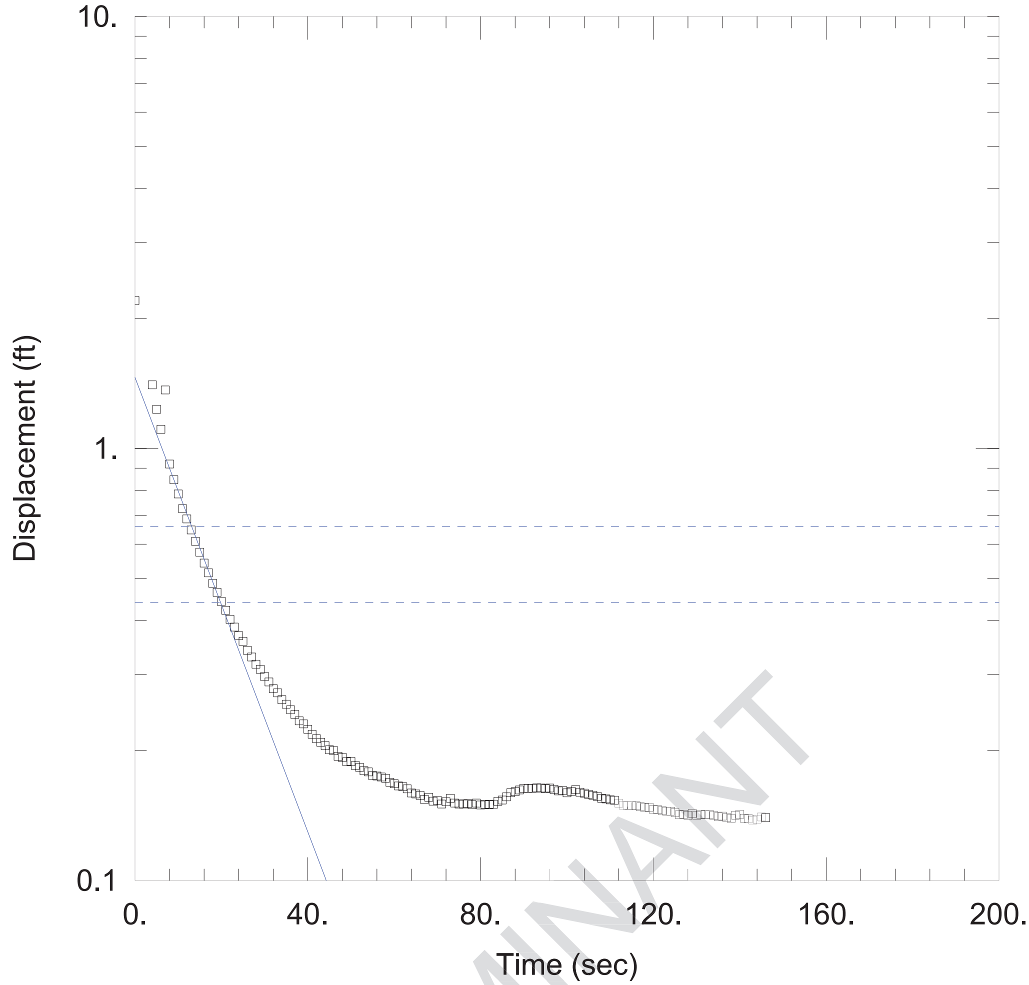
ln(Re/rw): 3.079

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.00175	cm/sec
y0	1.15	ft

T = K*b = 0.8 cm²/sec



WELL TEST ANALYSIS

Data Set: J:\...\BMW-23 Slug OUT.aqt
Date: 12/16/15 Time: 10:22:59

PROJECT INFORMATION

Company: PBW
Client: Luminant
Project: 5164-B
Location: Beckville Mine
Test Well: BMW-23
Test Date: 9-22-2015

AQUIFER DATA

Saturated Thickness: 15. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 2.2 ft Static Water Column Height: 21.76 ft
Total Well Penetration Depth: 15. ft Screen Length: 15. ft
Casing Radius: 0.083 ft Well Radius: 0.27 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice
K = 0.001305 cm/sec y0 = 1.46 ft

Data Set: J:\5164 - Luminant CCR Well Installation and GW Sampling\5164-B_Martin Lake\Slug Tests\A1 LF\Aqtes
Date: 12/16/15
Time: 10:24:02

PROJECT INFORMATION

Company: PBW
Client: Luminant
Project: 5164-B
Location: Beckville Mine
Test Date: 9-22-2015
Test Well: BMW-23

AQUIFER DATA

Saturated Thickness: 15. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: New Well

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.2 ft
Static Water Column Height: 21.76 ft
Casing Radius: 0.083 ft
Well Radius: 0.27 ft
Well Skin Radius: 0.27 ft
Screen Length: 15. ft
Total Well Penetration Depth: 15. ft

No. of Observations: 144

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	0.	75.	0.1502
4.	1.404	76.	0.1502
5.	1.232	77.	0.1506
6.	1.108	78.	0.1497
7.	1.366	79.	0.151
8.	0.9205	80.	0.1495
9.	0.8461	81.	0.15
10.	0.7847	82.	0.1498
11.	0.7252	83.	0.1501
12.	0.687	84.	0.1525
13.	0.6474	85.	0.1535
14.	0.6094	86.	0.1561
15.	0.5752	87.	0.1596
16.	0.5429	88.	0.1605
17.	0.5153	89.	0.162
18.	0.487	90.	0.1634
19.	0.4645	91.	0.1633
20.	0.4424	92.	0.1634
21.	0.4221	93.	0.1638
22.	0.4021	94.	0.1637
23.	0.3858	95.	0.1631
24.	0.3684	96.	0.1637
25.	0.3576	97.	0.1624
26.	0.3409	98.	0.1611
27.	0.3289	99.	0.1614
28.	0.3165	100.	0.1595
29.	0.308	101.	0.1608
30.	0.2965	102.	0.1623
31.	0.288	103.	0.1601
32.	0.278	104.	0.1592

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
33.	0.2717	105.	0.1582
34.	0.262	106.	0.1575
35.	0.2558	107.	0.1565
36.	0.2484	108.	0.1549
37.	0.2422	109.	0.1544
38.	0.2341	110.	0.1536
39.	0.2304	111.	0.1534
40.	0.2238	112.	0.1509
41.	0.218	113.	0.1494
42.	0.2128	114.	0.149
43.	0.2089	115.	0.149
44.	0.2051	116.	0.1487
45.	0.2006	117.	0.148
46.	0.1996	118.	0.1475
47.	0.1937	119.	0.1477
48.	0.1926	120.	0.146
49.	0.1884	121.	0.1457
50.	0.1885	122.	0.1451
51.	0.1846	123.	0.1447
52.	0.1826	124.	0.1447
53.	0.1795	125.	0.1435
54.	0.1783	126.	0.1419
55.	0.1749	127.	0.1423
56.	0.1744	128.	0.1414
57.	0.1735	129.	0.143
58.	0.1724	130.	0.1414
59.	0.1688	131.	0.1422
60.	0.1675	132.	0.1419
61.	0.1655	133.	0.142
62.	0.1647	134.	0.1413
63.	0.1629	135.	0.1405
64.	0.1594	136.	0.1409
65.	0.1585	137.	0.1398
66.	0.1573	138.	0.1392
67.	0.154	139.	0.1415
68.	0.1557	140.	0.1422
69.	0.1526	141.	0.1394
70.	0.1531	142.	0.1389
71.	0.1502	143.	0.138
72.	0.1521	144.	0.1387
73.	0.1549	145.	0.1402
74.	0.151	146.	0.1398

SOLUTION

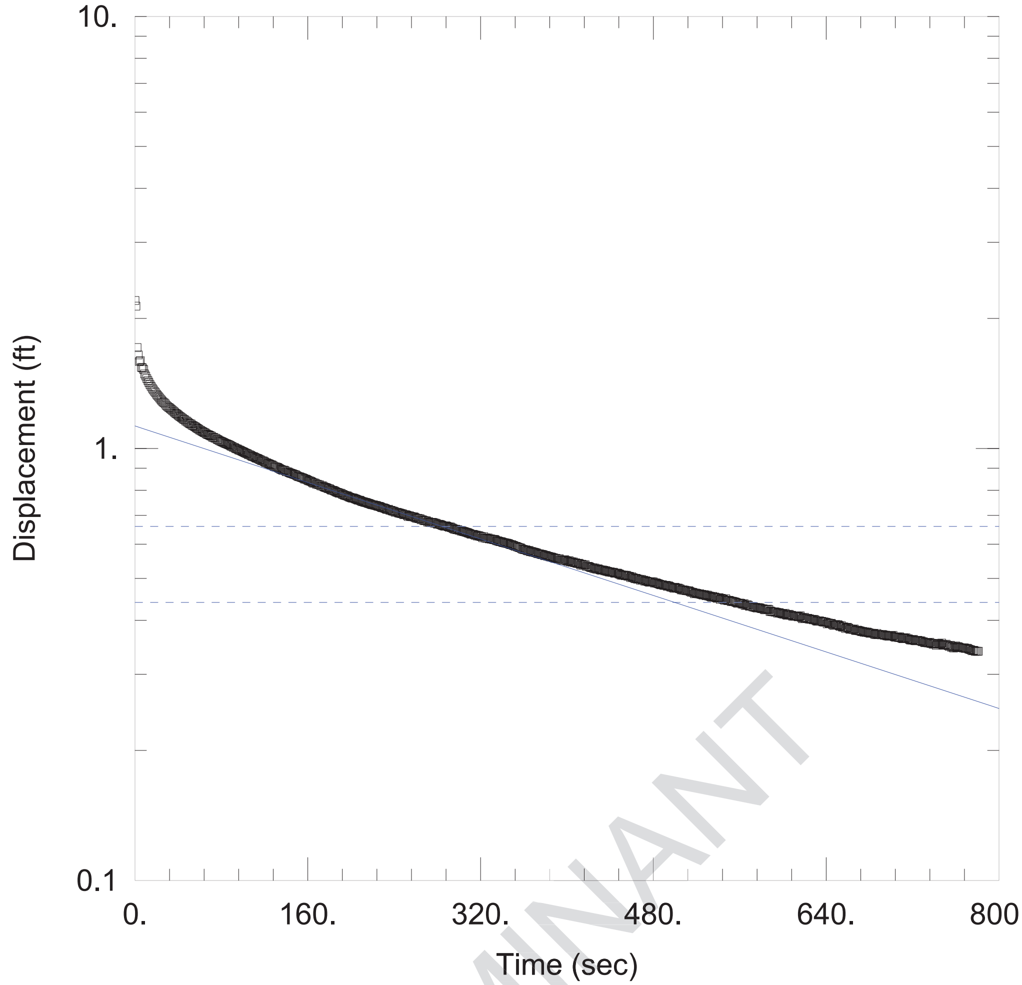
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
In(Re/rw): 3.079

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.001305	cm/sec
y0	1.46	ft

T = K*b = 0.5966 cm²/sec



WELL TEST ANALYSIS

Data Set: J:\...\BMW-24 Slug IN.aqt
Date: 12/16/15 Time: 10:23:09

PROJECT INFORMATION

Company: PBW
Client: Luminant
Project: 5164-B
Location: Beckville Mine
Test Well: BMW-24
Test Date: 9-22-2015

AQUIFER DATA

Saturated Thickness: 5. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 2.2 ft Static Water Column Height: 23.87 ft
Total Well Penetration Depth: 5. ft Screen Length: 5. ft
Casing Radius: 0.083 ft Well Radius: 0.27 ft

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 8.517E-5 cm/sec y0 = 1.127 ft

Data Set: J:\5164 - Luminant CCR Well Installation and GW Sampling\5164-B_Martin Lake\Slug Tests\A1 LF\Aqtes
Date: 12/16/15
Time: 10:23:49

PROJECT INFORMATION

Company: PBW
Client: Luminant
Project: 5164-B
Location: Beckville Mine
Test Date: 9-22-2015
Test Well: BMW-24

AQUIFER DATA

Saturated Thickness: 5. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: New Well

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.2 ft
Static Water Column Height: 23.87 ft
Casing Radius: 0.083 ft
Well Radius: 0.27 ft
Well Skin Radius: 0.27 ft
Screen Length: 5. ft
Total Well Penetration Depth: 5. ft

No. of Observations: 782

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	0.	391.	0.5552
1.	2.135	392.	0.5553
2.	1.713	393.	0.5553
3.	1.646	394.	0.5526
4.	1.59	395.	0.5518
5.	1.596	396.	0.5522
6.	1.54	397.	0.5522
7.	1.536	398.	0.5526
8.	1.523	399.	0.5501
9.	1.487	400.	0.5492
10.	1.47	401.	0.5474
11.	1.451	402.	0.5498
12.	1.435	403.	0.546
13.	1.42	404.	0.547
14.	1.405	405.	0.5451
15.	1.392	406.	0.5462
16.	1.379	407.	0.5438
17.	1.367	408.	0.5439
18.	1.357	409.	0.5421
19.	1.346	410.	0.5412
20.	1.335	411.	0.5423
21.	1.326	412.	0.5402
22.	1.317	413.	0.5369
23.	1.308	414.	0.5397
24.	1.298	415.	0.5362
25.	1.289	416.	0.537
26.	1.282	417.	0.5378
27.	1.276	418.	0.5334
28.	1.268	419.	0.5335
29.	1.258	420.	0.5332

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
30.	1.252	421.	0.5318
31.	1.246	422.	0.5301
32.	1.241	423.	0.5296
33.	1.235	424.	0.5297
34.	1.23	425.	0.5268
35.	1.223	426.	0.5285
36.	1.218	427.	0.526
37.	1.21	428.	0.5259
38.	1.205	429.	0.5262
39.	1.201	430.	0.5248
40.	1.195	431.	0.5231
41.	1.189	432.	0.5223
42.	1.185	433.	0.5234
43.	1.178	434.	0.5223
44.	1.174	435.	0.5206
45.	1.168	436.	0.5215
46.	1.166	437.	0.5194
47.	1.158	438.	0.5192
48.	1.157	439.	0.5175
49.	1.15	440.	0.5178
50.	1.145	441.	0.517
51.	1.14	442.	0.5163
52.	1.139	443.	0.5172
53.	1.132	444.	0.5146
54.	1.129	445.	0.5139
55.	1.125	446.	0.5144
56.	1.122	447.	0.5143
57.	1.116	448.	0.5122
58.	1.112	449.	0.5116
59.	1.108	450.	0.509
60.	1.103	451.	0.5093
61.	1.1	452.	0.5082
62.	1.096	453.	0.509
63.	1.092	454.	0.5074
64.	1.089	455.	0.5089
65.	1.087	456.	0.5065
66.	1.082	457.	0.5062
67.	1.077	458.	0.5055
68.	1.076	459.	0.5023
69.	1.073	460.	0.5043
70.	1.069	461.	0.5021
71.	1.067	462.	0.5016
72.	1.06	463.	0.4994
73.	1.061	464.	0.5005
74.	1.056	465.	0.4986
75.	1.055	466.	0.4985
76.	1.05	467.	0.4982
77.	1.048	468.	0.4954
78.	1.043	469.	0.4974
79.	1.041	470.	0.4953
80.	1.038	471.	0.4956
81.	1.035	472.	0.4929
82.	1.032	473.	0.494
83.	1.029	474.	0.4924
84.	1.026	475.	0.4916
85.	1.024	476.	0.4904
86.	1.022	477.	0.4903
87.	1.019	478.	0.4915
88.	1.017	479.	0.4913
89.	1.012	480.	0.4907
90.	1.01	481.	0.488
91.	1.007	482.	0.4887
92.	1.005	483.	0.488
93.	1.002	484.	0.4865
94.	0.9982	485.	0.4857
95.	0.9974	486.	0.4846

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
96.	0.9917	487.	0.4832
97.	0.9907	488.	0.4839
98.	0.9886	489.	0.483
99.	0.9849	490.	0.4818
100.	0.9827	491.	0.482
101.	0.9804	492.	0.482
102.	0.9768	493.	0.4798
103.	0.9743	494.	0.4807
104.	0.973	495.	0.4792
105.	0.9678	496.	0.4776
106.	0.9668	497.	0.4771
107.	0.9641	498.	0.4763
108.	0.9607	499.	0.4746
109.	0.9582	500.	0.4771
110.	0.9574	501.	0.4757
111.	0.9536	502.	0.4744
112.	0.9508	503.	0.4752
113.	0.9487	504.	0.4737
114.	0.9473	505.	0.4728
115.	0.9434	506.	0.4705
116.	0.9415	507.	0.4707
117.	0.9378	508.	0.4698
118.	0.9362	509.	0.4699
119.	0.9351	510.	0.4688
120.	0.9313	511.	0.4688
121.	0.9274	512.	0.4679
122.	0.9269	513.	0.4682
123.	0.9236	514.	0.4665
124.	0.9219	515.	0.4648
125.	0.9196	516.	0.4647
126.	0.9171	517.	0.4638
127.	0.9155	518.	0.461
128.	0.9118	519.	0.4628
129.	0.9077	520.	0.462
130.	0.9065	521.	0.4611
131.	0.9058	522.	0.4603
132.	0.9041	523.	0.4609
133.	0.9008	524.	0.4594
134.	0.8978	525.	0.4593
135.	0.8947	526.	0.4576
136.	0.8924	527.	0.4587
137.	0.8902	528.	0.4578
138.	0.8906	529.	0.4562
139.	0.8887	530.	0.4575
140.	0.8833	531.	0.4555
141.	0.8834	532.	0.4552
142.	0.8817	533.	0.4539
143.	0.8786	534.	0.4523
144.	0.8768	535.	0.4544
145.	0.8751	536.	0.4524
146.	0.8732	537.	0.4529
147.	0.8714	538.	0.4514
148.	0.8696	539.	0.4501
149.	0.8685	540.	0.4512
150.	0.865	541.	0.4516
151.	0.8609	542.	0.4472
152.	0.8604	543.	0.4499
153.	0.8588	544.	0.4486
154.	0.8563	545.	0.4473
155.	0.8552	546.	0.4453
156.	0.8527	547.	0.4489
157.	0.8492	548.	0.4457
158.	0.8494	549.	0.4443
159.	0.8471	550.	0.445
160.	0.8441	551.	0.4443
161.	0.8414	552.	0.4418

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
162.	0.8407	553.	0.443
163.	0.8385	554.	0.4425
164.	0.8355	555.	0.4415
165.	0.8311	556.	0.4409
166.	0.8323	557.	0.4397
167.	0.8306	558.	0.4383
168.	0.8266	559.	0.4382
169.	0.8268	560.	0.4384
170.	0.8241	561.	0.4382
171.	0.8233	562.	0.4365
172.	0.8194	563.	0.4364
173.	0.8188	564.	0.4371
174.	0.8189	565.	0.4331
175.	0.8143	566.	0.4341
176.	0.8123	567.	0.4343
177.	0.8115	568.	0.4332
178.	0.8098	569.	0.4311
179.	0.807	570.	0.4312
180.	0.8068	571.	0.4313
181.	0.8033	572.	0.4298
182.	0.8006	573.	0.4296
183.	0.8	574.	0.4287
184.	0.7986	575.	0.4284
185.	0.7965	576.	0.4272
186.	0.7942	577.	0.4283
187.	0.791	578.	0.4278
188.	0.7909	579.	0.427
189.	0.7882	580.	0.4255
190.	0.788	581.	0.4258
191.	0.7866	582.	0.4249
192.	0.783	583.	0.4231
193.	0.7822	584.	0.4233
194.	0.7793	585.	0.4234
195.	0.778	586.	0.4245
196.	0.7764	587.	0.4238
197.	0.7756	588.	0.4192
198.	0.7725	589.	0.4203
199.	0.7709	590.	0.4188
200.	0.7696	591.	0.4186
201.	0.7672	592.	0.4186
202.	0.7677	593.	0.4182
203.	0.7659	594.	0.4176
204.	0.7641	595.	0.4158
205.	0.7625	596.	0.4171
206.	0.7602	597.	0.4162
207.	0.7587	598.	0.4153
208.	0.759	599.	0.4143
209.	0.7565	600.	0.4139
210.	0.7539	601.	0.4134
211.	0.7531	602.	0.4152
212.	0.7516	603.	0.4119
213.	0.7502	604.	0.4111
214.	0.75	605.	0.4129
215.	0.748	606.	0.4129
216.	0.7463	607.	0.4107
217.	0.7454	608.	0.4111
218.	0.7435	609.	0.409
219.	0.7418	610.	0.4098
220.	0.7402	611.	0.4086
221.	0.7402	612.	0.4098
222.	0.7382	613.	0.4094
223.	0.7381	614.	0.4074
224.	0.737	615.	0.4085
225.	0.7348	616.	0.4097
226.	0.7343	617.	0.406
227.	0.7337	618.	0.4034

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
228.	0.7303	619.	0.405
229.	0.7293	620.	0.4064
230.	0.7283	621.	0.4034
231.	0.727	622.	0.4046
232.	0.7251	623.	0.4044
233.	0.7232	624.	0.4027
234.	0.7221	625.	0.403
235.	0.7228	626.	0.4021
236.	0.7194	627.	0.4025
237.	0.7192	628.	0.401
238.	0.7168	629.	0.4022
239.	0.7164	630.	0.4008
240.	0.715	631.	0.3986
241.	0.7121	632.	0.3983
242.	0.7121	633.	0.3982
243.	0.711	634.	0.399
244.	0.7088	635.	0.3981
245.	0.7087	636.	0.3978
246.	0.707	637.	0.3966
247.	0.7063	638.	0.3966
248.	0.7051	639.	0.3964
249.	0.7025	640.	0.3958
250.	0.7026	641.	0.3926
251.	0.7023	642.	0.3945
252.	0.6998	643.	0.3931
253.	0.6955	644.	0.3933
254.	0.6995	645.	0.3936
255.	0.6965	646.	0.3906
256.	0.6958	647.	0.3896
257.	0.6944	648.	0.39
258.	0.6946	649.	0.3913
259.	0.6934	650.	0.3904
260.	0.6903	651.	0.391
261.	0.689	652.	0.3885
262.	0.6885	653.	0.3873
263.	0.688	654.	0.3893
264.	0.6874	655.	0.3859
265.	0.6842	656.	0.3862
266.	0.6837	657.	0.3858
267.	0.6822	658.	0.3829
268.	0.6806	659.	0.385
269.	0.6802	660.	0.3852
270.	0.6799	661.	0.3835
271.	0.6752	662.	0.3814
272.	0.6771	663.	0.3817
273.	0.6741	664.	0.3813
274.	0.674	665.	0.3811
275.	0.6736	666.	0.3821
276.	0.674	667.	0.3789
277.	0.672	668.	0.379
278.	0.6716	669.	0.3796
279.	0.6705	670.	0.3791
280.	0.6679	671.	0.378
281.	0.6675	672.	0.3778
282.	0.6673	673.	0.3764
283.	0.6662	674.	0.377
284.	0.6641	675.	0.3755
285.	0.6626	676.	0.3758
286.	0.6618	677.	0.3748
287.	0.6602	678.	0.3757
288.	0.6621	679.	0.3749
289.	0.6605	680.	0.3738
290.	0.6585	681.	0.3732
291.	0.6568	682.	0.3735
292.	0.6579	683.	0.3733
293.	0.6555	684.	0.3729

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
294.	0.654	685.	0.3711
295.	0.6514	686.	0.371
296.	0.6498	687.	0.373
297.	0.6505	688.	0.3703
298.	0.6482	689.	0.3708
299.	0.6489	690.	0.3704
300.	0.6466	691.	0.37
301.	0.6463	692.	0.3711
302.	0.644	693.	0.3704
303.	0.6441	694.	0.3693
304.	0.6419	695.	0.3699
305.	0.6422	696.	0.3681
306.	0.6405	697.	0.3683
307.	0.6395	698.	0.3678
308.	0.6383	699.	0.3683
309.	0.6368	700.	0.3684
310.	0.6358	701.	0.368
311.	0.6332	702.	0.3691
312.	0.633	703.	0.3662
313.	0.6328	704.	0.3658
314.	0.632	705.	0.3661
315.	0.6295	706.	0.3656
316.	0.6299	707.	0.3647
317.	0.6271	708.	0.3665
318.	0.6285	709.	0.3648
319.	0.627	710.	0.3635
320.	0.6253	711.	0.3627
321.	0.6246	712.	0.3648
322.	0.6213	713.	0.3636
323.	0.6248	714.	0.3646
324.	0.6208	715.	0.3626
325.	0.6208	716.	0.3625
326.	0.619	717.	0.3614
327.	0.6205	718.	0.3602
328.	0.6175	719.	0.3606
329.	0.6178	720.	0.3606
330.	0.6171	721.	0.3614
331.	0.6164	722.	0.359
332.	0.615	723.	0.3586
333.	0.6157	724.	0.359
334.	0.6138	725.	0.3594
335.	0.6113	726.	0.359
336.	0.6109	727.	0.3585
337.	0.6097	728.	0.3582
338.	0.6087	729.	0.3567
339.	0.6083	730.	0.3571
340.	0.607	731.	0.3554
341.	0.6053	732.	0.3551
342.	0.6056	733.	0.3556
343.	0.6039	734.	0.3547
344.	0.6041	735.	0.3548
345.	0.6021	736.	0.3559
346.	0.6023	737.	0.3536
347.	0.5998	738.	0.3542
348.	0.5988	739.	0.3522
349.	0.5987	740.	0.3526
350.	0.5967	741.	0.3534
351.	0.5957	742.	0.3503
352.	0.5938	743.	0.3523
353.	0.5934	744.	0.3536
354.	0.5915	745.	0.3526
355.	0.5907	746.	0.352
356.	0.5891	747.	0.3543
357.	0.5885	748.	0.3512
358.	0.5861	749.	0.3503
359.	0.5843	750.	0.3507

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
360.	0.5838	751.	0.3522
361.	0.5826	752.	0.3504
362.	0.5824	753.	0.3497
363.	0.5801	754.	0.3482
364.	0.5789	755.	0.3501
365.	0.5805	756.	0.3465
366.	0.5769	757.	0.3477
367.	0.5776	758.	0.3452
368.	0.5755	759.	0.347
369.	0.5758	760.	0.3491
370.	0.5747	761.	0.3456
371.	0.5739	762.	0.3477
372.	0.5727	763.	0.3469
373.	0.5706	764.	0.3458
374.	0.5705	765.	0.3456
375.	0.5697	766.	0.3458
376.	0.5682	767.	0.3452
377.	0.5679	768.	0.3455
378.	0.5681	769.	0.3442
379.	0.5651	770.	0.3449
380.	0.5651	771.	0.3445
381.	0.5651	772.	0.3432
382.	0.5632	773.	0.3425
383.	0.5624	774.	0.342
384.	0.561	775.	0.3402
385.	0.5607	776.	0.3408
386.	0.5602	777.	0.3407
387.	0.5588	778.	0.3391
388.	0.5578	779.	0.3396
389.	0.5562	780.	0.3391
390.	0.5569	781.	0.3394

SOLUTION

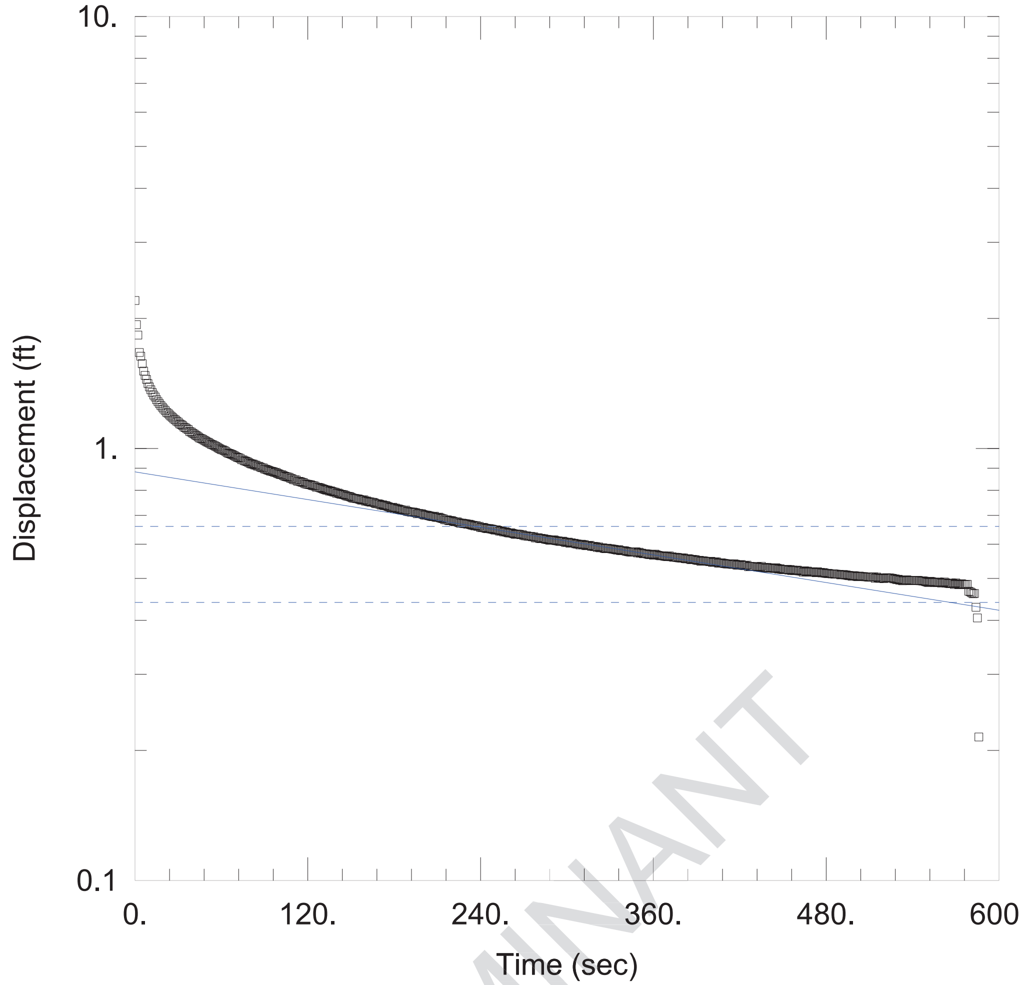
Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.155

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	8.517E-5	cm/sec
y0	1.127	ft

T = K*b = 0.01298 cm²/sec



WELL TEST ANALYSIS

Data Set: J:\...\BMW-24 Slug OUT.aqt
Date: 10/03/17 Time: 17:25:14

PROJECT INFORMATION

Company: PBW
Client: Luminant
Project: 5164-B
Location: Beckville Mine
Test Well: BMW-24
Test Date: 9-22-2015

AQUIFER DATA

Saturated Thickness: 5. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BMW-24)

Initial Displacement: 2.2 ft
Static Water Column Height: 23.87 ft
Total Well Penetration Depth: 5. ft
Screen Length: 5. ft
Casing Radius: 0.083 ft
Well Radius: 0.27 ft

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 5.558E-5 cm/sec
y0 = 0.8822 ft

Data Set: J:\5164 - Luminant CCR GW Monitoring\5164-B_Martin Lake\Slug Tests\A1 LF\Aqtesolv files\BMW-24 Sl
Date: 10/03/17
Time: 17:25:42

PROJECT INFORMATION

Company: PBW
Client: Luminant
Project: 5164-B
Location: Beckville Mine
Test Date: 9-22-2015
Test Well: BMW-24

AQUIFER DATA

Saturated Thickness: 5. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: BMW-24

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.2 ft
Static Water Column Height: 23.87 ft
Casing Radius: 0.083 ft
Well Radius: 0.27 ft
Well Skin Radius: 0.27 ft
Screen Length: 5. ft
Total Well Penetration Depth: 5. ft

No. of Observations: 587

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	0.	294.	0.6108
1.	1.934	295.	0.609
2.	1.83	296.	0.6095
3.	1.668	297.	0.6098
4.	1.635	298.	0.6078
5.	1.571	299.	0.6053
6.	1.51	300.	0.6062
7.	1.476	301.	0.6068
8.	1.444	302.	0.6035
9.	1.414	303.	0.6047
10.	1.389	304.	0.6031
11.	1.367	305.	0.6035
12.	1.347	306.	0.6012
13.	1.329	307.	0.6008
14.	1.315	308.	0.6001
15.	1.297	309.	0.5979
16.	1.282	310.	0.6005
17.	1.269	311.	0.598
18.	1.256	312.	0.5994
19.	1.246	313.	0.5958
20.	1.234	314.	0.5955
21.	1.224	315.	0.5955
22.	1.212	316.	0.5966
23.	1.206	317.	0.593
24.	1.196	318.	0.5936
25.	1.188	319.	0.5928
26.	1.18	320.	0.5928
27.	1.17	321.	0.5894
28.	1.165	322.	0.5917
29.	1.156	323.	0.5886

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
30.	1.151	324.	0.5889
31.	1.14	325.	0.5887
32.	1.136	326.	0.5868
33.	1.13	327.	0.5863
34.	1.121	328.	0.5876
35.	1.117	329.	0.5859
36.	1.11	330.	0.5863
37.	1.105	331.	0.5853
38.	1.094	332.	0.5846
39.	1.091	333.	0.5838
40.	1.084	334.	0.5827
41.	1.08	335.	0.5814
42.	1.074	336.	0.5829
43.	1.069	337.	0.5803
44.	1.063	338.	0.5796
45.	1.057	339.	0.5803
46.	1.054	340.	0.5798
47.	1.05	341.	0.5781
48.	1.045	342.	0.5772
49.	1.04	343.	0.5764
50.	1.036	344.	0.5756
51.	1.032	345.	0.5754
52.	1.027	346.	0.5752
53.	1.022	347.	0.5755
54.	1.019	348.	0.5763
55.	1.016	349.	0.5727
56.	1.011	350.	0.575
57.	1.007	351.	0.5722
58.	1.002	352.	0.5722
59.	0.9982	353.	0.5703
60.	0.9939	354.	0.5709
61.	0.9917	355.	0.5701
62.	0.9883	356.	0.5693
63.	0.9845	357.	0.568
64.	0.9776	358.	0.5684
65.	0.9747	359.	0.5686
66.	0.9727	360.	0.5661
67.	0.969	361.	0.5692
68.	0.9658	362.	0.5674
69.	0.9621	363.	0.5659
70.	0.958	364.	0.5648
71.	0.9541	365.	0.564
72.	0.9517	366.	0.5643
73.	0.9493	367.	0.5641
74.	0.9413	368.	0.5627
75.	0.9407	369.	0.5621
76.	0.9359	370.	0.562
77.	0.9342	371.	0.5641
78.	0.931	372.	0.5613
79.	0.9275	373.	0.5613
80.	0.9232	374.	0.5598
81.	0.9206	375.	0.5602
82.	0.9199	376.	0.5592
83.	0.9155	377.	0.5594
84.	0.9145	378.	0.5578
85.	0.9098	379.	0.5577
86.	0.9092	380.	0.5571
87.	0.9057	381.	0.5578
88.	0.9026	382.	0.5554
89.	0.9012	383.	0.555
90.	0.8962	384.	0.556
91.	0.8945	385.	0.5549
92.	0.8913	386.	0.5524
93.	0.8893	387.	0.5536
94.	0.8861	388.	0.5526
95.	0.8848	389.	0.5532

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
96.	0.8834	390.	0.5513
97.	0.8793	391.	0.5503
98.	0.88	392.	0.5505
99.	0.8748	393.	0.5477
100.	0.8728	394.	0.55
101.	0.8702	395.	0.5487
102.	0.8692	396.	0.5483
103.	0.8651	397.	0.5479
104.	0.8628	398.	0.5479
105.	0.8602	399.	0.5472
106.	0.8587	400.	0.5479
107.	0.8572	401.	0.5446
108.	0.8528	402.	0.5449
109.	0.8515	403.	0.546
110.	0.8466	404.	0.546
111.	0.8458	405.	0.5429
112.	0.8451	406.	0.5423
113.	0.8395	407.	0.5436
114.	0.8391	408.	0.5426
115.	0.8369	409.	0.5412
116.	0.8349	410.	0.5414
117.	0.8333	411.	0.5398
118.	0.8285	412.	0.5405
119.	0.8273	413.	0.5409
120.	0.826	414.	0.5395
121.	0.8249	415.	0.5386
122.	0.8239	416.	0.5403
123.	0.8205	417.	0.5394
124.	0.8197	418.	0.5368
125.	0.8183	419.	0.5371
126.	0.8134	420.	0.5371
127.	0.8133	421.	0.5385
128.	0.8118	422.	0.5359
129.	0.8095	423.	0.536
130.	0.8075	424.	0.5356
131.	0.8049	425.	0.5369
132.	0.8027	426.	0.5324
133.	0.8009	427.	0.5334
134.	0.801	428.	0.5324
135.	0.797	429.	0.5328
136.	0.7972	430.	0.5323
137.	0.795	431.	0.5328
138.	0.7927	432.	0.5319
139.	0.7918	433.	0.5313
140.	0.7874	434.	0.5303
141.	0.7883	435.	0.5335
142.	0.7854	436.	0.5302
143.	0.783	437.	0.5301
144.	0.7827	438.	0.5283
145.	0.7812	439.	0.5304
146.	0.7795	440.	0.5294
147.	0.7756	441.	0.529
148.	0.7747	442.	0.5283
149.	0.7737	443.	0.5277
150.	0.7715	444.	0.5271
151.	0.7683	445.	0.5295
152.	0.7667	446.	0.5278
153.	0.7659	447.	0.5255
154.	0.7649	448.	0.5267
155.	0.7639	449.	0.5245
156.	0.7624	450.	0.5247
157.	0.7595	451.	0.5245
158.	0.7591	452.	0.524
159.	0.7602	453.	0.5251
160.	0.755	454.	0.5228
161.	0.7554	455.	0.5248

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
162.	0.7528	456.	0.5214
163.	0.7516	457.	0.5229
164.	0.751	458.	0.5216
165.	0.7503	459.	0.5217
166.	0.7491	460.	0.5228
167.	0.7456	461.	0.5204
168.	0.7448	462.	0.5206
169.	0.7439	463.	0.5198
170.	0.7426	464.	0.517
171.	0.7393	465.	0.5205
172.	0.7402	466.	0.5183
173.	0.737	467.	0.5203
174.	0.7376	468.	0.5172
175.	0.7355	469.	0.5183
176.	0.733	470.	0.5172
177.	0.7305	471.	0.5185
178.	0.7291	472.	0.5167
179.	0.7312	473.	0.5158
180.	0.7271	474.	0.5185
181.	0.7278	475.	0.516
182.	0.7249	476.	0.5168
183.	0.7244	477.	0.5148
184.	0.7224	478.	0.516
185.	0.7207	479.	0.5147
186.	0.7189	480.	0.5137
187.	0.7184	481.	0.5137
188.	0.72	482.	0.5135
189.	0.7152	483.	0.5126
190.	0.7142	484.	0.5123
191.	0.7128	485.	0.5128
192.	0.7117	486.	0.5119
193.	0.7123	487.	0.5117
194.	0.7105	488.	0.5113
195.	0.7099	489.	0.5115
196.	0.7059	490.	0.5096
197.	0.7069	491.	0.5101
198.	0.7062	492.	0.5107
199.	0.7056	493.	0.5095
200.	0.7037	494.	0.5095
201.	0.7012	495.	0.5077
202.	0.7009	496.	0.508
203.	0.7005	497.	0.5068
204.	0.6987	498.	0.5062
205.	0.6977	499.	0.5078
206.	0.6958	500.	0.507
207.	0.6955	501.	0.5054
208.	0.6968	502.	0.505
209.	0.6928	503.	0.5066
210.	0.692	504.	0.505
211.	0.6936	505.	0.5048
212.	0.6903	506.	0.5051
213.	0.6886	507.	0.5046
214.	0.6876	508.	0.5042
215.	0.6841	509.	0.5038
216.	0.6835	510.	0.5041
217.	0.6832	511.	0.5032
218.	0.6807	512.	0.5039
219.	0.681	513.	0.5045
220.	0.6804	514.	0.5006
221.	0.6779	515.	0.5038
222.	0.6765	516.	0.502
223.	0.6765	517.	0.5
224.	0.6756	518.	0.5016
225.	0.673	519.	0.5004
226.	0.6711	520.	0.4998
227.	0.6718	521.	0.5008

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
228.	0.6702	522.	0.5023
229.	0.67	523.	0.5006
230.	0.6687	524.	0.5015
231.	0.6678	525.	0.5008
232.	0.6676	526.	0.5004
233.	0.6658	527.	0.4988
234.	0.6643	528.	0.4987
235.	0.6631	529.	0.4966
236.	0.6615	530.	0.4981
237.	0.6624	531.	0.4955
238.	0.6596	532.	0.4962
239.	0.6606	533.	0.4938
240.	0.6559	534.	0.4953
241.	0.6565	535.	0.4958
242.	0.6563	536.	0.4962
243.	0.6542	537.	0.4956
244.	0.6524	538.	0.494
245.	0.6519	539.	0.4947
246.	0.6523	540.	0.4949
247.	0.6507	541.	0.494
248.	0.6506	542.	0.4948
249.	0.6487	543.	0.4946
250.	0.6471	544.	0.4951
251.	0.6482	545.	0.4936
252.	0.6467	546.	0.4938
253.	0.6439	547.	0.4935
254.	0.6439	548.	0.4935
255.	0.6436	549.	0.4913
256.	0.6406	550.	0.4904
257.	0.6417	551.	0.4893
258.	0.6401	552.	0.4919
259.	0.6379	553.	0.4919
260.	0.6371	554.	0.4903
261.	0.6378	555.	0.4893
262.	0.6363	556.	0.4904
263.	0.6343	557.	0.4893
264.	0.6324	558.	0.4903
265.	0.6336	559.	0.4894
266.	0.6336	560.	0.4879
267.	0.6326	561.	0.4887
268.	0.6312	562.	0.4908
269.	0.6312	563.	0.4885
270.	0.6286	564.	0.4875
271.	0.6274	565.	0.4866
272.	0.6274	566.	0.4865
273.	0.6263	567.	0.4878
274.	0.6261	568.	0.4871
275.	0.6256	569.	0.4843
276.	0.6244	570.	0.4883
277.	0.6241	571.	0.4862
278.	0.6208	572.	0.484
279.	0.621	573.	0.4842
280.	0.6218	574.	0.4863
281.	0.6187	575.	0.485
282.	0.6191	576.	0.4841
283.	0.6187	577.	0.4845
284.	0.6181	578.	0.4845
285.	0.6163	579.	0.467
286.	0.6154	580.	0.4656
287.	0.6155	581.	0.4631
288.	0.6129	582.	0.461
289.	0.6139	583.	0.4616
290.	0.6134	584.	0.4288
291.	0.6142	585.	0.4051
292.	0.6121	586.	0.2148
293.	0.6109		

SOLUTION

Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.155

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	5.558E-5	cm/sec
y0	0.8822	ft

T = K*b = 0.00847 cm²/sec

APPENDIX F11 - TABLES SUMMARIZING CONSTITUENT CONCENTRATIONS AT EACH MONITORING WELL (A-1 AREA LANDFILL)

TABLE 1
APPENDIX III GROUNDWATER ANALYTICAL DATA
MARTIN LAKE STEAM ELECTRIC STATION
A1 LANDFILL

Sample Location	Date Sampled	B (mg/L)	Ca (mg/L)	Cl (mg/L)	Fl (mg/L)	pH (s.u.)	SO_4 (mg/L)	TDS (mg/L)
Upgradient Wells								
BMW-11-AR	10/29/15	0.332	91.5	11.3	<0.100	6.97	243	923
	12/30/15	0.285	92.3	2.39	0.26 J	6.87	114	642
	02/25/16	0.44	136	18.8	0.123 J	6.52	382	1,450
	04/07/16	0.391	151	17.5	<0.100	6.34	334	1,290
	06/09/16	0.417	182	19.8	<0.100	6.63	603	1,700
	08/11/16	0.389	170	20.8	<0.100	6.68	682	1,790
	10/26/16	0.316	99.7	15.8	<0.100	6.85	495	1,590
	12/14/16	0.409	201	19.8	<0.100	6.65	665	1,970
	09/25/17	0.448	199	15.2	<0.100	6.97	561	1,620
	06/12/18	0.634	173	8.37	0.323 J	6.82	320	1,080
	09/14/18	0.455	175	19.7	0.353 J	5.86	538	1,720
	05/15/19	0.374	138	6.11	0.198 J	6.84	324	970
	09/04/19	0.368	149	6.41	0.170 J	6.82	356	1,090
	05/20/20	0.289	114	4.43	<0.100	6.89	266	907
Downgradient Wells								
BMW-18	10/30/15	0.41	7.2	26.6	0.148 J	6.65	97	768
	12/30/15	0.322	346	7.14	0.101 J	6.77	1,570	2,470
	02/26/16	0.406	9.49	17.1	0.164 J	6.91	90	508
	04/07/16	0.423	7.08	16.3	0.117 J	6.52	87	489
	06/09/16	0.429	7.32	18.7	0.128 J	6.64	101	498
	08/11/16	0.415	7.02	18.5	<0.100	6.81	100	493
	10/26/16	0.45	6.55	18.1	0.158 J	6.67	94.3	534
	12/14/16	0.411	9.26	17.6	0.134 J	6.77	94.1	493
	9/25/17	0.437	6.49	16.9	0.128 J	6.87	87.2	476
	6/12/18	0.636	14.4	18.2	0.176 J	6.82	87.2	464
	9/14/18	0.423	6.06	18.6	0.201 J	5.7	81.3	476
	5/15/19	0.443	7.91	20	0.229 J	6.65	89.9	473
	9/4/19	0.435	7.72	19.2	0.203 J	6.51	91.8	478
	05/20/20	0.476	9.13	17.8	0.144	6.87	82.3	477
BMW-19	10/29/18	0.385	417	16.2	<0.100	6.77	2,070	4,060
	12/30/15	0.4	441	11.4	0.127 J	6.49	2,100	3,260
	02/25/16	0.458	504	8.4	<0.100	6.14	2,330	2,960
	04/07/16	0.424	480	8.46	<0.100	6.71	2,270	3,740
	06/09/16	0.444	489	8.04	<0.100	6.32	2,390	4,180
	08/11/16	0.419	458	8.26	<0.100	6.95	2,370	3,780
	10/26/16	0.417	443	8.26	<0.100	6.97	2,210	4,410
	12/14/16	0.427	481	7.2	<0.100	6.75	2220	3,660
	09/25/17	0.481	496	6.11	<0.100	6.95	2,360	3,670
	06/12/18	0.667	539	6.08	<0.100	6.92	2,080	3,660
	09/13/18	0.460	514	6.86	0.404	6.26	2,330	4,010
	05/15/19	0.474	388	4.66	0.189 J	6.88	1,760	3,090
	09/04/19	0.430	434	5.93	<0.1	6.74	2,010	3,320
	05/20/20	0.487	445	5.54	<0.100	6.74	2,020	3,470

TABLE 1
APPENDIX III GROUNDWATER ANALYTICAL DATA
MARTIN LAKE STEAM ELECTRIC STATION
A1 LANDFILL

Sample Location	Date Sampled	B (mg/L)	Ca (mg/L)	Cl (mg/L)	Fl (mg/L)	pH (s.u.)	SO_4 (mg/L)	TDS (mg/L)
BMW-20	10/23/15	0.139 J	71.2	64.8	<0.100	6.28	223	804
	12/30/15	0.144	96	36.4	0.12 J	6.32	443	987
	02/25/16	0.202	157	30.7	<0.100	5.7	131	888
	04/07/16	0.0787	80	30	<0.100	6.22	219	600
	06/09/16	0.129	128	37.5	<0.100	6.24	557	1,220
	08/11/16	0.106	107	39.4	<0.100	6.86	602	1,310
	10/26/16	0.113	93.5	48.2	<0.100	6.93	801	1,610
	12/13/16	0.0687	62.8	42.8	<0.100	6.64	335	757
	09/26/17	0.0973	116	33.5	<0.100	6.73	472	986
	06/11/18	0.0912	149	35.9	0.144 J	6.67	654	1,160
	09/13/18	0.0773	91.1	48.8	<0.100	5.26	831	1,360
	05/15/19	0.979	146	426	<0.418	6.71	474	2,030
	09/04/19	0.101	136	50.7	<0.100	6.74	1160	1,830
	05/20/20	0.179	162	35.8	<0.100	6.81	797	1,450
BMW-21	10/23/15	0.973	157	496	<0.100	7.28	484	2,510
	12/30/15	0.951	142	365	0.126 J	7.08	444	2,020
	02/25/16	1.01	148	393	<0.100	6.64	462	1,990
	04/07/16	0.99	158	373	<0.100	7.02	454	2,190
	06/09/16	1.17	155	415	<0.100	7.09	477	2,230
	08/11/16	1.04	143	425	<0.100	6.66	484	1,860
	10/26/16	1.14	145	399	<0.100	6.85	434	2,170
	12/13/16	0.993	149	426	<0.100	6.93	483	2,170
	09/26/17	1.02	138	364	<0.100	6.76	417	1,850
	06/11/18	1.01	168	402	0.233 J	6.75	457	1,990
	09/13/18	0.987	151	418	0.136 J	6.64	474	2,100
	05/15/19	0.994	147	428	0.366 J	6.92	474	1,980
	09/04/19	0.0409	152	426	<0.1	6.73	477	2,090
	05/20/20	1.07	166	416	<0.100	6.87	457	1910
BMW-22	10/23/15	2.76	209	377	<0.100	6.86	927	2,720
	12/30/15	2.54	150	215	0.186 J	6.92	670	1,870
	02/25/16	3.18	209	295	<0.100	6.27	949	2,430
	04/07/16	3.34	202	256	<0.100	6.84	839	2,230
	06/08/16	3.53	193	279	<0.100	6.84	890	2,340
	08/11/16	3.18	198	311	<0.100	6.25	946	2,520
	10/26/16	3.38	183	241	<0.100	6.89	803	2,600
	12/13/16	3.45	191	281	<0.100	6.73	896	2,370
	09/26/17	3.53	209	270	<0.100	6.82	860	2,250
	06/11/18	3.49	219	280	0.312 J	6.85	883	2,180
	09/13/18	3.28	188	296	0.205 J	6.34	919	2,310
	05/15/19	3.39	198	311	0.351 J	6.68	967	2,260
	09/09/19	3.65	208	307	<0.100	6.58	960	2,420
	05/20/20	3.67	205	290	<0.100	6.69	906	2,230

TABLE 1
APPENDIX III GROUNDWATER ANALYTICAL DATA
MARTIN LAKE STEAM ELECTRIC STATION
A1 LANDFILL

Sample Location	Date Sampled	B (mg/L)	Ca (mg/L)	Cl (mg/L)	Fl (mg/L)	pH (s.u.)	SO_4 (mg/L)	TDS (mg/L)
BMW-23	10/23/15	1.19	102	287	<0.100	6.84	577	1,980
	12/30/15	1.25	95.2	214	0.122 J	6.76	529	1,500
	02/25/16	1.31	97.7	225	<0.100	6.16	527	1,520
	04/07/16	1.22	95.1	221	<0.100	6.63	503	1,510
	06/08/16	1.31	102	254	<0.100	6.71	558	1,720
	08/11/16	1.28	90.4	242	<0.100	6.15	539	1,430
	10/26/16	1.22	86.8	219	<0.100	6.85	467	1,700
	12/13/16	1.25	91.8	237	<0.100	6.63	510	1,870
	09/26/17	1.46	99.6	223	<0.100	6.65	482	1,550
	06/12/18	1.49	104	236	0.204 J	6.72	490	1,530
	09/13/18	1.34	91.7	236	0.190 J	6.25	482	1,560
	05/15/19	1.31	89.9	240	<0.100	6.84	613	1,640
	09/09/19	1.47	98.9	257	<0.100	6.65	503	1,680
	05/20/20	1.63	105	256	<0.100	6.63	494	1580
BMW-24	10/23/15	0.144 J	61.6	633	0.247 J	7.14	45	1,510
	12/30/15	0.347	58.8	404	0.391 J	7.07	125	1,210
	02/25/16	0.431	61.6	332	0.236 J	5.8	184	1,210
	04/07/16	0.532	63.4	224	0.109 J	7.07	240	1,100
	06/08/16	0.612	60.1	201	0.147 J	7.06	259	984
	08/11/16	0.248	58.5	481	0.225 J	5.84	97.8	1,150
	10/26/16	0.225	59.2	518	0.305 J	6.78	34.2	1,490
	12/13/16	0.225	62.5	518	0.3 J	6.78	33	1,480
	09/26/17	0.656	66.8	229	<0.100	6.82	242	940
	06/11/18	0.469	70.6	336	0.466	6.76	117	970
	09/13/18	0.197	59.5	488	0.769	6.45	40	1,090
	05/15/19	0.601	57.9	169	0.219 J	6.78	280	881
	09/09/19	0.247	56.4	501	0.534 J	6.65	16.4	985
	05/20/20	0.758	67.8	175	0.129 J	6.72	254	907
BMW-26	9/13/16	0.457	234	97.8	<0.100	6.51	671	2,120
	10/26/16	0.127	44.3	16.2	<0.100	6.87	140	414
	12/14/16	0.251	130	152	0.344 J	6.96	1210	2,050
	01/23/17	0.478	224	126	<0.100	6.33	669	1,950
	02/23/17	0.0683	52	23.9	0.106 J	6.22	20.4	209
	03/24/17	0.44	215	112	<0.100	6.68	610	1,690
	04/24/17	0.495	218	111	<0.100	6.37	576	2,210
	05/25/17	0.613	178	115	<0.100	6.82	613	2,110
	06/29/17	0.507	233	111	<0.100	--[3]	604	1700
	09/25/17	0.514	71	112	<0.100	6.95	606	1,510
	06/12/18	0.726	96.5	120	<0.100	6.61	633	1,550
	09/13/18	0.474	230	125	<0.100	5.32	671	2,020
	05/15/19	0.449	200	135	<0.100	6.9	706	1,930
	09/04/19	0.473	262	140	<0.100	6.78	753	2,170
	05/20/20	0.547	252	131	<0.100	6.77	701	1,980

TABLE 1
APPENDIX III GROUNDWATER ANALYTICAL DATA
MARTIN LAKE STEAM ELECTRIC STATION
A1 LANDFILL

Sample Location	Date Sampled	B (mg/L)	Ca (mg/L)	Cl (mg/L)	Fl (mg/L)	pH (s.u.)	SO_4 (mg/L)	TDS (mg/L)
BMW-27	9/13/16	0.486	160	133	0.668	5.87	1,150	2,750
	10/26/16	0.548	196	102	<0.100	6.73	700	2,020
	12/14/16	0.529	211	101	<0.100	6.9	674	1,810
	01/23/17	0.393	152	143	0.573	5.62	1,280	2,260
	02/23/17	0.0832	52.4	24	0.252 J	6.4	20.6	239
	03/24/17	0.304	120	132	0.738	6.35	1,190	2,100
	04/24/17	0.34	132	130	0.663	6.22	1,150	2,290
	05/25/17	0.331	122	124	1.61	6.67	1,150	2,320
	06/29/17	0.39	144	129	0.717	--[3]	1,180	2,080
	09/25/17	0.336	128	126	0.254 J	6.89	1,160	2,110
	06/12/18	0.478	96.1	98.4	<0.100	6.87	522	1,420
	09/13/18	0.398	143	132	0.750	5.6	1,230	2,380
	05/15/19	0.46	190	129	<0.100	6.72	674	1,840
	09/04/19	0.463	257	141	<0.100	6.95	755	2,130
	05/20/20	0.46	213	108	<0.100	6.56	579	1,670
BMW-28	12/14/16	1.22	234	111	<0.100	6.87	1280	2,360
	01/23/17	1.18	221	122	0.104 J	6.85	1,370	2,810
	02/23/17	0.0776	53.3	24	0.11 J	6.43	20.3	203
	03/24/17	1.14	242	121	<0.100	6.36	1,350	2,580
	04/24/17	1.16	266	121	0.19 J	6.57	1,330	2,980
	05/25/17	1.23	255	130	<0.100	6.70	1,410	3,180
	06/29/17	1.21	269	130	0.137 J	6.98	1,450	2,950
	08/01/17	1.17	260	132	<0.100	--[3]	1,460	2,780
	09/25/17	1.35 J	262	130	<0.100	6.85	1,430	3,060
	06/12/18	1.41	262	139	0.529	6.92	1,470	3,100
	09/13/18	1.35	243	143	0.445	5.71	1,420	3,180
	05/15/19	1.01	249	133	0.496	6.77	1,820	3,610
	09/04/19	1.22	277	137	<0.1	6.77	1,720	3,470
	05/20/20	1.29	284	137	<0.100	6.86	1520	3270

TABLE 2
APPENDIX IV GROUNDWATER ANALYTICAL DATA
MARTIN LAKE STEAM ELECTRIC STATION
A1 LANDFILL

Sample Location	Date Sampled	Sb (mg/L)	As (mg/L)	Ba (mg/L)	Be (mg/L)	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	Fl (mg/L)	Pb (mg/L)	Li (mg/L)	Hg (mg/L)	Mo (mg/L)	Se (mg/L)	Tl (mg/L)	Ra 226 (pCi/L)	Ra 228 (pCi/L)	Ra 226/228 Comb.^ (pCi/L)
	Prediction Limit:	0.006	0.0164	2	0.004	0.005	0.1	0.0124	4	0.015	0.103	0.002	0.1	0.05	0.002	--	--	10.7
Upgradient Wells																		
BMW-11-AR	10/29/15	<0.0008	0.0116	0.0659	<0.0003	<0.0003	<0.002	0.0124	<0.1	0.000391 J	0.0594	<0.00008	0.00496 J	<0.002	<0.0005	1.60	4.75	6.35
	12/30/15	<0.0008	0.00362 J	0.0433	<0.0003	<0.0003	<0.002	<0.003	0.26 J	0.000362 J	0.0589	<0.00008	0.00384 J	<0.002	<0.0005	1.66	3.19	4.85
	02/25/16	<0.0008	0.00608	0.0724	<0.0003	<0.0003	<0.002	0.0049 J	0.123 J	<0.0003	0.0276	<0.00008	0.00597	<0.002	<0.0005	2.43	3.80	6.23
	04/07/16	<0.0008	0.00614	0.0929	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0195	<0.00008	0.00444 J	<0.002	<0.0005	0.885	1.48	2.37
	06/09/16	<0.0008	0.00532	0.0891	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0187	<0.00008	0.00355 J	<0.002	<0.0005	0.47	<0.674	1.14
	08/11/16	<0.0008	0.00271 J	0.0772	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0147	<0.00008	0.00346 J	<0.002	<0.0005	0.810	2.42	3.23
	10/26/16	<0.0008	<0.002	0.0429	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0508	<0.00008	0.00363 J	<0.002	<0.0005	0.631	0.922	1.55
	12/14/16	<0.0008	0.0061	0.074	<0.0003	<0.0003	<0.002	<0.003	<0.1	0.00347	0.0139	<0.00008	0.00303 J	<0.002	<0.0005	<0.821	<1.73	<2.551
	06/12/18	<0.0008	0.00444 J	0.0692	<0.0003	<0.0003	0.00295 J	<0.003	0.323 J	0.0017	0.0686	<0.00008	0.00340 J	<0.002	<0.0005	0.996	1.7	2.696
	09/14/18	--	0.0056	0.0735	--	--	<0.002	<0.003	0.353 J	0.00147	0.0196	--	0.00299 J	--	--	1.52	1.11	2.63
	05/15/19	<0.0008	0.00208 J	0.0399	<0.0003	<0.0003	<0.002	<0.003	0.198 J	<0.0003	0.0404	<0.00008	<0.002	<0.002	<0.0005	0.83	4.89	5.72
	09/04/19	--	<0.2	0.0393	--	--	--	<0.003	0.170 J	--	0.0411	--	<0.002	--	--	0.382	0.317	0.699
	05/20/20	<0.0008	0.00479 J	0.0439	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0348	<0.00008	<0.00200	<0.002	<0.0005	0.289	1.54	1.83
BMW-33	08/01/19	--	<0.00200	--	--	--	--	0.0176	0.342	--	0.0206	--	--	--	--	--	--	--
	09/09/19	--	<0.00200	0.285	--	--	--	0.0122	0.145 J	--	0.0177	--	0.00325 J	--	--	0.738	-0.0903	0.738
	05/20/20	0.00102 J	<0.002	0.203	<0.0003	<0.0003	<0.002	0.0065	<0.100	<0.0003	0.0145	<0.00008	0.00207 J	<0.002	<0.0005	0.499	0.394	0.893
Downgradient Wells																		
BMW-18	10/30/15	<0.0008	<0.002	0.0401	<0.0003	<0.0003	0.00944	<0.003	0.148 J	<0.0003	0.14	<0.00008	<0.002	<0.002	<0.0005	0.526	<1.51	2.04
	12/30/15	<0.0008	<0.002	0.0168	<0.0003	<0.0003	<0.002	0.0129	0.101 J	<0.0003	0.0415	<0.00008	<0.002	<0.002	<0.0005	<0.405	<2.04	<2.445
	02/26/16	<0.0008	<0.002	0.0446	<0.0003	<0.0003	0.0021 J	<0.003	0.164 J	<0.0003	0.0156	<0.00008	<0.002	<0.002	<0.0005	<0.406	<1.9	<2.306
	04/07/16	<0.0008	<0.002	0.0306	<0.0003	<0.0003	<0.002	<0.003	0.117 J	<0.0003	0.0171	<0.00008	<0.002	<0.002	<0.0005	<0.109	<1.00	<1.109
	06/09/16	<0.0008	<0.002	0.0283	<0.0003	<0.0003	<0.002	<0.003	0.128 J	<0.0003	0.0152	<0.00008	<0.002	<0.002	<0.0005	<0.143	0.857	1.00
	08/11/16	<0.0008	<0.002	0.0291	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0147	<0.00008	<0.002	<0.002	<0.0005	<0.22	<1.07	<1.29
	10/26/16	<0.0008	<0.002	0.029	<0.0003	<0.0003	<0.002	<0.003	0.158 J	<0.0003	0.0156	<0.00008	<0.002	<0.002	<0.0005	<0.132	<0.534	<0.666
	12/14/16	<0.0008	<0.002	0.0384	<0.0003	<0.0003	<0.002	<0.003	0.134 J	<0.0003	0.0158	<0.00008	<0.002	<0.002	<0.0005	0.140	<1.99	2.13
	06/12/18	<0.0008	<0.002	0.0412	<0.0003	<0.0003	<0.002	<0.003	0.176 J	0.0013	0.0185	<0.00008	<0.002	<0.002	<0.0005	0.232	0.706	0.938
	09/14/18	--	<0.002	0.0277	--	--	<0.002	<0.003	0.201 J	<0.0003	0.0165	--	<0.002	--	--	<0.509	<0.589	<1.098
	05/15/19	<0.0008	<0.002	0.0362	<0.0003	<0.0003	<0.002	<0.003	0.229 J	<0.0003	0.016	<0.00008	<0.002	<0.002	<0.0005	<0.264	3.95	4.214
	9/4/2019	--	<0.002	0.0337	--	--	--	<0.003	0.203 J	--	0.0128	--	<0.002	--	--	0.304	1.48	1.79
	5/20/2020	<0.0008	<0.002	0.0431	<0.0003	<0.0003	<0.002	<0.003	0.144 J	<0.0003	0.0136	<0.00008	<0.002	<0.002	<0.0005	0.555	1.21	1.76
BMW-19	10/29/18	<0.0008	<0.002	0.0231	<0.0003	<0.0003	<0.002	0.0161	<0.1	<0.0003	0.0545	<0.00008	<0.002	<0.002	<0.0005	0.395	<1.56	1.96
	12/30/15	<0.0008	<0.002	0.0222	<0.0003	<0.0003	<0.002	0.0166	0.127 J	<0.0003	0.0506	<0.00008	<0.002	<0.002	<0.0005	0.598	<2.89	3.49
	02/25/16	<0.0008	0.00235 J	0.0169	<0.0003	<0.0003	<0.002	0.0149	<0.1	<0.0003	0.0711	<0.00008	<0.002	<0.002	<0.0005	0.571	1.94	2.51
	04/07/16	<0.0008	<0.002	0.0178	<0.0003	<0.0003	<0.002	0.0137	<0.1	<0.0003	0.0591	<0.00008	<0.002	<0.002	<0.0005	<0.185	<0.715	<0.9
	06/09/16	<0.0008	<0.002	0.0158	<0.0003	<0.0003	<0.002	0.0141	<0.1	<0.0003	0.0644	<0.00008	<0.002	<0.002	<0.0005	<0.142	1.98	2.12
	08/11/16	<0.0008	0.00711	0.0158	<0.0003	<0.0003	<0.002	0.0128	<0.1	<0.0003	0.0568	<0.00008	<0.002	<0.002	<0.0005	0.927	<0.812	1.74
	10/26/16	<0.0008	<0.002	0.0144	<0.0003	<0.0003	<0.002	0.0104	<0.1	<0.0003	0.0495	<0.00008	<0.002	<0.002	<0.0005	<0.152	<0.48	<0.632
	12/14/16	<0.0008	0.00369 J	0.0171	<0.0003	<0.0003	<0.002	0.0125	<0.1	<0.0003	0.0584	<0.00008	<0.002	<0.002	<0.0005	0.309	0.827	1.14
	06/12/18	<0.0008	0.0428	0.0243	<0.0003	<0.0003	0.00267	0.0115	<0.100	0.00183	0.0734	<0.00008	<0.002	<0.002	<0.0005	<0.395	1.17	1.565
	09/13/18	--	0.00491 J	0.0132	--	--	<0.002	0.0125	0.404 J	<0.0003	0.0845	--	<0.002	--	--	<0.376	1.46	1.836
	05/15/19	<0.0008	<0.002	0.0104	<0.0003	<0.0003	<0.002	<0.003	0.189 J	<0.0003	0.0647	<0.00008	<0.002	<0.002	<0.0005	0.487	4.66	5.147
	09/04/19	--	<0.002	0.0117	--	--	--	<0.003	<0.1	--	0.0694	--	<0.002	--	--	-0.00769	0.563	0.563
	05/20/20	<0.0008	<0.00200	0.0109	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0783	<0.00008	0.00231 J	<0.002	<0.0005	0.0651	0.127	0.192
BMW-20	10/23/15	<0.0008	0.00236 J	0.0778	<0.0003	<0.0003	<0.002	0.0256	<0.1	0.0005 J	<0.005	<0.00008	<0.002	<0.002	<0.0005	0.463	<1.89	2.35
	12/30/15	<0.0008	0.00344 J	0.0777	<0.0003	<0.0003	<0.002	0.051	0.12 J	<0.0003	<0.005	<0.00008	<0.002	<0.002	<0.0005	0.816	<2.41	3.23
	02/25/16	<0.0008	0.00474 J	0.0989	<0.0003	<0.0003	<0.002	0.022	<0.1	<0.0003	<0.005	<0.00008	<0.002	<0.002	<0.0005	<0.61	2.85	3.46
	04/07/16	<0.0008	0.00411 J	0.0912	<0.0003	<0.0003	<0.002	0.0276	<0.1	<0.0003	<0.005	<0.00008	<0.002	<0.002	<0.0005	0.221	<1.08	1.30
	06/09/16	<0.0008	0.0103	0.0776	<0.0003	<0.0003	<0.002	0.054	<0.1	0.0007 J	<0.005	<0.00008	<0.002	<0.002	<0.0005	0.51	<0.716	1.23
	08/11/16	<0.0008	<0.002	0.0637	<0.0003	<0.0003	<0.002	0.0513	<0.1	<0.0003	<0.005	<0.00008	<0.002	<0.002	<0.0005	0.322	1.40	1.72
	10/26/16	<0.0008	0.00444 J	0.0421	<0.0003	<0.0003	<0.002	0.0786	<0.1	<0.0003	<0.005	<0.00008	<0.002	<0.002	<0.0005	0.347	0.848	1.20
	12/13/16	<0.0008	0.00483 J	0.0377	<0.0003	<0.0003	<0.002	0.0451	<0.1	<0.0003	<0.005	<0.00008	<0.002	<0.002	<0.0005	0.246	1.15	1.40
	06/11/18	<0.0008	0.00473 J	0.0515	<0.0003	<0.0003	<0.002	0.0681	0.144 J	0.000476	<0.005	<0.00008	<0.002	<0.002	<0.0005	0.74	0.865	1.605
	09/13/18	--	0.00473 J	0.0258	--	--	<0.002	0.0645	<0.100	0.000368 J	<0.005	--	<0.002	--	--	0.519	0.711	1.23
	05/15/18	<0.0008	0.00541	0.0412	<0.0003	<0.0003	<0.002	0.003	0.418	<0.0003	0.0615	<0.00008	<0.002	<0.002	<0.0005	1.18	0.657	1.837
	09/04/19	--	0.00768	0.0261	--	--	--	0.108	<0.1	--	<0.005	--	<0.002	--	--	0.0996	1.62	1.72
	05/20/20	<0.0008	0.0126	0.0494	<0.0003	<0.0003	<0.002	0.0912	<0.1	0.000956 J	<0.005	<0.00008	<0.002	0.0044 J	<0.0005	0.5	2.15	2.65

TABLE 2
APPENDIX IV GROUNDWATER ANALYTICAL DATA
MARTIN LAKE STEAM ELECTRIC STATION
A1 LANDFILL

Sample Location	Date Sampled	Sb (mg/L)	As (mg/L)	Ba (mg/L)	Be (mg/L)	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	Fl (mg/L)	Pb (mg/L)	Li (mg/L)	Hg (mg/L)	Mo (mg/L)	Se (mg/L)	Tl (mg/L)	Ra 226 (pCi/L)	Ra 228 (pCi/L)	Ra 226/228 Comb.^ (pCi/L)
	Prediction Limit:	0.006	0.0164	2	0.004	0.005	0.1	0.0124	4	0.015	0.103	0.002	0.1	0.05	0.002	--	--	10.7
BMW-21	10/23/15	<0.0008	0.00324 J	0.0703	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0623	<0.00008	<0.002	<0.002	<0.0005	<0.436	<0.948	<1.384
	12/30/15	<0.0008	0.00247 J	0.0478	<0.0003	<0.0003	<0.002	<0.003	0.126 J	<0.0003	0.0602	<0.00008	<0.002	<0.002	<0.0005	0.584	<2.00	2.58
	02/25/16	<0.0008	0.00327 J	0.0471	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0602	<0.00008	<0.002	<0.002	<0.0005	0.735	2.13	2.87
	04/07/16	<0.0008	0.00337 J	0.0472	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0653	<0.00008	<0.002	<0.002	<0.0005	0.470	<2.78	3.25
	06/09/16	<0.0008	0.0034 J	0.0457	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0675	<0.00008	<0.002	<0.002	<0.0005	0.32	<0.917	1.24
	08/11/16	<0.0008	0.00373 J	0.0445	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0527	<0.00008	<0.002	<0.002	<0.0005	0.655	<0.728	1.38
	10/26/16	<0.0008	0.0037 J	0.0443	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0611	<0.00008	<0.002	<0.002	<0.0005	0.383	1.61	1.99
	12/13/16	<0.0008	0.00217 J	0.0438	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0631	<0.00008	<0.002	<0.002	<0.0005	0.213	1.00	1.21
	06/11/18	<0.0008	0.00373 J	0.0438	<0.0003	<0.0003	<0.002	<0.003	0.233 J	<0.0003	0.07	<0.00008	<0.002	<0.002	<0.0005	<0.239	<0.939	<1.178
	09/13/18	--	0.00353 J	0.0412	--	--	<0.002	<0.003	0.136 J	<0.0003	0.0646	--	<0.002	--	--	0.562	1.49	2.052
	05/15/19	<0.0008	0.00399 J	0.0412	<0.0003	<0.0003	<0.002	<0.003	0.366 J	<0.0003	0.0613	<0.00008	<0.002	<0.002	<0.0005	<0.322	1.07	1.392
	9/4/2019	--	0.00378	0.0409	--	--	--	<0.003	<0.1	--	0.0683	--	<0.002	--	--	0.506	1.51	2.06
	5/20/2020	<0.0008	0.00434 J	0.0421	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0632	<0.00008	<0.002	<0.002	<0.0005	0.562	1.76	2.32
BMW-22	10/23/15	<0.0008	<0.002	0.106	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0675	<0.00008	<0.002	<0.002	<0.0005	1.59	2.11	3.70
	12/30/15	<0.0008	<0.002	0.084	<0.0003	<0.0003	<0.002	<0.003	0.186 J	<0.0003	0.0594	<0.00008	<0.002	<0.002	<0.0005	0.973	<1.55	2.52
	02/25/16	<0.0008	<0.002	0.0761	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0801	<0.00008	<0.002	<0.002	<0.0005	0.594	<1.93	2.52
	04/07/16	<0.0008	<0.002	0.072	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0773	<0.00008	<0.002	<0.002	<0.0005	0.480	1.46	1.94
	06/08/16	<0.0008	0.00206 J	0.0667	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0847	<0.00008	<0.002	<0.002	<0.0005	0.888	1.88	2.77
	08/11/16	<0.0008	<0.002	0.0679	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0675	<0.00008	<0.002	<0.002	<0.0005	0.607	1.93	2.54
	10/26/16	<0.0008	0.00216 J	0.0645	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0753	<0.00008	<0.002	<0.002	<0.0005	0.633	1.02	1.65
	12/13/16	<0.0008	0.00232 J	0.0655	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0689	<0.00008	<0.002	<0.002	<0.0005	<0.209	1.05	1.26
	06/11/18	<0.0008	<0.002	0.0638	<0.0003	<0.0003	<0.002	<0.003	0.312 J	<0.0003	0.089	<0.00008	<0.002	<0.002	<0.0005	0.522	<1.020	1.54
	09/13/18	--	<0.002	0.063	--	--	<0.002	<0.003	0.205 J	<0.0003	0.0882	--	<0.002	--	--	1.29	2.89	4.18
	05/15/19	<0.0008	<0.002	0.0618	<0.0003	<0.0003	<0.002	<0.003	0.351 J	<0.0003	0.0779	<0.00008	<0.002	<0.002	<0.0005	3.36	1.64	5.00
	09/09/19	--	<0.002	0.0599	--	--	--	<0.003	<0.100	--	0.0829	--	<0.002	--	--	0.954	1.85	2.81
	05/20/20	<0.0008	<0.002	0.0621	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0855	<0.00008	<0.002	<0.002	<0.0005	0.909	2.67	3.58
BMW-23	10/23/15	<0.0008	<0.002	0.0519	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0802	<0.00008	<0.002	<0.002	<0.0005	1.19	<1.91	3.10
	12/30/15	<0.0008	<0.002	0.0462	<0.0003	<0.0003	<0.002	<0.003	0.122 J	<0.0003	0.0897	<0.00008	<0.002	<0.002	<0.0005	0.711	<2.62	3.33
	02/25/16	<0.0008	<0.002	0.0488	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0959	<0.00008	<0.002	<0.002	<0.0005	0.604	<1.78	2.38
	04/07/16	<0.0008	<0.002	0.0472	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.095	<0.00008	<0.002	<0.002	<0.0005	0.723	1.98	2.70
	06/08/16	<0.0008	<0.002	0.0497	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.103	<0.00008	<0.002	<0.002	<0.0005	0.654	1.29	1.94
	08/11/16	<0.0008	<0.002	0.0458	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.077	<0.00008	<0.002	<0.002	<0.0005	0.936	1.94	2.88
	10/26/16	<0.0008	<0.002	0.0437	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0856	<0.00008	<0.002	<0.002	<0.0005	0.472	1.76	2.23
	12/13/16	<0.0008	<0.002	0.0407	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0817	<0.00008	<0.002	<0.002	<0.0005	<0.225	0.704	0.93
	06/11/18	<0.0008	<0.002	0.0381	<0.0003	<0.0003	<0.002	<0.003	0.204 J	<0.0003	0.106	<0.00008	<0.002	<0.002	<0.0005	0.442	1.79	2.23
	09/13/18	--	<0.002	0.0414	--	--	<0.002	<0.003	0.190 J	<0.0003	0.0915	--	<0.002	--	--	0.774	1.23	2.00
	05/15/19	<0.0008	0.0024	0.0381	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0951	<0.00008	<0.002	<0.002	<0.0005	2.54	1	3.54
	09/09/19	--	<0.002	0.0382	--	--	--	<0.003	<0.100	--	0.0896	--	<0.002	--	--	0.583	2.4	2.98
	05/20/20	<0.0008	<0.002	0.039	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0927	<0.00008	<0.002	<0.002	<0.0005	0.669	2.27	2.93
BMW-24	10/23/15	<0.0008	0.00494 J	1.87	<0.0003	<0.0003	<0.002	0.00802	0.247 J	<0.0003	<0.005	<0.00008	<0.002	<0.002	<0.0005	1.83	3.32	5.15
	12/30/15	<0.0008	0.00579	0.801	<0.0003	<0.0003	<0.002	0.0146	0.391 J	<0.0003	0.0161	<0.00008	<0.002	<0.002	<0.0005	0.485	<1.66	2.15
	02/25/16	<0.0008	0.00442 J	0.645	<0.0003	<0.0003	<0.002	0.0137	0.236 J	<0.0003	0.0267	<0.00008	<0.002	<0.002	<0.0005	1.20	<1.93	3.13
	04/07/16	<0.0008	0.00376 J	0.202	<0.0003	<0.0003	<0.002	0.0238	0.109 J	<0.0003	0.0415	<0.00008	<0.002	<0.002	<0.0005	<0.349	<1.58	<1.929
	06/08/16	<0.0008	0.00481 J	0.181	<0.0003	<0.0003	<0.002	0.0227	0.147 J	<0.0003	0.0475	<0.00008	<0.002	<0.002	<0.0005	0.360	1.26	1.62
	08/11/16	<0.0008	0.00414 J	1.26	<0.0003	<0.0003	<0.002	0.00707	0.225 J	<0.0003	0.00938 J	<0.00008	<0.002	<0.002	<0.0005	0.564	<0.942	1.51
	10/26/16	<0.0008	0.00364 J	1.88	<0.0003	<0.0003	<0.002	<0.003	0.305 J	<0.0003	0.00767 J	<0.00008	<0.002	<0.002	<0.0005	1.37	1.31	2.68
	12/13/16	<0.0008	0.00498 J	1.96	<0.0003	<0.0003	<0.002	0.0033 J	0.3 J	<0.0003	0.00914 J	<0.00008	<0.002	<0.002	<0.0005	0.270	1.16	1.43
	06/11/18	<0.0008	0.00266 J	0.487	<0.0003	<0.0003	<0.002	0.00633	0.466	<0.0003	0.0198	<0.00008	<0.002	<0.002	<0.0005	0.668	0.975	1.643
	09/13/18	--	<0.002	2.19	--	--	<0.002	0.00304 J	0.769	<0.0003	0.00764 J	--	<0.002	--	--	1.82	1.45	3.27
	05/15/19	<0.0008	0.00272 J	0.221	<0.0003	<0.0003	<0.002	0.000643	0.219 J	<0.0003	0.0512	<0.00008	<0.002	<0.002	<0.0005	1.45	<1.21	2.66
	09/09/19	--	<0.002	1.48	--	--	--	<0.003	0.534	--	0.00826 J	--	<0.002	--	--	0.584	1.41	2
	05/20/20	<0.0008	0.00207 J	0.244	<0.0003	<0.0003	<0.002	0.0109	0.129 J	<0.0003	0.046	<0.00008	<0.002	<0.002	<0.0005	0.532	<2.45	2.99

TABLE 2
APPENDIX IV GROUNDWATER ANALYTICAL DATA
MARTIN LAKE STEAM ELECTRIC STATION
A1 LANDFILL

Sample Location	Date Sampled	Sb (mg/L)	As (mg/L)	Ba (mg/L)	Be (mg/L)	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	Fl (mg/L)	Pb (mg/L)	Li (mg/L)	Hg (mg/L)	Mo (mg/L)	Se (mg/L)	Tl (mg/L)	Ra 226 (pCi/L)	Ra 228 (pCi/L)	Ra 226/228 Comb.^ (pCi/L)
	Prediction Limit:	0.006	0.0164	2	0.004	0.005	0.1	0.0124	4	0.015	0.103	0.002	0.1	0.05	0.002	--	--	10.7
BMW-25	06/13/19	--	--	--	--	--	--	0.013	0.142	--	0.0501	--	--	--	--	--	--	--
	07/08/19	--	--	--	--	--	--	0.00514	--	--	--	--	--	--	--	--	--	--
	09/09/19	--	--	--	--	--	--	0.00717	--	--	--	--	--	--	--	--	--	--
BMW-26	9/13/16	<0.0008	0.017	0.0425	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0944	<0.00008	0.00215 J	<0.002	<0.0005	0.154	<1.02	1.17
	10/26/16	<0.0008	0.00318 J	0.0731	<0.0003	<0.0003	<0.002	0.004 J	<0.1	<0.0003	<0.005	<0.00008	<0.002	<0.002	<0.0005	0.175	<0.695	0.87
	12/14/16	<0.0008	<0.002	0.0424	<0.0003	0.00082 J	<0.002	0.236	0.344 J	<0.0003	0.0527	<0.00008	<0.002	<0.002	<0.0005	0.177	<1.29	1.47
	01/23/17	<0.0008	0.0325	0.0446	<0.0003	<0.0003	<0.002	<0.003	<0.1	0.00059 J	0.0977	<0.00008	0.0035 J	<0.002	<0.0005	0.351	0.936	1.29
	02/23/17	<0.0008	<0.002	0.0705	<0.0003	<0.0003	<0.002	<0.003	0.106 J	0.00073 J	0.0052 J	<0.00008	<0.002	<0.002	<0.0005	0.306	0.951	1.26
	03/24/17	<0.0008	0.0107	0.0371	<0.0003	<0.0003	<0.002	<0.003	<0.1	0.00074 J	0.0964	<0.00008	0.00461 J	<0.002	<0.0005	0.335	<0.627	0.96
	05/25/17	<0.0008	0.00347 J	0.0243	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0951	<0.0008	0.00302 J	<0.002	<0.0005	<0.477	0.818	1.30
	06/29/17	<0.0008	0.0328	0.0352	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0985	<0.0008	0.00257 J	<0.002	<0.0005	0.198	0.677	0.88
	5/2017																	0.00
	06/12/18	<0.0008	0.00316 J	0.0222	<0.0003	<0.0003	0.00231 J	<0.003	<0.100	0.00152	0.111	<0.00008	0.0029 J	<0.002	<0.0005	<0.251	<0.508	<0.759
	09/13/18	--	0.0165	0.0360	--	--	<0.002	<0.003	<0.100	<0.0003	0.11	--	<0.002	--	--	<0.426	0.826	1.252
	05/15/19	<0.0008	<0.002	0.0253	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.101	<0.00008	0.00218 J	<0.002	<0.0005	0.457	<1.13	1.587
	9/4/2019	--	0.00725	0.0317	--	--	--	<0.003	<0.1	--	0.109	--	<0.002	--	--	0.126	1.53	1.66
	5/20/2020	<0.0008	<0.002	0.0293	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0999	<0.00008	<0.002	<0.002	<0.0005	0.158	0.696	0.853
BMW-27	9/13/16	<0.0008	0.00536	0.0434	<0.0003	0.00062 J	<0.002	0.15	0.668	0.00043 J	0.0541	<0.00008	<0.002	<0.002	<0.0005	0.308	<1.14	1.45
	10/26/16	<0.0008	0.00625	0.0339	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0933	<0.00008	<0.002	<0.002	<0.0005	0.156	1.94	2.10
	12/14/16	<0.0008	0.0051	0.0342	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0932	<0.00008	<0.002	<0.002	<0.0005	<0.12	<1.05	<1.17
	01/23/17	<0.0008	0.00845	0.0333	<0.0003	0.00071 J	0.0028 J	0.195	0.573	0.00032 J	0.0484	<0.00008	<0.002	<0.002	<0.0005	0.369	0.934	1.30
	02/23/17	<0.0008	<0.002	0.0704	<0.0003	<0.0003	<0.002	<0.003	0.252 J	0.00074 J	<0.005	<0.00008	<0.002	<0.002	<0.0005	<0.209	0.660	0.87
	03/24/17	<0.0008	0.00319 J	0.0296	<0.0003	0.00078 J	<0.002	0.222	0.738	<0.0003	0.0474	<0.00008	<0.002	<0.002	<0.0005	0.414	<0.725	1.14
	05/25/17	<0.0008	<0.002	0.0266	<0.0003	0.000521 J	<0.002	0.2	1.61	0.000439 J	0.0471	<0.00008	<0.002	<0.002	<0.0005	<0.443	1.38	1.82
	06/29/17	<0.0008	0.00593	0.0307	<0.0003	0.00851 J	0.00266 J	0.255	0.717	<0.0003	0.048	<0.0008	<0.002	<0.002	<0.0005	0.303	0.628	0.93
	5/2017																	
	06/12/18	<0.0008	0.00223 J	0.0182	<0.0003	<0.0003	<0.002	<0.003	<0.100	0.00097 J	0.0721	<0.00008	<0.002	<0.002	<0.0005	0.305	<0.5860	0.891
	09/13/18	--	0.00467 J	0.0250	--	--	0.002 J	0.190	0.750	<0.0003	0.0531	--	<0.002	--	--	0.691	1.04	1.731
	05/15/19	<0.0008	<0.002	0.0238	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0943	<0.00008	<0.002	<0.002	<0.0005	<0.195	0.962	1.157
	9/4/2019	--	0.00759	0.32	--	--	--	<0.003	<0.1	--	0.107	--	<0.002	--	--	0.0726	1.68	1.75
	5/20/2020	<0.0008	<0.002	0.025	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.084	<0.00008	<0.002	<0.002	<0.0005	0.265	0.255	0.52
BMW-28	12/14/16	0.0012 J	<0.002	0.0509	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.11	<0.00008	0.0103	0.0045 J	<0.0005	<0.566	<2.22	2.79
	01/23/17	0.001 J	<0.002	0.0518	<0.0003	<0.0003	<0.002	<0.003	0.104 J	<0.0003	0.116	<0.00008	0.00881	<0.002	<0.0005	0.626	1.12	1.75
	02/23/17	<0.0008	<0.002	0.0734	<0.0003	<0.0003	<0.002	<0.003	0.11 J	0.00097 J	0.00514 J	<0.00008	<0.002	<0.002	<0.0005	0.168	0.835	1.00
	03/24/17	0.0012 J	<0.002	0.046	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.1	<0.00008	0.00773	0.0021 J	<0.0005	1.04	1.17	2.21
	04/24/17	0.0011 J	<0.002	0.047	<0.0003	<0.0003	<0.002	<0.003	0.19 J	<0.0003	0.109	<0.00008	0.00766	<0.002	<0.0005	0.356	1.880	2.24
	06/12/18	<0.0008	<0.002	0.0505	<0.0003	<0.0003	<0.002	<0.003	0.529	0.00122	0.116	<0.00008	0.00764	<0.002	<0.0005	0.197	1.12	1.32
	09/14/18	--	<0.002	0.0419	--	--	<0.002	<0.003	0.445	<0.0003	0.114	--	0.00782	--	--	0.35	1.15	1.50
	05/15/19	<0.0008	<0.002	0.0285	<0.0003	<0.0003	<0.002	<0.003	0.496	<0.0003	0.119	<0.00008	0.0124	<0.002	<0.0005	0.289	0.924	1.21
	9/4/2019	--	<0.002	0.027	--	--	--	<0.003	<0.1	--	0.131	--	0.00961	--	--	0.0173	3.2	3.21
	5/20/2020	<0.0008	<0.002	0.0297	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.133	<0.00008	0.00617	<0.002	<0.0005	0.157	2.38	2.54
BMW-29	06/13/19	--	--	--	--	--	--	--	<0.100	--	0.114	--	--	--	--	--	--	--
	07/08/19	--	--	--	--	--	--	--	--	--	0.104	--	--	--	--	--	--	--
	09/09/19	--	--	--	--	--	--	--	--	--	0.107	--	--	--	--	--	--	--
BMW-30	06/13/19	--	--	0.0982	--	--	--	--	<0.100	--	--	--	--	--	--	--	--	--
	09/09/19	--	--	0.0636	--	--	--	--	--	--	0.0539	--	--	--	--	--	--	--
BMW-31	06/13/19	--	--	--	--	--	--	--	0.255	--	0.0203	--	--	--	--	--	--	--
BMW-32	06/13/19	--	--	--	--	--	--	0.00705	0.822		0.115	--	--	--	--	--	--	--
	07/08/19	--	--	--	--	--	--	--	--	--	0.116	--	--	--	--	--	--	--
	09/09/19	--	--	--	--	--	--	<0.0069	--	--	0.115	--	--	--	--	--	--	--
AI-2-OB	08/14/19	NA	NA	NA	NA	NA	NA	<0.003	NA	NA	<0.005	NA	NA	NA	NA	NA	NA	NA

APPENDIX F12 – CORRECTIVE MEASURES ASSESSMENT (A-1 AREA LANDFILL)

REPORT

CCR ASSESSMENT OF CORRECTIVE MEASURES

Martin Lake Steam Electric Station - A1 Area Landfill
Panola County, Texas

Submitted to:

Luminant Generation Company LLC

Submitted by:

Golder Associates Inc.

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September 2019

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APPENDICES

1.0 INTRODUCTION

Golder Associates Inc. (Golder) has prepared this assessment of corrective measures (ACM) report on behalf of Luminant Generation Company LLC (Luminant) for the A1 Area Landfill (A1 LF) located at the Martin Lake Steam Electric Station (MLSES) in Panola County, Texas (hereafter, the “Site”). The ACM was prepared in accordance with §257.96 of the Coal Combustion Residual (CCR) Rule and was required due to the presence of concentrations of selected Appendix IV constituents in the uppermost Site aquifer at statistically significant levels (SSLs) above the groundwater protection standards (GWPS) established for the constituents at the Site. This ACM Report will be placed in the MLSES operating record in accordance with §257.105(h)(10).

This report also incorporates the results of a site investigation conducted at the A1 LF in May and June 2019. The objectives of the site investigation were:

- delineate the nature and extent of the selected Appendix IV constituents to their respective GWPS;
- update the statistical evaluations of the Appendix IV constituents to include data collected during 2019 to confirm that SSL exceedances continue to occur at the Site;
- collect data to evaluate potential future alternate source demonstrations (ASDs) for the Appendix IV constituents; and
- assess the potential for monitored natural attenuation (MNA) to be successful at the Site for the Appendix IV constituents.

The MLSES is located approximately 5 miles southeast of Tatum in Rusk County, Texas (Figure 1). The MLSES is expected to remain in operation for the foreseeable future, depending on future power demands.

The A1 LF is located approximately 2.5 miles southeast of the MLSES (Figure 1). The A1 LF is an above grade landfill that considered an existing CCR Landfill under the CCR Rule. CCR is transported to the landfill in rail cars, off loaded and placed within the active areas at the landfill. The A1 LF was registered with the Texas Commission on Environmental Quality (TCEQ) as a Class 2 non-hazardous industrial waste landfill in 1980 under SWR No. 31277 and has been receiving CCR since that time.

The A1 LF is located within reclaimed areas of the former Beckville Lignite Mine (a subsection of the Martin Lake Lignite Mine). The landfill is surrounded by earthen embankments constructed of mine spoil that extend approximately 10 to 20 feet or more above surrounding grade (PBW 2016). The A1 LF is lined with a 1-foot thick compacted clay bottom liner consisting of clay-rich mine spoil scarified and re-compacted to achieve an in-place permeability of 1×10^{-7} cm/sec or less. The bottom liner is underlain by low-permeability, clay-rich mine spoil 70 to 100 feet or more in thickness. The earthen embankments are provided with a 3-foot thick compacted clay liner.

Progressive capping/closure of the A-1 LF is performed as placement of CCR in the landfill reaches design elevations. Existing capped areas have been capped/closed using a 3-foot thick compacted clay cap (in-place permeability of 1×10^{-7} cm/sec or less) covered with a minimum 2-foot thick vegetative cover layer.

2.0 REGIONAL AND SITE SETTING

2.1 Regional Geology

The A1 Area Landfill is located in the outcrop area of the Eocene-aged undifferentiated Wilcox Group (Barnes, 1965). The Wilcox Group in the vicinity of the Site consists mostly of unconsolidated to moderately consolidated clay and silt, with various amounts of interbedded sand and lignite. The depositional environment is associated with fluvial-deltaic processes such as inter-channel crevasse splays, overbank deposits, and localized channel fills. The Wilcox Group is overlain by sands of the Carrizo Formation, which is present only at higher elevations in the area. The Carrizo Formation is not present at the Site.

2.2 Regional Hydrogeology

Groundwater within the upper 100 feet below ground surface (bgs) in the region typically flows under unconfined to semi-confined conditions. The direction and rate of groundwater movement in the Calvert Bluff Formation is affected by a number of physical features, including topography, surface drainage, and geology. The natural groundwater potentiometric surface in these shallow flow systems is generally a subdued replica of topography. In general, groundwater flow occurs from high potentiometric areas (recharge zones) toward valleys (discharge zones). Groundwater divides generally coincide with surface drainage divides. Reclaimed mine spoil is not typically used as a water production source. Water wells in the region are typically completed in channel sands of the Wilcox Group or in the Carrizo Formation.

2.3 Site Hydrogeology and CCR Monitoring Well Network

The CCR groundwater monitoring well network at the A1 Area Landfill was established in 2015 using Site monitoring wells BMW-11A-R, BMW-18, BMW-19, BMW-20, BMW-21, BMW-22, BMW-23, and BMW-24. Monitoring wells BMW-26, BMW-27, and BMW-28 were added to the CCR monitoring network in 2016, during the background sampling period. Nature and extent wells BMW-29, BMW-30, BMW-31, BMW-32, and BMW-33 were installed in May 2019 and were sampled, along with one pre-existing non-CCR well (BMW-25), in June 2019. Pre-existing mine monitoring wells A-I-2-OB, AI-17-SPOIL, and AIV-18-OB-95 were also sampled as nature and extent wells in July and August 2019. Boring logs for the CCR monitoring wells and nature and extent wells are provided in Appendix A. The uppermost GWBU occurs under unconfined conditions within the spoil zone. The CCR monitoring wells and nature and extent wells are completed in the spoil zone, except for nature and extent wells A-I-2-OB and AIV-18-OB-95, which are both completed in native Wilcox sands in the overburden interval at the mine. Geologic cross sections of the A1 Area Landfill are presented on Figures 3, 4, 5, and 6.

Prior to the installation of the nature and extent wells, the highest groundwater elevation in the CCR monitoring well network had been consistently observed at well BMW-11-AR, which is located near the northern corner of the A1 Area Landfill. When the initial nature and extent wells were sampled in June 2019, the highest groundwater elevation was observed at BMW-33 (401.69 feet above mean sea level (amsl)), which is located on the northeast side of the landfill. Based on the new water elevation information from the nature and extent wells, BMW-33 is considered an upgradient well relative to the A1 Area Landfill and the inferred direction of groundwater flow is to the east-southeast and west from the A1 Area Landfill, with a lesser flow component to the south. A groundwater potentiometric surface map of the A1 Area Landfill is provided on Figure 7.

Nature and extent wells AI-2-OB, AI-17-SPOIL, and AIV-18-OB-95 were initially selected for evaluation based on the previously inferred groundwater flow direction shown on historic CCR groundwater potentiometric surface maps (PBW 2017a) and the well locations relative to the A1 Area Landfill. Groundwater elevation data collected during the nature and extent evaluation indicate that wells AI-17-SPOIL and AIV-18-OB-95 are upgradient of the A1 Area Landfill and that well AI-2-OB is downgradient of the A1 Area Landfill. Based on the inferred groundwater flow direction, the locations of the CCR monitoring wells and nature and extent wells to the A1 Area Landfill are as follows:

Upgradient/Background Wells	Downgradient Wells	
BMW-11A-R	BMW-18	BMW-26
BMW-27	BMW-19	BMW-28
BMW-33	BMW-20	BMW-29
AI-17-SPOIL	BMW-21	BMW-30
AIV-18-OB-95	BMW-22	BMW-31
	BMW-23	BMW-32
	BMW-24	AI-2-OB
	BMW-25	

Rising- and falling-head aquifer tests (i.e., slug tests) were conducted in 2015 at monitoring wells BMW-21, BMW-23, and BMW-24 to evaluate lateral groundwater flow velocities of the uppermost GWBU. The test methods and results were documented in the CCR Groundwater System Certification Report for the Site (PBW 2017a). Based on the test results, the uppermost GWBU has an estimated horizontal hydraulic conductivity value of 3.05E-04 cm/sec and an estimated lateral groundwater flow velocity of 14 feet per year.

Golder performed a survey of water supply wells located in the vicinity of the A1 Area Landfill in May 2019 as part of a Texas Commission on Environmental Quality (TCEQ) Texas Risk Reduction Program (TRRP) assessment of the Site. A Drinking Water Survey Report (Golder, 2019) documenting the water well survey activities and findings was approved by the TCEQ in a letter dated August 2, 2019. No imminent threats to water wells or potentially affected drinking water wells were identified.

3.0 NATURE AND EXTENT EVALUATION

3.1 Groundwater Monitoring Summary

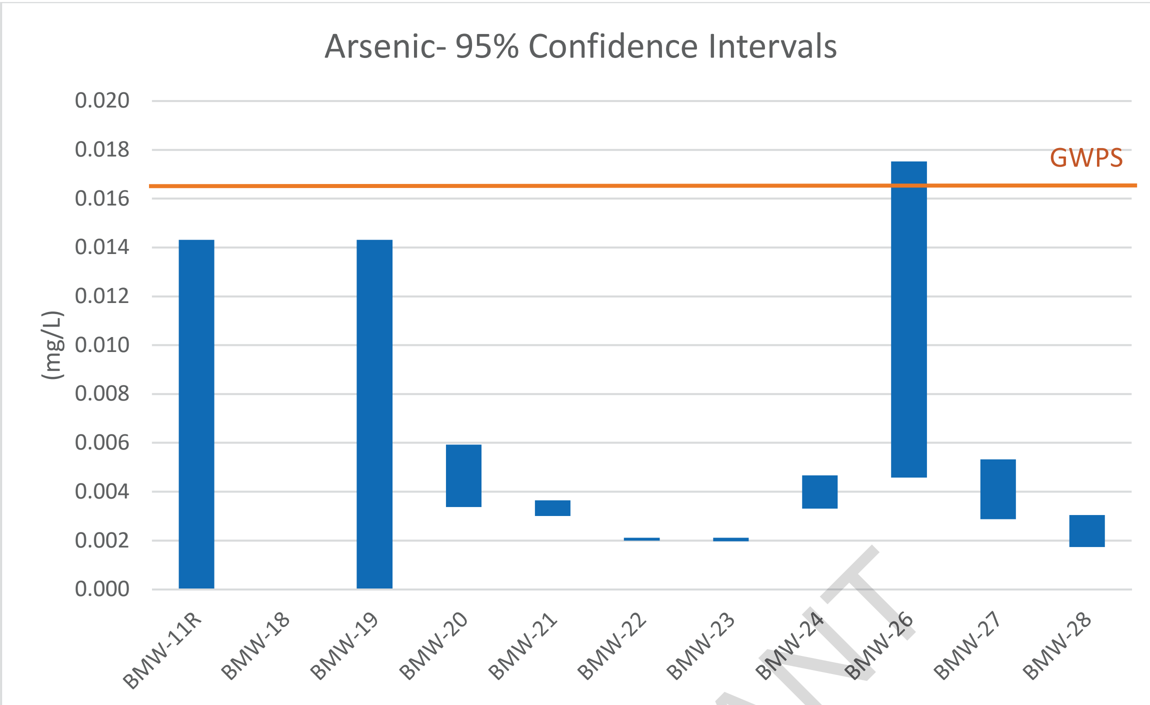
Background monitoring of groundwater in the vicinity of the A1 Area Landfill began in October 2015 and was completed in December 2016. Samples collected during this period were analyzed for Appendix III and Appendix IV constituents to establish background concentrations pursuant to §257.94(b).

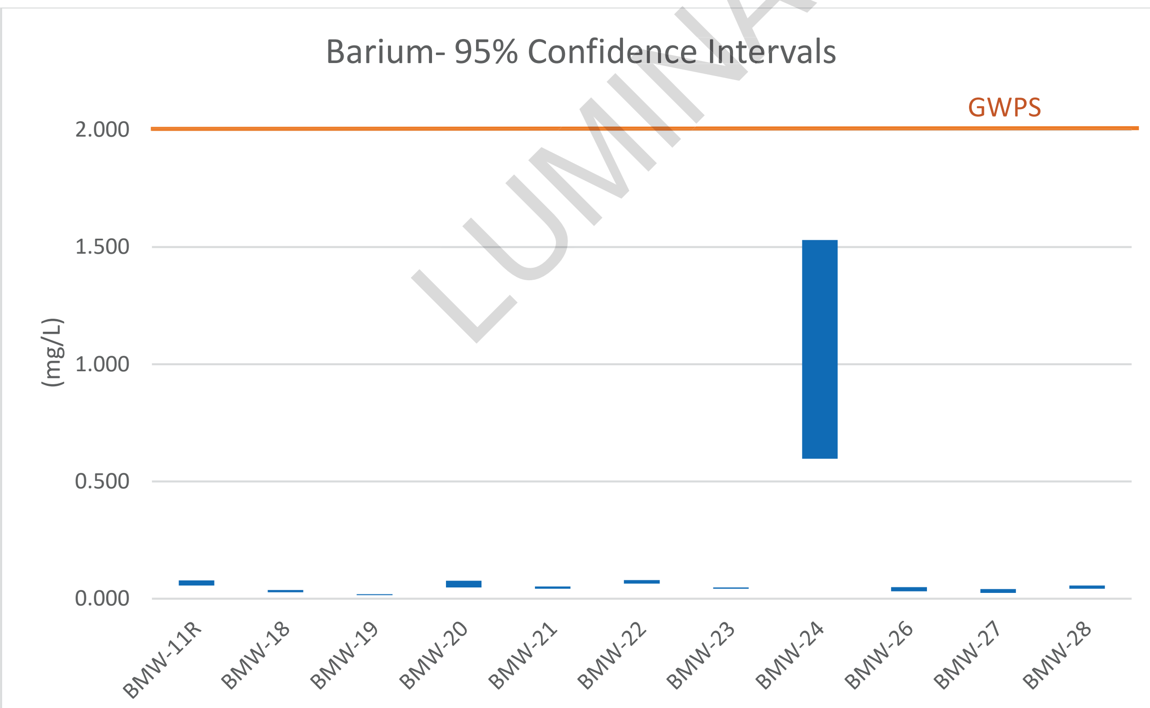
A detection monitoring program in accordance with §257.94 was initiated in September 2017. The evaluation of those data was completed in 2018 using procedures described in the Statistical Analysis Plan (PBW, 2017b) to identify statistically significant increases (SSIs) of Appendix III parameters above background concentrations. Based on the identification of SSIs for one or more Appendix III parameters, an assessment monitoring program was established pursuant to §257.94(e)(1).

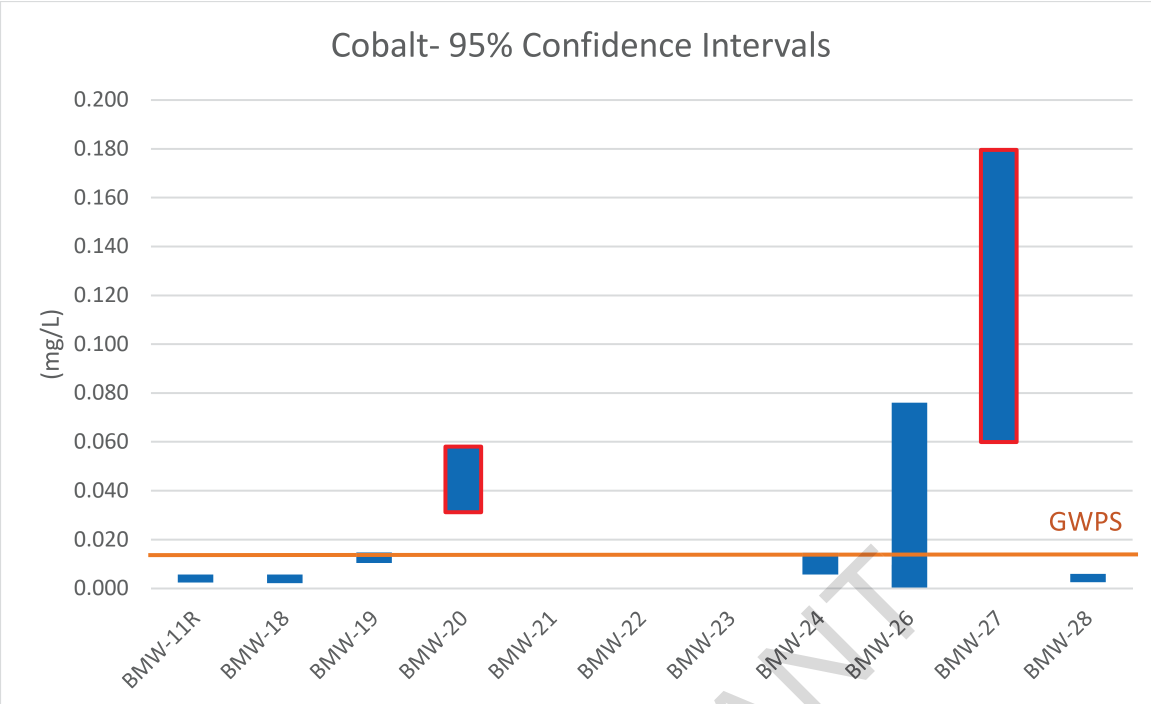
The initial assessment monitoring event was performed in June 2018 and a subsequent semi-annual assessment monitoring event was conducted in September 2018 in accordance with §257.95(a) and §257.95(d). Using the Appendix IV data collected during the assessment period through September 2018, SSLs above GWPSs were initially identified for arsenic (BMW-26), barium (BMW-24), cobalt (BMW-19, BMW-20 and BMW-27); and lithium (BMW-26 and BMW-28). An ACM was initiated on April 8, 2019 pursuant to §257.95(g). A justification letter for a 60-day extension due to site-specific circumstances that delayed work on the ACM was certified on July 3, 2019 in accordance with §257.96(a). Based on the extension, the deadline for completing the ACM is September 5, 2019.

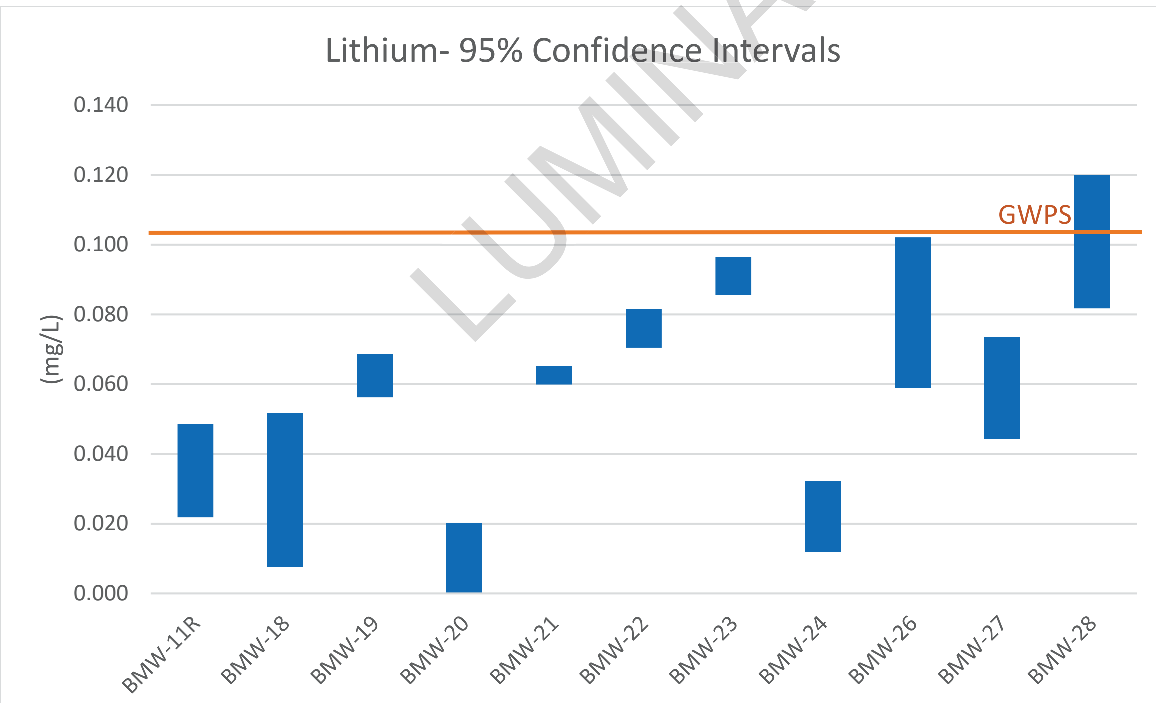
3.2 Assessment Monitoring SSL Evaluation

An additional assessment monitoring event was performed in May 2019. Groundwater sampling analytical results for all Appendix IV parameters from 2015 through 2019 are presented in Table 1. An updated statistical analysis of the Appendix IV results from downgradient CCR monitoring wells was conducted, including the May 2019 data, to evaluate if constituent concentrations detected in the samples remained at SSLs relative to the GWPSs. The updated statistical analysis was performed in accordance with the Statistical Analysis Plan for CCR Groundwater Monitoring (PBW, 2017b) and the USEPA Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities-Unified Guidance (USEPA 2009). Confidence intervals were calculated for any Appendix IV parameter that historically has had more than one exceedance of the GWPS in any well within the monitoring network. Plots of the confidence intervals for each of these Appendix IV parameters are presented below (red boxes indicate SSLs):


Arsenic- 95% Confidence Intervals
GWPS
(mg/L)
0.020
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
BMW-11R
BMW-18
BMW-19
BMW-20
BMW-21
BMW-22
BMW-23
BMW-24
BMW-26
BMW-27
BMW-28


Barium- 95% Confidence Intervals
GWPS
(mg/L)
2.000
1.500
1.000
0.500
0.000
BMW-11R
BMW-18
BMW-19
BMW-20
BMW-21
BMW-22
BMW-23
BMW-24
BMW-26
BMW-27
BMW-28





The previous statistical analysis using data collected during the assessment monitoring period through September 2018 indicated SSLs for arsenic (BMW-26), barium (BMW-24), cobalt (BMW-19, BMW-20, and BMW-27) as identified in the February 2019 SSL notification; and lithium (BMW-26 and BMW-28). The updated statistical analysis identified only cobalt (BMW-20 and BMW-27) as having SSLs above GWPSs Based on the groundwater elevations measured in the nature and extent wells in June 2019, CCR well BMW-27 is now considered to be upgradient of the A1 Area Landfill; therefore, the SSLs for cobalt identified in well BMW-27 are were characterized as background concentrations in the updated statistical analysis. Cobalt in well BMW-20 was the only occurrence of SSLs above GWPSs in the updated statistical analysis. Although only cobalt was observed at SSLs above the GWPS during the updated statistical analysis, the monitoring wells will continue to be monitored for arsenic, barium, and lithium to confirm that their concentrations remain below SSLs in the future in accordance with the CCR Rule. For the purposes of this ACM evaluation, concentrations are conservatively assumed to be present at SSLs above their respective GWPSs for the following constituents in the wells indicated based on the initial statistical analysis:

- Arsenic (BMW-26);
- Barium (BMW-24);
- Cobalt (BMW-19, BMW-20, and BMW-27); and
- Lithium (BMW-26 and BMW-28).

Figure 8 shows the extent of Appendix IV constituents detected at SSLs above GWPSs based on the initial and updated statistical analysis.

3.3 Field Investigation

3.3.1 General

Field investigation activities conducted as part of the ACM included collection of soil samples for mineralogical assessment and chemical analysis, installation and development of nature and extent monitoring wells, groundwater-level measurements, and groundwater sampling and analysis. Figure 2 presents the locations of soil borings and monitoring wells installed and sampled as part of the field investigation.

3.3.2 Soil Sample Collection

Soil borings were completed in May 2019 at proposed nature and extent monitoring well locations BMW-29, BMW-30, BMW-31, BMW-32, and BMW-33. Soil samples were collected within the target GWBU in each of the soil borings. Soil samples were submitted under chain-of-custody for laboratory analysis of the following parameters:

- Mineralogical composition: The purpose of the mineralogical analysis was to identify and quantify the crystalline mineral phases in each sample. This information is required for geochemical modeling as the release or attenuation of constituents of interest is influenced by the mineral phase(s) present in the aquifer (Hem 1985). The mineralogical testing laboratory (SGS Minerals Services) performed the analysis using quantitative (Rietveld) X-ray diffraction (XRD) (ME-LR-MIN-MET-MN-DO5) and a Bruker AXS D8 Advance Diffractometer.

- Total metals: Analysis of total metals was conducted to quantify the chemical composition of soil materials. The total mass of metals, in combination with the results of sequential extraction testing, can be used to determine the provenance of metals and verify sequential extraction results.

- Sequential extraction (SEP): This test consists of a seven-step metals extraction from solids as per Tessier et al. (1979) to identify the provenance of constituents of interest (i.e. the operationally-defined fraction that contains the metal)[1] and determine their potential environmental mobility. For instance, metals bound in the carbonate fraction, or that are exchangeable, are much more likely to become mobile due to changes in groundwater conditions than metals bound within a sulfide or silicate fraction. The total concentration of a metal measured from all seven steps can be compared to the concentration determined from the total metal analysis for compositional accountability.

3.3.3 Monitoring Well Installation

Five new nature and extent monitoring wells were completed (BMW-29, BMW-30, BMW-31, BMW-32, and BMW-33) in May 2019 in the uppermost GWBU. The wells were constructed of 2-inch diameter, schedule 40 PVC casing and 0.010-inch slotted screen. Annular materials consisted of a sand/gravel pack around the screened interval, a bentonite seal above the sand/gravel pack, and grout or bentonite chips to ground surface. Surface completions consisted of a concrete pad, protective steel casing stickup, and guard posts. The monitoring wells were developed by surging the wells several times and purging the wells using an inertial pump to remove fine-sized particles and to establish a hydraulic connection between the well and the formation.

3.3.4 Groundwater Sampling

Groundwater samples were collected from the CCR monitoring network in May 2019 and from the nature and extent wells in June 2019 through August 2019. Laboratory analytical reports are provided in Appendix B and groundwater sampling records, which include field-measured parameters, are presented in Appendix C.

Chemical/geochemical analysis of groundwater samples included field parameters, metals, nutrients, and major cations and anions. The rationale and methods used are as follows:

- Field Parameters: Parameters measured in the field included pH, dissolved oxygen, oxidation reduction potential (ORP), conductivity, and temperature. These parameters were used to evaluate general geochemical conditions in the groundwater and support geochemical modeling.
- Metals and Regulated COIs: Analysis of Appendix III parameters and Appendix IV metals to better understand the geochemical composition of groundwater. Metals analysis allows for the delineation of a potential plume, evaluation of mineral saturation indices, and evaluation of background contributions from natural sources or anthropogenic sources.
- Major Cations, Anions, and Nutrients: Geochemical modeling of mineral solubility, metals attenuation and background contributions requires analysis of major cations and anions because they affect and participate in sorption and mineral dissolution or precipitation reactions.

[1] Sequential extraction of metals from soil samples consisted of seven discrete steps for this investigation:
Step 1 - Exchangeable Fraction: This extraction includes trace elements that are reversibly adsorbed to soil minerals, amorphous solids, and/or organic material by electrostatic forces.

Step 2 - Carbonate Fraction: This extraction targets trace elements that are adsorbed or otherwise bound to carbonate minerals.

Step 3 - Non-Crystalline Materials Fraction: This extraction targets trace elements that are complexed by amorphous minerals (e.g., iron).

Step 4 - Metal Hydroxide Fraction: Trace elements bound to hydroxides of iron, manganese, and/or aluminum.

Step 5 - Organic Fraction: This extraction targets trace elements strongly bound via chemisorption to organic material.

Step 6 - Acid/Sulfide Fraction: The extraction is used to identify trace elements precipitated as sulfide minerals.

Step 7 - Residual Fraction: Trace elements remaining in soil after the previous extractions will be distributed between silicates, phosphates, and refractory oxides.

3.4 Evaluation of Groundwater Data

3.4.1 Geochemical Modeling Approach

Geochemical modeling was conducted to evaluate general groundwater quality, determine the potential for precipitation of sorbent media, evaluate the potential for mineral precipitation or adsorption in the aquifer, and determine the speciation of metals of interest. The geochemical computer code developed by the United States Geological Survey (USGS), PHREEQC, was used for these simulations (Parkhurst and Appelo 2013). PHREEQC version 3.4 is a general-purpose geochemical modeling code used to simulate reactions in water and between water and solid mineral phases (e.g., rocks and sediments). Reactions include aqueous equilibria, mineral dissolution and precipitation, ion exchange, surface complexation, solid solutions, gas-water equilibrium, and kinetic biogeochemical reactions. The widely-accepted thermodynamic database Minteq.v4, 2017 edition, was used as a basis for the thermodynamic constants required for modeling.

The Geochemist's Workbench Version 12 (Bethke 2015) was used to generate graphical representations of geochemical modeling outputs in the form of predominance, or Pourbaix diagrams (also known as Eh-pH diagrams) for the species of interest (e.g. cobalt) and trilinear plots (also known as Piper plots) displaying the relative abundance of major ions. The Minteq.v4 database was used as the basis for the Pourbaix diagrams.

3.4.2 Summary of Groundwater Results

Groundwater quality data from background well BMW-11-A-R; monitoring wells BMW-18, BMW-19, BMW-20, BMW-21, BMW-22, BMW-23, BMW-24, BMW-26, BMW-27 (now considered upgradient from the A1 Area Landfill), and BMW-28; and nature and extent monitoring wells BMW-25, BMW-29, BMW-30, BMW-31, BMW-32, BMW-33 were used for this evaluation. The water quality monitoring data are presented in Appendices B and C and can be summarized as follows:

General Chemistry Parameters

- pH: The pH of groundwater samples collected from CCR monitoring network and nature and extent wells ranged from 6.6 to 7.2 in May 2019. Historically, the pH in the CCR monitoring well network has ranged from 5.3 to 7.3. However, other than some values that appear to be outliers or are due to seasonality, the pH of groundwater in the CCR network has been consistently between 6.0 and 7.2.
- ORP (Redox): Field-measured redox values, corrected to Eh (+200mV), ranged from +123 to +184 mV in the groundwater samples in the CCR monitoring well network in May 2019. The Eh of groundwater in the nature and extent monitoring wells ranged from +168 mV to +190 mV, indicating that redox conditions were similar to those in the CCR monitoring network wells.
- Total Dissolved Solids (TDS): Groundwater TDS concentrations were variable in May 2019 in the CCR monitoring and nature and extent well network. The lowest TDS concentration (327 mg/L) was observed in nature and extent monitoring well BMW-31 and the highest TDS concentration (3,610 mg/L) was observed in CCR monitoring wells BMW-28. Groundwater in CCR monitoring well BMW-28, while having the highest TDS, does not have a SSL of any Appendix IV constituent as of May 2019.
- Major ion chemistry: A Piper plot was generated for groundwater samples to facilitate the identification of water types and source contributions (Figure 9a). Except for upgradient wells BMW-18, BMW-19 and nature and extent well BMW-31, all background, downgradient, and nature and extent wells demonstrate a similar major ion relative abundance. Based on the molar ratios of calcium, chloride, and sulfate (Figure 9b), all

wells show major ion compositions ranging between those from BMW-11AR (upgradient) and BMW-31 (nature and extent).

- Iron: Oxidized iron (Fe^{+3}) concentrations were variable, ranging from 0.0633 mg/L (BMW-28) to 35.1 mg/L (BMW-24) in May 2019 (Appendix B). Reduced iron (Fe^{+2}) was non-detect (<0.05 mg/L) in all groundwater samples but two: BMW-23 (0.0937 mg/L) and nature and extent well BMW-29 (0.342 mg/L). Based on the oxidized iron concentrations in groundwater, it is likely ferrihydrite, an iron oxide mineral, is present at the A1 LF, indicating the potential for attenuation of metals and metalloids from groundwater.

- Nutrients: Nitrate (nitrate as N) was present in groundwater at monitoring wells at variable levels, ranging from non-detect (< 0.1 mg/L as N) to 1.35 mg/L as N at BMW-19 in May 2019 (Appendix B). Nitrate was not detected in nature and extent wells. Phosphate concentrations in groundwater ranged from non-detect (0.03 mg/L) to 0.202 mg/L in CCR monitoring and nature and extent wells. No spatial trend was apparent in the nitrate or phosphate distribution in groundwater.

Constituents Identified in February 2019 SSL Notification

- Arsenic: Historically, arsenic concentrations in groundwater surrounding the A1 LF have ranged from non-detect (<0.002 mg/L) to 0.0428 mg/L in CCR monitoring well BMW-19 (June 2018; Figure 10a). Only CCR monitoring wells BMW-19 and BMW-26 have ever exceeded the GWPS. Prior to, and after, the highest groundwater arsenic concentration measured in BMW-19 in June 2018, arsenic concentrations were at or near detection limits in BMW-19 (<0.005 mg/), indicating that the elevated value likely represented an outlier. Arsenic concentrations in groundwater at BMW-26 exceeded the GWPS on four of 12 sampling occasions since October 2016. Based on the evaluation of 95% confidence intervals, no CCR monitoring wells contain arsenic at a concentration above the SSL as of May 2019. Also, , all arsenic concentrations in CCR monitoring wells were below the GWPS as of May 2019.

- Barium: Historically, barium concentrations in groundwater have only exceeded the GWPS of 2.0 mg/L in CCR monitoring well BMW-19 (Figure 10b) on one occasion. Since October 2015, the barium concentration in groundwater at BMW-19 has ranged from 0.181 mg/L to 2.19 mg/L and, as of May 2019, was observed at 0.221 mg/L. No other nature and extent or CCR monitoring wells have ever reported barium concentrations in groundwater exceeding the GWPS. Based on the evaluation of 95% confidence intervals, barium in groundwater is not at an SSL in groundwater at BMW-19, or in any other CCR monitoring well.

- Cobalt: Cobalt concentrations in groundwater samples collected from the nature and extent monitoring wells ranged from non-detect (<0.003 mg/L) to just above non-detect (0.00705 mg/L) in May 2019 (Table 1). The highest observed cobalt concentration in a groundwater occurred at monitoring well BMW-24 (0.00643 mg/L; Figure 10c). All other CCR monitoring wells did not contain cobalt concentrations above the detection limit in May 2019. Historically, cobalt concentrations have ranged from non-detect (<0.003 mg/l) to 0.2550 mg/L in CCR monitoring well BMW-22. The highest cobalt concentration in this well was observed in June 2017, and since then levels have been generally stable or decreasing. CCR monitoring well BMW-24 shows substantial variation between sampling events, of +/- 0.2 mg/L in some cases. Based on an evaluation of 95% confidence intervals, CCR monitoring wells BMW-20 and BMW-27 contain cobalt at a SSL above the GWPS of 0.0124 mg/L (Section 3.2). Cobalt is likely present in groundwater as the divalent cation Co^{+2} while, based on the pH and Eh of groundwater, ferrihydrite, an iron hydroxide mineral phase known to adsorb cobalt, is expected to be present and stable (Figure 11).

- Lithium: Lithium has exceeded the GWPS (0.103 mg/L) since October 2015 in groundwater from four wells: BMW-18, BMW-23, BMW-26, and BMW-28 (Figure 10d). In May 2019, lithium concentrations in groundwater in the CCR monitoring wells network were only above the GWPS in one well: BMW-28. Based on the evaluation of the 95% confidence intervals, the GWPS exceedances for lithium at BMW-24 are not at an SSL above the GWPS for lithium, nor at any other CCR monitoring well at the A1 LF.

3.5 Evaluation of Soil

3.5.1 Mineralogical Composition

Quantitative X-ray diffraction (XRD) with Rietveld refinement was used to identify and quantify minerals in five overburden samples collected during the drilling activities - one sample from each of the soil borings completed in June 2019 (BMW-29, BMW-30, BMW-31, BMW-32, and BMW-33). These samples were obtained to better understand the mineralogical composition of the aquifer system and identify any minerals that would potentially influence attenuation of constituents of interest. In contrast, the presence of certain minerals could also indicate a potential for naturally-occurring release of metals into groundwater, for instance due to oxidation of sulfide minerals.

The mineralogical analysis identified the materials in boreholes samples at the A1 LF predominantly consist of quartz with varying amounts of the silicate minerals K-feldspar, albite, chlorite, muscovite, biotite, kaolinite, vermiculite, and montmorillonite, plus calcite. Trace amounts of titanomagnetite and ilmenite were encountered in one sample as well. Some of the aluminum phyllosilicates identified in the samples (i.e., kaolinite, vermiculite and montmorillonite) reflect the presence of clays at the A1 LF. Analytical reports for the XRD samples are provided in Appendix B.

3.5.2 Chemical Composition and Sequential Extraction

Chemical analysis and sequential extractions were used to determine the chemical composition of the soil and the distribution of constituents of interest over various operationally-defined fractions comprising the soil. Testing was completed as described in Section 3.3.2 on soil samples obtained from three borehole locations (Figure 2) and the analytical reports for the soil analyses are provided in Appendix B.

Soil sample locations were chosen to gain a better understanding of the underlying geological conditions of the area surrounding the A1 LF, mostly adjacent to or downgradient of a CCR monitoring well. In addition, this information allows for a better understanding of naturally-occurring metal contributions to groundwater or the potential for sequestration of constituents from groundwater.

A description of the individual fractions determined by sequential extraction is presented in Section 3.3.2. Metals extracted in steps 1 through 5 are considered environmentally available, whereas metals extracted in steps 6 and 7 are present in refractory fractions and are not expected to be released under conditions typically encountered in aquifers (Tessier et al. 1979). Total metal quantities from the sequential extraction are expressed as “SEP Total” in Appendix B. The sum of the sequential extraction steps is also presented for comparison but does not represent an analytically-determined value.

The results from the chemical analysis and sequential extraction presented in Appendix B are summarized as follows:

General Chemistry Parameters

- Aluminum: Aluminum is not a constituent of interest (COI) at the site but it has been well studied as a sorbing medium in soils (e.g., Karamalidis and Dzombak 2011). Total aluminum in soils ranged from 29,526 to 53,368 mg/kg, and the environmentally-available fraction ranged from just 1,208 mg/kg (BMW-30) to 3,286 mg/kg (BMW-29). Aluminum in the soil at the site is, therefore, largely (~84% to 94%) present in the residual, or silicate-bound fraction. This fraction is likely at least partially represented by hydrous aluminum phyllosilicates minerals or clays intermixed in the silica sand matrix. Clays represent an important sorptive reservoir for numerous trace metals and metalloids (Uddin 2017).
- Iron: While not a COI, iron and its minerals commonly represent one of most abundant reservoirs for metal/metalloid attenuation in soils (Dzombak and Morel 1990; Smith 1999). Iron was present in all three core samples analyzed, varying from 5,814 mg/kg (BMW-30) to 24,578 mg/kg (BMW-29). In nearly all samples (except BMW-29 and BMW-31), the sulfide and residual fractions accounted for the largest proportion of total iron (59% to 79%) and, as such, most of the iron is not environmentally available. The remainder of the iron in the samples is present in the amorphous metal and metal hydroxide phase with a small amount <0.6% also occurring in the carbonate fraction. The metal hydroxide fraction, part of the labile fraction in steps 1 through 5, can generally be considered representative of the amount of iron in soil that may be available as a sorbing medium and can, therefore, be used as a proxy for determine the potential for attenuation of cobalt or other COIs.

Constituents Identified in February 2019 SSL Notifiation

- Arsenic: Total arsenic in soil ranged from 3.0 to 4.12 mg/kg while the environmentally-available fraction ranged from 1.38 mg/kg in BMW-31 to 2.27 mg/kg in BMW-29, representing from 46% to 65% of total arsenic. Arsenic in the non-environmentally available fraction (acid/sulfide and residual fractions) ranged from 35% to 54% of total arsenic, indicating the presence of a reservoir of naturally-occurring arsenic in soils. All of the arsenic that was present in the environmentally-available fraction was associated with the amorphous metal and metal hydroxide fractions, indicating potential attenuation of arsenic from groundwater.
- Barium: Total barium in soil ranged from 376 to 597 mg/kg while the environmentally-available fraction ranged from 9.9 mg/kg in BMW-30 to 52 mg/kg in BMW-31, representing from 3% to 14% of total barium. The majority of barium (83% to 96%) was present in the silicate mineral or residual fraction, as such indicating the presence of a considerable reservoir of naturally-occurring barium in soils. Of the barium that occurred in the environmentally-available fraction, the majority was associated with metal hydroxides, indicating potential attenuation of barium from groundwater.
- Cobalt: Total cobalt in soil ranged from 1.7 to 20 mg/kg while the environmentally-available fraction ranged from 0.66 mg/kg in BMW-32 to 18.8 mg/kg in BMW-31, representing from 39% to 94% of total cobalt. Environmentally-available cobalt was present in all the fractions across the A1 LF site. In BMW-31, which contained the highest cobalt concentration measured in the soils samples, the amorphous metal and metal hydroxide fractions accounted for all of the environmentally-available cobalt, indicating its potential attenuation or incorporation into metal hydroxides, such as ferrihydrite.
- Lithium: Total lithium in soil ranged from 11.7 to 24.7 mg/kg, of which between only 12% and 27% of the lithium occurred in the environmentally-available fraction. Lithium that was environmentally available (1.7 to

6.7 mg/kg), was all present in the metal hydroxide fraction. This distribution of lithium indicates the presence of naturally-occurring lithium contained within the non-environmentally available fractions as well as potential attenuation of lithium by metal hydroxide minerals.

The results from the soil analysis indicate the following:

- Naturally-occurring sources of arsenic, barium, cobalt, and lithium are present in the vicinity of the A1 LF; and
- Attenuation of arsenic, barium, cobalt, and lithium in groundwater is likely occurring in the vicinity of the A1 LF.

3.6 Summary of Site Characterization

Based on the above site characterization and nature and extent investigation, the following conclusions are drawn with respect to the target Appendix IV constituents:

- Arsenic: Recent data indicates that arsenic concentrations in all CCR monitoring wells and nature and extent wells are currently below the GWPS for arsenic. Based on the data collected to date, arsenic concentrations are no longer considered to be present at an SSL above the GWPS; however, arsenic concentrations in groundwater will continue to be monitored to confirm that arsenic levels remain below the GWPS in the future. For the purposes of this ACM evaluation, arsenic concentrations are conservatively assumed to be present at an SSL above the GWPS in well BMW-26 based on the February 2019 SSL notification.
- Barium: Recent data indicates that barium concentrations in all CCR monitoring wells and nature and extent wells are currently below the GWPS for barium. Based on the data collected to date, barium concentrations are no longer considered to be present at an SSL above the GWPS; however, barium concentrations in groundwater will continue to be monitored to confirm that barium levels remain below the GWPS in the future. For the purposes of this ACM evaluation, barium concentrations are conservatively assumed to be present at an SSL above the GWPS in well BMW-24 based on the February 2019 SSL notification..
- Cobalt: CCR monitoring wells in which, historically, cobalt exceeded the GWPS show stable or decreasing cobalt concentrations. Cobalt statistically exceeds the GWPS in two CCR monitoring wells (BMW-20 and BMW-27) while cobalt concentrations in groundwater at all nature and extent monitoring wells (including mine monitoring well A1-2-OB downgradient of BMW-33) are below the GWPS for cobalt. Therefore, cobalt in groundwater is likely limited to the immediate perimeter of the A1 LF and likely attenuates before reaching downgradient wells. The presence of clays and metal hydroxides in soils supports a strong potential for cobalt attenuation (Smith 1999), and attenuation of cobalt on metal hydroxides was confirmed by sequential extraction. Cobalt should, therefore, be considered for further evaluation as part of an ACM as a viable candidate for monitored natural attenuation based on the results of this initial assessment (USEPA 2007a, b).
- Lithium: Recent data indicates that lithium concentrations statistically no longer exceed the GWPS in groundwater at any monitoring or nature and extent well (including mine monitoring well A1-2-OB downgradient of BMW-32). Based on the data collected to date, lithium concentrations are no longer considered to be present at an SSL above the GWPS; however, lithium concentrations in groundwater will continue to be monitored to confirm that lithium levels remain below the GWPS in the future. For the

purposes of this ACM evaluation, lithium concentrations are conservatively assumed to be present at an SSL above the GWPS in wells BMW-26 and BMW-28 based on the February 2019 SSL notification.

4.0 ASSESSMENT OF CORRECTIVE MEASURES

In accordance with §257.96 and §257.97, an ACM was conducted for the A1 LF to address concentrations of the following Appendix IV constituents that are conservatively assumed to occur at SSLs above their respective GWPS based on the February 2019 SSL notification:

- arsenic concentrations in monitoring well BMW-26;
- barium concentrations in monitoring well BMW-24;
- cobalt concentrations in monitoring wells BMW-19, BMW-20, and BMW-27; and
- lithium concentrations in monitoring wells BMW-26 and BMW-28.

Potential response technologies were identified for Source Control (to reduce the potential for releases of constituents to groundwater) and Groundwater Response Actions (to reduce constituent concentrations below GWPS). The potential response technologies were then screened to identify options that are appropriate for further consideration in developing potential corrective measures alternatives for the Site. The results of the ACM are presented in this section.

4.1 Corrective Measures Objectives and Evaluation Criteria

As described in §257.96(a), the corrective measures must prevent further releases, remediate any releases and restore the affected area to original conditions. Potential corrective measures must meet the requirements specified in §257.97(b):

1) Be protective of human health and the environment;
2) Attain the groundwater protection standard as specified pursuant to § 257.95(h);
3) Control the source(s) of releases to reduce or eliminate, to the maximum extent feasible, further releases of constituents in appendix IV to this part into the environment;
4) Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, considering factors such as avoiding inappropriate disturbance of sensitive ecosystems;
5) Comply with standards for management of wastes as specified in § 257.98(d).

In accordance with §257.96(c), the assessment of potential corrective measures alternatives must include an evaluation of the following:

1) The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination
2) The time required to begin and complete the remedy
3) Institutional requirements, such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy(s).

4.2 Potential Source Control Response Technologies

One of the listed objectives in §257.97(b) for the corrective measures is to control the source of releases of Appendix IV constituents to the environment from the CCR Unit. In this section, potential source control response technologies are identified and screened for further consideration in developing potential corrective measures alternatives for the A1 LF.

4.2.1 Closure in Place/Capping

Source control can be achieved through construction of a low permeability cap on the surface of the landfill to close the CCR material in-place. Potential final cap options for the A1 LF include either:

- Compacted Clay Cap. This cap option utilizes a low permeability compacted clay liner (infiltration layer) covered by a vegetative soil layer and permanent vegetation.
- Geomembrane Cap. This cap option utilizes a low/high density polyethylene (LLDPE/HDPE) geomembrane liner covered by a vegetative soil layer and permanent vegetation.

The cap would be designed to isolate the CCR material in the landfill and minimize the potential for migration of CCR constituents to groundwater by controlling infiltration of precipitation through the CCR material in the landfill. Long-term cap maintenance (vegetation control, erosion repairs, etc.) would be required.

Capping is a proven method of source control and provides reliable, long-term containment to prevent, or significantly reduce exposure to the source material and migration of precipitation through the source area. Section 257.102(f)(1)(i) of the CCR Rule states that closure of an existing CCR landfill must be completed within six months of commencing closure activities. Section 257.102(f)(2)(ii)(C) of the CCR Rule states that CCR landfills may extend the timeframe to complete closure of the CCR unit multiple times, in one-year increments, with no more than a total of two one-year extensions obtained for any CCR landfill.

4.2.2 Removal and Off-site Disposal

Another option for source control at the A1 LF is excavation/removal of the CCR material in the landfill and transportation to and disposal in an existing or new off-site landfill. This option would involve either:

- Identifying an existing Luminant or commercial landfill that has the available capacity to receive the material from the A1 LF, or
- Siting, regulatory approval, designing, and constructing a new lined repository for the material from the A1 LF.

All material would be excavated from the A1 LF, loaded onto trucks, transported to the designated location, and placed in the selected repository. Once placement is complete, a cap would be constructed over the material. The new repository would require long term maintenance and monitoring.

Removal is an effective method of source control, since the CCR material would be removed from the Site and would no longer potentially impact groundwater once the removal is complete; however, removal of material is only implementable if a suitable repository location is identified. Assuming a suitable repository can be constructed within 10 miles of the A1 LF, it is estimated that it will take 25 to 30 years or more to excavate, transport and place the CCR from A1 LF in the new repository. Other significant limitations to removal as a source control option include:

- Much of the CCR in the A1 LF is currently protected by a low permeability soil cap. Excavation of CCR from the landfill would expose the material to precipitation/infiltration and increase the possibility of underlying groundwater contamination from the unit.
- Excavation of the CCR would result in increased risk of exposure to workers and the public to the CCR material itself and fugitive dust emissions during excavation, transportation, and placement at the new repository. It would also result in increased greenhouse gas emissions and carbon footprint.
- A very large number of truck trips (many hundreds of thousands of trips) would be required to transport the material to the new repository. The large volume of truck traffic would result in increased risk to the public due to accidents and potential spills of material during transport.

4.2.3 Screening of Potential Source Control Response Technologies

Following identification of potential source control technologies, Golder screened the potential options for further consideration in developing potential corrective measures alternatives for the A1 LF. The initial screening results for each potential source technology are summarized in Table 2. Based on the initial screening, the following potential source control technology was retained for future evaluation as part of the corrective measures alternatives for the A1 LF:

- Closure in Place/Capping

4.3 Potential Groundwater Response Technologies

For the purposes of this ACM, arsenic, barium, cobalt and lithium are conservatively assumed to be present in groundwater at the Site at SSLs above their respective GWPS based on the February 2019 SSL notification. In this section, potential groundwater response technologies to address these constituents are identified and screened for further consideration in developing potential corrective measures alternatives for the A1 LF.

4.3.1 Monitored Natural Attenuation

Monitored natural attenuation (MNA) refers to the reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific groundwater remediation objectives within a time frame that is reasonable compared to that offered by more active remediation methods (USEPA 2007a). MNA relies on a range of natural processes, including dispersion, dilution, sorption, (co)precipitation, radioactive decay, and abiotic degradation/transformation to achieve remediation objectives (ITRC 2010). Routine groundwater monitoring would be required to verify MNA is occurring at the Site.

Where necessary, MNA processes can be enhanced through the use of low-energy, in-situ techniques to stimulate or increase the attenuation of contaminants or reduce contaminate loading (ITRC 2010). Enhancement options include increasing the attenuation capacity of the aquifer, decreasing the mobility of contaminants, and/or increasing the stability of immobilized contaminants by increasing the ability of aquifer solids to remove contaminants from groundwater and/or manipulating the geochemistry to reduce remobilization of contaminants by desorption or dissolution of precipitates (ITRC 2010).

MNA has been demonstrated effective in reducing arsenic, barium and cobalt concentrations in groundwater (ITRC 2010; USEPA 2007b). Arsenic is removed through sorption to iron hydroxides or formation of insoluble sulfides and barium is removed through sorption to iron hydroxides and formation of insoluble sulfate and carbonate minerals (ITRC 2010). Cobalt is removed through adsorption to iron hydroxides and/or amorphous metals and the level of effectiveness is dependent on iron hydroxide availability as well as pH, alkalinity, and calcium levels (ITRC 2010). The removal mechanisms for lithium are not identified in the professional literature; however, as described in Section 3.4 - 3.6 of this report, the Site is a good candidate for MNA, since natural attenuation of arsenic, barium, cobalt and lithium is ongoing in the vicinity of the A1 LF.

MNA would be effective in remediating groundwater beneath and downgradient of the landfill. The estimated time to implement MNA is estimated to be approximately 2 to 3 years, including characterization, design, and construction. The estimated time to achieve GWPS for the target Appendix IV constituents is dependent on site-specific conditions and groundwater modeling is needed to better evaluate remedial timeframes.

4.3.2 Groundwater Extraction and Treatment

Groundwater extraction and treatment is one of the most widely implemented groundwater remediation technologies and is used to provide 1) hydraulic containment and 2) treatment (USEPA 1996). A groundwater extraction and treatment system consists of the following major components:

- A series of extraction wells or trenches strategically located to modify/interrupt the natural flow of groundwater;
- Extraction pumps installed in each well/trench to pump groundwater from the subsurface;
- A treatment system to remove constituents of concern from the extracted groundwater; and
- A point of discharge for the treated groundwater (surface water, re-injection to groundwater, etc.).

For the A1 LF, a system of extraction wells would be installed along the downgradient edge of the landfill to provide hydraulic control of the Appendix IV constituent groundwater plumes. The extracted groundwater would be treated in an on-site treatment system and treated water would be discharged to Martin Lake or re-injected into the aquifer.

Potential groundwater treatment methods for the target Appendix IV constituents include the following:

- Arsenic – activated alumina, ion exchange, reverse osmosis, precipitative softening, coagulation/filtration and oxidation/filtration (USEPA 2019a);
- Barium - ion exchange, lime softening, reverse osmosis, and electrodialysis (USEPA 1992)
- Cobalt - ion exchange, adsorptive media, activated carbon, and chemical treatment with membrane filtration (USEPA 2019a).
- Lithium - reverse osmosis, precipitation/co-precipitation, and ion exchange. (USACE 2010).

Treatment methods for these constituents would need to be bench/pilot tested to evaluate their effectiveness prior to designing a full-scale system. Treatment will generate residual material (sludge, regenerate brine, etc.) containing concentrated levels of the target Appendix IV constituents that must managed.

Groundwater extraction and treatment would be effective in reducing contaminant concentrations in groundwater downgradient of the A1 LF through hydraulic containment, but would have little effect on groundwater conditions beneath the landfill. The estimated time to implement groundwater extraction and treatment is estimated to be approximately 3 to 4 years, including testing, design, and construction. The estimated time to achieve GWPS for the target Appendix IV constituents is dependent on site-specific conditions and groundwater modeling is needed to better evaluate remedial timeframes.

4.3.3 Vertical Hydraulic Barrier

A vertical, low permeability hydraulic barrier can be installed to provide a physical barrier to groundwater flow to contain the migration of contaminated groundwater. Vertical hydraulic barriers that have been demonstrated effective at controlling groundwater flow include the following (USEPA 1998):

- Slurry Wall. Slurry walls consist of a narrow, excavated trench that is filled with a soil-bentonite slurry mixture. The slurry shores and supports the trench walls and forms a low-permeability barrier in the trench. Key design considerations include wall depth, key depth, and material compatibility. Slurry trenches can be excavated to depths of 50 feet using standard excavators and over 80 feet using long-reach excavators or a crane mounted drag line/clamshell bucket. Geosynthetic materials can be placed in the trench in conjunction with the slurry wall to improve the hydraulic performance (decrease permeability) and chemical resistance.
- Soil-Mixed Wall. Soil-mixed walls form a hydraulic barrier through in-situ mixing of soil with amendments, such as bentonite and/or cement. Soil-mixed barrier walls can be installed to depths of over 100 feet. The walls are installed by sections or panels that overlap to achieve a continuous barrier.
- Grout Curtain. Grout curtain barriers are constructed by injecting grout into the subsurface in an overlapping injection pattern to form a continuous barrier. Grouted barriers can be installed using permeation grouting, jet grouting, or vibrating beam technologies. Grouted barriers must be designed and constructed to ensure hydrofracturing does not occur and the completed wall is effective at restricting groundwater flow.
- Sheet-pile Wall. Sheet-pile walls consist of steel, vinyl, or other materials driven into the subsurface using a hydraulic percussion hammer or vibratory hammer. Sheet-pile walls are common in civil engineering applications; however, their use in environmental applications has been more limited. One of the major concerns with sheet-walls in environmental applications is leakage through the vertical joints between piles; however, improvements in pile interlock designs have been made to improve joint sealing.

For a vertical hydraulic barrier to be effective, the bottom of the barrier must be “keyed” into a low-permeability confining layer. A detailed engineering analysis and design, likely including a bench/pilot test to identify most appropriate barrier materials, would be required for the construction of a vertical hydraulic barrier.

For the A1 LF, the vertical hydraulic barrier would be constructed along the downgradient edge of the landfill to provide hydraulic control of the target Appendix IV constituent groundwater plumes. A vertical hydraulic barrier physically interrupts the natural flow of groundwater; consequently, groundwater elevations upgradient of the barrier will rise, potentially to the point that groundwater could begin to flow around the edges of the barrier. To address this concern, a groundwater extraction and treatment system would be required upgradient of the barrier to control the groundwater levels. The groundwater extraction and treatment system used in conjunction with the vertical hydraulic barrier would be similar to the system described in Section 4.3.2; however, the required capacity of the system would be less since the rate of groundwater extraction would be limited to that required to control upgradient groundwater levels.

Construction of a vertical hydraulic barrier is expected to require significant effort and time. Prior to implementation of the barrier, pre-design field work, including site investigations and bench/pilot-scale barrier material testing would be required, followed by full-scale design and construction. The estimated time to implement a vertical hydraulic barrier with groundwater extraction and treatment is estimated to be approximately 5 to 8 years, including testing, design, and construction. The estimated time to achieve GWPS for the target Appendix IV constituents is dependent on site-specific conditions and groundwater modeling is needed to better evaluate remedial timeframes.

4.3.4 Permeable Reactive Barrier

A permeable reactive barrier (PRB) is an in-situ, permeable treatment zone that contains reactive media designed to intercept impacted groundwater and either immobilize contaminants or transform the contaminants to a more desirable state (ITRC 2011). A PRB is a passive treatment system that acts as a barrier to groundwater contamination but not groundwater flow. The PRB must intercept the flow of impacted groundwater and must be designed and constructed such that impacted groundwater cannot bypass the reactive media by flowing over, under, or around the PRB. A PRB must include the appropriate reactive media and the residence time within the PRB needs to sufficient to allow for effective treatment. The effectiveness of the reactive media will be reduced over time and the media will likely have to be replaced periodically. Groundwater monitoring is used to evaluate the performance/effectiveness of a PRB system.

There are two primary PRB configurations: continuous and funnel-and-gate. A continuous PRB features permeable reactive media across the entire length of the barrier. A funnel-and -gate PRB uses sections of vertical hydraulic barriers to direct groundwater flow through permeable reactive media sections that allow the groundwater to pass through while treating contaminants. In both configurations, the permeability of the reactive media must be greater than the aquifer to ensure flow is not diverted around the PRB media. For the A1 LF, PRB system would be constructed along the downgradient edge of the landfill to provide control of the cobalt and lithium groundwater plumes.

PRB systems are generally considered a proven technology, however, site conditions and the specific contaminants of interest affect the system performance. The potential applicability of a PRB system for the target Appendix IV constituents can be summarized as follows:

- Arsenic – potentially removed zero-valent iron (ZVI) or combination of ZVI and organic material (ITRC 2011);
- Barium – potentially precipitated as phosphate, sulfate or hydroxide (Arnseth 2018)
- Cobalt - potentially removed using sulfate-reducing media or combination of ZVI and organic material (Ludwig 2002; ITRC 2011);
- Lithium – potentially precipitated as phosphate using appetite media, (Arnseth 2018).

Other than arsenic, removal of the remaining target Appendix IV constituents using a PRB system has not been consistently demonstrated under full-scale conditions and bench/pilot-scale testing would be required to confirm the effectiveness of a PRB system at the Site. A groundwater model would be needed to evaluate the remedial timeframes.

Similar to a vertical hydraulic barrier, construction of a PRB system is expected to require significant effort and time. Prior to implementation of the PRB, pre-design field work, including site investigations, groundwater modeling, and bench-scale soil mix testing would be required, followed by full-scale design and construction. The estimated time to implement a PRB system is estimated to be approximately 5 to 8 years, including testing, design, and construction. The estimated time to achieve GWPS for the target Appendix IV constituents is dependent on site-specific conditions and groundwater modeling is needed to better evaluate remedial timeframes.

4.3.5 In-situ Chemical Treatment

In-situ Chemical Treatment (ICT) involves the injection of a chemical reagent or other material into the groundwater aquifer to adjust the geochemistry to enhance the direct precipitation, co-precipitation, or related adsorption/precipitation of the target contaminants (USEPA 2019c). Direct precipitation occurs when a constituent exceeds its solubility in water and precipitates out of solution. Co-precipitation refers to the removal of a constituent through adsorption onto the precipitate of another chemical reaction.

Arsenic has the potential to be removed through reduction and precipitation or co-precipitation, barium has the potential to be precipitated as a sulfate and lithium has the potential to be precipitated as a phosphate under appropriate geochemical conditions (Arnseth 2018). Cobalt has the potential to be removed through adsorption and/or coprecipitation under reducing groundwater conditions (Goldemund and Robb 2018).

Injection wells would be installed into the aquifer along the downgradient edge of the A1 LF and the chemical reagents would be injected to provide control of the target Appendix IV constituent groundwater plumes.

ICT is considered an emerging remediation technology for the target Appendix IV constituents and the effectiveness of the technology on most of the constituents is uncertain. Bench/pilot-scale testing would be required to confirm the effectiveness of an ICT system at the Site. The estimated time to implement an ICT system is estimated to be approximately 5 to 8 years, including testing, design, and construction. The estimated time to achieve GWPS for the target Appendix IV constituents is dependent on site-specific conditions and groundwater modeling is needed to better evaluate remedial timeframes.

4.3.6 Phytoremediation

Phytoremediation refers to the use of plants to partially or substantially remediate selected contaminants in contaminated soil, sludge, sediment, ground water, surface water, and wastewater (USEPA 2001). The process utilizes a variety of plant biological processes and plant physical characteristics to aid in remediation; however, the primary plant process potentially applicable to the target Appendix IV constituents at the Site is phytoextraction, which is the uptake and accumulation of contaminants within aboveground portions of a plant. The contaminants are removed from the Site when the plants are harvested and managed off-site. No information concerning the effectiveness of phytoremediation for lithium removal was identified.

Phytoextraction occurs in the root zone of plants, which is typically relatively shallow, with the bulk of roots at shallower rather than deeper depths. This would limit the effectiveness of phytoextraction at the Site due to the depth of groundwater. Phytoremediation for arsenic and cobalt removal from groundwater has not been demonstrated under full-scale conditions and no information concerning the effectiveness of phytoremediation for barium and lithium removal was identified (USEPA 2001).

Implementation of a phytoremediation process at the Site would involve planting appropriate vegetation at intervals along the downgradient edge of the A1 LF and across the affected groundwater plume area. A comprehensive bench/pilot testing program would be required to select the most appropriate plants for removal of the target Appendix IV constituents from groundwater at the Site. Since the target Appendix IV constituents would likely accumulate in the plants, management of harvested plants in accordance with RCRA may be required.

The estimated time to implement an ICT system is estimated to be approximately 15 to 20 years, based on the success and rate of vegetation growth. The estimated time to achieve GWPS for the target Appendix IV constituents is dependent on site-specific conditions and groundwater modeling is needed to better evaluate remedial timeframes.

4.3.7 Screening of Potential Groundwater Response Technologies

Following identification of potential groundwater response technologies, Golder screened the potential options for further consideration in developing potential corrective measures alternatives for the A1 LF. The screening results for each potential source technology are summarized in Table 3. Based on the initial screening, the following potential groundwater response technologies were retained for future evaluation as part of the corrective measures alternatives for the A1 LF:

- Monitored Natural Attenuation
- Groundwater Extraction and Treatment
- Vertical Hydraulic Barrier

4.4 Potential Corrective Measures Alternatives

Based on the response technology screening discussed above, Golder assembled the following potential corrective measures alternatives that could be both effective and implementable at the Site:

- Closure-in-Place/Capping with Monitored Natural Attenuation
- Closure-in-Place/Capping with Groundwater Extraction and Treatment
- Closure-in-Place/Capping with Vertical Hydraulic Barrier

A summary of the corrective measure alternatives, including an assessment of each alternative against the evaluation criteria presented in §257.96(c) is provided in Table 4.

4.5 Remedy Selection

The corrective measure alternative proposed as the remedy for the A1 LF will be selected in accordance with §257.97 a minimum of 30 days after the public meeting required under §257.96(e) has been completed.

It should also be noted that, for purposes of this ACM, arsenic, barium, cobalt and lithium concentrations were conservatively assumed to be present at SSLs above their respective GWPSs based on the February 2019 SSL notification. However, as discussed in Sections 3.4-3.6, arsenic, barium and lithium concentrations are no longer considered to be present at SSLs above the GWPSs based on recent data and it is likely that the arsenic, barium and lithium concentrations observed in Site monitoring wells originate from a natural source other than the landfill. Arsenic, barium, cobalt and lithium concentrations in groundwater will continue to be monitored in accordance with the CCR Rule to confirm that the concentrations of these constituents remain below the GWPSs in the future. These monitoring results, along with updated statistical analysis and alternate source demonstrations (if applicable), will be considered as part of the remedy selection process.

5.0 REFERENCES

Arnseth, Richard W., 2018. Remedial Technologies to Address CCR Constituents in Groundwater, Tennessee Department of Environmental Conservation - Environmental Show of the South, May

Barnes, Virgil E., 1970. Geologic Atlas of Texas, Waco Sheet. Texas Bureau of Economic Geology.

Bethke, C., 2015. Geochemist's Workbench: Release 12.0 - Aqueous Solutions, LLC.

Code of Federal Regulations, 2015 April. Chapter 40, Part 257, Subpart D.

Dzombak, D.A. and Morel, F., 1990. Surface complexation modeling: hydrous ferric oxide. John Wiley & Sons.

Goldemund, H and Robb, C, 2018. Current Overview of Groundwater Remediation Options for CCR Units, Proceedings of 2018 World of Coal Ash Conference.

Golder, 2019. Drinking Water Survey Report – Revision No. 1, Martin Lake Steam Electric Station – A1 Area Landfill, Panola County, Texas. July 25.

Hem, J.D., 1985. Study and interpretation of the chemical characteristics of natural water (Vol. 2254). US Geological Survey.

ITRC. 2010. A Decision Framework for Applying Monitored Natural Attenuation Processes to Metals and Radionuclides in Groundwater. Technical/Regulatory Guidance, December 2010.

ITRC. 2011. Permeable Reactive Barrier: Technology Update. PRB-5. June 2011.

Karamalidis, A. and Dzombak, D., 2011. Surface complexation modeling: gibbsite. John Wiley & Sons.

Ludwig, R, et. al., 2002. A Permeable Reactive Barrier for Treatment of Heavy Metals in Ground Water 40(1):59-66, January 2002

Parkhurst, D. and Appelo, C., 2013. Description of input and examples for PHREEQC version 3: a computer program for speciation, batch-reaction, one-dimensional transport, and inverse geochemical calculations (No. 6-A43). US Geological Survey.

Pastor, Behling & Wheeler, LLC (PBW), 2016. CCR Closure Plan – Martin Lake Steam Electric Station A-1 Area Landfill, Panola County, Texas, October.

PBW, 2017a. Coal Combustion Residual Rule Groundwater Monitoring System Certification, Martin Lake Steam Electric Station, A1 Area Landfill. October 16, 2017.

PBW, 2017b. Coal Combustion Residual Rule Statistical Analysis Plan, Martin Lake Steam Electric Station, A1 Area Landfill. October 11, 2017.

Smith, K., 1999. Metal sorption on mineral surfaces: an overview with examples relating to mineral deposits. The Environmental Geochemistry of Mineral Deposits. Part B: Case Studies and Research Topics, 6, pp.161-182.

Tessier, A., Campbell, P.G. and Bisson, M., 1979. Sequential extraction procedure for the speciation of particulate trace metals. Analytical chemistry, 51(7), pp.844-851.

Uddin, M., 2017. A review on the adsorption of heavy metals by clay minerals, with special focus on the past decade. Chemical Engineering Journal, 308, pp.438-462.

US Army Corps of Engineers (USACE), 2010. Maywood Chemical Company Superfund Site, Groundwater Feasibility Study Report, September

USEPA, 1992. Barium - Fact Sheet on a Drinking Water Chemical Contaminant.

USEPA, 1996. Pump-and-Treat Ground-Water Remediation: A Guide for Decision Makers and Practitioners. EPA/625/R-95/005. July 1996.

USEPA. 1998. Evaluation of Subsurface Engineered Barriers at Waste Sites, EPA-542-R-98-005, July 1998.

USEPA. 2001. Phytoremediation of Contaminated Soil and Ground Water at Hazardous Waste Sites, EPA/540-S-01/500. February 2001.

USEPA, 2007a. Monitored Natural Attenuation of Inorganic Contaminants in Ground Water. Volume 1. Technical Basis for Assessment. EPA/600/R-07/139.

USEPA, 2007b. Monitored Natural Attenuation of Inorganic Contaminants in Ground Water. Volume 2. Assessment for Non-Radionuclides Including Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Nitrate, Perchlorate, and Selenium. EPA/600/R-07/140.

USEPA, 2009. Unified Guidance Document: Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, EPA 530-R-09-007, March 2009.

USEPA, 2014. Reference Guide to Treatment Technologies for Mining-Influenced Water. March 2014.

USEPA, 2015. 40 CFR Parts 257 and 261; Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule. April 17, 2015.

USEPA, 2015. Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites. U.S. Environmental Protection Agency Office of Solid Waste and Emergency Response Directive 9283.1-36. August 2015.

USEPA, 2019a. Drinking Water Treatability Database – Arsenic and Cobalt . Retrieved from https://oaspub.epa.gov/tdb/pages/general/home.do

USEPA, 2019b. Permeable Reactive Barriers. CLU-IN. Retrieved from https://clu-in.org/techfocus/default.focus/sec/Permeable_Reactive_Barriers%2C_Permeable_Treatment_Zones%2C_and_Application_of_Zero-Valent_Iron/cat/Overview/

USEPA, 2019c. In Situ Chemical Reduction. CLU-IN. Retrieved from https://clu-in.org/techfocus/default.focus/sec/In_Situ_Chemical_Reduction/cat/Overview/

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TABLES

TABLE 1
APPENDIX IV GROUNDWATER ANALYTICAL DATA SUMMARY
A1 AREA LANDFILL

Sample Location	Date Sampled	Sb (mg/L)	As (mg/L)	Ba (mg/L)	Be (mg/L)	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	Fl (mg/L)	Pb (mg/L)	Li (mg/L)	Hg (mg/L)	Mo (mg/L)	Se (mg/L)	Tl (mg/L)	Ra 226 (pCi/L)	Ra 228 (pCi/L)	Ra 226/228 Comb.^ (pCi/L)
	GWPS:	0.006	0.0164	2	0.004	0.005	0.1	0.0124	4	0.015	0.103	0.002	0.1	0.05	0.002	--	--	10.7
Upgradient Wells																		
BMW-11-AR	10/29/15	<0.0008	0.0116	0.0659	<0.0003	<0.0003	<0.002	0.0124	<0.1	0.000391 J	0.0594	<0.00008	0.00496 J	<0.002	<0.0005	1.60	4.75	6.35
	12/30/15	<0.0008	0.00362 J	0.0433	<0.0003	<0.0003	<0.002	<0.003	0.26 J	0.000362 J	0.0589	<0.00008	0.00384 J	<0.002	<0.0005	1.66	3.19	4.85
	02/25/16	<0.0008	0.00608	0.0724	<0.0003	<0.0003	<0.002	0.00486 J	0.123 J	<0.0003	0.0276	<0.00008	0.00597	<0.002	<0.0005	2.43	3.80	6.23
	04/07/16	<0.0008	0.00614	0.0929	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0195	<0.00008	0.00444 J	<0.002	<0.0005	0.885	1.48	2.37
	06/09/16	<0.0008	0.00532	0.0891	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0187	<0.00008	0.00355 J	<0.002	<0.0005	0.47	<0.674	1.14
	08/11/16	<0.0008	0.00271 J	0.0772	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0147	<0.00008	0.00346 J	<0.002	<0.0005	0.810	2.42	3.23
	10/26/16	<0.0008	<0.002	0.0429	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0508	<0.00008	0.00363 J	<0.002	<0.0005	0.631	0.922	1.55
	12/14/16	<0.0008	0.0061	0.074	<0.0003	<0.0003	<0.002	<0.003	<0.1	0.00347	0.0139	<0.00008	0.00303 J	<0.002	<0.0005	<0.821	<1.73	<2.551
	06/12/18	<0.0008	0.00444 J	0.0692	<0.0003	<0.0003	0.00295 J	<0.003	0.323 J	0.0017	0.0686	<0.00008	0.00340 J	<0.002	<0.0005	0.996	1.7	2.696
	09/14/18	NA	0.0056	0.0735	NA	NA	<0.002	<0.003	0.353 J	0.00147	0.0196	NA	0.00299 J	NA	NA	1.52	1.11	2.63
	05/15/19	<0.0008	0.00208 J	0.0399	<0.0003	<0.0003	<0.002	<0.003	0.198 J	<0.0003	0.0404	<0.00008	<0.002	<0.002	<0.0005	0.83	4.89	5.72
BMW-27	9/13/16	<0.0008	0.00536	0.0434	<0.0003	0.00062 J	<0.002	0.15	0.668	0.000432 J	0.0541	<0.00008	<0.002	<0.002	<0.0005	0.308	<1.14	1.45
	10/26/16	<0.0008	0.00625	0.0339	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0933	<0.00008	<0.002	<0.002	<0.0005	0.156	1.94	2.10
	12/14/16	<0.0008	0.0051	0.0342	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0932	<0.00008	<0.002	<0.002	<0.0005	<0.12	<1.05	<1.17
	01/23/17	<0.0008	0.00845	0.0333	<0.0003	0.00071 J	0.00278 J	0.195	0.573	0.000323 J	0.0484	<0.00008	<0.002	<0.002	<0.0005	0.369	0.934	1.30
	02/23/27	<0.0008	<0.002	0.0704	<0.0003	<0.0003	<0.002	<0.003	0.252 J	0.000736 J	<0.005	<0.00008	<0.002	<0.002	<0.0005	<0.209	0.660	0.87
	03/24/17	<0.0008	0.00319 J	0.0296	<0.0003	0.00078 J	<0.002	0.222	0.738	<0.0003	0.0474	<0.00008	<0.002	<0.002	<0.0005	0.414	<0.725	1.14
	04/24/17	<0.0008	<0.002	0.0269	<0.0003	0.00066 J	<0.002	0.21	0.663	<0.0003	0.0497	<0.00008	<0.002	<0.002	<0.0005	<0.452	1.53	1.98
	05/25/17	<0.0008	<0.002	0.0266	<0.0003	0.000521 J	<0.002	0.2	1.61	0.000439 J	0.0471	<0.00008	<0.002	<0.002	<0.0005	<0.443	1.38	1.82
	06/29/17	<0.0008	0.00593	0.0307	<0.0003	0.00851 J	0.00266 J	0.255	0.717	<0.0003	0.048	<0.0008	<0.002	<0.002	<0.0005	0.303	0.628	0.93
	06/12/18	<0.0008	0.00223 J	0.0182	<0.0003	<0.0003	<0.002	<0.003	<0.100	0.00097 J	0.0721	<0.00008	<0.002	<0.002	<0.0005	0.305	<0.5860	0.891
	09/13/18	NA	0.00467 J	0.0250	NA	NA	0.002 J	0.190	0.750	<0.0003	0.0531	NA	<0.002	NA	NA	0.691	1.04	1.731
	05/15/19	<0.0008	<0.002	0.0238	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0943	<0.00008	<0.002	<0.002	<0.0005	<0.195	0.962	1.157
BMW-33	08/01/19	NA	<0.00200	NA	NA	NA	NA	0.0176	0.342	NA	0.0206	NA	NA	NA	NA	NA	NA	NA
AI-17-SPOIL	08/14/19	NA	NA	NA	NA	NA	NA	<0.003	NA	NA	0.0394	NA	NA	NA	NA	NA	NA	NA
AIV-18-OB-95	07/08/19	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.0454	NA	NA	NA	NA	NA	NA	NA
Downgradient Wells																		
BMW-18	10/30/15	<0.0008	<0.002	0.0401	<0.0003	<0.0003	0.00944	<0.003	0.148 J	<0.0003	0.14	<0.00008	<0.002	<0.002	<0.0005	0.526	<1.51	2.04
	12/30/15	<0.0008	<0.002	0.0168	<0.0003	<0.0003	<0.002	0.0129	0.101 J	<0.0003	0.0415	<0.00008	<0.002	<0.002	<0.0005	<0.405	<2.04	<2.445
	02/26/16	<0.0008	<0.002	0.0446	<0.0003	<0.0003	0.00214 J	<0.003	0.164 J	<0.0003	0.0156	<0.00008	<0.002	<0.002	<0.0005	<0.406	<1.9	<2.306
	04/07/16	<0.0008	<0.002	0.0306	<0.0003	<0.0003	<0.002	<0.003	0.117 J	<0.0003	0.0171	<0.00008	<0.002	<0.002	<0.0005	<0.109	<1.00	<1.109
	06/09/16	<0.0008	<0.002	0.0283	<0.0003	<0.0003	<0.002	<0.003	0.128 J	<0.0003	0.0152	<0.00008	<0.002	<0.002	<0.0005	<0.143	0.857	1.00
	08/11/16	<0.0008	<0.002	0.0291	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0147	<0.00008	<0.002	<0.002	<0.0005	<0.22	<1.07	<1.29
	10/26/16	<0.0008	<0.002	0.029	<0.0003	<0.0003	<0.002	<0.003	0.158 J	<0.0003	0.0156	<0.00008	<0.002	<0.002	<0.0005	<0.132	<0.534	<0.666
	12/14/16	<0.0008	<0.002	0.0384	<0.0003	<0.0003	<0.002	<0.003	0.134 J	<0.0003	0.0158	<0.00008	<0.002	<0.002	<0.0005	0.140	<1.99	2.13
	06/12/18	<0.0008	<0.002	0.0412	<0.0003	<0.0003	<0.002	<0.003	0.176 J	0.0013	0.0185	<0.00008	<0.002	<0.002	<0.0005	0.232	0.706	0.938
	09/14/18	NA	<0.002	0.0277	NA	NA	<0.002	<0.003	0.201 J	<0.0003	0.0165	NA	<0.002	NA	NA	<0.509	<0.589	<1.098
	05/15/19	<0.0008	<0.002	0.0362	<0.0003	<0.0003	<0.002	<0.003	0.229 J	<0.0003	0.016	<0.00008	<0.002	<0.002	<0.0005	<0.264	3.95	4.214
BMW-19	10/29/18	<0.0008	<0.002	0.0231	<0.0003	<0.0003	<0.002	0.0161	<0.1	<0.0003	0.0545	<0.00008	<0.002	<0.002	<0.0005	0.395	<1.56	1.96
	12/30/15	<0.0008	<0.002	0.0222	<0.0003	<0.0003	<0.002	0.0166	0.127 J	<0.0003	0.0506	<0.00008	<0.002	<0.002	<0.0005	0.598	<2.89	3.49
	02/25/16	<0.0008	0.00235 J	0.0169	<0.0003	<0.0003	<0.002	0.0149	<0.1	<0.0003	0.0711	<0.00008	<0.002	<0.002	<0.0005	0.571	1.94	2.51
	04/07/16	<0.0008	<0.002	0.0178	<0.0003	<0.0003	<0.002	0.0137	<0.1	<0.0003	0.0591	<0.00008	<0.002	<0.002	<0.0005	<0.185	<0.715	<0.9
	06/09/16	<0.0008	<0.002	0.0158	<0.0003	<0.0003	<0.002	0.0141	<0.1	<0.0003	0.0644	<0.00008	<0.002	<0.002	<0.0005	<0.142	1.98	2.12
	08/11/16	<0.0008	0.00711	0.0158	<0.0003	<0.0003	<0.002	0.0128	<0.1	<0.0003	0.0568	<0.00008	<0.002	<0.002	<0.0005	0.927	<0.812	1.74
	10/26/16	<0.0008	<0.002	0.0144	<0.0003	<0.0003	<0.002	0.0104	<0.1	<0.0003	0.0495	<0.00008	<0.002	<0.002	<0.0005	<0.152	<0.48	<0.632
	12/14/16	<0.0008	0.00369 J	0.0171	<0.0003	<0.0003	<0.002	0.0125	<0.1	<0.0003	0.0584	<0.00008	<0.002	<0.002	<0.0005	0.309	0.827	1.14
	06/12/18	<0.0008	0.0428	0.0243	<0.0003	<0.0003	0.00267	0.0115	<0.100	0.00183	0.0734	<0.00008	<0.002	<0.002	<0.0005	<0.395	1.17	1.565
	09/13/18	NA	0.00491 J	0.0132	NA	NA	<0.002	0.0125	0.404 J	<0.0003	0.0845	NA	<0.002	NA	NA	<0.376	1.46	1.836
	05/15/19	<0.0008	<0.002	0.0104	<0.0003	<0.0003	<0.002	<0.003	0.189 J	<0.0003	0.0647	<0.00008	<0.002	<0.002	<0.0005	0.487	4.66	5.147

APPENDIX G-Revision 1 December 15, 2022

TABLE 1
APPENDIX IV GROUNDWATER ANALYTICAL DATA SUMMARY
A1 AREA LANDFILL

Sample Location	Date Sampled	Sb (mg/L)	As (mg/L)	Ba (mg/L)	Be (mg/L)	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	Fl (mg/L)	Pb (mg/L)	Li (mg/L)	Hg (mg/L)	Mo (mg/L)	Se (mg/L)	Tl (mg/L)	Ra 226 (pCi/L)	Ra 228 (pCi/L)	Ra 226/228 Comb.^ (pCi/L)
	GWPS:	0.006	0.0164	2	0.004	0.005	0.1	0.0124	4	0.015	0.103	0.002	0.1	0.05	0.002	--	--	10.7
BMW-20	10/23/15	<0.0008	0.00236 J	0.0778	<0.0003	<0.0003	<0.002	0.0256	<0.1	0.000501 J	<0.005	<0.00008	<0.002	<0.002	<0.0005	0.463	<1.89	2.35
	12/30/15	<0.0008	0.00344 J	0.0777	<0.0003	<0.0003	<0.002	0.051	0.12 J	<0.0003	<0.005	<0.00008	<0.002	<0.002	<0.0005	0.816	<2.41	3.23
	02/25/16	<0.0008	0.00474 J	0.0989	<0.0003	<0.0003	<0.002	0.022	<0.1	<0.0003	<0.005	<0.00008	<0.002	<0.002	<0.0005	<0.61	2.85	3.46
	04/07/16	<0.0008	0.00411 J	0.0912	<0.0003	<0.0003	<0.002	0.0276	<0.1	<0.0003	<0.005	<0.00008	<0.002	<0.002	<0.0005	0.221	<1.08	1.30
	06/09/16	<0.0008	0.0103	0.0776	<0.0003	<0.0003	<0.002	0.054	<0.1	0.000696 J	<0.005	<0.00008	<0.002	<0.002	<0.0005	0.51	<0.716	1.23
	08/11/16	<0.0008	<0.002	0.0637	<0.0003	<0.0003	<0.002	0.0513	<0.1	<0.0003	<0.005	<0.00008	<0.002	<0.002	<0.0005	0.322	1.40	1.72
	10/26/16	<0.0008	0.00444 J	0.0421	<0.0003	<0.0003	<0.002	0.0786	<0.1	<0.0003	<0.005	<0.00008	<0.002	<0.002	<0.0005	0.347	0.848	1.20
	12/13/16	<0.0008	0.00483 J	0.0377	<0.0003	<0.0003	<0.002	0.0451	<0.1	<0.0003	<0.005	<0.00008	<0.002	<0.002	<0.0005	0.246	1.15	1.40
	06/11/18	<0.0008	0.00473 J	0.0515	<0.0003	<0.0003	<0.002	0.0681	0.144 J	0.000476	<0.005	<0.00008	<0.002	<0.002	<0.0005	0.74	0.865	1.605
	09/13/18	NA	0.00473 J	0.0258	NA	NA	<0.002	0.0645	<0.100	0.000368 J	<0.005	NA	<0.002	NA	NA	0.519	0.711	1.23
	05/15/18	<0.0008	0.00541	0.0412	<0.0003	<0.0003	<0.002	0.003	0.418	<0.0003	0.0615	<0.00008	<0.002	<0.002	<0.0005	1.18	0.657	1.837
BMW-21	10/23/15	<0.0008	0.00324 J	0.0703	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0623	<0.00008	<0.002	<0.002	<0.0005	<0.436	<0.948	<1.384
	12/30/15	<0.0008	0.00247 J	0.0478	<0.0003	<0.0003	<0.002	<0.003	0.126 J	<0.0003	0.0602	<0.00008	<0.002	<0.002	<0.0005	0.584	<2.00	2.58
	02/25/16	<0.0008	0.00327 J	0.0471	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0602	<0.00008	<0.002	<0.002	<0.0005	0.735	2.13	2.87
	04/07/16	<0.0008	0.00337 J	0.0472	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0653	<0.00008	<0.002	<0.002	<0.0005	0.470	<2.78	3.25
	06/09/16	<0.0008	0.0034 J	0.0457	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0675	<0.00008	<0.002	<0.002	<0.0005	0.32	<0.917	1.24
	08/11/16	<0.0008	0.00373 J	0.0445	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0527	<0.00008	<0.002	<0.002	<0.0005	0.655	<0.728	1.38
	10/26/16	<0.0008	0.0037 J	0.0443	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0611	<0.00008	<0.002	<0.002	<0.0005	0.383	1.61	1.99
	12/13/16	<0.0008	0.00217 J	0.0438	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0631	<0.00008	<0.002	<0.002	<0.0005	0.213	1.00	1.21
	06/11/18	<0.0008	0.00373 J	0.0438	<0.0003	<0.0003	<0.002	<0.003	0.233 J	<0.0003	0.07	<0.00008	<0.002	<0.002	<0.0005	<0.239	<0.939	<1.178
	09/13/18	NA	0.00353 J	0.0412	NA	NA	<0.002	<0.003	0.136 J	<0.0003	0.0646	NA	<0.002	NA	NA	0.562	1.49	2.052
	05/15/19	<0.0008	0.00399 J	0.0412	<0.0003	<0.0003	<0.002	<0.003	0.366 J	<0.0003	0.0613	<0.00008	<0.002	<0.002	<0.0005	<0.322	1.07	1.392
BMW-22	10/23/15	<0.0008	<0.002	0.106	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0675	<0.00008	<0.002	<0.002	<0.0005	1.59	2.11	3.70
	12/30/15	<0.0008	<0.002	0.084	<0.0003	<0.0003	<0.002	<0.003	0.186 J	<0.0003	0.0594	<0.00008	<0.002	<0.002	<0.0005	0.973	<1.55	2.52
	02/25/16	<0.0008	<0.002	0.0761	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0801	<0.00008	<0.002	<0.002	<0.0005	0.594	<1.93	2.52
	04/07/16	<0.0008	<0.002	0.072	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0773	<0.00008	<0.002	<0.002	<0.0005	0.480	1.46	1.94
	06/08/16	<0.0008	0.00206 J	0.0667	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0847	<0.00008	<0.002	<0.002	<0.0005	0.888	1.88	2.77
	08/11/16	<0.0008	<0.002	0.0679	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0675	<0.00008	<0.002	<0.002	<0.0005	0.607	1.93	2.54
	10/26/16	<0.0008	0.00216 J	0.0645	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0753	<0.00008	<0.002	<0.002	<0.0005	0.633	1.02	1.65
	12/13/16	<0.0008	0.00232 J	0.0655	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0689	<0.00008	<0.002	<0.002	<0.0005	<0.209	1.05	1.26
	06/11/18	<0.0008	<0.002	0.0638	<0.0003	<0.0003	<0.002	<0.003	0.312 J	<0.0003	0.089	<0.00008	<0.002	<0.002	<0.0005	0.522	<1.020	1.54
	09/13/18	NA	<0.002	0.063	NA	NA	<0.002	<0.003	0.205 J	<0.0003	0.0882	NA	<0.002	NA	NA	1.29	2.89	4.18
	05/15/19	<0.0008	<0.002	0.0618	<0.0003	<0.0003	<0.002	<0.003	0.351 J	<0.0003	0.0779	<0.00008	<0.002	<0.002	<0.0005	3.36	1.64	5.00
BMW-23	10/23/15	<0.0008	<0.002	0.0519	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0802	<0.00008	<0.002	<0.002	<0.0005	1.19	<1.91	3.10
	12/30/15	<0.0008	<0.002	0.0462	<0.0003	<0.0003	<0.002	<0.003	0.122 J	<0.0003	0.0897	<0.00008	<0.002	<0.002	<0.0005	0.711	<2.62	3.33
	02/25/16	<0.0008	<0.002	0.0488	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0959	<0.00008	<0.002	<0.002	<0.0005	0.604	<1.78	2.38
	04/07/16	<0.0008	<0.002	0.0472	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.095	<0.00008	<0.002	<0.002	<0.0005	0.723	1.98	2.70
	06/08/16	<0.0008	<0.002	0.0497	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.103	<0.00008	<0.002	<0.002	<0.0005	0.654	1.29	1.94
	08/11/16	<0.0008	<0.002	0.0458	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.077	<0.00008	<0.002	<0.002	<0.0005	0.936	1.94	2.88
	10/26/16	<0.0008	<0.002	0.0437	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0856	<0.00008	<0.002	<0.002	<0.0005	0.472	1.76	2.23
	12/13/16	<0.0008	<0.002	0.0407	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0817	<0.00008	<0.002	<0.002	<0.0005	<0.225	0.704	0.93
	06/11/18	<0.0008	<0.002	0.0381	<0.0003	<0.0003	<0.002	<0.003	0.204 J	<0.0003	0.106	<0.00008	<0.002	<0.002	<0.0005	0.442	1.79	2.23
	09/13/18	NA	<0.002	0.0414	NA	NA	<0.002	<0.003	0.190 J	<0.0003	0.0915	NA	<0.002	NA	NA	0.774	1.23	2.00
	05/15/19	<0.0008	0.0024	0.0381	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0951	<0.00008	<0.002	<0.002	<0.0005	2.54	1	3.54

TABLE 1
APPENDIX IV GROUNDWATER ANALYTICAL DATA SUMMARY
A1 AREA LANDFILL

Sample Location	Date Sampled	Sb (mg/L)	As (mg/L)	Ba (mg/L)	Be (mg/L)	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	Fl (mg/L)	Pb (mg/L)	Li (mg/L)	Hg (mg/L)	Mo (mg/L)	Se (mg/L)	Tl (mg/L)	Ra 226 (pCi/L)	Ra 228 (pCi/L)	Ra 226/228 Comb.^ (pCi/L)
	GWPS:	0.006	0.0164	2	0.004	0.005	0.1	0.0124	4	0.015	0.103	0.002	0.1	0.05	0.002	--	--	10.7
BMW-24	10/23/15	<0.0008	0.00494 J	1.87	<0.0003	<0.0003	<0.002	0.00802	0.247 J	<0.0003	<0.005	<0.00008	<0.002	<0.002	<0.0005	1.83	3.32	5.15
	12/30/15	<0.0008	0.00579	0.801	<0.0003	<0.0003	<0.002	0.0146	0.391 J	<0.0003	0.0161	<0.00008	<0.002	<0.002	<0.0005	0.485	<1.66	2.15
	02/25/16	<0.0008	0.00442 J	0.645	<0.0003	<0.0003	<0.002	0.0137	0.236 J	<0.0003	0.0267	<0.00008	<0.002	<0.002	<0.0005	1.20	<1.93	3.13
	04/07/16	<0.0008	0.00376 J	0.202	<0.0003	<0.0003	<0.002	0.0238	0.109 J	<0.0003	0.0415	<0.00008	<0.002	<0.002	<0.0005	<0.349	<1.58	<1.929
	06/08/16	<0.0008	0.00481 J	0.181	<0.0003	<0.0003	<0.002	0.0227	0.147 J	<0.0003	0.0475	<0.00008	<0.002	<0.002	<0.0005	0.360	1.26	1.62
	08/11/16	<0.0008	0.00414 J	1.26	<0.0003	<0.0003	<0.002	0.00707	0.225 J	<0.0003	0.00938 J	<0.00008	<0.002	<0.002	<0.0005	0.564	<0.942	1.51
	10/26/16	<0.0008	0.00364 J	1.88	<0.0003	<0.0003	<0.002	<0.003	0.305 J	<0.0003	0.00767 J	<0.00008	<0.002	<0.002	<0.0005	1.37	1.31	2.68
	12/13/16	<0.0008	0.00498 J	1.96	<0.0003	<0.0003	<0.002	0.00326 J	0.3 J	<0.0003	0.00914 J	<0.00008	<0.002	<0.002	<0.0005	0.270	1.16	1.43
	06/11/18	<0.0008	0.00266 J	0.487	<0.0003	<0.0003	<0.002	0.00633	0.466	<0.0003	0.0198	<0.00008	<0.002	<0.002	<0.0005	0.668	0.975	1.643
	09/13/18	NA	<0.002	2.19	NA	NA	<0.002	0.00304 J	0.769	<0.0003	0.00764 J	NA	<0.002	NA	NA	1.82	1.45	3.27
	05/15/19	<0.0008	0.00272 J	0.221	<0.0003	<0.0003	<0.002	0.000643	0.219 J	<0.0003	0.0512	<0.00008	<0.002	<0.002	<0.0005	1.45	<1.21	2.66
BMW-25	06/13/19	NA	NA	NA	NA	NA	NA	0.013	0.142	NA	0.0501	NA	NA	NA	NA	NA	NA	NA
	07/08/19	NA	NA	NA	NA	NA	NA	0.00514	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
BMW-26	9/13/16	<0.0008	0.017	0.0425	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0944	<0.00008	0.00215 J	<0.002	<0.0005	0.154	<1.02	1.17
	10/26/16	<0.0008	0.00318 J	0.0731	<0.0003	<0.0003	<0.002	0.00402 J	<0.1	<0.0003	<0.005	<0.00008	<0.002	<0.002	<0.0005	0.175	<0.695	0.87
	12/14/16	<0.0008	<0.002	0.0424	<0.0003	0.00082 J	<0.002	0.236	0.344 J	<0.0003	0.0527	<0.00008	<0.002	<0.002	<0.0005	0.177	<1.29	1.47
	01/23/17	<0.0008	0.0325	0.0446	<0.0003	<0.0003	<0.002	<0.003	<0.1	0.000594 J	0.0977	<0.00008	0.0035 J	<0.002	<0.0005	0.351	0.936	1.29
	02/23/27	<0.0008	<0.002	0.0705	<0.0003	<0.0003	<0.002	<0.003	0.106 J	0.000726 J	0.0052 J	<0.00008	<0.002	<0.002	<0.0005	0.306	0.951	1.26
	03/24/17	<0.0008	0.0107	0.0371	<0.0003	<0.0003	<0.002	<0.003	<0.1	0.000742 J	0.0964	<0.00008	0.00461 J	<0.002	<0.0005	0.335	<0.627	0.96
	04/24/17	<0.0008	0.00732	0.0322	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.099	<0.00008	0.00303 J	<0.002	<0.0005	<0.363	1.60	1.96
	05/25/17	<0.0008	0.00347 J	0.0243	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0951	<0.0008	0.00302 J	<0.002	<0.0005	<0.477	0.818	1.30
	06/29/17	<0.0008	0.0328	0.0352	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0985	<0.0008	0.00257 J	<0.002	<0.0005	0.198	0.677	0.88
	06/12/18	<0.0008	0.00316 J	0.0222	<0.0003	<0.0003	0.00231 J	<0.003	<0.100	0.00152	0.111	<0.00008	0.0029 J	<0.002	<0.0005	<0.251	<0.508	<0.759
	09/13/18	NA	0.0165	0.0360	NA	NA	<0.002	<0.003	<0.100	<0.0003	0.11	NA	<0.002	NA	NA	<0.426	0.826	1.252
	05/15/19	<0.0008	<0.002	0.0253	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.101	<0.00008	0.00218 J	<0.002	<0.0005	0.457	<1.13	1.587
BMW-27	9/13/16	<0.0008	0.00536	0.0434	<0.0003	0.00062 J	<0.002	0.15	0.668	0.000432 J	0.0541	<0.00008	<0.002	<0.002	<0.0005	0.308	<1.14	1.45
	10/26/16	<0.0008	0.00625	0.0339	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0933	<0.00008	<0.002	<0.002	<0.0005	0.156	1.94	2.10
	12/14/16	<0.0008	0.0051	0.0342	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.0932	<0.00008	<0.002	<0.002	<0.0005	<0.12	<1.05	<1.17
	01/23/17	<0.0008	0.00845	0.0333	<0.0003	0.00071 J	0.00278 J	0.195	0.573	0.000323 J	0.0484	<0.00008	<0.002	<0.002	<0.0005	0.369	0.934	1.30
	02/23/27	<0.0008	<0.002	0.0704	<0.0003	<0.0003	<0.002	<0.003	0.252 J	0.000736 J	<0.005	<0.00008	<0.002	<0.002	<0.0005	<0.209	0.660	0.87
	03/24/17	<0.0008	0.00319 J	0.0296	<0.0003	0.00078 J	<0.002	0.222	0.738	<0.0003	0.0474	<0.00008	<0.002	<0.002	<0.0005	0.414	<0.725	1.14
	04/24/17	<0.0008	<0.002	0.0269	<0.0003	0.00066 J	<0.002	0.21	0.663	<0.0003	0.0497	<0.00008	<0.002	<0.002	<0.0005	<0.452	1.53	1.98
	05/25/17	<0.0008	<0.002	0.0266	<0.0003	0.000521 J	<0.002	0.2	1.61	0.000439 J	0.0471	<0.00008	<0.002	<0.002	<0.0005	<0.443	1.38	1.82
	06/29/17	<0.0008	0.00593	0.0307	<0.0003	0.00851 J	0.00266 J	0.255	0.717	<0.0003	0.048	<0.0008	<0.002	<0.002	<0.0005	0.303	0.628	0.93
	06/12/18	<0.0008	0.00223 J	0.0182	<0.0003	<0.0003	<0.002	<0.003	<0.100	0.00097 J	0.0721	<0.00008	<0.002	<0.002	<0.0005	0.305	<0.5860	0.891
	09/13/18	NA	0.00467 J	0.0250	NA	NA	0.002 J	0.190	0.750	<0.0003	0.0531	NA	<0.002	NA	NA	0.691	1.04	1.731
	05/15/19	<0.0008	<0.002	0.0238	<0.0003	<0.0003	<0.002	<0.003	<0.100	<0.0003	0.0943	<0.00008	<0.002	<0.002	<0.0005	<0.195	0.962	1.157
BMW-28	12/14/16	0.0012 J	<0.002	0.0509	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.11	<0.00008	0.0103	0.0045 J	<0.0005	<0.566	<2.22	2.79
	01/23/17	0.001 J	<0.002	0.0518	<0.0003	<0.0003	<0.002	<0.003	0.104 J	<0.0003	0.116	<0.00008	0.00881	<0.002	<0.0005	0.626	1.12	1.75
	02/23/27	<0.0008	<0.002	0.0734	<0.0003	<0.0003	<0.002	<0.003	0.11 J	0.000965 J	0.00514 J	<0.00008	<0.002	<0.002	<0.0005	0.168	0.835	1.00
	03/24/17	0.0012 J	<0.002	0.046	<0.0003	<0.0003	<0.002	<0.003	<0.1	<0.0003	0.1	<0.00008	0.00773	0.0021 J	<0.0005	1.04	1.17	2.21
	04/24/17	0.0011 J	<0.002	0.047	<0.0003	<0.0003	<0.002	<0.003	0.19 J	<0.0003	0.109	<0.00008	0.00766	<0.002	<0.0005	0.356	1.880	2.24
	05/25/17	0.00119 J	<0.002	0.0468	<0.0003	<0.0003	<0.002	<0.003	<0.1	0.000427 J	0.102	<0.00008	0.00764	<0.002	<0.0005	<0.739	1.170	1.91
	06/29/17	<0.0008	0.00253 J	0.0549	<0.0003	<0.0003	<0.002	0.0084	0.137 J	<0.0003	0.104	<0.00008	0.00754	<0.002	<0.0005	0.489	2.310	2.80
	08/01/17	<0.0008	0.0057	0.0524	<0.0003	<0.0003	<0.002	0.0115	<0.1	<0.0003	0.114	<0.00008	0.00707	<0.002	<0.0005	0.536	2.43	2.97
	06/12/18	<0.0008	<0.002	0.0505	<0.0003	<0.0003	<0.002	<0.003	0.529	0.00122	0.116	<0.00008	0.00764	<0.002	<0.0005	0.197	1.12	1.32
	09/14/18	NA	<0.002	0.0419	NA	NA	<0.002	<0.003	0.445	<0.0003	0.114	NA	0.00782	NA	NA	0.35	1.15	1.50
	05/15/19	<0.0008	<0.002	0.0285	<0.0003	<0.0003	<0.002	<0.003	0.496	<0.0003	0.119	<0.00008	0.0124	<0.002	<0.0005	0.289	0.924	1.21

TABLE 1
APPENDIX IV GROUNDWATER ANALYTICAL DATA SUMMARY
A1 AREA LANDFILL

Sample Location	Date Sampled	Sb (mg/L)	As (mg/L)	Ba (mg/L)	Be (mg/L)	Cd (mg/L)	Cr (mg/L)	Co (mg/L)	Fl (mg/L)	Pb (mg/L)	Li (mg/L)	Hg (mg/L)	Mo (mg/L)	Se (mg/L)	Tl (mg/L)	Ra 226 (pCi/L)	Ra 228 (pCi/L)	Ra 226/228 Comb.^ (pCi/L)
	GWPS:	0.006	0.0164	2	0.004	0.005	0.1	0.0124	4	0.015	0.103	0.002	0.1	0.05	0.002	--	--	10.7
BMW-29	06/13/19	NA	NA	NA	NA	NA	NA	NA	<0.100	NA	0.114	NA	NA	NA	NA	NA	NA	NA
	07/08/19	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.104	NA	NA	NA	NA	NA	NA	NA
BMW-30	06/13/19	NA	NA	0.0982	NA	NA	NA	NA	<0.100	NA	NA	NA	NA	NA	NA	NA	NA	NA
BMW-31	06/13/19	NA	NA	NA	NA	NA	NA	NA	0.255	NA	0.0203	NA	NA	NA	NA	NA	NA	NA
BMW-32	06/13/19	NA	NA	NA	NA	NA	NA	0.115	0.822	NA	0.115	NA	NA	NA	NA	NA	NA	NA
	07/08/19	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.116	NA	NA	NA	NA	NA	NA	NA
AI-2-OB	08/14/19	NA	NA	NA	NA	NA	NA	<0.003	NA	NA	<0.005	NA	NA	NA	NA	NA	NA	NA

Notes:
1. Abbreviations: GWPS - groundwater protection standard; mg/L - milligrams per liter; pCi/L - picocuries per liter.
2. ^ - Sum of Ra 226 and Ra 228 concentrations. Non-detect isotope results were assigned a value equal to the minimum detectable concentration.
3. J - concentration is below method quantitation limit; result is an estimate.
4. NA - Not analyzed.

Table 2

Screening of Potential Source Control Response Technologies
Martin Lake Steam Electric Station
A1 Area Landfill

Source Control Response Technology	Description	Protective of Human Health and Environment	Attain Groundwater Protection Standard	Control Source of Release	Remove Contaminated Material From Environment	RCRA Compliance	Screening Comments	Retained for Further Evaluation
Closure In Place/Capping	Low-permeability cap constructed over landfill.	Isolates CCR material in landfill.	Mitigates on-going source of CCR constituents to groundwater, enhancing achievement of GWPS by Groundwater Response Technologies.	Minimizes potential for migration of CCR constituents to groundwater by controlling infiltration of precipitation through CCR material.	CCR material remains in landfill. Mitigates on-going source of CCR constituents to groundwater.	Complies with applicable RCRA requirements.	Capping is proven method of source control. Long-term cap maintenance and monitoring required.	Yes
Removal and Off-site Disposal	CCR material excavated from landfill, loaded onto trucks, transported to designated location, and placed in selected repository. Once placement complete, cap constructed over material.	CCR material removed from Site and no longer source of CCR constituents to groundwater. CCR material placed in new repository. Increased chance of exposure to workers and public during excavation, transportation, and placement at new repository.	Mitigates on-going source of CCR constituents to groundwater, enhancing achievement of GWPS by Groundwater Response Technologies.	Removes source of CCR constituents from Site.	Removes source of CCR constituents from Site. CCR material relocated to new repository.	Complies with applicable RCRA requirements.	Removal of material only implementable if suitable repository location is identified. Siting, regulatory approval, design, and construction of new repository likely required. Very large number of round-trip truck trips required to transport material to new location. New repository would require long term maintenance and monitoring. Difficult to implement due to logistics of excavation, transportation, and placement at new repository.	No

Table 3

Screening of Potential Groundwater Response Technologies
Martin Lake Steam Electric Station
A1 Area Landfill

Groundwater Response Technology	Description	Protective of Human Health and Environment	Attain Groundwater Protection Standard	Control Source of Release	Remove Contaminated Material From Environment	RCRA Compliance	Screening Comments	Retained for Further Evaluation
Monitored Natural Attenuation	Natural processes (dispersion, dilution, sorption, coprecipitation, degradation/transformation, etc.) remove CCR constituents from groundwater in-situ. Groundwater monitoring to verify MNA effectiveness.	Migration of CCR constituents in groundwater controlled and CCR concentrations in groundwater reduced.	CCR constituents removed from groundwater through adsorption, precipitation, and/or coprecipitation. CCR constituents retained in aquifer soil matrix to achieve GWPS below and downgradient of CCR Unit.	CCR constituents removed from groundwater below and downgradient of CCR Unit.	CCR constituents removed from groundwater and retained in aquifer soil matrix.	Purge water from groundwater monitoring requires management in accordance with applicable RCRA requirements.	Site is good MNA candidate based on field MNA evaluation. Long-term groundwater monitoring required. Easy to implement. Groundwater modelling required to assess remediation timeframe.	Yes
Groundwater Extraction and Treatment	System of extraction wells along downgradient edge of landfill to provide hydraulic control of CR constituent groundwater plumes. Extracted groundwater treated in an on-site treatment system and discharged to Martin Lake or re-injected into aquifer. Groundwater monitoring to verify system effectiveness.	Migration of CCR constituents in groundwater controlled.	GWPS attained downgradient of CCR Unit, but limited effect on concentrations beneath unit.	CCR groundwater constituents contained at edge of landfill.	CCR constituents removed from extracted groundwater by treatment system. Treatment residuals (sludge, regenerate brine, etc.) require management.	Treatment residuals (sludge, regenerate brine, etc.) require management in accordance with applicable RCRA requirements.	Regulatory authorization for treated water discharge required. Bench/pilot testing of treatment system required. Groundwater modelling required to assess remediation timeframe.	Yes
Vertical Hydraulic Barrier	Vertical, low permeability hydraulic barrier along downgradient edge of landfill to provide hydraulic control of CCR constituent groundwater plumes. Groundwater extraction and treatment required upgradient of barrier to control groundwater elevations. Groundwater monitoring to verify system effectiveness.	Migration of CCR constituents in groundwater controlled.	GWPS attained downgradient of CCR Unit, but limited effect on concentrations beneath unit.	CCR groundwater constituents contained at edge of landfill.	CCR constituents removed from extracted groundwater by treatment system. Treatment residuals (sludge, regenerate brine, etc.) require management.	Excavated soil generated from barrier installation requires testing and management as necessary. Treatment residuals (sludge, regenerate brine, etc.) require management in accordance with applicable RCRA requirements.	Bench/pilot test of barrier materials likely required. Regulatory authorization for treated water discharge required. Bench/pilot testing of treatment system required. Groundwater modelling required to assess remediation timeframe.	Yes

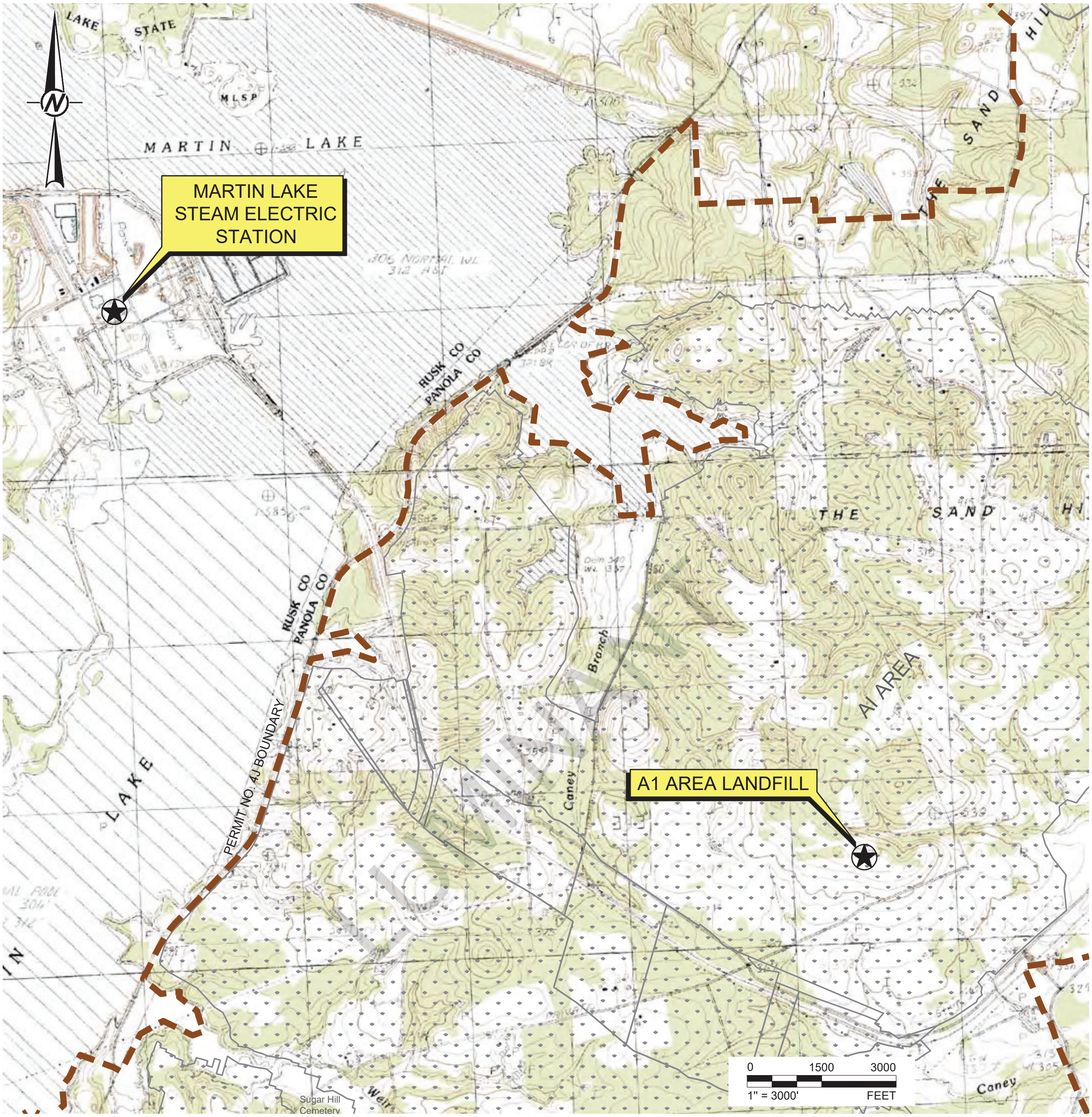
Groundwater Response Technology	Description	Protective of Human Health and Environment	Attain Groundwater Protection Standard	Control Source of Release	Remove Contaminated Material From Environment	RCRA Compliance	Screening Comments	Retained for Further Evaluation
Permeable Reactive Barrier	In-situ, passive, permeable treatment zone containing reactive media designed to intercept impacted groundwater and adjust geochemistry to immobilize CCR contaminants. CCR constituents removed through adsorption, precipitation and/or coprecipitation. PRB acts as a barrier to groundwater contamination but not groundwater flow. Groundwater monitoring to verify system effectiveness.	Migration of CCR constituents in groundwater controlled.	GWPS attained downgradient of CCR Unit, but limited effect on concentrations beneath unit.	CCR groundwater constituents removed from groundwater downgradient of CCR Unit.	CCR constituents removed from groundwater and retained on reactive media or aquifer soil matrix.	Excavated soil generated from PRB installation requires testing and management as necessary.	Potential removal of CCR constituents, but full-scale performance uncertain. Reactive media effectiveness reduced over time and media likely replaced periodically. Bench/pilot testing of PRB media/system required. Groundwater modelling required to assess remediation timeframe.	No
In-Situ Chemical Treatment	Injection of chemical/material into aquifer to adjust geochemistry and enhance precipitation, co-precipitation, or indirect adsorption of CCR constituents. Groundwater monitoring to verify system effectiveness.	Migration of CCR constituents in groundwater controlled.	GWPS attained downgradient of CCR Unit, but limited effect on concentrations beneath unit.	CCR groundwater constituents removed from groundwater downgradient of CCR Unit.	CCR constituents removed from groundwater and retained on aquifer soil matrix.	No significant RCRA compliance issues anticipated.	ICR considered emerging remediation technology for CCR constituents - not demonstrated under full-scale conditions. Bench/pilot-scale testing of ICR system required. Groundwater modelling required to assess remediation timeframe.	No
Phytoremediation	Use of plants to remove CCR constituents through uptake and accumulation within above ground portions of the plant. Primary plant process for removal is phytoextraction (uptake/accumulation of contaminants within aboveground portions of a plant). Groundwater monitoring to verify system effectiveness.	Migration of CCR constituents in groundwater controlled.	GWPS attained downgradient of CCR Unit, but limited effect on concentrations beneath unit.	CCR groundwater constituents removed from groundwater downgradient of CCR Unit.	CCR constituents removed from groundwater and accumulates in plants.	Management of harvested plants in accordance with RCRA may be required if accumulated CCR constituent concentrations are high.	Phytoextraction occurs in shallow root zone of plants, which limits the effectiveness for the groundwater depths at the Site. Phytoremediation for CCR constituent removal from groundwater has not been demonstrated under full-scale conditions Bench/pilot-scale testing of phytoremediation system required. Groundwater modelling required to assess remediation timeframe.	No

Table 4

Evaluation of Corrective Measures Alternatives
Martin Lake Steam Electric Station
A1 Area Landfill

Corrective Measures Alternative	Description	Performance	Reliability	Ease of Implementation	Potential Impacts	Time Requirements	Institutional Requirements
Capping with Monitored Natural Attenuation	Low-permeability cap constructed over landfill. MNA to remove CCR constituents from groundwater and control migration. Groundwater monitoring to verify MNA effectiveness.	Cap isolates CCR material in landfill and mitigates on-going source of CCR constituents to groundwater. Site is good MNA candidate for CCR constituents based on MNA field evaluation.	Capping is a common and effective source control technology. On-going attenuation of CCR constituents in groundwater demonstrated during MNA field evaluation. Groundwater monitoring used to verify long-term MNA effectiveness.	Readily implementable with common construction techniques.	Source controlled through capping. CCR constituents removed from groundwater beneath and downgradient of landfill.	Cap Implementation: Up to 2.5 years after commencing closure activities per 257.102(f). MNA Implementation: 2-3 years Groundwater modelling required to assess remediation timeframe.	Minimal regulatory requirements. Deed restrictions required for downgradient plume areas that exceed GWPS.
Capping with Groundwater Extraction and Treatment	Low-permeability cap constructed over landfill. System of extraction wells along downgradient edge of landfill to provide hydraulic control of CCR constituent groundwater plumes. Extracted groundwater treated in an on-site treatment system and discharged to Martin Lake or re-injected into aquifer. Groundwater monitoring to verify system effectiveness.	Cap isolates CCR material in landfill and mitigates on-going source of CCR constituents to groundwater. Migration of CCR constituents in groundwater controlled at landfill boundary by extraction wells.	Capping is a common and effective source control technology. Groundwater extraction and treatment is a common and effective hydraulic control technology. Treatment system operational reliability is key component of overall reliability.	Readily implementable with common construction techniques. Bench/pilot testing of treatment system required. Regulatory authorization for treated water discharge could be difficult to obtain.	Source controlled through capping. Control of CCR constituent migration downgradient of landfill by extraction wells. Extraction system does not address groundwater beneath landfill.	Cap Implementation: Up to 2.5 years after commencing closure activities per 257.102(f). GW Ext/Treatment Implementation: 3-4 years Groundwater modelling required to assess remediation timeframe.	Regulatory authorization for treated water discharge required. Treatment system residuals (sludge, regenerate brine, etc.) require management.
Capping with Vertical Hydraulic Barrier and Groundwater Extraction and Treatment	Low-permeability cap constructed over landfill. Vertical, low permeability hydraulic barrier along downgradient edge of landfill to provide hydraulic control of CCR constituent groundwater plumes. Groundwater extraction and treatment required upgradient of barrier to control groundwater elevations. Groundwater monitoring to verify system effectiveness.	Cap isolates CCR material in landfill and mitigates on-going source of CCR constituents to groundwater. Migration of CCR constituents in groundwater controlled at landfill boundary by vertical barrier. Groundwater elevations upgradient of barrier controlled by groundwater extraction.	Capping is a common and effective source control technology. Vertical hydraulic barrier must be keyed into lower impermeable layer. Groundwater extraction and treatment is a common and effective hydraulic control technology. Treatment system operational reliability is key component of overall reliability.	Readily implementable with common construction techniques. Bench/pilot testing of treatment system required. Regulatory authorization for treated water discharge could be difficult to obtain.	Source controlled through capping. Control of CCR constituent migration downgradient of landfill by vertical barrier. Vertical barrier does not address groundwater beneath landfill.	Cap Implementation: Up to 2.5 years after commencing closure activities per 257.102(f). Barrier and GW Ext/Treat Implementation: 5-8 years Groundwater modelling required to assess remediation timeframe.	Regulatory authorization for treated water discharge required. Treatment system residuals (sludge, regenerate brine, etc.) require management.

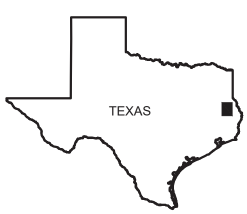
FIGURES



LEGEND

MARTIN LAKE LIGNITE MINE PERMIT BOUNDARY

MINED OUT AREA



QUADRANGLE LOCATION

REFERENCE(S)
BASE MAP TAKEN FROM TNRIS.GOV, TATUM, TX 7.5 MIN. USGS QUADRANGLE DATED 1983.

CLIENT
LUMINANT

PROJECT
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

TITLE
SITE LOCATION MAP

CONSULTANT
GOLDER

YYYY-MM-DD	2019-08-28
DESIGNED	AJD
PREPARED	AJD
REVIEWED	WFV
APPROVED	WFV

PROJECT NO.	REV.	FIGURE
19121403	0	1

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Path: \\texarkanaldata\Projects - Round Rock\19121403 - Luminant\Martin Lake A1 Area Landfill\ | File Name: FIG 1 - Site Location Map.dwg

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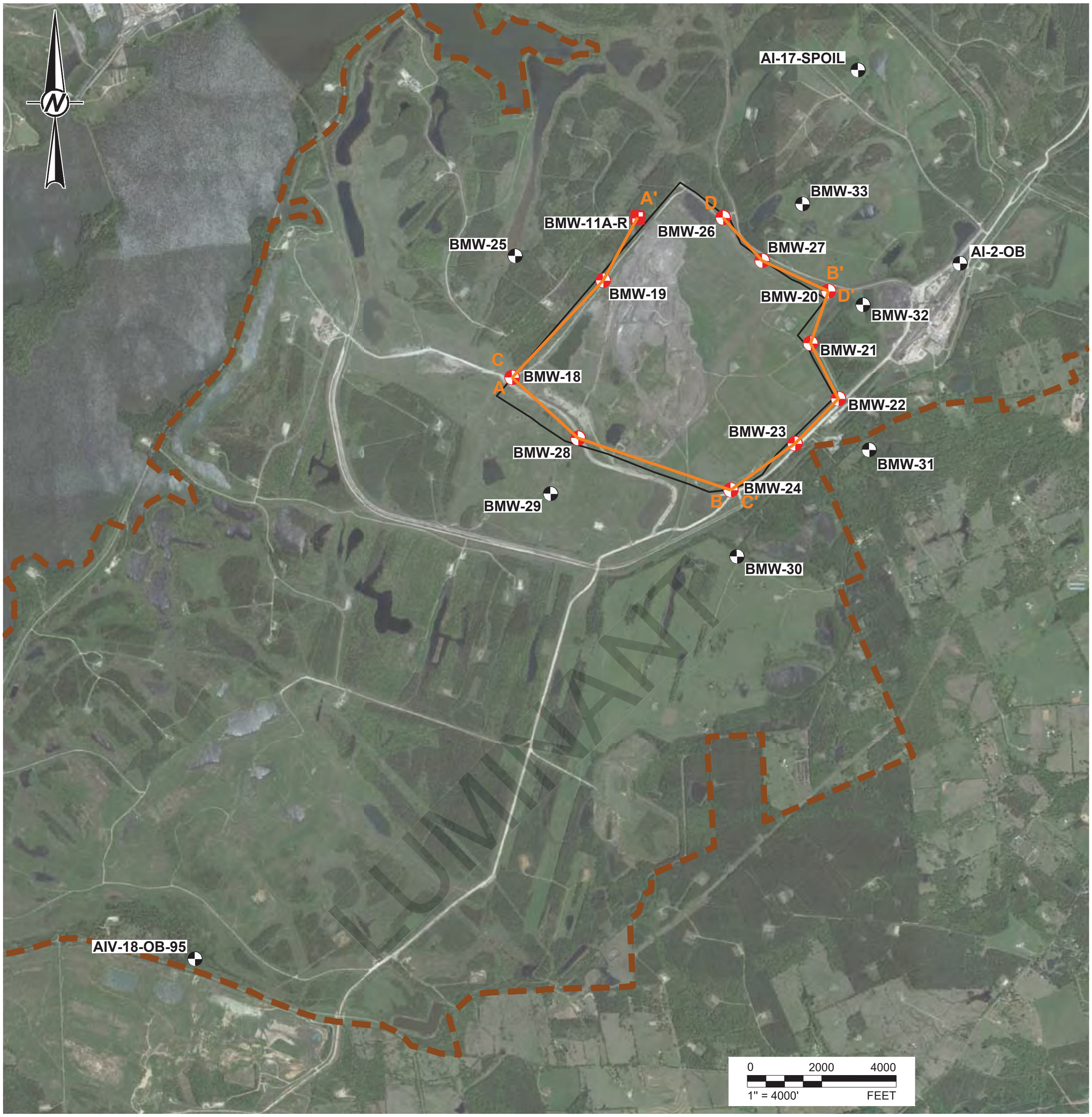


LEGEND

- MARTIN LAKE LIGNITE MINE PERMIT BOUNDARY
- DOWNGRADIENT CCR MONITORING WELL
- UPGRADIENT CCR MONITORING WELL
- CCR DELINEATION WELL
- A —— A' CROSS SECTION LOCATION

REFERENCE(S)

BASE MAP TAKEN FROM GOOGLE EARTH, IMAGERY DATED 4/6/17.

CLIENT
LUMINANT

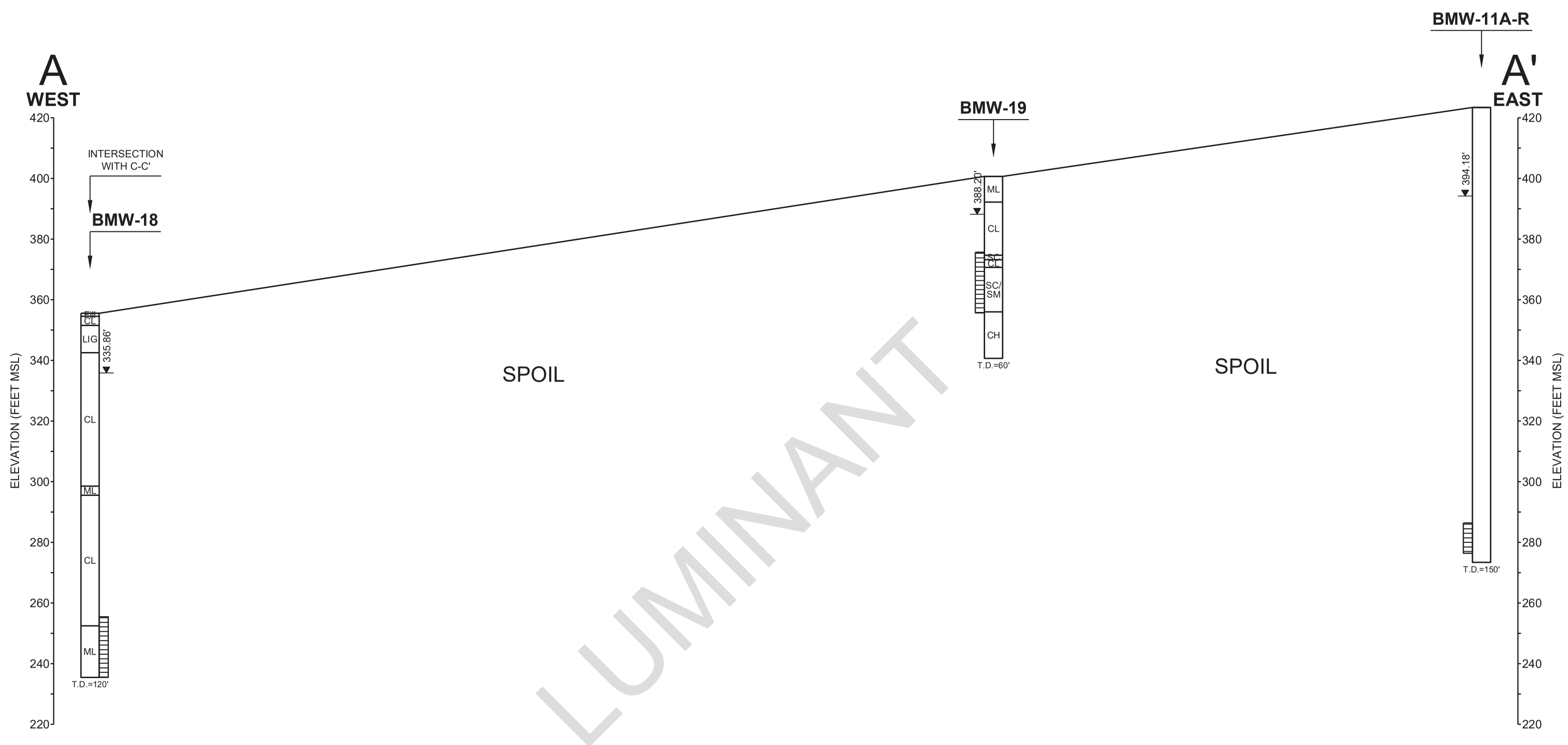
PROJECT
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

TITLE
DETAILED SITE PLAN - A1 AREA LANDFILL

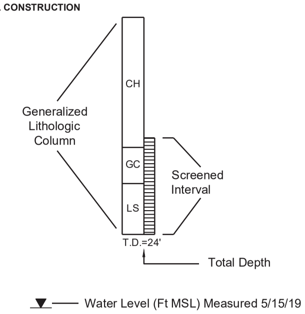
CONSULTANT
GOLDER

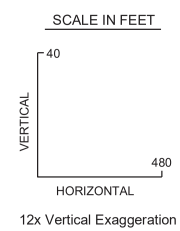
YYYY-MM-DD	2019-08-28
DESIGNED	AJD
PREPARED	AJD
REVIEWED	WFV
APPROVED	WFV

PROJECT NO.	REV.	FIGURE
19121403	0	2



MONITORING WELL CONSTRUCTION





CLIENT
LUMINANT

PROJECT
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

TITLE
A1 AREA LANDFILL
GEOLOGIC CROSS SECTION A-A'
NORTH SIDE OF A1 EXPANSION AREA

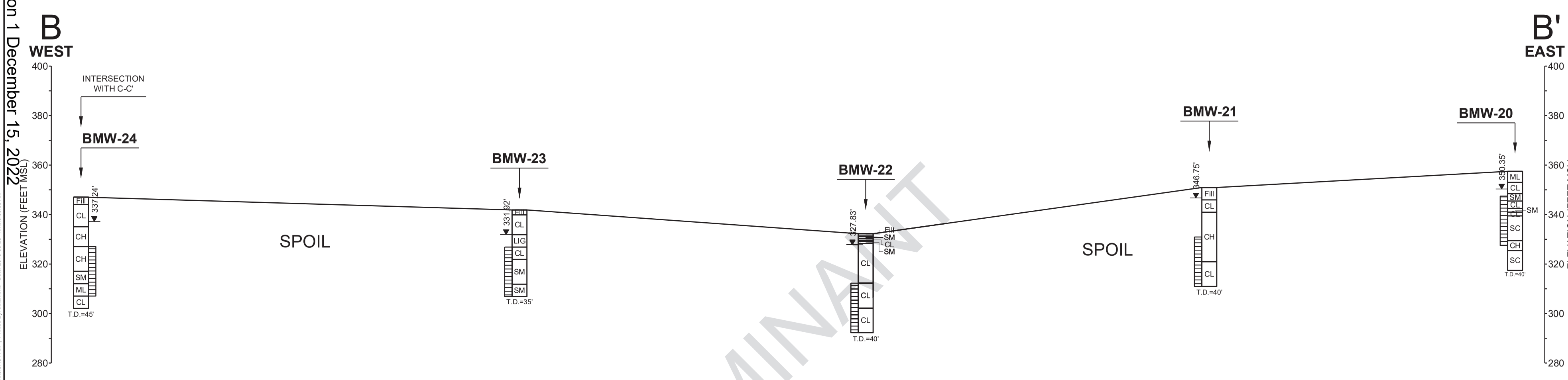
CONSULTANT

GOLDER

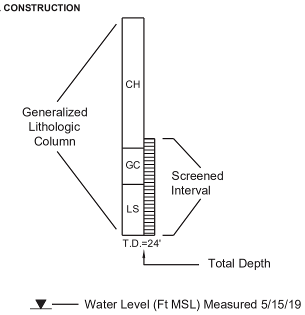
YYYY-MM-DD	2019-08-28
DESIGNED	AJD
PREPARED	AJD
REVIEWED	WFV
APPROVED	WFV

PROJECT NO. 19121403 | REV. 0 | FIGURE 3

APPENDIX G-Revision 1 December 15, 2022



MONITORING WELL CONSTRUCTION



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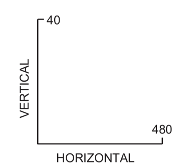


12x Vertical Exaggeration

CLIENT
LUMINANT

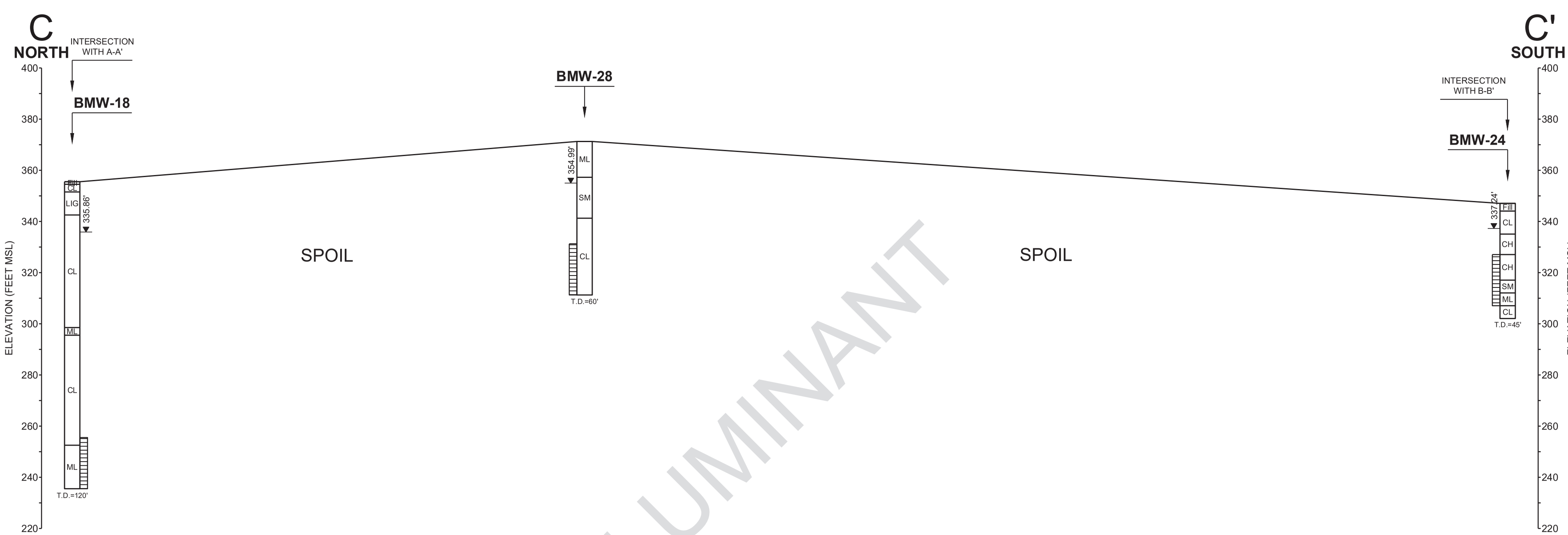
PROJECT
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

TITLE
A1 AREA LANDFILL
GEOLOGIC CROSS SECTION B-B'
SOUTH SIDE OF A1 LANDFILL

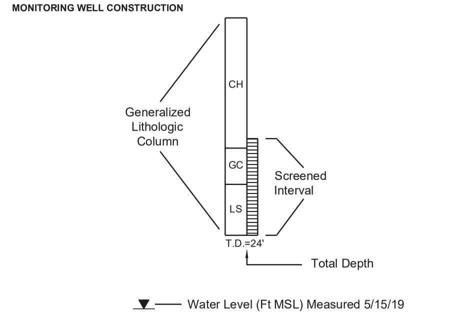
CONSULTANT
GOLDER

YYYY-MM-DD	2019-08-28
DESIGNED	AJD
PREPARED	AJD
REVIEWED	WFV
APPROVED	WFV

PROJECT NO. 19121403 | REV. 0 | FIGURE 4



MONITORING WELL CONSTRUCTION



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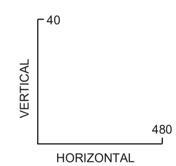


12x Vertical Exaggeration

CLIENT
LUMINANT

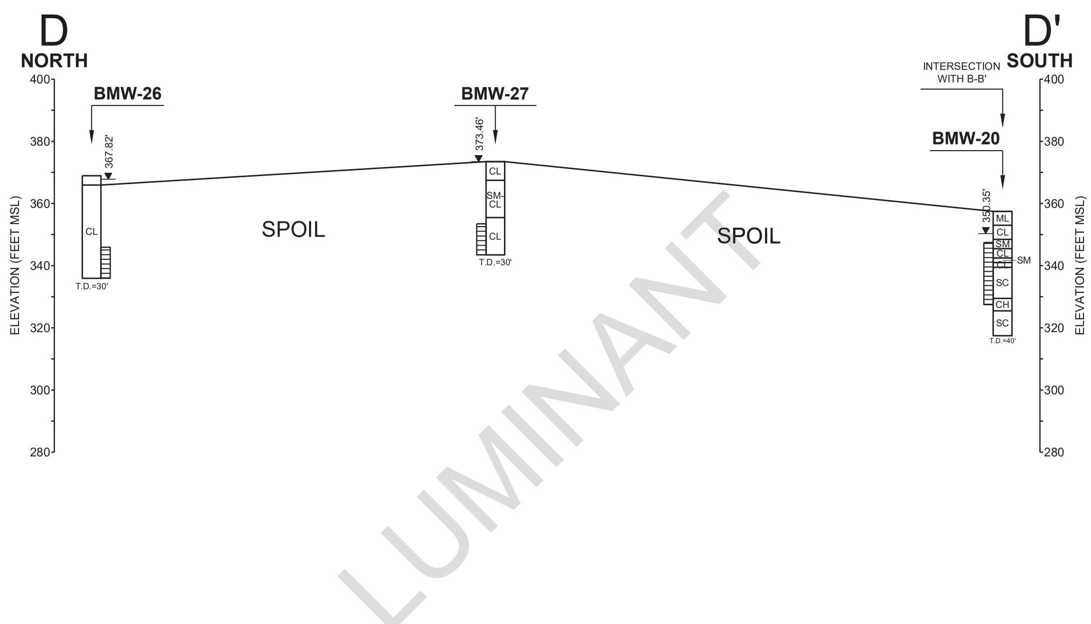
PROJECT
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

TITLE
A1 AREA LANDFILL
GEOLOGIC CROSS SECTION C-C'
WEST SIDE OF A1 LANDFILL

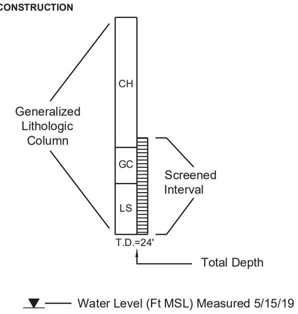
CONSULTANT
GOLDER

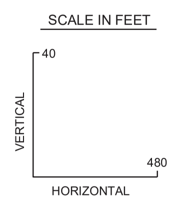
YYYY-MM-DD	2019-08-28
DESIGNED	AJD
PREPARED	AJD
REVIEWED	WFV
APPROVED	WFV

PROJECT NO.	REV.	FIGURE
19121403	0	5



MONITORING WELL CONSTRUCTION





12x Vertical Exaggeration

CLIENT
LUMINANT

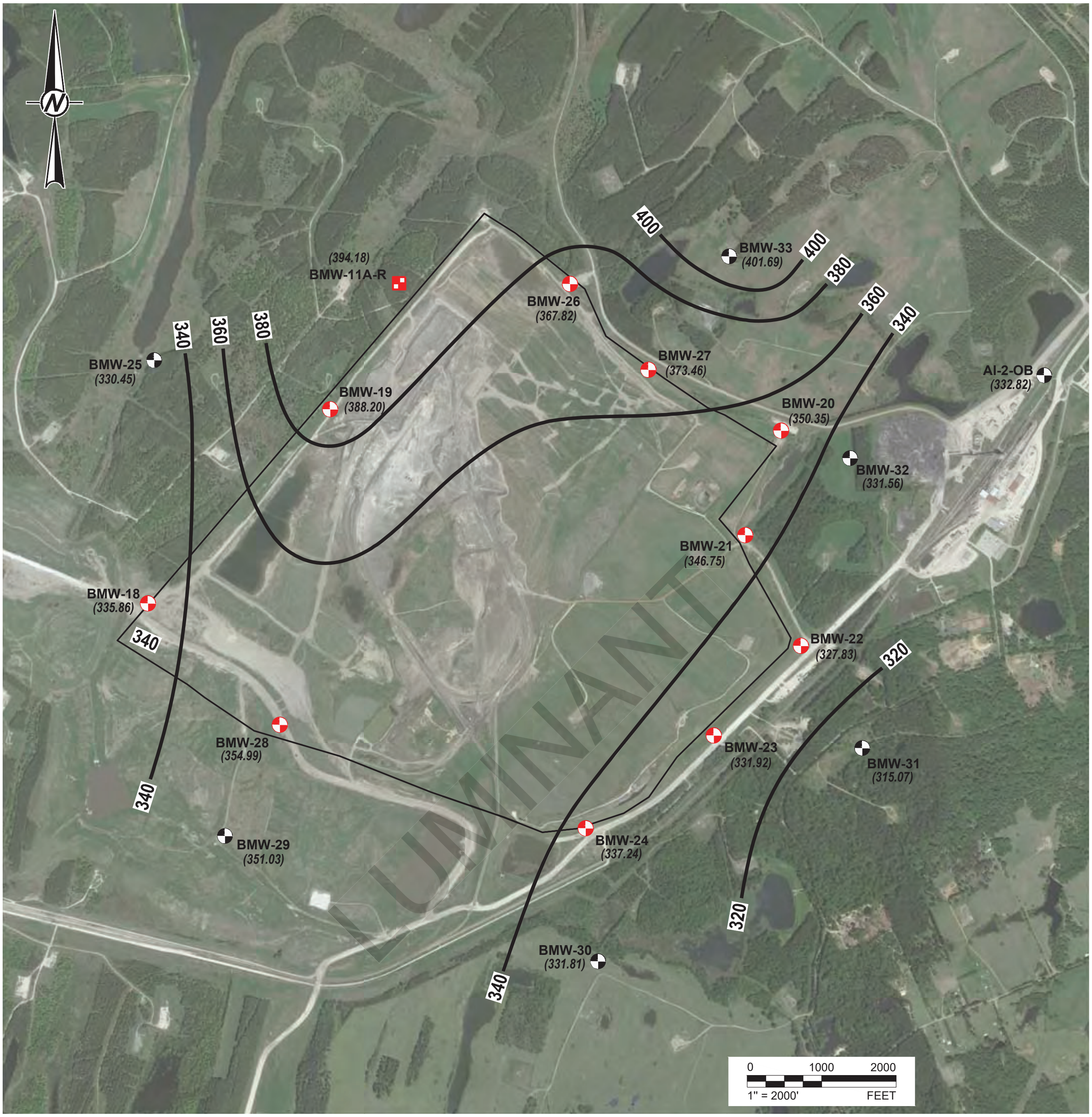
PROJECT
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

TITLE
A1 AREA LANDFILL
GEOLOGIC CROSS SECTION D-D'
EAST SIDE OF A1 LANDFILL

CONSULTANT
GOLDER

YYYY-MM-DD	2019-08-28
DESIGNED	AJD
PREPARED	AJD
REVIEWED	WFV
APPROVED	WFV

PROJECT NO. 19121403 REV. 0 FIGURE 6



LEGEND

	DOWNGRADIENT CCR MONITORING WELL
	UPGRADIENT CCR MONITORING WELL
	CCR DELINEATION WELL
(358.02)	GROUNDWATER POTENTIOMETRIC SURFACE (FT MSL)
360	GROUNDWATER POTENTIOMETRIC SURFACE CONTOUR (C.I. = 20 FT)

NOTE(S)

1. CCR MONITORING WELL WATER LEVELS MEASURED 5/15/19. CCR DELINEATION WELL WATER LEVELS MEASURED 6/13/19. WELL AI-2-OB WATER LEVELS MEASURED 8/14/19.

REFERENCE(S)

BASE MAP TAKEN FROM GOOGLE EARTH, IMAGERY DATED 4/9/17.

APPENDIX G Revision 1 December 15, 2022

CLIENT
LUMINANT

PROJECT
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

TITLE
A1 AREA LANDFILL
POTENTIOMETRIC SURFACE MAP
MAY 15, 2019

CONSULTANT

GOLDER

YYYY-MM-DD	2019-08-30
DESIGNED	AJD
PREPARED	AJD
REVIEWED	WFV
APPROVED	WFV

PROJECT NO.	REV.	FIGURE
19121403	0	7

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Path: \\texarkanaldata\Projects - Round Rock\19121403 - Luminant\Martin Lake A1 Area Landfill\ | File Name: FIG 7 - POT Surface Map-A1 Area Landfill (May 2019) with AI-2-OB.dwg

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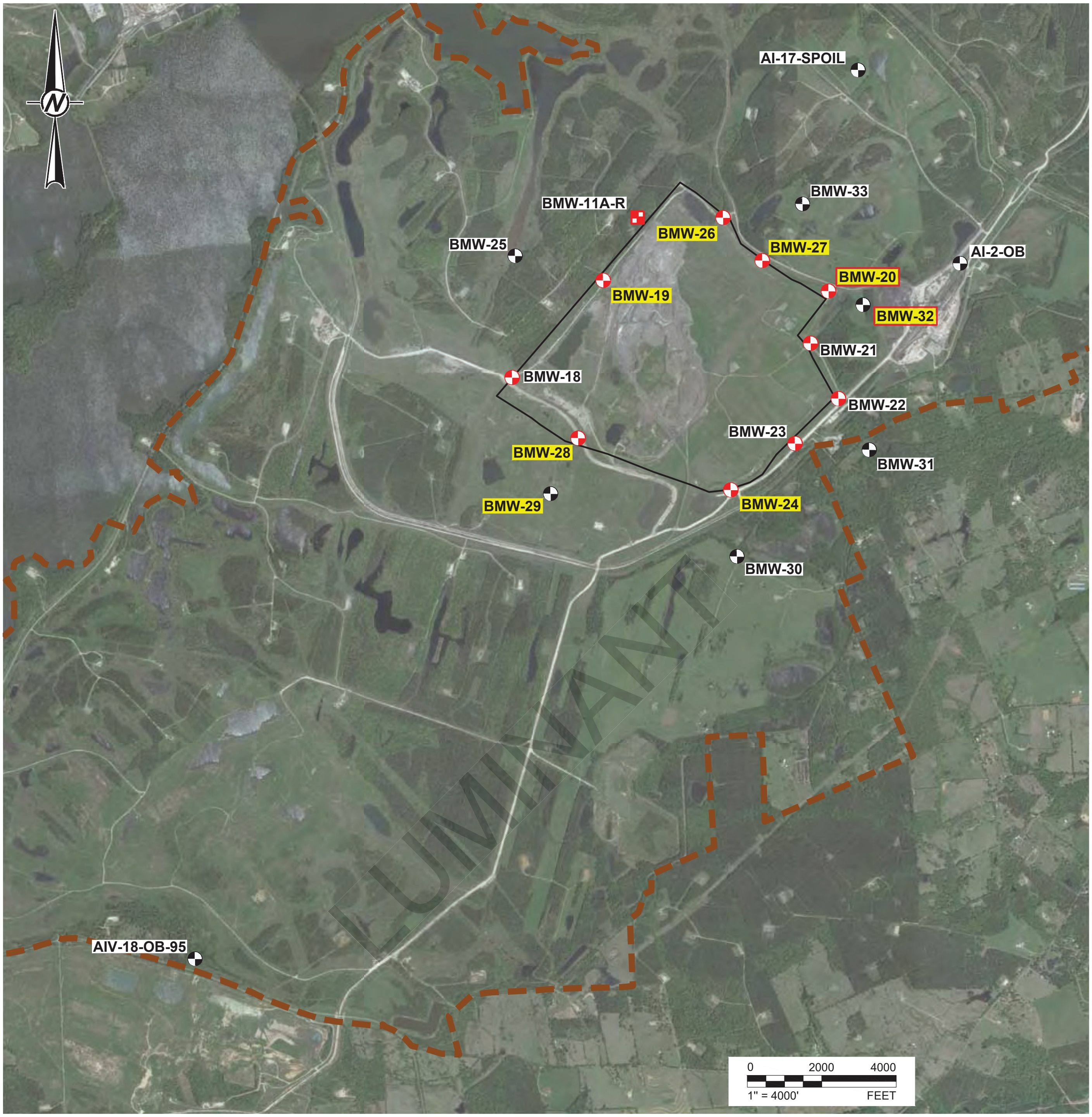


LEGEND

	MARTIN LAKE LIGNITE MINE PERMIT BOUNDARY
	DOWNGRADIENT CCR MONITORING WELL
	UPGRADIENT CCR MONITORING WELL
	CCR DELINEATION WELL
	SSLs FOR ONE OR MORE APPENDIX IV CONSTITUENTS IN DOWNGRADIENT WELLS BASED ON INITIAL STATISTICAL EVALUATION
	SSLs FOR ONE OR MORE APPENDIX IV CONSTITUENTS IN DOWNGRADIENT WELLS BASED ON UPDATED STATISTICAL EVALUATION

NOTE(S)

1. BMW-27 WAS PREVIOUSLY CONSIDERED TO BE A DOWNGRADINET WELL; HOWEVER, BASED ON ADDITIONAL GROUNDWATER ELEVATION DATA FROM THE NATURE AND EXTENT WELLS (SEE FIGURE 7), IT AND BMW-33 ARE CONSIDERED TO BE UPGRADIENT WELLS.

REFERENCE(S)

BASE MAP TAKEN FROM GOOGLE EARTH, IMAGERY DATED 4/6/17.

CLIENT
LUMINANT

PROJECT
MARTIN LAKE STEAM ELECTRIC STATION
TATUM, TEXAS

TITLE
A1 AREA LANDFILL
EXTENT OF APPENDIX IV CONSTITUENTS DETECTED AT SSLs ABOVE GWPSs

CONSULTANT
GOLDER

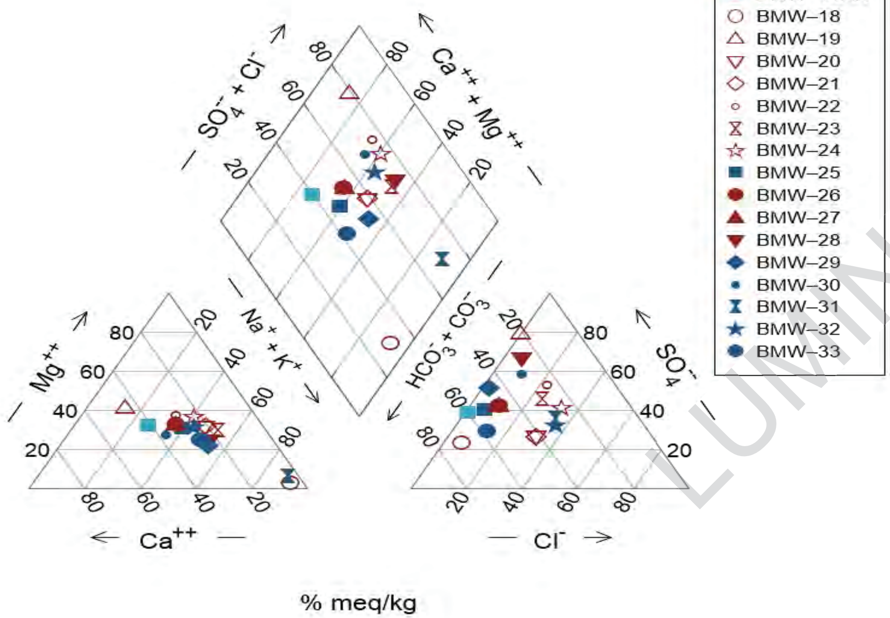
YYYY-MM-DD	2019-08-29
DESIGNED	AJD
PREPARED	AJD
REVIEWED	WFV
APPROVED	WFV

PROJECT NO.	REV.	FIGURE
19121403	0	8

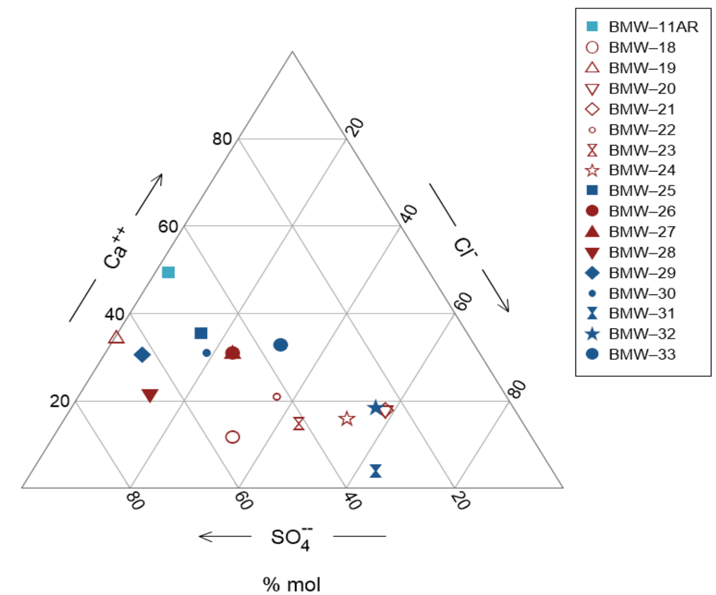
Last Edited By: adiamond Date: 2019-08-29 Time:12:04:45 PM | Printed By: adiamond Date: 2019-08-29 Time:1:52:57 PM
Path: \\texarkana\data\Projects - Round Rock\19121403 - Luminant\Martin Lake A1 Area Landfill\ | File Name: FIG 8 - Extent of App IV Constituents (A1 Area Landfill).dwg

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A
0 1 in

(a)



(b)



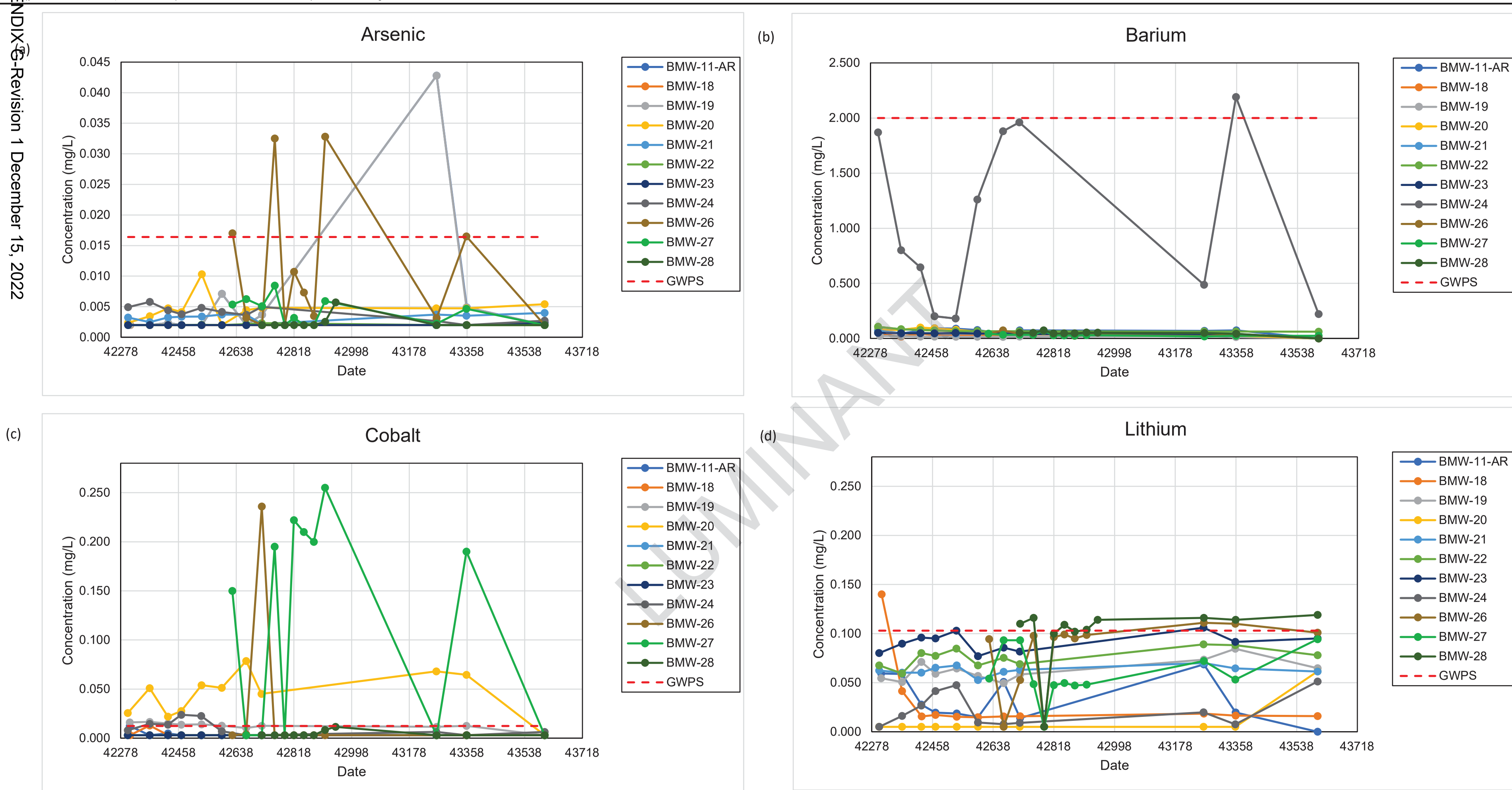
CLIENT
LUMINANT
MARTIN LAKE
A1 LANDFILL

CONSULTANT
GOLDER

PROJECT
ASSESSMENT OF CORRECTIVE MEASURES
Monitored Natural Attenuation
GEOCHEMICAL ASSESSMENT

TITLE
MAJOR GROUNDWATER CEHMISTRY (A) AND SELECT RELATIVE ION ABUNDANCE (B)

PROJECT NO.	PHASE	REV.	FIGURE
19122434	01	A	9a-b



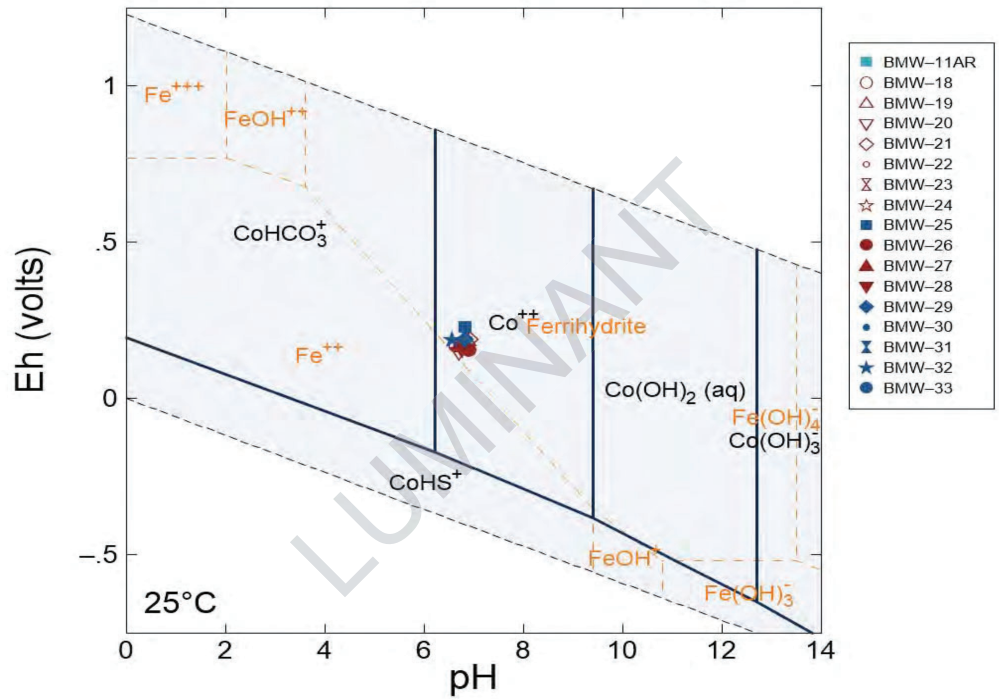
CLIENT
LUMINANT
MARTIN LAKE
A1 LANDFILL

CONSULTANT
GOLDER

PROJECT
ASSESSMENT OF CORRECTIVE MEASURES
GEOCHEMICAL ASSESSMENT

TITLE
HISTORICAL TRENDS OF ARSENIC (A), BARIUM (B), COBALT (C), AND LITHIUM (D) IN GROUNDWATER

PROJECT NO.	PHASE	REV.	FIGURE
19122434	01	A	10a-d



CLIENT
LUMINANT
MARTIN LAKE
A1 LANDFILL

CONSULTANT
GOLDER

PROJECT
ASSESSMENT OF CORRECTIVE MEASURES
GEOCHEMICAL ASSESSMENT

TITLE
SPECIATION OF COBALT IN GROUNDWATER

PROJECT NO.	PHASE	REV.	FIGURE
19122434	01	A	11

PATH: C:\Users\pjnolan\Golder Associates\19121403.Luminant CCR ACM Reports - 5 Technical Work\Phase 2000 - ML A1 Area LF | FILE NAME: Geochem Figures.xlsx

APPENDIX A

BORING LOGS

Luminant

Log of Boring: BMW-18

Martin Lake Steam Electric Station
Tatum, TX

PBW Project No. 5164B

Completion Date:	9/29/2015	Drilling Method:	Sonic
Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
Driller:	Timmy Beach	Total Depth (ft):	120
Driller's License:	5814M	TOC Elevation (ft. AMSL):	357.833
Logged By:	Jeremiah Bihl	Northing:	1051216950.561
Sampling Method:	4"x10' Core barrel	Easting:	2915599.992

Depth (ft)	Recovery (ft/ft)
0–10	10.0/10.0
10–20	5.0/10.0
20–30	10.0/10.0
30–40	10.0/10.0
40–50	10.0/10.0
50–60	10.0/10.0
60–70	10.0/10.0
70–80	10.0/10.0
80–90	10.0/10.0
90–100	10.0/10.0
100–110	10.0/10.0
110–120	10.0/10.0

USCS	Lithologic Description
FILL	(0 - 1) Top soil, light brown, rocks (1-3 cm) present
CL	(1 - 4) CLAY spoil, dark gray to black with pale tan mottling, dry, firm, brittle
LIG	(4 - 13) LIGNITE with clay spoil, dark grey to black, dry to moist, soft, brittle, angular, low plasticity
CL	(13 - 57) Silty CLAY spoil, dark gray to dark brown with red and yellow mottling, dry, soft to firm, crumbly, medium plasticity, color change to tan at 30', coal seam at 32' (black, dry to moist, soft), pieces of lignite present, color change to gray to dark gray at 35'
ML	(57 - 60) Clayey SILT spoil, light brown to tan, moist, soft, low plasticity, lignite seam at 59'
CL	(60 - 81) Silty CLAY spoil, black to gray, dry, soft to firm, low plasticity, crumbly, 6" dry white gravel layer at 69', 4" light brown silty sand layer at 81'
CL	(81 - 103) Silty CLAY spoil, light gray, dry to moist, soft, low to medium plasticity, crumbly, rubber tire pieces at 89', hard lignite seam at 90' (hard, dry, black, firm), streaks of black (91'- 94'), becomes hard at 94', light to dark gray (94'-103')
ML	(103 - 106) Clayey SILT spoil, gray, very moist, soft, medium plasticity
ML	(106 - 120) Clayey SILT spoil, gray to dark gray, dry, firm, low plasticity

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Notes:
1. This log should not be used separately from the report to which it is attached.

Well Materials
(0-100) Casing, 2" Sch 40 FJT PVC
(100-120) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-96') Grout
(96'-98') Bentonite pellets
(98'-110') 20/40 sand

Luminant

Log of Boring: BMW-19

Martin Lake Steam Electric Station
Tatum, TX

PBW Project No. 5164B

Completion Date:	10/7/2015	Drilling Method:	Sonic
Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
Driller:	Timmy Beach	Total Depth (ft):	60
Driller's License:	5814M	TOC Elevation (ft. AMSL):	400.685
Logged By:	Nolan Townsend	Northing:	1048219535.121
Sampling Method:	4"x10' Core barrel	Easting:	2918071.024

Depth (ft): 0, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44, 48, 52, 56, 60

Recovery (ft/ft)
9.2/10.0
4.2/10.0
9.7/10.0
10.0/10.0
7.2/10.0
10.0/10.0

USCS	Lithologic Description
ML	(0 - 8.5) Sandy SILT with clay spoil, light brown to brownish yellow, dry to slightly mosit, soft, low plasticity, more clay content below ~1.0', trace black lignite fragments - dry, firm to hard, brittle, friable, sharp basal contact
CL	(8.5 - 26) Sandy CLAY spoil, yellowish brown, gray after 9.5', trace to moderate orange-yellow mottling, dry to moist, firm, low plasticity, trace black lignite fragments, very fine sand, sharp basal contact
SC	(26 - 27.5) Clayey SAND spoil, gray to yellowish brown, very moist to wet, soft, low plasticity, very fine sand, sharp basal conact
CL	(27.5 - 30) Sandy CLAY spoil, gray to yellowish brown, trace to moderate orange mottling, moist to very moist, soft to firm, moderate plasticity, very fine sand, small lignite seam 29.7'-30.0', brittle and friable, dry, black, hard, sharp basal contact
SC/SM	(30 - 44.7) Clayey silty SAND spoil - sandy CLAY spoil, brownish yellow to gray to greenish gray, trace orange mottling, abundant orange mottling 37.5'-38.5' and 42'-44.7', very moist to wet, soft to firm, moderate to high plasicity, very fine sand
CH	(44.7 - 60) Sandy CLAY spoil, greenish gray to gray, trace orange-red mottling, dry to moist, firm, moderate to high plasticity, trace black lignite fragments, abundant orange and red mottling 56.0'-59.5'

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Notes:
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2. Hole collapsed - drilled back down to 45' with 6" casing to set well.

Well Materials
(0-25) Casing, 2" Sch 40 FJT PVC
(25-45) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-21') Grout
(21'-23') Bentonite pellets
(23'-45') 20/40 sand

Luminant

Log of Boring: BMW-20

Martin Lake Steam Electric Station Tatum, TX	Completion Date:	10/8/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	40
PBW Project No. 5164B	Driller's License:	5814M	TOC Elevation (ft. AMSL):	357.512
	Logged By:	Nolan Townsend	Northing:	1057219166.631
	Sampling Method:	4"x10' Core barrel	Easting:	2923995.525

Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0 - 4.5	9.5/10.0	ML	(0 - 4.5) Sandy SILT with clay spoil, brownish yellow to gray, trace to moderate orange mottling near 4.0', dry, soft, low plasticity, very fine sand
4.5 - 9		CL	(4.5 - 9) CLAY spoil with trace sand lenses, gray with trace to moderate orange/yellow mottling, dry to slightly moist, firm to hard, low to moderate plasticity, trace calcareous precipitates, sharp basal contact
9 - 12	9.8/10.0	SM	(9 - 12) Slightly silty SAND spoil, yellowish orange to tan, moist to very moist, slightly unconsolidated, moderate to high plasticity, very fine sand, moderately to well sorted, mostly quarts with ~5-10% lithic fragments, clay content present 10'-12', dark gray, sharp basal contact
12 - 15		CL	(12 - 15) CLAY spoil, slightly sandy, gray to dark gray, dry to slihgtly moist, firm to hard, low to moderate plasticity, trace black lignite fragments, sandy lenses, trace orange mottling
15 - 16.5		SM	(15 - 16.5) Silty SAND with clay spoil, tan to yellowish orange, moist to very moist, moderately consolidated, medium to high plasticity, very fine sand
16.5 - 18		CL	(16.5 - 18) CLAY spoil as above, dry to moist, firm to hard, moderate plasticity
18 - 28	10.0/10.0	SC	(18 - 28) Clayey SAND spoil, reddish orange and gray, very moist, wet at 20.0', moderately consolidated, moderate to high plasticity, clay composition increases and decreases throughout, very fine sand, becomes gray at 28.0' and more clay content
28 - 32		CH	(28 - 32) Sandy CLAY spoil, gray, trace orange mottling, moist to very moist, firm, moderate to high plasticity, locally sandy lenses/interbeds, trace lignitic fragments (black)
32 - 40	10.0/10.0	SC	(32 - 40) Clayey SAND spoil, reddish orange with gray clay, very moist to wet, moderately consolidated, moderate to high plasticity, very fine sand, localized small sandy clay seams, trace lignite fragments

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Notes:
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Well Materials
(0-10) Casing, 2" Sch 40 FJT PVC
(10-30) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-6') Grout
(6'-8') Bentonite pellets
(8'-30') 20/40 sand

Luminant

Log of Boring: BMW-21

Martin Lake Steam Electric Station Tatum, TX	Completion Date:	9/27/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	40
PBW Project No. 5164B	Driller's License:	5814M	TOC Elevation (ft. AMSL):	350.976
	Logged By:	Jeremiah Bihl	Northing:	1054217792.58
	Sampling Method:	4"x10' Core barrel	Easting:	2923478.615

Depth (ft)	Well Materials	Recovery (ft/ft)	USCS	Lithologic Description
0 - 5		10.0/10.1	FILL	(0 - 5) Top soil, sandy with small amounts of clay, tan/brown, moist, soft, low plasticity
5 - 10			CL	(5 - 10) Sandy CLAY spoil, dark gray to black, moist, soft, low to medium plasticity, trace amounts of lignite, clay content increases with depth
10 - 20		10.0/10.0	CH	(10 - 30) CLAY spoil with angular lignite, light gray, moist, soft, high plasticity, 1'-thick lignite layer at 25', hardness increases from 26' to 30'
20 - 30		10.0/10.0		
30 - 40		10.0/10.0	CL	(30 - 40) CLAY spoil with angular lignite pieces, wet, soft with increasing hardness with depth, medium plasticity, water present at 30', moisture decreases at 35'

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Notes:
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Well Materials
(0-20) Casing, 2" Sch 40 FJT PVC
(20-40) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-37') Grout
(16'-18') Bentonite pellets
(18'-40') 20/40 sand

Luminant

Log of Boring: BMW-22

Martin Lake Steam Electric Station
Tatum, TX

PBW Project No. 5164B

Completion Date:	9/27/2015	Drilling Method:	Sonic
Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
Driller:	Timmy Beach	Total Depth (ft):	40
Driller's License:	5814M	TOC Elevation (ft. AMSL):	332.304
Logged By:	Jeremiah Bihl	Northing:	1060216298.457
Sampling Method:	4"x10' Core barrel	Easting:	2924359.671

Depth (ft)	Well Materials	Recovery (ft/ft)	USCS	Lithologic Description
0			FILL	(0 - 1) Top soil, light brown
1			SM	(1 - 2) Sandy silty spoil with pieces of rock, light brown, abundant organics
2			CL	(2 - 3) CLAY spoil, yellow-reddish
3			SM	(3 - 4) Sandy silty spoil with pieces of rock, light brown/tan, abundant organics
0-10		10.0/10.0		
4-20			CL	(4 - 20) CLAY spoil, dark gray, lignite present (angular), color change to light gray to yellow clay with some red mottling at 6', firm, moist, medium plasticity, color change to tan at 10', moist and soft lignite layer (12'-13'), hard and lignite layer (angular pieces) at 13'
10-20		10.0/10.0		
20-30		10.0/10.0	CL	(20 - 30) Sandy CLAY spoil, light gray, moist, soft, medium plasticity, moisture content decreases with depth, hardness increases with depth, plasticity decreases with depth
30-40		10.0/10.0	CL	(30 - 40) Sandy CLAY spoil, light gray, wet, soft, hardness increases with depth

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Notes:
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Well Materials
(0-20) Casing, 2" Sch 40 FJT PVC
(20-40) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-37') Grout
(16'-18') Bentonite pellets
(18'-40') 20/40 sand

Luminant

Log of Boring: BMW-23

Martin Lake Steam Electric Station
Tatum, TX

PBW Project No. 5164B

Completion Date:	9/28/2015	Drilling Method:	Sonic
Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
Driller:	Timmy Beach	Total Depth (ft):	35
Driller's License:	5814M	TOC Elevation (ft. AMSL):	341.903
Logged By:	Jeremiah Bihl	Northing:	1061215105.129
Sampling Method:	4"x10' Core barrel	Easting:	2923179.729

Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0 - 2	10.0/10.0	FILL	(0 - 2) Top soil, sandy silty CLAY, moist, soft, light brown
2 - 10		CL	(2 - 10) CLAY spoil, light gray to pale yellow, some sand present, soft, moist, low plasticity, color change to brown at 5'
10 - 15	10.0/10.0	LIG	(10 - 15) LIGNITE spoil, black, soft, moist, crumbly, sharp contact
15 - 20		CL	(15 - 20) CLAY spoil, dark gray and light tan, dry, hard, medium plasticity
20 - 30	10.0/10.0	SM	(20 - 30) Silty SAND spoil with small amounts of clay, moist, soft, low plasticity, small seams of lignite, clay content increases with depth (20'-30')
30 - 35	10.0/10.0		(30 - 35) Silty SAND spoil, light gray, wet, very soft, low plasticity, some clay content at 32', sand lenses present

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Notes:
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Well Materials
(0-15) Casing, 2" Sch 40 FJT PVC
(15-35) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-11') Grout
(11'-13') Bentonite pellets
(13'-35') 20/40 sand

Luminant

Log of Boring: BMW-24

Martin Lake Steam Electric Station Tatum, TX	Completion Date:	9/28/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	45
PBW Project No. 5164B	Driller's License:	5814M	TOC Elevation (ft. AMSL):	347.074
	Logged By:	Jeremiah Bihl	Northing:	1066213874.314
	Sampling Method:	4"x10' Core barrel	Easting:	2921447.467

Depth (ft)	Well Materials	Recovery (ft/ft)	USCS	Lithologic Description
0		10.0/10.0	FILL	(0 - 3) Top soil, brown, moist, roots present
			CL	(3 - 4) CLAY spoil, light brown with yellow and orange mottling, dry, soft, low plasticity
4				(4 - 6) CLAY spoil with some silt, tan to yellow/gray, moist, firm, medium plasticity
8				(6 - 12) CLAY spoil, black with lignite pieces (0.2-1 cm), dry, soft, low plasticity, sharp contact
12, 16		10.0/10.0	CH	(12 - 20) CLAY spoil, dark gray with yellow and red mottling, dry, hard, medium to high plasticity
20, 24, 28		10.0/10.0		(20 - 30) Silty CLAY spoil, light gray to gray, yellow and red mottling, moist, very soft, high plasticity, pieces of lignite present, decreasing silt content with depth and becomes harder, more brittle, and dry (28'-30'), increase in red, yellow, and black mottling at 28'
32		10.0/10.0	SM	(30 - 35) Silty SAND spoil, gray, wet, soft, low plasticity, subangular to rounded
36			ML	(35 - 40) Clayey SILT spoil, dry, firm, low plasticity, silt content decreases with depth
40, 44		10.0/10.0	CL	(40 - 45) Silty CLAY spoil, light gray, dry, firm, low plasticity
48				

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Notes:
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Well Materials
(0-20) Casing, 2" Sch 40 FJT PVC
(20-40) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-16') Grout
(16'-18') Bentonite pellets
(18'-40') 20/40 sand

Luminant

Log of Boring: BMW-25

Martin Lake Steam Electric Station Tatum, TX	Completion Date:	10/7/2015	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6.5
	Driller:	Timmy Beach	Total Depth (ft):	40
	Driller's License:	5814M	TOC Elevation (ft. AMSL):	339.946
PBW Project No. 5164B	Logged By:	Nolan Townsend	Northing:	1070220215.073
	Sampling Method:	4"x10' Core barrel	Easting:	2915715.233

Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0 - 0.8	4.1/10.0 (0-10)	CH	(0 - 0.8) Silty CLAY spoil, gray, dry to moist, soft, moderate to high plasticity, trace roots, sharp basal contact
0.8 - 3.8		SM	(0.8 - 3.8) Silty, clayey SAND spoil, yellow brown/light brown, dry, soft, low to moderate plasticity, very fine sand, loose/unconsoldated, trace roots, sharp basal contact
3.8 - 10		CL	(3.8 - 10) Sandy CLAY spoil, gray, dry, frim to hard, low to moderate plasticity, trace sand, trace to moderate red mottling, sharp basal contact
10 - 34.5	8.1/10.0 (10-20); 8.5/10.0 (20-30); 10.0/10.0 (30-40)	SC/CL	(10 - 34.5) Clayey SAND spoil/sandy CLAY spoil, brownish yellow to light brown to gray, moist to very moist to wet (12'-20', 20'-35'), soft, moderate to high plasticity, trace to moderate orange and rust red mottling, dark gray-gray color 17.5'-20.0', continues as brown-yellow below 20.0', very fine sand, small linterval of clay from 27.4'-28.4' then returns to sandy clay, sharp basal contact
34.5 - 40		CL	(34.5 - 40) Sandy CLAY spoil, light gray to gray, moist to very moist, firm to hard, low to moderate plasticity, moderate to abundant orange and rust mottling, localized sandy interbeds, very fine sand

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Notes:
1. This log should not be used separately from the report to which it is attached.

Well Materials
(0-20) Casing, 2" Sch 40 FJT PVC
(20-40) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-16') Grout
(16'-18') Bentonite pellets
(18'-40') 20/40 sand

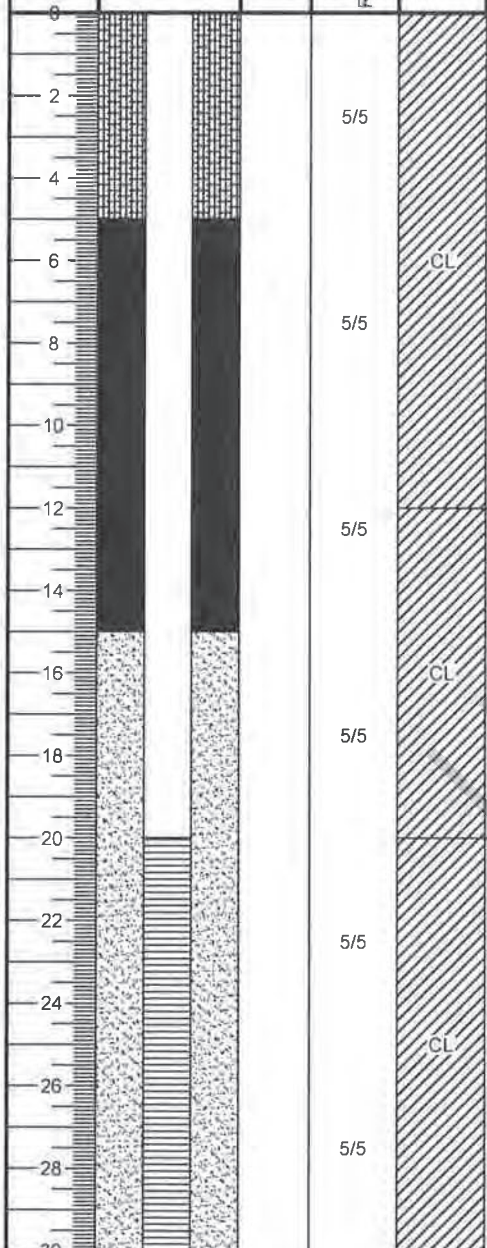
LUMINANT

Log of Boring: BMW-26

A-1 AREA LANDFILL
TATUM, TEXAS

PBW PROJECT No.: 5164-F

Completion Date:	8-31-16	Drilling Method:	HS Auger
Drilling Company:	Walker-Hill Env	Borehole Diameter (in.):	10.25"
Driller:	Jeremy Thornhill	Total Depth (ft):	30.0'
Driller's License:	NA	Northing:	221187.022
Field Supervisor:	RKS	Easting:	2921306.755
Sampling Method:	5'Macrocore Sampler	Ground Elev. (ft AMSL):	365.958



Depth (ft)	Well Materials	PID (ppm-v)	Recovery (ft/ft)	USCS	Lithologic Description
0–5			5/5	CL	0.0-12.0 - Clay with silt and lignite fragments, dark gray-black, soft, moist, low plasticity Wet at 4.0'
5–10			5/5		
10–15			5/5	CL	12.0-20.0 - Silty clay, dark brown, saturated, low plasticity
15–20			5/5		
20–25			5/5	CL	20.0-30.0 - Silty clay, fine grained, dark brown, saturated, low plasticity
25–30			5/5		

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Notes:

1. All logged material is mine spoil.

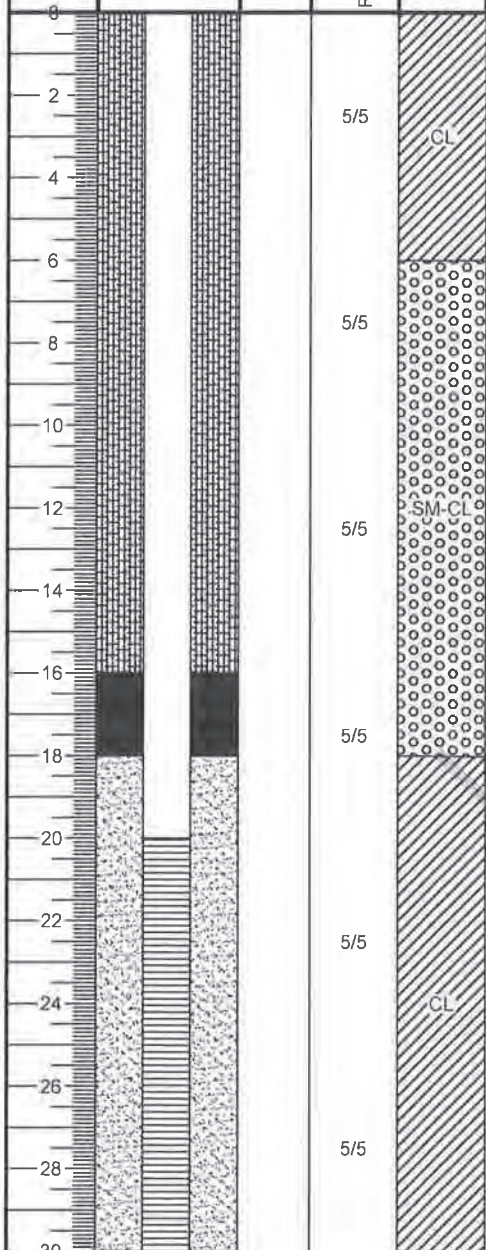
Depth (bgs)	Well Materials	Depth (bgs)	Annular Materials
0' - 20'	Casing, 4" Sch 40 PVC, FJT	0' - 5'	Grout
20' - 30'	Screen, 4" Sch 40 PVC, .010 Slot	5' - 15'	Bentonite Pellet Seal
		15' - 30'	20/40 Sand

LUMINANT	Log of Boring: BMW-27

A-1 AREA LANDFILL TATUM, TEXAS			
Completion Date:	9-1-16	Drilling Method:	HS Auger
Drilling Company:	Walker-Hill Env	Borehole Diameter (in.):	10 25"
Driller:	Jeremy Thornhill	Total Depth (ft):	30.0'
Driller's License:	NA	Northing	220024 389
Field Supervisor:	RKS	Easting	2922347 297
Sampling Method:	5'Macrocore Sampler	Ground Elev (ft AMSL):	373 463

PBW PROJECT No.: 5164-F

Depth (ft)	Well Materials	PID (ppm-v)	Recovery (ft/ft)	USCS	Lithologic Description
0–6			5/5	CL	0.0-6.0 - Clay with silt and fine sand, dark gray, soft, moist, low plasticity Wet at 5 0'
6–18			5/5, 5/5, 5/5	SM-CL	6 0-18 0 - Silty sand with clay, brown, soft, moist
18–30			5/5, 5/5	CL	18.0-30.0 - Silty clay with lignite, dark brown-gray, wet, low plasticity



PBW
Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446

Notes:

1. All logged material is mine spoil.

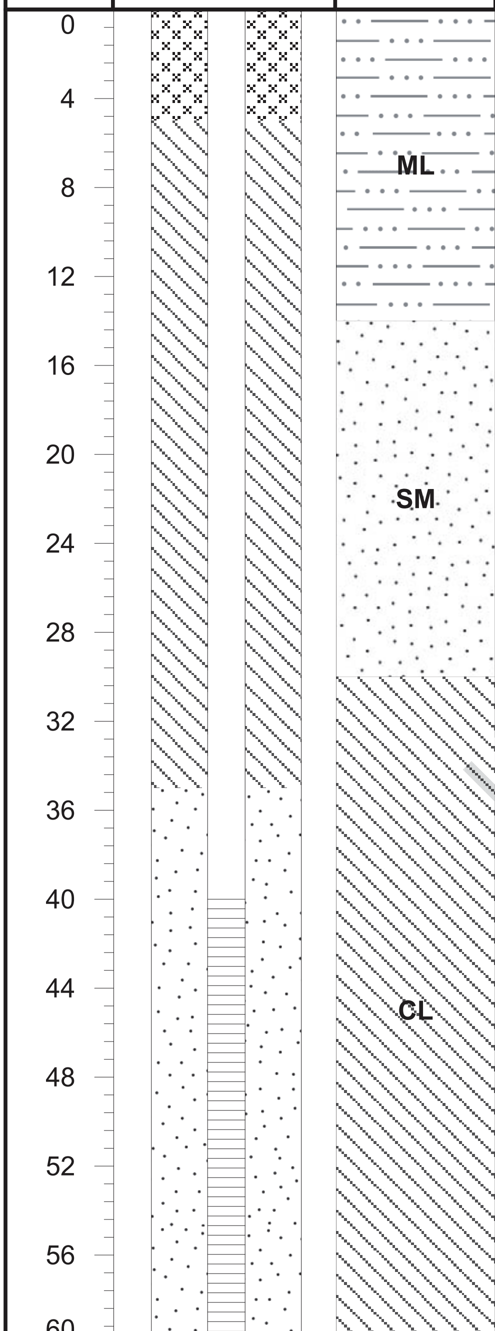
Depth (bgs)	Well Materials	Depth (bgs)	Annular Materials
0' - 20'	Casing, 4" Sch 40 PVC, FJT	0' - 16'	Grout
20' - 30'	Screen, 4" Sch 40 PVC, 010 Slot	16' - 18'	Bentonite Pellet Seal
		18' - 30'	20/40 Sand

Luminant

Log of Boring: BMW-28

A-1 Area Landfill Tatum, TX	Completion Date:	10/27/2016	Drilling Method:	HSA
	Drilling Company:	ETTL	Borehole Diameter (in.):	10.25
	Driller:	Tommy Cook	Total Depth (ft):	60
PBW Project No. 5164F	Driller's License:	2853	TOC Elevation (ft. AMSL):	373.208
	Logged By:	Jeremiah Bihl	Northing:	
	Sampling Method:	4"x10' Core barrel	Easting:	

Depth (ft)	Well Materials	USCS	Lithologic Description
0 - 14		ML	(0 - 14) Clayey SILT (spoil), black to brown, some pieces of coal, moist, low plasticity.
14 - 30		SM	(14 - 30) SAND with silt and small amounts of clay (spoil), some coal pieces, black, soft, dry, low plasticity.
30 - 60		CL	(30 - 60) CLAY with some silt (spoil), pieces of coal, soft, black to dark gray, dry, low plasticity, possible sandstone/siltstone boulder at 40'.



PBW
Pastor, Behling & Wheeler, LLC
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Round Rock, TX 78664
Tel (512) 671-3434 Fax (512) 671-3446

Notes:
1. This log should not be used separately from the report to which it is attached.
2. All logged material is mine spoil.

Well Materials
(0-40) Casing, 2" Sch 40 FJT PVC
(40-60) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-5') Grout
(5'-35') Bentonite pellets
(35'-60') 20/40 sand

Luminant

Log of Boring: BMW-29

Big Brown Steam Electric Station Franklin, Texas	Completion Date:	5/31/2019	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6
	Driller:	Rodney Labrosse	Total Depth (ft):	40
Golder Project No. 19122434E	Driller's License:	60059	TOC Elevation (ft. AMSL):	380.83
	Logged By:	Kelsey Worley	Northing:	3565716
	Sampling Method:	4"x10' Core barrel	Easting:	355228.3

Depth (ft)	Well Materials	Recovery (ft/ft)	USCS	Lithologic Description
0 - 8.2		1.8/10.0	NR	(0 - 8.2) No return
8.2 - 10			CH	(8.2 - 10) CLAY, some fine sand present, brown to gray, dry, firm, no plasticity
10 - 12.7		7.3/10.0	NR	(10 - 12.7) No terturn
12.7 - 24			CH	(12.7 - 24) CLAY, dark gray, some organic staining, pieces of lignite present, slighlty moist, firm, moderate plasticity, fine to large lignite 21'-23.6'
24 - 29.8		9.6/10.0	CL	(24 - 29.8) Silty CLAY, gray, moist, soft, moderate plasticity, minor sand conent at 28.2', Saturated at 29.8'
29.8 - 40		9.4/10.0	SC	(29.8 - 40) Clayey SAND, fine to very fine sand, gray to brown, sand content decreases with depth, saturated, moist at 34.7, dry at 38.1

GOLDER
2201 Double Creek Dr., Suite 4004
Round Rock, Texas 78664
O·512.671.3434 F·512.671.3446

Notes:
1. This log should not be used separately from the report to which it is attached
2. Entire core is composed of mine spoil.

Well Materials
(+3.77 - 30) Casing, 2" Sch 40 FJT PVC
(30 - 40) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-25') Grout
(25'-28') Bentonite pellets
(28'-40') 20/40 sand

Luminant

Log of Boring: BMW-30

Big Brown Steam Electric Station Franklin, Texas	Completion Date:	5/30/2019	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6
	Driller:	Rodney Labrosse	Total Depth (ft):	52
Golder Project No. 19122434E	Driller's License:	60059	TOC Elevation (ft. AMSL):	363.35
	Logged By:	Kelsey Worley	Northing:	3568008
	Sampling Method:	4"x10' Core barrel	Easting:	357427.5

Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0 – 10	5.7/10.0	CL	(0 - 15.3) Sandy CLAY, dark gray, fine sand throughout, pebble to cobble size lignite throughout, trace Fe staining, roots in top 2', 9'-15.3' dark gray with light gray and some trace mottling
10 – 20	6.8/10.0	CH	(15.3 - 33.8) CLAY, dark gray transition to mix of tan, orange, gray, mottle hard to very hard, moderate to high plastitcity, transition to greenish/ gray at 20', rooting at 25.2'
20 – 30	6.8/10.0		
30 – 35	4.8/5.0	LIG	(33.8 - 39.7) LIGNITE, fine to large cobble size pieces
35 – 42	7.0/7.0		
42 – 52	10.0/10.0	SC	(39.7 - 52) Clayey SAND, wet at 40' very fine sand in clay, light gray to gray with some black, very tight 42 to 46, wet again below 46'

GOLDER
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Round Rock, Texas 78664
O·512.671.3434 F·512.671.3446

Notes:
1. This log should not be used separately from the report to which it is attached
2. Entire core is composed of mine spoil.

Well Materials
(+3 - 42) Casing, 2" Sch 40 FJT PVC
(42 - 52) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-37') Grout
(37'-40') Bentonite pellets
(40'-52') 20/40 sand

Luminant

Log of Boring: BMW-31

Big Brown Steam Electric Station
Franklin, Texas

Golder Project No. 19122434E

Completion Date:	5/31/2019	Drilling Method:	Sonic
Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6
Driller:	Rodney Labrosse	Total Depth (ft):	23
Driller's License:	60059	TOC Elevation (ft. AMSL):	324.33
Logged By:	Kelsey Worley	Northing:	3565972
Sampling Method:	4"x10' Core barrel	Easting:	357863.1

Depth (ft)	Well Materials	Recovery (ft/ft)	USCS	Lithologic Description
0–10		9.1/10.0	CL	(0 - 12.3) CLAY, with some find sand, light gray with orange below 2'
10–20		8.8/10.0	CL/SC	(12.3 - 17.9) Sandy CLAY, light gray to orange, moist to wet, soft, subangular, low plasticity, saturated at 14.0'
20–23		3.0/3.0	CL	(17.9 - 23) Sandy CLAY, light gray, firm to very firm, dry below 14.3', some organic staining throughout gray and orange mottle below 16', low to moderate plasticity, very firm

GOLDER
2201 Double Creek Dr., Suite 4004
Round Rock, Texas 78664
O·512.671.3434 F·512.671.3446

Notes:
1. This log should not be used separately from the report to which it is attached
2. Entire core is composed of mine spoil.

Well Materials
(+3.60 - 13) Casing, 2" Sch 40 FJT PVC
(13'- 23') Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-8') Grout
(8'-11') Bentonite pellets
(11'-23') 20/40 sand

Luminant

Log of Boring: BMW-32

Big Brown Steam Electric Station Franklin, Texas	Completion Date:	5/29/2019	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6
	Driller:	Rodney Labrosse	Total Depth (ft):	37
Golder Project No. 19122434E	Driller's License:	60059	TOC Elevation (ft. AMSL):	344.09
	Logged By:	Kelsey Worley	Northing:	3567175
	Sampling Method:	4"x10' Core barrel	Easting:	357875

Depth (ft)	Recovery (ft/ft)	USCS	Lithologic Description
0 - 8.9	6.9/10.0	CL	(0 - 8.9) CLAY fill material, organics and roots on the top foot, mix of tan gray and orange, some iron content, firm, trace sand, black coal pieces mixed in clay below 8.0'
8.9 - 14.7	6.5/10.0	CH	(8.9 - 14.7) CLAY, mixture of clay with black staining, and lignite pieces, soft to firm, moist to wet, subangular, moderate to high plasticity
14.7 - 24.5		LIG	(14.7 - 24.5) LIGNITE, fine to large lignite pieces, subangular, wet at 22.5'-23.5' small to fine lignite, hard, black to brown, soft to hard
24.5 - 25	4.4/5.0	CL/CH	(24.5 - 25) CLAY, dark brown, black, dry, very hard, some orange streaks throughout with black staining
25 - 37	7.0/7.0	SC	(25 - 37) Clayey SAND, gray with some oxidation, soft, round, low plasticity, sand is fine to very fine, increasing clay content with depth

Notes:
1. This log should not be used separately from the report to which it is attached
2. Entire core is composed of mine spoil.

Well Materials
(+3 - 27) Casing, 2" Sch 40 FJT PVC
(27 - 37) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-21') Grout
(21'-25') Bentonite pellets
(25'-37') 20/40 sand

GOLDER
2201 Double Creek Dr., Suite 4004
Round Rock, Texas 78664
O·512.671.3434 F·512.671.3446

Luminant

Log of Boring: BMW-33

Big Brown Steam Electric Station Franklin, Texas	Completion Date:	5/30/2019	Drilling Method:	Sonic
	Drilling Company:	Walker-Hill Environmental	Borehole Diameter (in.):	6
	Driller:	Rodney Labrosse	Total Depth (ft):	48
Golder Project No. 19122434E	Driller's License:	60059	TOC Elevation (ft. AMSL):	427.7
	Logged By:	Sergio Ruiz	Northing:	3568008
	Sampling Method:	4"x10' Core barrel	Easting:	357427.5

Depth (ft)	Well Materials	Recovery (ft/ft)	USCS	Lithologic Description
0–10		6.2/10.0	SP	(0 - 16.7) SAND, fine grained, wet, soft, subround, no plasticity, mix of orange, light orange, few gray clay lenses, thick clay lense 7.3' to 7.8', saturated at 11', trace organics in top 1'
10–20		6.4/10.0	CH	(16.7 - 18.4) CLAY, dark gray, moist, very firm, high plasticity
20–30		7.3/10.0	SC	(18.4 - 48.9) Clayey SAND, wet below 20', mix of gray, light gray, and tan, soft to firm, large pieces of lignite 18.5' to 20' and mixed throughout, dark gray fat clay lense 27.7'-28.2', mixed clay nodules below 29', saturated at 38',
30–40		6.1/10.0		
40–49		6.9/9.0		(48.9 - 49) CLAY , gray stiff, with some sand throughout, some black lignite pieces

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50

GOLDER
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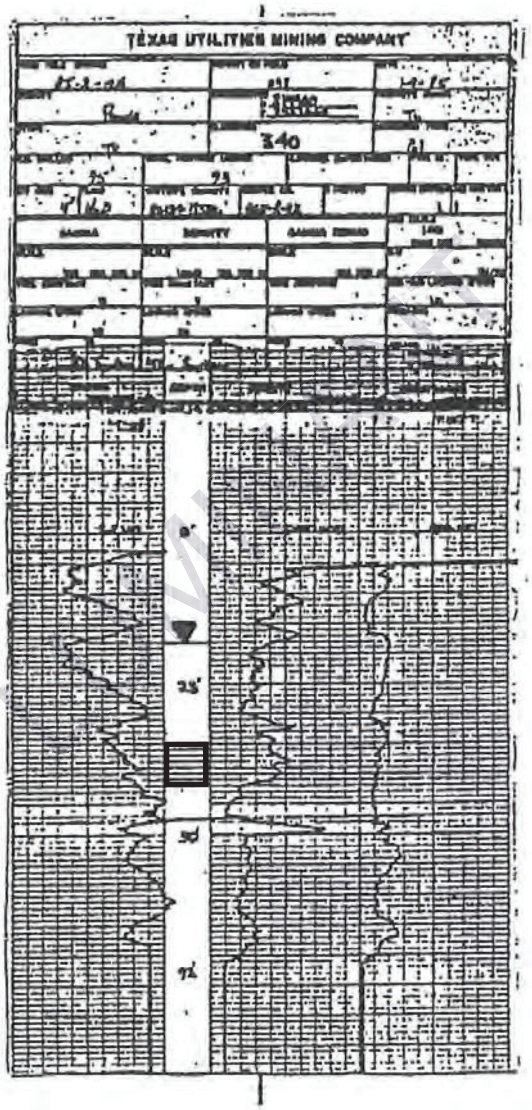
Round Rock, Texas 78664
O·512.671.3434 F·512.671.3446

Notes:
1. This log should not be used separately from the report to which it is attached
2. Entire core is composed of mine spoil.

Well Materials
(+3 - 38) Casing, 2" Sch 40 FJT PVC
(38 - 48) Screen, 2" Sch 40 FJT PVC, 0.010" slot

Annular Materials
(0'-32') Grout
(32'-36') Bentonite pellets
(36'-48') 20/40 sand

AI-2-OB



APPENDIX B

LABORATORY ANALYTICAL REPORTS

June 18, 2019

Will Vienne
Golder
2201 Double Creek Dr #4004
Round Rock, Texas 78664
TEL: (512) 671-3434
FAX (512) 671-3446

Order No.: 1905185

RE: Luminant-A1 Landfill

Dear Will Vienne:

DHL Analytical, Inc. received 11 sample(s) on 5/16/2019 for the analyses presented in the following report.

There were no problems with the analyses and all data met requirements of NELAP except where noted in the Case Narrative. All non-NELAP methods will be identified accordingly in the case narrative and all estimated uncertainties of test results are within method or EPA specifications.

If you have any questions regarding these tests results, please feel free to call. Thank you for using DHL Analytical.

Sincerely,

John DuPont
General Manager

This report was performed under the accreditation of the State of Texas Laboratory Certification Number: T104704211-19-24

Table of Contents

DHL ANALYTICAL

2300 Double Creek Dr. ■ Round Rock, TX 78664
Phone (512) 388-8222 ■ FAX (512) 388-8229
Web: www.dhlanalytical.com
E-Mail: login@dhlanalytical.com

№ 82167

CHAIN-OF-CUSTODY

CLIENT: GOLDER
ADDRESS: 2201 DOUBLE CREEK DR, ROUND ROCK, TX 78664
PHONE: 512-671-3434 FAX/E-MAIL: 512-671-3446
DATA REPORTED TO: WILL VIENNE
ADDITIONAL REPORT COPIES TO:

DATE: 5-15-19 PAGE 1 OF 1
PO #:
DHL WORK ORDER #: 1905185
PROJECT LOCATION OR NAME: LUMINANT - AL LANDFILL
CLENT PROJECT #: 19122262-D COLLECTOR: J. BEAYON

Authorize 5% surcharge for TRRP Report? ❑ Yes ❑ No

S=SOIL P=PAINT
W=WATER SL=SLUDGE
A=AIR O=OTHER
L=LIQUID SO=SOLID
SE=SEDIMENT

PRESERVATION: HCl, HNO_3, H_2SO_4 ❑ NaOH ❑, ICE, UNPRESERVED

ANALYSES: BTEX ❑ MTBE ❑ [METHOD 8021] TPH 1005 ❑ TPH 1006 ❑ HOLD 1006 ❑ GRO [METHOD 8015] ❑ DRO [METHOD 8105] ❑ VOC 8260 ❑ VOC 624 ❑ VOC 8260/5035 ❑ SVOC 8270 ❑ PAH 8270 ❑ HOLD PAH ❑ SVOC 625 ❑ 8270 PEST ❑ 625 PEST/PCB ❑ 608 PCB ❑ 8270 O-P PEST ❑ 8082 PCB ❑ 8270 PCB ❑ 8321 HERB ❑ T PHOS, AMMONIA ❑ METALS 6020 ❑ METALS 200.8 ❑ DISS. METALS ❑ RCRA ❑ TX11 ❑ PH ❑ HEX CHROM ❑ ALKALINITY ❑ COD ❑ CHLORIDE ❑ ANIONS ❑ TCLP-SVOC ❑ VOC ❑ PEST ❑ HERB ❑ TCLP-METALS ❑ RCRA 8 ❑ TX-11 ❑ Pb ❑ RCI ❑ FLASHPOINT ❑ DGAS ❑ TDS ❑ TSS ❑ % MOISTURE ❑ CYANIDE ❑ APPENDIX III & IV; ALK, NO_3, SO_4, Na, Mg, K; FERROUS AND FERRIC IRON

Field Sample I.D.	DHL Lab #	Date	Time	Matrix	Container Type	# of Containers	APPENDIX III & IV	ALK, NO_3, SO_4, Na, Mg, K	FERROUS AND FERRIC IRON	FIELD NOTES
BMW-24	01	5-15-19	0735	W		7	X	X	X	
BMW-23	02		0825	W		7	X	✓	X	
BMW-22	03		0915	W		7	X	X	X	
BMW-21	04		0955	W		7	X	X	X	
BMW-27	05		1055	W		7	X	X	X	
BMW-26	06		1140	W		7	X	X	X	
BMW-11AR	07		1235	W		7	X	X	X	
BMW-19	08		1325	W		7	X	X	X	
BMW-18	09		1410	W		7	X	X	X	
BMW-28	10		1500	W		7	X	X	X	
BMW-20	11		1600	W		7	X	X	X	

RELINQUISHED BY: (Signature) [signature] DATE/TIME 5-16-19 9:15 RECEIVED BY: (Signature) [signature]
RELINQUISHED BY: (Signature) [signature] DATE/TIME 5-16-19 11:21 RECEIVED BY: (Signature) [signature]
RELINQUISHED BY: (Signature) DATE/TIME RECEIVED BY: (Signature)

❑ DHL DISPOSAL @ $5.00 each ❑ Return

TURN AROUND TIME
RUSH ❑ CALL FIRST
1 DAY ❑ CALL FIRST
2 DAY ❑
NORMAL ☒
OTHER ❑

LABORATORY USE ONLY:
RECEIVING TEMP: 1.3/0.4/1.0/2.3 THERM #: 73
CUSTODY SEALS: ❑ BROKEN ❑ INTACT ☒ NOT USED
CARRIER: ❑ LONE STAR ❑ FEDEX ❑ UPS ❑ OTHER
❑ COURIER DELIVERY
☒ HAND DELIVERED

DHL COC Rev 1 | FEB 2010

Eric Lau

From: John DuPont
Sent: Tuesday, May 28, 2019 11:35 AM
To: Eric Lau
Subject: FW: CCR Analysis

Appendix III Parameters:
Metals (Ca and B)
Anions (Cl, F, and SO4)
TDS

Appendix IV Parameters:

Metals (As, Ba, Be, Cd, Co, Cr, Hg, Li, Mo, Pb, Sb, Se, and Tl)
Ra-226
Ra-228

From: Vienne, Will [mailto:William_Vienne@golder.com]
Sent: Tuesday, April 09, 2019 12:48 PM
To: John DuPont <dupont@dhlanalytical.com>
Subject: CCR Analysis

DHL Analytical, Inc.

Sample Receipt Checklist

Client Name Golder

Work Order Number 1905185

Date Received: 5/16/2019

Received by EL

Checklist completed by: [signature] 5/16/2019
Signature Date

Reviewed by DS 5/16/2019
Initials Date

Carrier name Hand Delivered

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shippping container/cooler?	Yes ☐	No ☐	Not Present ☑
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ~~☑~~ EL 5/16/19	No ☑	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐	1.3 °C
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH<2 acceptable upon receipt?	Yes ☑	No ☐	NA ☐ LOT # 11837
	Adjusted? No		Checked by EL
Water - ph>9 (S) or ph>10 (CN) acceptable upon receipt?	Yes ☐	No ☐	NA ☑ LOT #
	Adjusted?		Checked by

Any No response must be detailed in the comments section below.

Client contacted ____ Date contacted: ____ Person contacted ____

Contacted by: ____ Regarding: ____

Comments: One VOA for sample "BMW-23" broken in Login.

Corrective Action Proceed w/ 2 remaining unbroken VOAs

Page 1 of 1

APPENDIX G-Revision 1 December 15, 2022

DHL Analytical, Inc.

Date: *18-Jun-19*

CLIENT: Golder
Project: Luminant-A1 Landfill
Lab Order: 1905185

CASE NARRATIVE

Samples were analyzed using the methods outlined in the following references:

Method SW6020A - Metals Analysis
Method SW7470A - Mercury Analysis
Method E300 - Anions Analysis
Method M2320 B - Alkalinity Analysis
Method M3500-Fe D - Ferrous Iron Analysis (this parameter is not NELAP certified)
Method M3500-Fe D - Ferric Iron (calculation) (this calculation is not NELAP certified).
Method M4500-P E - Orthophosphate Analysis
Method M2540C - TDS Analysis
Sub-contract - Radium-228 and Radium-226 analyses by methods E904 and SM 7500 Ra B M. Analyzed at Pace Analytical.

LOG IN

The samples were received and log-in performed on 5/16/19. A total of 11 samples were received. For sample BMW-23 one VOA vial was broken in login. Proceeded with analysis of Ferrous Iron with the remaining two VOA vials. The samples arrived in good condition and were properly packaged.

METALS ANALYSIS

For Metals analysis performed on 5/22/19 the matrix spike and matrix spike duplicate recoveries were out of control limits for three analytes. These are flagged accordingly in the QC summary report. The sample selected for the matrix spike and matrix spike duplicate was from this work order. The LCS was within control limits for these analytes. No further corrective actions were taken.

For Metals analysis performed on 5/22/19 the RPD for the serial dilution was slightly above control limits for Boron. This is flagged accordingly. The PDS was within control limits for this analyte. No further corrective actions were taken.

DHL Analytical, Inc.

Date: *18-Jun-19*

CLIENT: Golder
Project: Luminant-A1 Landfill
Lab Order: 1905185

Work Order Sample Summary

Lab Smp ID	Client Sample ID	Tag Number	Date Collected	Date Recved
1905185-01	BMW-24		05/15/19 07:35 AM	5/16/2019
1905185-02	BMW-23		05/15/19 08:25 AM	5/16/2019
1905185-03	BMW-22		05/15/19 09:15 AM	5/16/2019
1905185-04	BMW-21		05/15/19 09:55 AM	5/16/2019
1905185-05	BMW-27		05/15/19 10:55 AM	5/16/2019
1905185-06	BMW-26		05/15/19 11:40 AM	5/16/2019
1905185-07	BMW-11AR		05/15/19 12:35 PM	5/16/2019
1905185-08	BMW-19		05/15/19 01:25 PM	5/16/2019
1905185-09	BMW-18		05/15/19 02:10 PM	5/16/2019
1905185-10	BMW-28		05/15/19 03:00 PM	5/16/2019
1905185-11	BMW-20		05/15/19 04:00 PM	5/16/2019

Lab Order: 1905185
Client: Golder
Project: Luminant-A1 Landfill

PREP DATES REPORT

Sample ID	Client Sample ID	Collection Date	Matrix	Test Number	Test Name	Prep Date	Batch ID
1905185-01A	BMW-24	05/15/19 07:35 AM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002
1905185-01B	BMW-24	05/15/19 07:35 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989
	BMW-24	05/15/19 07:35 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989
	BMW-24	05/15/19 07:35 AM	Aqueous	SW7470A	Mercury Aq Prep	05/23/19 09:25 AM	91059
1905185-01C	BMW-24	05/15/19 07:35 AM	Aqueous	M2320 B	Alkalinity Preparation	05/17/19 09:00 AM	90967
	BMW-24	05/15/19 07:35 AM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-24	05/15/19 07:35 AM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-24	05/15/19 07:35 AM	Aqueous	M4500-P E	Orthophosphate Prep	05/16/19 02:09 PM	90950
	BMW-24	05/15/19 07:35 AM	Aqueous	M2540C	TDS Preparation	05/20/19 12:59 PM	91001
1905185-02A	BMW-23	05/15/19 08:25 AM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002
1905185-02B	BMW-23	05/15/19 08:25 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989
	BMW-23	05/15/19 08:25 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989
	BMW-23	05/15/19 08:25 AM	Aqueous	SW7470A	Mercury Aq Prep	05/23/19 09:25 AM	91059
1905185-02C	BMW-23	05/15/19 08:25 AM	Aqueous	M2320 B	Alkalinity Preparation	05/17/19 09:00 AM	90967
	BMW-23	05/15/19 08:25 AM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-23	05/15/19 08:25 AM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-23	05/15/19 08:25 AM	Aqueous	M4500-P E	Orthophosphate Prep	05/16/19 02:09 PM	90950
	BMW-23	05/15/19 08:25 AM	Aqueous	M2540C	TDS Preparation	05/20/19 12:59 PM	91001
1905185-03A	BMW-22	05/15/19 09:15 AM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002
1905185-03B	BMW-22	05/15/19 09:15 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989
	BMW-22	05/15/19 09:15 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989
	BMW-22	05/15/19 09:15 AM	Aqueous	SW7470A	Mercury Aq Prep	05/23/19 09:25 AM	91059
1905185-03C	BMW-22	05/15/19 09:15 AM	Aqueous	M2320 B	Alkalinity Preparation	05/17/19 09:00 AM	90967
	BMW-22	05/15/19 09:15 AM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-22	05/15/19 09:15 AM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-22	05/15/19 09:15 AM	Aqueous	M4500-P E	Orthophosphate Prep	05/16/19 02:09 PM	90950
	BMW-22	05/15/19 09:15 AM	Aqueous	M2540C	TDS Preparation	05/20/19 12:59 PM	91001
1905185-04A	BMW-21	05/15/19 09:55 AM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002

Lab Order: 1905185
Client: Golder
Project: Luminant-A1 Landfill

PREP DATES REPORT

Sample ID	Client Sample ID	Collection Date	Matrix	Test Number	Test Name	Prep Date	Batch ID
1905185-04B	BMW-21	05/15/19 09:55 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989
	BMW-21	05/15/19 09:55 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989
	BMW-21	05/15/19 09:55 AM	Aqueous	SW7470A	Mercury Aq Prep	05/23/19 09:25 AM	91059
1905185-04C	BMW-21	05/15/19 09:55 AM	Aqueous	M2320 B	Alkalinity Preparation	05/17/19 09:00 AM	90967
	BMW-21	05/15/19 09:55 AM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-21	05/15/19 09:55 AM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-21	05/15/19 09:55 AM	Aqueous	M4500-P E	Orthophosphate Prep	05/16/19 02:09 PM	90950
	BMW-21	05/15/19 09:55 AM	Aqueous	M2540C	TDS Preparation	05/20/19 12:59 PM	91001
1905185-05A	BMW-27	05/15/19 10:55 AM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002
1905185-05B	BMW-27	05/15/19 10:55 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989
	BMW-27	05/15/19 10:55 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989
	BMW-27	05/15/19 10:55 AM	Aqueous	SW7470A	Mercury Aq Prep	05/23/19 09:25 AM	91059
1905185-05C	BMW-27	05/15/19 10:55 AM	Aqueous	M2320 B	Alkalinity Preparation	05/17/19 09:00 AM	90967
	BMW-27	05/15/19 10:55 AM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-27	05/15/19 10:55 AM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-27	05/15/19 10:55 AM	Aqueous	M4500-P E	Orthophosphate Prep	05/16/19 02:09 PM	90950
	BMW-27	05/15/19 10:55 AM	Aqueous	M2540C	TDS Preparation	05/20/19 12:59 PM	91001
1905185-06A	BMW-26	05/15/19 11:40 AM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002
1905185-06B	BMW-26	05/15/19 11:40 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989
	BMW-26	05/15/19 11:40 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989
	BMW-26	05/15/19 11:40 AM	Aqueous	SW7470A	Mercury Aq Prep	05/23/19 09:25 AM	91059
1905185-06C	BMW-26	05/15/19 11:40 AM	Aqueous	M2320 B	Alkalinity Preparation	05/17/19 09:00 AM	90967
	BMW-26	05/15/19 11:40 AM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-26	05/15/19 11:40 AM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-26	05/15/19 11:40 AM	Aqueous	M4500-P E	Orthophosphate Prep	05/16/19 02:09 PM	90950
	BMW-26	05/15/19 11:40 AM	Aqueous	M2540C	TDS Preparation	05/20/19 12:59 PM	91001
1905185-07A	BMW-11AR	05/15/19 12:35 PM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002
1905185-07B	BMW-11AR	05/15/19 12:35 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989

Lab Order: 1905185
Client: Golder
Project: Luminant-A1 Landfill

PREP DATES REPORT

Sample ID	Client Sample ID	Collection Date	Matrix	Test Number	Test Name	Prep Date	Batch ID
1905185-07B	BMW-11AR	05/15/19 12:35 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989
	BMW-11AR	05/15/19 12:35 PM	Aqueous	SW7470A	Mercury Aq Prep	05/23/19 09:25 AM	91059
1905185-07C	BMW-11AR	05/15/19 12:35 PM	Aqueous	M2320 B	Alkalinity Preparation	05/17/19 09:00 AM	90967
	BMW-11AR	05/15/19 12:35 PM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-11AR	05/15/19 12:35 PM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-11AR	05/15/19 12:35 PM	Aqueous	M4500-P E	Orthophosphate Prep	05/16/19 02:09 PM	90950
	BMW-11AR	05/15/19 12:35 PM	Aqueous	M2540C	TDS Preparation	05/20/19 12:59 PM	91001
1905185-08A	BMW-19	05/15/19 01:25 PM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002
1905185-08B	BMW-19	05/15/19 01:25 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989
	BMW-19	05/15/19 01:25 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989
	BMW-19	05/15/19 01:25 PM	Aqueous	SW7470A	Mercury Aq Prep	05/23/19 09:25 AM	91059
1905185-08C	BMW-19	05/15/19 01:25 PM	Aqueous	M2320 B	Alkalinity Preparation	05/17/19 09:00 AM	90967
	BMW-19	05/15/19 01:25 PM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-19	05/15/19 01:25 PM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-19	05/15/19 01:25 PM	Aqueous	E300	Anion Preparation	05/17/19 09:26 AM	90964
	BMW-19	05/15/19 01:25 PM	Aqueous	M4500-P E	Orthophosphate Prep	05/16/19 02:09 PM	90950
	BMW-19	05/15/19 01:25 PM	Aqueous	M2540C	TDS Preparation	05/20/19 12:59 PM	91001
1905185-09A	BMW-18	05/15/19 02:10 PM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002
1905185-09B	BMW-18	05/15/19 02:10 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989
	BMW-18	05/15/19 02:10 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989
	BMW-18	05/15/19 02:10 PM	Aqueous	SW7470A	Mercury Aq Prep	05/23/19 09:25 AM	91059
1905185-09C	BMW-18	05/15/19 02:10 PM	Aqueous	M2320 B	Alkalinity Preparation	05/17/19 09:00 AM	90967
	BMW-18	05/15/19 02:10 PM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-18	05/15/19 02:10 PM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-18	05/15/19 02:10 PM	Aqueous	M4500-P E	Orthophosphate Prep	05/16/19 02:09 PM	90950
	BMW-18	05/15/19 02:10 PM	Aqueous	M2540C	TDS Preparation	05/20/19 12:59 PM	91001
1905185-10A	BMW-28	05/15/19 03:00 PM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002
1905185-10B	BMW-28	05/15/19 03:00 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989

Lab Order: 1905185
Client: Golder
Project: Luminant-A1 Landfill

PREP DATES REPORT

Sample ID	Client Sample ID	Collection Date	Matrix	Test Number	Test Name	Prep Date	Batch ID
1905185-10B	BMW-28	05/15/19 03:00 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989
	BMW-28	05/15/19 03:00 PM	Aqueous	SW7470A	Mercury Aq Prep	05/23/19 09:25 AM	91059
1905185-10C	BMW-28	05/15/19 03:00 PM	Aqueous	M2320 B	Alkalinity Preparation	05/17/19 09:00 AM	90967
	BMW-28	05/15/19 03:00 PM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-28	05/15/19 03:00 PM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-28	05/15/19 03:00 PM	Aqueous	E300	Anion Preparation	05/17/19 09:26 AM	90964
	BMW-28	05/15/19 03:00 PM	Aqueous	M4500-P E	Orthophosphate Prep	05/16/19 02:09 PM	90950
	BMW-28	05/15/19 03:00 PM	Aqueous	M2540C	TDS Preparation	05/20/19 12:59 PM	91001
1905185-11A	BMW-20	05/15/19 04:00 PM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	05/20/19 02:56 PM	91002
1905185-11B	BMW-20	05/15/19 04:00 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989
	BMW-20	05/15/19 04:00 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	05/20/19 09:30 AM	90989
	BMW-20	05/15/19 04:00 PM	Aqueous	SW7470A	Mercury Aq Prep	05/23/19 09:25 AM	91059
1905185-11C	BMW-20	05/15/19 04:00 PM	Aqueous	M2320 B	Alkalinity Preparation	05/17/19 09:00 AM	90967
	BMW-20	05/15/19 04:00 PM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-20	05/15/19 04:00 PM	Aqueous	E300	Anion Preparation	05/16/19 01:49 PM	90934
	BMW-20	05/15/19 04:00 PM	Aqueous	M4500-P E	Orthophosphate Prep	05/16/19 02:09 PM	90950
	BMW-20	05/15/19 04:00 PM	Aqueous	M2540C	TDS Preparation	05/20/19 12:59 PM	91001

Lab Order: 1905185
Client: Golder
Project: Luminant-A1 Landfill

ANALYTICAL DATES REPORT

Sample ID	Client Sample ID	Matrix	Test Number	Test Name	Batch ID	Dilution	Analysis Date	Run ID
1905185-01A	BMW-24	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91002	1	05/24/19	UV/VIS_2_190524A
	BMW-24	Aqueous	M3500-Fe D	Ferrous Iron	91002	1	05/20/19 03:58 PM	UV/VIS_2_190520A
1905185-01B	BMW-24	Aqueous	SW7470A	Mercury Total: Aqueous	91059	1	05/24/19 09:39 AM	CETAC2_HG_190524A
	BMW-24	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	1	05/22/19 02:56 PM	ICP-MS4_190522D
	BMW-24	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	10	05/23/19 11:22 AM	ICP-MS4_190523A
1905185-01C	BMW-24	Aqueous	M2320 B	Alkalinity	90967	1	05/17/19 01:18 PM	TITRATOR_190517A
	BMW-24	Aqueous	E300	Anions by IC method - Water	90934	1	05/16/19 06:01 PM	IC2_190516B
	BMW-24	Aqueous	E300	Anions by IC method - Water	90934	10	05/17/19 01:13 AM	IC2_190516B
	BMW-24	Aqueous	M4500-P E	Orthophosphate	90950	1	05/16/19 02:47 PM	UV/VIS_2_190516B
	BMW-24	Aqueous	M2540C	Total Dissolved Solids	91001	1	05/20/19 04:45 PM	WC_190520A
1905185-02A	BMW-23	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91002	1	05/24/19	UV/VIS_2_190524A
	BMW-23	Aqueous	M3500-Fe D	Ferrous Iron	91002	1	05/20/19 04:00 PM	UV/VIS_2_190520A
1905185-02B	BMW-23	Aqueous	SW7470A	Mercury Total: Aqueous	91059	1	05/24/19 09:42 AM	CETAC2_HG_190524A
	BMW-23	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	1	05/22/19 02:58 PM	ICP-MS4_190522D
	BMW-23	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	20	05/23/19 11:24 AM	ICP-MS4_190523A
1905185-02C	BMW-23	Aqueous	M2320 B	Alkalinity	90967	1	05/17/19 01:36 PM	TITRATOR_190517A
	BMW-23	Aqueous	E300	Anions by IC method - Water	90934	1	05/16/19 06:17 PM	IC2_190516B
	BMW-23	Aqueous	E300	Anions by IC method - Water	90934	10	05/17/19 01:29 AM	IC2_190516B
	BMW-23	Aqueous	M4500-P E	Orthophosphate	90950	1	05/16/19 02:47 PM	UV/VIS_2_190516B
	BMW-23	Aqueous	M2540C	Total Dissolved Solids	91001	1	05/20/19 04:45 PM	WC_190520A
1905185-03A	BMW-22	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91002	1	05/24/19	UV/VIS_2_190524A
	BMW-22	Aqueous	M3500-Fe D	Ferrous Iron	91002	1	05/20/19 04:00 PM	UV/VIS_2_190520A
1905185-03B	BMW-22	Aqueous	SW7470A	Mercury Total: Aqueous	91059	1	05/24/19 09:44 AM	CETAC2_HG_190524A
	BMW-22	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	1	05/22/19 03:00 PM	ICP-MS4_190522D
	BMW-22	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	20	05/23/19 11:26 AM	ICP-MS4_190523A
1905185-03C	BMW-22	Aqueous	M2320 B	Alkalinity	90967	1	05/17/19 02:01 PM	TITRATOR_190517A

Lab Order: 1905185
Client: Golder
Project: Luminant-A1 Landfill

ANALYTICAL DATES REPORT

Sample ID	Client Sample ID	Matrix	Test Number	Test Name	Batch ID	Dilution	Analysis Date	Run ID
1905185-03C	BMW-22	Aqueous	E300	Anions by IC method - Water	90934	10	05/17/19 01:45 AM	IC2_190516B
	BMW-22	Aqueous	E300	Anions by IC method - Water	90934	1	05/16/19 06:33 PM	IC2_190516B
	BMW-22	Aqueous	M4500-P E	Orthophosphate	90950	1	05/16/19 02:48 PM	UV/VIS_2_190516B
	BMW-22	Aqueous	M2540C	Total Dissolved Solids	91001	1	05/20/19 04:45 PM	WC_190520A
1905185-04A	BMW-21	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91002	1	05/24/19	UV/VIS_2_190524A
	BMW-21	Aqueous	M3500-Fe D	Ferrous Iron	91002	1	05/20/19 04:00 PM	UV/VIS_2_190520A
1905185-04B	BMW-21	Aqueous	SW7470A	Mercury Total: Aqueous	91059	1	05/24/19 09:46 AM	CETAC2_HG_190524A
	BMW-21	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	1	05/22/19 03:02 PM	ICP-MS4_190522D
	BMW-21	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	20	05/23/19 11:28 AM	ICP-MS4_190523A
1905185-04C	BMW-21	Aqueous	M2320 B	Alkalinity	90967	1	05/17/19 02:47 PM	TITRATOR_190517A
	BMW-21	Aqueous	E300	Anions by IC method - Water	90934	1	05/16/19 06:49 PM	IC2_190516B
	BMW-21	Aqueous	E300	Anions by IC method - Water	90934	10	05/17/19 02:01 AM	IC2_190516B
	BMW-21	Aqueous	M4500-P E	Orthophosphate	90950	1	05/16/19 02:48 PM	UV/VIS_2_190516B
	BMW-21	Aqueous	M2540C	Total Dissolved Solids	91001	1	05/20/19 04:45 PM	WC_190520A
1905185-05A	BMW-27	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91002	1	05/24/19	UV/VIS_2_190524A
	BMW-27	Aqueous	M3500-Fe D	Ferrous Iron	91002	1	05/20/19 04:01 PM	UV/VIS_2_190520A
1905185-05B	BMW-27	Aqueous	SW7470A	Mercury Total: Aqueous	91059	1	05/24/19 09:48 AM	CETAC2_HG_190524A
	BMW-27	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	20	05/23/19 11:30 AM	ICP-MS4_190523A
	BMW-27	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	1	05/22/19 03:04 PM	ICP-MS4_190522D
1905185-05C	BMW-27	Aqueous	M2320 B	Alkalinity	90967	1	05/17/19 03:13 PM	TITRATOR_190517A
	BMW-27	Aqueous	E300	Anions by IC method - Water	90934	1	05/16/19 07:05 PM	IC2_190516B
	BMW-27	Aqueous	E300	Anions by IC method - Water	90934	10	05/17/19 02:17 AM	IC2_190516B
	BMW-27	Aqueous	M4500-P E	Orthophosphate	90950	1	05/16/19 02:48 PM	UV/VIS_2_190516B
	BMW-27	Aqueous	M2540C	Total Dissolved Solids	91001	1	05/20/19 04:45 PM	WC_190520A
1905185-06A	BMW-26	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91002	1	05/24/19	UV/VIS_2_190524A
	BMW-26	Aqueous	M3500-Fe D	Ferrous Iron	91002	1	05/20/19 04:01 PM	UV/VIS_2_190520A

Lab Order: 1905185
Client: Golder
Project: Luminant-A1 Landfill

ANALYTICAL DATES REPORT

Sample ID	Client Sample ID	Matrix	Test Number	Test Name	Batch ID	Dilution	Analysis Date	Run ID
1905185-06B	BMW-26	Aqueous	SW7470A	Mercury Total: Aqueous	91059	1	05/24/19 09:51 AM	CETAC2_HG_190524A
	BMW-26	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	1	05/22/19 02:52 PM	ICP-MS4_190522D
	BMW-26	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	20	05/23/19 11:18 AM	ICP-MS4_190523A
1905185-06C	BMW-26	Aqueous	M2320 B	Alkalinity	90967	1	05/17/19 03:40 PM	TITRATOR_190517A
	BMW-26	Aqueous	E300	Anions by IC method - Water	90934	10	05/17/19 02:33 AM	IC2_190516B
	BMW-26	Aqueous	E300	Anions by IC method - Water	90934	1	05/16/19 07:21 PM	IC2_190516B
	BMW-26	Aqueous	M4500-P E	Orthophosphate	90950	1	05/16/19 02:49 PM	UV/VIS_2_190516B
	BMW-26	Aqueous	M2540C	Total Dissolved Solids	91001	1	05/20/19 04:45 PM	WC_190520A
1905185-07A	BMW-11AR	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91002	1	05/24/19	UV/VIS_2_190524A
	BMW-11AR	Aqueous	M3500-Fe D	Ferrous Iron	91002	1	05/20/19 04:01 PM	UV/VIS_2_190520A
1905185-07B	BMW-11AR	Aqueous	SW7470A	Mercury Total: Aqueous	91059	1	05/24/19 09:53 AM	CETAC2_HG_190524A
	BMW-11AR	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	1	05/22/19 03:06 PM	ICP-MS4_190522D
	BMW-11AR	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	10	05/23/19 11:32 AM	ICP-MS4_190523A
1905185-07C	BMW-11AR	Aqueous	M2320 B	Alkalinity	90967	1	05/17/19 03:59 PM	TITRATOR_190517A
	BMW-11AR	Aqueous	E300	Anions by IC method - Water	90934	1	05/16/19 07:37 PM	IC2_190516B
	BMW-11AR	Aqueous	E300	Anions by IC method - Water	90934	10	05/17/19 02:49 AM	IC2_190516B
	BMW-11AR	Aqueous	M4500-P E	Orthophosphate	90950	1	05/16/19 02:49 PM	UV/VIS_2_190516B
	BMW-11AR	Aqueous	M2540C	Total Dissolved Solids	91001	1	05/20/19 04:45 PM	WC_190520A
1905185-08A	BMW-19	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91002	1	05/24/19	UV/VIS_2_190524A
	BMW-19	Aqueous	M3500-Fe D	Ferrous Iron	91002	1	05/20/19 04:02 PM	UV/VIS_2_190520A
1905185-08B	BMW-19	Aqueous	SW7470A	Mercury Total: Aqueous	91059	1	05/24/19 09:55 AM	CETAC2_HG_190524A
	BMW-19	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	1	05/22/19 03:07 PM	ICP-MS4_190522D
	BMW-19	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	20	05/23/19 11:34 AM	ICP-MS4_190523A
1905185-08C	BMW-19	Aqueous	M2320 B	Alkalinity	90967	1	05/17/19 04:15 PM	TITRATOR_190517A
	BMW-19	Aqueous	E300	Anions by IC method - Water	90934	1	05/16/19 07:53 PM	IC2_190516B
	BMW-19	Aqueous	E300	Anions by IC method - Water	90934	10	05/17/19 03:05 AM	IC2_190516B

Lab Order: 1905185
Client: Golder
Project: Luminant-A1 Landfill

ANALYTICAL DATES REPORT

Sample ID	Client Sample ID	Matrix	Test Number	Test Name	Batch ID	Dilution	Analysis Date	Run ID
1905185-08C	BMW-19	Aqueous	E300	Anions by IC method - Water	90964	100	05/17/19 04:09 PM	IC2_190517B
	BMW-19	Aqueous	M4500-P E	Orthophosphate	90950	1	05/16/19 02:49 PM	UV/VIS_2_190516B
	BMW-19	Aqueous	M2540C	Total Dissolved Solids	91001	1	05/20/19 04:45 PM	WC_190520A
1905185-09A	BMW-18	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91002	1	05/24/19	UV/VIS_2_190524A
	BMW-18	Aqueous	M3500-Fe D	Ferrous Iron	91002	1	05/20/19 04:02 PM	UV/VIS_2_190520A
1905185-09B	BMW-18	Aqueous	SW7470A	Mercury Total: Aqueous	91059	1	05/24/19 09:58 AM	CETAC2_HG_190524A
	BMW-18	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	20	05/23/19 11:36 AM	ICP-MS4_190523A
	BMW-18	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	1	05/22/19 03:09 PM	ICP-MS4_190522D
1905185-09C	BMW-18	Aqueous	M2320 B	Alkalinity	90967	1	05/17/19 04:24 PM	TITRATOR_190517A
	BMW-18	Aqueous	E300	Anions by IC method - Water	90934	1	05/16/19 08:09 PM	IC2_190516B
	BMW-18	Aqueous	E300	Anions by IC method - Water	90934	10	05/17/19 03:21 AM	IC2_190516B
	BMW-18	Aqueous	M4500-P E	Orthophosphate	90950	1	05/16/19 02:50 PM	UV/VIS_2_190516B
	BMW-18	Aqueous	M2540C	Total Dissolved Solids	91001	1	05/20/19 04:45 PM	WC_190520A
1905185-10A	BMW-28	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91002	1	05/24/19	UV/VIS_2_190524A
	BMW-28	Aqueous	M3500-Fe D	Ferrous Iron	91002	1	05/20/19 04:02 PM	UV/VIS_2_190520A
1905185-10B	BMW-28	Aqueous	SW7470A	Mercury Total: Aqueous	91059	1	05/24/19 10:04 AM	CETAC2_HG_190524A
	BMW-28	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	1	05/22/19 03:11 PM	ICP-MS4_190522D
	BMW-28	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	50	05/23/19 11:38 AM	ICP-MS4_190523A
1905185-10C	BMW-28	Aqueous	M2320 B	Alkalinity	90967	1	05/17/19 04:49 PM	TITRATOR_190517A
	BMW-28	Aqueous	E300	Anions by IC method - Water	90934	1	05/16/19 08:25 PM	IC2_190516B
	BMW-28	Aqueous	E300	Anions by IC method - Water	90934	10	05/17/19 03:37 AM	IC2_190516B
	BMW-28	Aqueous	E300	Anions by IC method - Water	90964	100	05/17/19 04:25 PM	IC2_190517B
	BMW-28	Aqueous	M4500-P E	Orthophosphate	90950	1	05/16/19 02:50 PM	UV/VIS_2_190516B
	BMW-28	Aqueous	M2540C	Total Dissolved Solids	91001	1	05/20/19 04:45 PM	WC_190520A
1905185-11A	BMW-20	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91002	1	05/24/19	UV/VIS_2_190524A
	BMW-20	Aqueous	M3500-Fe D	Ferrous Iron	91002	1	05/20/19 04:02 PM	UV/VIS_2_190520A

Lab Order: 1905185
Client: Golder
Project: Luminant-A1 Landfill

ANALYTICAL DATES REPORT

Sample ID	Client Sample ID	Matrix	Test Number	Test Name	Batch ID	Dilution	Analysis Date	Run ID
1905185-11B	BMW-20	Aqueous	SW7470A	Mercury Total: Aqueous	91059	1	05/24/19 10:07 AM	CETAC2_HG_190524A
	BMW-20	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	1	05/22/19 03:50 PM	ICP-MS4_190522D
	BMW-20	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	90989	20	05/23/19 11:53 AM	ICP-MS4_190523A
1905185-11C	BMW-20	Aqueous	M2320 B	Alkalinity	90967	1	05/17/19 05:15 PM	TITRATOR_190517A
	BMW-20	Aqueous	E300	Anions by IC method - Water	90934	1	05/16/19 10:01 PM	IC2_190516B
	BMW-20	Aqueous	E300	Anions by IC method - Water	90934	10	05/17/19 04:57 AM	IC2_190516B
	BMW-20	Aqueous	M4500-P E	Orthophosphate	90950	1	05/16/19 02:52 PM	UV/VIS_2_190516B
	BMW-20	Aqueous	M2540C	Total Dissolved Solids	91001	1	05/20/19 04:45 PM	WC_190520A

DHL Analytical, Inc.

Date: *18-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-24
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-01
Project No:	19122262-D	**Collection Date:**	05/15/19 07:35 AM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **RO**
Antimony	<0.000800	0.000800	0.00250		mg/L	1	05/22/19 02:56 PM
Arsenic	0.00272	0.00200	0.00500	J	mg/L	1	05/22/19 02:56 PM
Barium	0.221	0.00300	0.0100		mg/L	1	05/22/19 02:56 PM
Beryllium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 02:56 PM
Boron	0.601	0.0100	0.0300		mg/L	1	05/22/19 02:56 PM
Cadmium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 02:56 PM
Calcium	57.9	1.00	3.00		mg/L	10	05/23/19 11:22 AM
Chromium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 02:56 PM
Cobalt	0.00643	0.00300	0.00500		mg/L	1	05/22/19 02:56 PM
Iron	35.1	0.300	1.00		mg/L	10	05/23/19 11:22 AM
Lead	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 02:56 PM
Lithium	0.0512	0.00500	0.0100		mg/L	1	05/22/19 02:56 PM
Magnesium	57.5	1.00	3.00		mg/L	10	05/23/19 11:22 AM
Molybdenum	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 02:56 PM
Potassium	3.22	0.100	0.300		mg/L	1	05/22/19 02:56 PM
Selenium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 02:56 PM
Sodium	119	1.00	3.00		mg/L	10	05/23/19 11:22 AM
Thallium	<0.000500	0.000500	0.00150		mg/L	1	05/22/19 02:56 PM
MERCURY TOTAL: AQUEOUS		**SW7470A**					Analyst: **BM**
Mercury	<0.0000800	0.0000800	0.000200		mg/L	1	05/24/19 09:39 AM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	169	3.00	10.0		mg/L	10	05/17/19 01:13 AM
Fluoride	0.219	0.100	0.400	J	mg/L	1	05/16/19 06:01 PM
Nitrate-N	<0.100	0.100	0.500		mg/L	1	05/16/19 06:01 PM
Sulfate	280	10.0	30.0		mg/L	10	05/17/19 01:13 AM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	176	10.0	20.0		mg/L @ pH 4.53	1	05/17/19 01:18 PM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.53	1	05/17/19 01:18 PM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.53	1	05/17/19 01:18 PM
Alkalinity, Total (As CaCO3)	176	20.0	20.0		mg/L @ pH 4.53	1	05/17/19 01:18 PM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	35.1	0.0500	0.100	N	mg/L	1	05/24/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	05/20/19 03:58 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *18-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-24
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-01
Project No:	19122262-D	**Collection Date:**	05/15/19 07:35 AM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **CC**
Phosphorus, Total Orthophosphate (As P)	0.0510	0.0300	0.100	J	mg/L	1	05/16/19 02:47 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	881	10.0	10.0		mg/L	1	05/20/19 04:45 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

CLIENT:	Golder	**Client Sample ID:**	BMW-23
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-02
Project No:	19122262-D	**Collection Date:**	05/15/19 08:25 AM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **RO**
Antimony	<0.000800	0.000800	0.00250		mg/L	1	05/22/19 02:58 PM
Arsenic	0.00240	0.00200	0.00500	J	mg/L	1	05/22/19 02:58 PM
Barium	0.0381	0.00300	0.0100		mg/L	1	05/22/19 02:58 PM
Beryllium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 02:58 PM
Boron	1.31	0.0100	0.0300		mg/L	1	05/22/19 02:58 PM
Cadmium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 02:58 PM
Calcium	89.9	2.00	6.00		mg/L	20	05/23/19 11:24 AM
Chromium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 02:58 PM
Cobalt	<0.00300	0.00300	0.00500		mg/L	1	05/22/19 02:58 PM
Iron	9.64	0.0300	0.100		mg/L	1	05/22/19 02:58 PM
Lead	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 02:58 PM
Lithium	0.0951	0.00500	0.0100		mg/L	1	05/22/19 02:58 PM
Magnesium	92.2	2.00	6.00		mg/L	20	05/23/19 11:24 AM
Molybdenum	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 02:58 PM
Potassium	4.28	0.100	0.300		mg/L	1	05/22/19 02:58 PM
Selenium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 02:58 PM
Sodium	311	2.00	6.00		mg/L	20	05/23/19 11:24 AM
Thallium	<0.000500	0.000500	0.00150		mg/L	1	05/22/19 02:58 PM
MERCURY TOTAL: AQUEOUS		**SW7470A**					Analyst: **BM**
Mercury	<0.0000800	0.0000800	0.000200		mg/L	1	05/24/19 09:42 AM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	240	3.00	10.0		mg/L	10	05/17/19 01:29 AM
Fluoride	<0.100	0.100	0.400		mg/L	1	05/16/19 06:17 PM
Nitrate-N	<0.100	0.100	0.500		mg/L	1	05/16/19 06:17 PM
Sulfate	613	10.0	30.0		mg/L	10	05/17/19 01:29 AM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	414	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 01:36 PM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 01:36 PM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 01:36 PM
Alkalinity, Total (As CaCO3)	414	20.0	20.0		mg/L @ pH 4.54	1	05/17/19 01:36 PM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	9.55	0.0500	0.100	N	mg/L	1	05/24/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	0.0937	0.0500	0.100	JN	mg/L	1	05/20/19 04:00 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *18-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-23
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-02
Project No:	19122262-D	**Collection Date:**	05/15/19 08:25 AM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **CC**
Phosphorus, Total Orthophosphate (As P)	0.202	0.0300	0.100		mg/L	1	05/16/19 02:47 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	1640	50.0	50.0		mg/L	1	05/20/19 04:45 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

CLIENT:	Golder	**Client Sample ID:**	BMW-22
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-03
Project No:	19122262-D	**Collection Date:**	05/15/19 09:15 AM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **RO**
Antimony	<0.000800	0.000800	0.00250		mg/L	1	05/22/19 03:00 PM
Arsenic	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:00 PM
Barium	0.0618	0.00300	0.0100		mg/L	1	05/22/19 03:00 PM
Beryllium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:00 PM
Boron	3.39	0.200	0.600		mg/L	20	05/23/19 11:26 AM
Cadmium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:00 PM
Calcium	198	2.00	6.00		mg/L	20	05/23/19 11:26 AM
Chromium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:00 PM
Cobalt	<0.00300	0.00300	0.00500		mg/L	1	05/22/19 03:00 PM
Iron	9.99	0.0300	0.100		mg/L	1	05/22/19 03:00 PM
Lead	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:00 PM
Lithium	0.0779	0.00500	0.0100		mg/L	1	05/22/19 03:00 PM
Magnesium	155	2.00	6.00		mg/L	20	05/23/19 11:26 AM
Molybdenum	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:00 PM
Potassium	6.15	0.100	0.300		mg/L	1	05/22/19 03:00 PM
Selenium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:00 PM
Sodium	265	2.00	6.00		mg/L	20	05/23/19 11:26 AM
Thallium	<0.000500	0.000500	0.00150		mg/L	1	05/22/19 03:00 PM
MERCURY TOTAL: AQUEOUS		**SW7470A**					Analyst: **BM**
Mercury	<0.0000800	0.0000800	0.000200		mg/L	1	05/24/19 09:44 AM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	311	3.00	10.0		mg/L	10	05/17/19 01:45 AM
Fluoride	0.351	0.100	0.400	J	mg/L	1	05/16/19 06:33 PM
Nitrate-N	<0.100	0.100	0.500		mg/L	1	05/16/19 06:33 PM
Sulfate	967	10.0	30.0		mg/L	10	05/17/19 01:45 AM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	474	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 02:01 PM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 02:01 PM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 02:01 PM
Alkalinity, Total (As CaCO3)	474	20.0	20.0		mg/L @ pH 4.54	1	05/17/19 02:01 PM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	9.99	0.0500	0.100	N	mg/L	1	05/24/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	05/20/19 04:00 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *18-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-22
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-03
Project No:	19122262-D	**Collection Date:**	05/15/19 09:15 AM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **CC**
Phosphorus, Total Orthophosphate (As P)	0.0540	0.0300	0.100	J	mg/L	1	05/16/19 02:48 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	2260	50.0	50.0		mg/L	1	05/20/19 04:45 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *18-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-21
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-04
Project No:	19122262-D	**Collection Date:**	05/15/19 09:55 AM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **RO**
Antimony	<0.000800	0.000800	0.00250		mg/L	1	05/22/19 03:02 PM
Arsenic	0.00399	0.00200	0.00500	J	mg/L	1	05/22/19 03:02 PM
Barium	0.0412	0.00300	0.0100		mg/L	1	05/22/19 03:02 PM
Beryllium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:02 PM
Boron	0.994	0.0100	0.0300		mg/L	1	05/22/19 03:02 PM
Cadmium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:02 PM
Calcium	147	2.00	6.00		mg/L	20	05/23/19 11:28 AM
Chromium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:02 PM
Cobalt	<0.00300	0.00300	0.00500		mg/L	1	05/22/19 03:02 PM
Iron	1.02	0.0300	0.100		mg/L	1	05/22/19 03:02 PM
Lead	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:02 PM
Lithium	0.0613	0.00500	0.0100		mg/L	1	05/22/19 03:02 PM
Magnesium	138	2.00	6.00		mg/L	20	05/23/19 11:28 AM
Molybdenum	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:02 PM
Potassium	5.21	0.100	0.300		mg/L	1	05/22/19 03:02 PM
Selenium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:02 PM
Sodium	386	2.00	6.00		mg/L	20	05/23/19 11:28 AM
Thallium	<0.000500	0.000500	0.00150		mg/L	1	05/22/19 03:02 PM
MERCURY TOTAL: AQUEOUS		**SW7470A**					Analyst: **BM**
Mercury	<0.0000800	0.0000800	0.000200		mg/L	1	05/24/19 09:46 AM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	428	3.00	10.0		mg/L	10	05/17/19 02:01 AM
Fluoride	0.366	0.100	0.400	J	mg/L	1	05/16/19 06:49 PM
Nitrate-N	<0.100	0.100	0.500		mg/L	1	05/16/19 06:49 PM
Sulfate	474	10.0	30.0		mg/L	10	05/17/19 02:01 AM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	780	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 02:47 PM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 02:47 PM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 02:47 PM
Alkalinity, Total (As CaCO3)	780	20.0	20.0		mg/L @ pH 4.54	1	05/17/19 02:47 PM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	1.02	0.0500	0.100	N	mg/L	1	05/24/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	05/20/19 04:00 PM

Qualifiers:	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *18-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-21
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-04
Project No:	19122262-D	**Collection Date:**	05/15/19 09:55 AM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **CC**
Phosphorus, Total Orthophosphate (As P)	<0.0300	0.0300	0.100		mg/L	1	05/16/19 02:48 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	1980	50.0	50.0		mg/L	1	05/20/19 04:45 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

CLIENT:	Golder	**Client Sample ID:**	BMW-27
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-05
Project No:	19122262-D	**Collection Date:**	05/15/19 10:55 AM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **RO**
Antimony	<0.000800	0.000800	0.00250		mg/L	1	05/22/19 03:04 PM
Arsenic	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:04 PM
Barium	0.0238	0.00300	0.0100		mg/L	1	05/22/19 03:04 PM
Beryllium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:04 PM
Boron	0.460	0.0100	0.0300		mg/L	1	05/22/19 03:04 PM
Cadmium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:04 PM
Calcium	190	2.00	6.00		mg/L	20	05/23/19 11:30 AM
Chromium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:04 PM
Cobalt	<0.00300	0.00300	0.00500		mg/L	1	05/22/19 03:04 PM
Iron	0.0447	0.0300	0.100	J	mg/L	1	05/22/19 03:04 PM
Lead	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:04 PM
Lithium	0.0943	0.00500	0.0100		mg/L	1	05/22/19 03:04 PM
Magnesium	122	2.00	6.00		mg/L	20	05/23/19 11:30 AM
Molybdenum	0.00204	0.00200	0.00500	J	mg/L	1	05/22/19 03:04 PM
Potassium	12.5	0.100	0.300		mg/L	1	05/22/19 03:04 PM
Selenium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:04 PM
Sodium	251	2.00	6.00		mg/L	20	05/23/19 11:30 AM
Thallium	<0.000500	0.000500	0.00150		mg/L	1	05/22/19 03:04 PM
MERCURY TOTAL: AQUEOUS		**SW7470A**					Analyst: **BM**
Mercury	<0.0000800	0.0000800	0.000200		mg/L	1	05/24/19 09:48 AM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	129	3.00	10.0		mg/L	10	05/17/19 02:17 AM
Fluoride	<0.100	0.100	0.400		mg/L	1	05/16/19 07:05 PM
Nitrate-N	0.798	0.100	0.500		mg/L	1	05/16/19 07:05 PM
Sulfate	674	10.0	30.0		mg/L	10	05/17/19 02:17 AM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	783	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 03:13 PM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 03:13 PM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 03:13 PM
Alkalinity, Total (As CaCO3)	783	20.0	20.0		mg/L @ pH 4.54	1	05/17/19 03:13 PM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	<0.0500	0.0500	0.100	N	mg/L	1	05/24/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	05/20/19 04:01 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *18-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-27
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-05
Project No:	19122262-D	**Collection Date:**	05/15/19 10:55 AM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **CC**
Phosphorus, Total Orthophosphate (As P)	<0.0300	0.0300	0.100		mg/L	1	05/16/19 02:48 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	1840	50.0	50.0		mg/L	1	05/20/19 04:45 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
S	Spike Recovery outside control limits	N	Parameter not NELAP certified

CLIENT:	Golder	**Client Sample ID:**	BMW-26
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-06
Project No:	19122262-D	**Collection Date:**	05/15/19 11:40 AM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **RO**
Antimony	<0.000800	0.000800	0.00250		mg/L	1	05/22/19 02:52 PM
Arsenic	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 02:52 PM
Barium	0.0253	0.00300	0.0100		mg/L	1	05/22/19 02:52 PM
Beryllium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 02:52 PM
Boron	0.449	0.0100	0.0300		mg/L	1	05/22/19 02:52 PM
Cadmium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 02:52 PM
Calcium	200	2.00	6.00		mg/L	20	05/23/19 11:18 AM
Chromium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 02:52 PM
Cobalt	<0.00300	0.00300	0.00500		mg/L	1	05/22/19 02:52 PM
Iron	<0.0300	0.0300	0.100		mg/L	1	05/22/19 02:52 PM
Lead	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 02:52 PM
Lithium	0.101	0.00500	0.0100		mg/L	1	05/22/19 02:52 PM
Magnesium	130	2.00	6.00		mg/L	20	05/23/19 11:18 AM
Molybdenum	0.00218	0.00200	0.00500	J	mg/L	1	05/22/19 02:52 PM
Potassium	13.3	0.100	0.300		mg/L	1	05/22/19 02:52 PM
Selenium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 02:52 PM
Sodium	265	2.00	6.00		mg/L	20	05/23/19 11:18 AM
Thallium	<0.000500	0.000500	0.00150		mg/L	1	05/22/19 02:52 PM
MERCURY TOTAL: AQUEOUS		**SW7470A**					Analyst: **BM**
Mercury	<0.0000800	0.0000800	0.000200		mg/L	1	05/24/19 09:51 AM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	135	3.00	10.0		mg/L	10	05/17/19 02:33 AM
Fluoride	<0.100	0.100	0.400		mg/L	1	05/16/19 07:21 PM
Nitrate-N	0.851	0.100	0.500		mg/L	1	05/16/19 07:21 PM
Sulfate	706	10.0	30.0		mg/L	10	05/17/19 02:33 AM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	828	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 03:40 PM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 03:40 PM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 03:40 PM
Alkalinity, Total (As CaCO3)	828	20.0	20.0		mg/L @ pH 4.54	1	05/17/19 03:40 PM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	<0.0500	0.0500	0.100	N	mg/L	1	05/24/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	05/20/19 04:01 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *18-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-26
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-06
Project No:	19122262-D	**Collection Date:**	05/15/19 11:40 AM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **CC**
Phosphorus, Total Orthophosphate (As P)	0.0340	0.0300	0.100	J	mg/L	1	05/16/19 02:49 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	1930	50.0	50.0		mg/L	1	05/20/19 04:45 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *18-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-11AR
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-07
Project No:	19122262-D	**Collection Date:**	05/15/19 12:35 PM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **RO**
Antimony	<0.000800	0.000800	0.00250		mg/L	1	05/22/19 03:06 PM
Arsenic	0.00208	0.00200	0.00500	J	mg/L	1	05/22/19 03:06 PM
Barium	0.0399	0.00300	0.0100		mg/L	1	05/22/19 03:06 PM
Beryllium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:06 PM
Boron	0.374	0.0100	0.0300		mg/L	1	05/22/19 03:06 PM
Cadmium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:06 PM
Calcium	138	1.00	3.00		mg/L	10	05/23/19 11:32 AM
Chromium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:06 PM
Cobalt	<0.00300	0.00300	0.00500		mg/L	1	05/22/19 03:06 PM
Iron	1.35	0.0300	0.100		mg/L	1	05/22/19 03:06 PM
Lead	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:06 PM
Lithium	0.0404	0.00500	0.0100		mg/L	1	05/22/19 03:06 PM
Magnesium	64.6	1.00	3.00		mg/L	10	05/23/19 11:32 AM
Molybdenum	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:06 PM
Potassium	20.3	0.100	0.300		mg/L	1	05/22/19 03:06 PM
Selenium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:06 PM
Sodium	90.4	1.00	3.00		mg/L	10	05/23/19 11:32 AM
Thallium	<0.000500	0.000500	0.00150		mg/L	1	05/22/19 03:06 PM
MERCURY TOTAL: AQUEOUS		**SW7470A**					Analyst: **BM**
Mercury	<0.0000800	0.0000800	0.000200		mg/L	1	05/24/19 09:53 AM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	6.11	0.300	1.00		mg/L	1	05/16/19 07:37 PM
Fluoride	0.198	0.100	0.400	J	mg/L	1	05/16/19 07:37 PM
Nitrate-N	<0.100	0.100	0.500		mg/L	1	05/16/19 07:37 PM
Sulfate	324	10.0	30.0		mg/L	10	05/17/19 02:49 AM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	527	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 03:59 PM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 03:59 PM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 03:59 PM
Alkalinity, Total (As CaCO3)	527	20.0	20.0		mg/L @ pH 4.54	1	05/17/19 03:59 PM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	1.35	0.0500	0.100	N	mg/L	1	05/24/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	05/20/19 04:01 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *18-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-11AR
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-07
Project No:	19122262-D	**Collection Date:**	05/15/19 12:35 PM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **CC**
Phosphorus, Total Orthophosphate (As P)	<0.0300	0.0300	0.100		mg/L	1	05/16/19 02:49 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	970	10.0	10.0		mg/L	1	05/20/19 04:45 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *18-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-19
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-08
Project No:	19122262-D	**Collection Date:**	05/15/19 01:25 PM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **RO**
Antimony	<0.000800	0.000800	0.00250		mg/L	1	05/22/19 03:07 PM
Arsenic	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:07 PM
Barium	0.0104	0.00300	0.0100		mg/L	1	05/22/19 03:07 PM
Beryllium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:07 PM
Boron	0.474	0.0100	0.0300		mg/L	1	05/22/19 03:07 PM
Cadmium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:07 PM
Calcium	388	2.00	6.00		mg/L	20	05/23/19 11:34 AM
Chromium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:07 PM
Cobalt	<0.00300	0.00300	0.00500		mg/L	1	05/22/19 03:07 PM
Iron	0.750	0.0300	0.100		mg/L	1	05/22/19 03:07 PM
Lead	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:07 PM
Lithium	0.0647	0.00500	0.0100		mg/L	1	05/22/19 03:07 PM
Magnesium	216	2.00	6.00		mg/L	20	05/23/19 11:34 AM
Molybdenum	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:07 PM
Potassium	11.7	0.100	0.300		mg/L	1	05/22/19 03:07 PM
Selenium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:07 PM
Sodium	135	2.00	6.00		mg/L	20	05/23/19 11:34 AM
Thallium	<0.000500	0.000500	0.00150		mg/L	1	05/22/19 03:07 PM
MERCURY TOTAL: AQUEOUS		**SW7470A**					Analyst: **BM**
Mercury	<0.0000800	0.0000800	0.000200		mg/L	1	05/24/19 09:55 AM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	4.66	0.300	1.00		mg/L	1	05/16/19 07:53 PM
Fluoride	0.189	0.100	0.400	J	mg/L	1	05/16/19 07:53 PM
Nitrate-N	1.35	0.100	0.500		mg/L	1	05/16/19 07:53 PM
Sulfate	1760	100	300		mg/L	100	05/17/19 04:09 PM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	482	10.0	20.0		mg/L @ pH 4.53	1	05/17/19 04:15 PM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.53	1	05/17/19 04:15 PM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.53	1	05/17/19 04:15 PM
Alkalinity, Total (As CaCO3)	482	20.0	20.0		mg/L @ pH 4.53	1	05/17/19 04:15 PM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	0.750	0.0500	0.100	N	mg/L	1	05/24/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	05/20/19 04:02 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

CLIENT:	Golder	**Client Sample ID:**	BMW-19
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-08
Project No:	19122262-D	**Collection Date:**	05/15/19 01:25 PM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **CC**
Phosphorus, Total Orthophosphate (As P)	<0.0300	0.0300	0.100		mg/L	1	05/16/19 02:49 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	3090	50.0	50.0		mg/L	1	05/20/19 04:45 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

CLIENT:	Golder	**Client Sample ID:**	BMW-18
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-09
Project No:	19122262-D	**Collection Date:**	05/15/19 02:10 PM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **RO**
Antimony	<0.000800	0.000800	0.00250		mg/L	1	05/22/19 03:09 PM
Arsenic	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:09 PM
Barium	0.0362	0.00300	0.0100		mg/L	1	05/22/19 03:09 PM
Beryllium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:09 PM
Boron	0.443	0.0100	0.0300		mg/L	1	05/22/19 03:09 PM
Cadmium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:09 PM
Calcium	7.91	0.100	0.300		mg/L	1	05/22/19 03:09 PM
Chromium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:09 PM
Cobalt	<0.00300	0.00300	0.00500		mg/L	1	05/22/19 03:09 PM
Iron	0.0676	0.0300	0.100	J	mg/L	1	05/22/19 03:09 PM
Lead	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:09 PM
Lithium	0.0160	0.00500	0.0100		mg/L	1	05/22/19 03:09 PM
Magnesium	2.47	0.100	0.300		mg/L	1	05/22/19 03:09 PM
Molybdenum	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:09 PM
Potassium	2.91	0.100	0.300		mg/L	1	05/22/19 03:09 PM
Selenium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:09 PM
Sodium	173	2.00	6.00		mg/L	20	05/23/19 11:36 AM
Thallium	<0.000500	0.000500	0.00150		mg/L	1	05/22/19 03:09 PM
MERCURY TOTAL: AQUEOUS		**SW7470A**					Analyst: **BM**
Mercury	<0.0000800	0.0000800	0.000200		mg/L	1	05/24/19 09:58 AM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	20.0	0.300	1.00		mg/L	1	05/16/19 08:09 PM
Fluoride	0.229	0.100	0.400	J	mg/L	1	05/16/19 08:09 PM
Nitrate-N	0.324	0.100	0.500	J	mg/L	1	05/16/19 08:09 PM
Sulfate	89.9	1.00	3.00		mg/L	1	05/16/19 08:09 PM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	285	10.0	20.0		mg/L @ pH 4.52	1	05/17/19 04:24 PM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.52	1	05/17/19 04:24 PM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.52	1	05/17/19 04:24 PM
Alkalinity, Total (As CaCO3)	285	20.0	20.0		mg/L @ pH 4.52	1	05/17/19 04:24 PM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	0.0676	0.0500	0.100	JN	mg/L	1	05/24/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	05/20/19 04:02 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *18-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-18
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-09
Project No:	19122262-D	**Collection Date:**	05/15/19 02:10 PM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **CC**
Phosphorus, Total Orthophosphate (As P)	0.140	0.0300	0.100		mg/L	1	05/16/19 02:50 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	473	10.0	10.0		mg/L	1	05/20/19 04:45 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
S	Spike Recovery outside control limits	N	Parameter not NELAP certified

CLIENT:	Golder	**Client Sample ID:**	BMW-28
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-10
Project No:	19122262-D	**Collection Date:**	05/15/19 03:00 PM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **RO**
Antimony	<0.000800	0.000800	0.00250		mg/L	1	05/22/19 03:11 PM
Arsenic	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:11 PM
Barium	0.0285	0.00300	0.0100		mg/L	1	05/22/19 03:11 PM
Beryllium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:11 PM
Boron	1.01	0.0100	0.0300		mg/L	1	05/22/19 03:11 PM
Cadmium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:11 PM
Calcium	249	5.00	15.0		mg/L	50	05/23/19 11:38 AM
Chromium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:11 PM
Cobalt	<0.00300	0.00300	0.00500		mg/L	1	05/22/19 03:11 PM
Iron	0.0633	0.0300	0.100	J	mg/L	1	05/22/19 03:11 PM
Lead	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:11 PM
Lithium	0.119	0.00500	0.0100		mg/L	1	05/22/19 03:11 PM
Magnesium	163	5.00	15.0		mg/L	50	05/23/19 11:38 AM
Molybdenum	0.0124	0.00200	0.00500		mg/L	1	05/22/19 03:11 PM
Potassium	18.6	0.100	0.300		mg/L	1	05/22/19 03:11 PM
Selenium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:11 PM
Sodium	652	5.00	15.0		mg/L	50	05/23/19 11:38 AM
Thallium	<0.000500	0.000500	0.00150		mg/L	1	05/22/19 03:11 PM
MERCURY TOTAL: AQUEOUS		**SW7470A**					Analyst: **BM**
Mercury	<0.0000800	0.0000800	0.000200		mg/L	1	05/24/19 10:04 AM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	133	3.00	10.0		mg/L	10	05/17/19 03:37 AM
Fluoride	0.496	0.100	0.400		mg/L	1	05/16/19 08:25 PM
Nitrate-N	0.493	0.100	0.500	J	mg/L	1	05/16/19 08:25 PM
Sulfate	1820	100	300		mg/L	100	05/17/19 04:25 PM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	751	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 04:49 PM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 04:49 PM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 04:49 PM
Alkalinity, Total (As CaCO3)	751	20.0	20.0		mg/L @ pH 4.54	1	05/17/19 04:49 PM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	0.0633	0.0500	0.100	JN	mg/L	1	05/24/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	05/20/19 04:02 PM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *18-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-28
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-10
Project No:	19122262-D	**Collection Date:**	05/15/19 03:00 PM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **CC**
Phosphorus, Total Orthophosphate (As P)	0.0370	0.0300	0.100	J	mg/L	1	05/16/19 02:50 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	3610	50.0	50.0		mg/L	1	05/20/19 04:45 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *18-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-20
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-11
Project No:	19122262-D	**Collection Date:**	05/15/19 04:00 PM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **RO**
Antimony	<0.000800	0.000800	0.00250		mg/L	1	05/22/19 03:50 PM
Arsenic	0.00541	0.00200	0.00500		mg/L	1	05/22/19 03:50 PM
Barium	0.0412	0.00300	0.0100		mg/L	1	05/22/19 03:50 PM
Beryllium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:50 PM
Boron	0.979	0.0100	0.0300		mg/L	1	05/22/19 03:50 PM
Cadmium	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:50 PM
Calcium	146	2.00	6.00		mg/L	20	05/23/19 11:53 AM
Chromium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:50 PM
Cobalt	<0.00300	0.00300	0.00500		mg/L	1	05/22/19 03:50 PM
Iron	1.28	0.0300	0.100		mg/L	1	05/22/19 03:50 PM
Lead	<0.000300	0.000300	0.00100		mg/L	1	05/22/19 03:50 PM
Lithium	0.0615	0.00500	0.0100		mg/L	1	05/22/19 03:50 PM
Magnesium	136	2.00	6.00		mg/L	20	05/23/19 11:53 AM
Molybdenum	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:50 PM
Potassium	5.21	0.100	0.300		mg/L	1	05/22/19 03:50 PM
Selenium	<0.00200	0.00200	0.00500		mg/L	1	05/22/19 03:50 PM
Sodium	382	2.00	6.00		mg/L	20	05/23/19 11:53 AM
Thallium	<0.000500	0.000500	0.00150		mg/L	1	05/22/19 03:50 PM
MERCURY TOTAL: AQUEOUS		**SW7470A**					Analyst: **BM**
Mercury	<0.0000800	0.0000800	0.000200		mg/L	1	05/24/19 10:07 AM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	426	3.00	10.0		mg/L	10	05/17/19 04:57 AM
Fluoride	0.418	0.100	0.400		mg/L	1	05/16/19 10:01 PM
Nitrate-N	0.595	0.100	0.500		mg/L	1	05/16/19 10:01 PM
Sulfate	474	10.0	30.0		mg/L	10	05/17/19 04:57 AM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	773	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 05:15 PM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 05:15 PM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	05/17/19 05:15 PM
Alkalinity, Total (As CaCO3)	773	20.0	20.0		mg/L @ pH 4.54	1	05/17/19 05:15 PM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	1.28	0.0500	0.100	N	mg/L	1	05/24/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	05/20/19 04:02 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

CLIENT:	Golder	**Client Sample ID:**	BMW-20
Project:	Luminant-A1 Landfill	**Lab ID:**	1905185-11
Project No:	19122262-D	**Collection Date:**	05/15/19 04:00 PM
Lab Order:	1905185	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **CC**
Phosphorus, Total Orthophosphate (As P)	<0.0300	0.0300	0.100		mg/L	1	05/16/19 02:52 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	2030	50.0	50.0		mg/L	1	05/20/19 04:45 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: **CETAC2_HG_190524A**

The QC data in batch 91059 applies to the following samples: 1905185-01B, 1905185-02B, 1905185-03B, 1905185-04B, 1905185-05B, 1905185-06B, 1905185-07B, 1905185-08B, 1905185-09B, 1905185-10B, 1905185-11B

Sample ID **MB-91059** Batch ID: **91059** TestNo: **SW7470A** Units: **mg/L**
SampType: **MBLK** Run ID: **CETAC2_HG_190524A** Analysis Date: **5/24/2019 9:28:33 AM** Prep Date: **5/23/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	<0.0000800	0.000200								

Sample ID **LCS-91059** Batch ID: **91059** TestNo: **SW7470A** Units: **mg/L**
SampType: **LCS** Run ID: **CETAC2_HG_190524A** Analysis Date: **5/24/2019 9:33:05 AM** Prep Date: **5/23/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00187	0.000200	0.00200	0	93.5	85	115			

Sample ID **LCSD-91059** Batch ID: **91059** TestNo: **SW7470A** Units: **mg/L**
SampType: **LCSD** Run ID: **CETAC2_HG_190524A** Analysis Date: **5/24/2019 9:35:22 AM** Prep Date: **5/23/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00195	0.000200	0.00200	0	97.5	85	115	4.19	15	

Sample ID **1905231-01A MS** Batch ID: **91059** TestNo: **SW7470A** Units: **mg/L**
SampType: **MS** Run ID: **CETAC2_HG_190524A** Analysis Date: **5/24/2019 10:20:46 AM** Prep Date: **5/23/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00960	0.00100	0.0100	0	96.0	80	120			

Sample ID **1905231-01A MSD** Batch ID: **91059** TestNo: **SW7470A** Units: **mg/L**
SampType: **MSD** Run ID: **CETAC2_HG_190524A** Analysis Date: **5/24/2019 10:23:02 AM** Prep Date: **5/23/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00925	0.00100	0.0100	0	92.5	80	120	3.71	15	

Sample ID **1905231-01A SD** Batch ID: **91059** TestNo: **SW7470A** Units: **mg/L**
SampType: **SD** Run ID: **CETAC2_HG_190524A** Analysis Date: **5/24/2019 10:25:18 AM** Prep Date: **5/23/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	<0.00200	0.00500	0	0				0	10	

Sample ID **1905231-01A PDS** Batch ID: **91059** TestNo: **SW7470A** Units: **mg/L**
SampType: **PDS** Run ID: **CETAC2_HG_190524A** Analysis Date: **5/24/2019 10:27:34 AM** Prep Date: **5/23/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.0120	0.00100	0.0125	0	95.6	85	115			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: **CETAC2_HG_190524A**

Sample ID **ICV-190524**	Batch ID: **R104261**	TestNo: **SW7470A**	Units: **mg/L**
SampType: **ICV**	Run ID: **CETAC2_HG_190524A**	Analysis Date: **5/24/2019 9:24:00 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00400	0.000200	0.00400	0	100	90	110			

Sample ID **CCV1-190524**	Batch ID: **R104261**	TestNo: **SW7470A**	Units: **mg/L**
SampType: **CCV**	Run ID: **CETAC2_HG_190524A**	Analysis Date: **5/24/2019 10:00:18 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00214	0.000200	0.00200	0	107	90	110			

Sample ID **CCV2-190524**	Batch ID: **R104261**	TestNo: **SW7470A**	Units: **mg/L**
SampType: **CCV**	Run ID: **CETAC2_HG_190524A**	Analysis Date: **5/24/2019 10:36:42 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.00212	0.000200	0.00200	0	106	90	110			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_190522D

The QC data in batch 90989 applies to the following samples: 1905185-01B, 1905185-02B, 1905185-03B, 1905185-04B, 1905185-05B, 1905185-06B, 1905185-07B, 1905185-08B, 1905185-09B, 1905185-10B, 1905185-11B

Sample ID **MB-90989** Batch ID: **90989** TestNo: **SW6020A** Units: **mg/L**
SampType: **MBLK** Run ID: **ICP-MS4_190522D** Analysis Date: **5/22/2019 2:44:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	<0.000800	0.00250								
Arsenic	<0.00200	0.00500								
Barium	<0.00300	0.0100								
Beryllium	<0.000300	0.00100								
Boron	<0.0100	0.0300								
Cadmium	<0.000300	0.00100								
Calcium	<0.100	0.300								
Chromium	<0.00200	0.00500								
Cobalt	<0.00300	0.00500								
Iron	<0.0300	0.100								
Lead	<0.000300	0.00100								
Lithium	<0.00500	0.0100								
Magnesium	<0.100	0.300								
Molybdenum	<0.00200	0.00500								
Potassium	<0.100	0.300								
Selenium	<0.00200	0.00500								
Sodium	<0.100	0.300								
Thallium	<0.000500	0.00150								

Sample ID **LCS-90989** Batch ID: **90989** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCS** Run ID: **ICP-MS4_190522D** Analysis Date: **5/22/2019 2:46:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.202	0.00250	0.200	0	101	80	120			
Arsenic	0.201	0.00500	0.200	0	100	80	120			
Barium	0.198	0.0100	0.200	0	99.2	80	120			
Beryllium	0.198	0.00100	0.200	0	99.2	80	120			
Boron	0.202	0.0300	0.200	0	101	80	120			
Cadmium	0.199	0.00100	0.200	0	99.6	80	120			
Calcium	4.60	0.300	5.00	0	92.1	80	120			
Chromium	0.200	0.00500	0.200	0	99.8	80	120			
Cobalt	0.202	0.00500	0.200	0	101	80	120			
Iron	5.23	0.100	5.00	0	105	80	120			
Lead	0.184	0.00100	0.200	0	91.9	80	120			
Lithium	0.196	0.0100	0.200	0	98.0	80	120			
Magnesium	5.02	0.300	5.00	0	100	80	120			
Molybdenum	0.190	0.00500	0.200	0	95.1	80	120			
Potassium	5.06	0.300	5.00	0	101	80	120			
Selenium	0.209	0.00500	0.200	0	104	80	120			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_190522D

Sample ID **LCS-90989** Batch ID: **90989** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCS** Run ID: **ICP-MS4_190522D** Analysis Date: **5/22/2019 2:46:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sodium	5.02	0.300	5.00	0	100	80	120			
Thallium	0.202	0.00150	0.200	0	101	80	120			

Sample ID **LCSD-90989** Batch ID: **90989** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCSD** Run ID: **ICP-MS4_190522D** Analysis Date: **5/22/2019 2:48:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.201	0.00250	0.200	0	100	80	120	0.333	15	
Arsenic	0.203	0.00500	0.200	0	101	80	120	0.942	15	
Barium	0.199	0.0100	0.200	0	99.3	80	120	0.128	15	
Beryllium	0.198	0.00100	0.200	0	99.1	80	120	0.129	15	
Boron	0.201	0.0300	0.200	0	101	80	120	0.298	15	
Cadmium	0.198	0.00100	0.200	0	99.2	80	120	0.362	15	
Calcium	4.62	0.300	5.00	0	92.4	80	120	0.325	15	
Chromium	0.199	0.00500	0.200	0	99.7	80	120	0.085	15	
Cobalt	0.203	0.00500	0.200	0	102	80	120	0.820	15	
Iron	5.15	0.100	5.00	0	103	80	120	1.50	15	
Lead	0.185	0.00100	0.200	0	92.3	80	120	0.421	15	
Lithium	0.200	0.0100	0.200	0	100	80	120	2.22	15	
Magnesium	5.07	0.300	5.00	0	101	80	120	0.937	15	
Molybdenum	0.190	0.00500	0.200	0	95.0	80	120	0.081	15	
Potassium	5.12	0.300	5.00	0	102	80	120	1.16	15	
Selenium	0.204	0.00500	0.200	0	102	80	120	2.39	15	
Sodium	5.05	0.300	5.00	0	101	80	120	0.519	15	
Thallium	0.199	0.00150	0.200	0	99.3	80	120	1.55	15	

Sample ID **1905185-06B SD** Batch ID: **90989** TestNo: **SW6020A** Units: **mg/L**
SampType: **SD** Run ID: **ICP-MS4_190522D** Analysis Date: **5/22/2019 2:54:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	<0.00400	0.0125	0	0				0	10	
Arsenic	<0.0100	0.0250	0	0				0	10	
Barium	0.0256	0.0500	0	0.0253				1.30	10	
Beryllium	<0.00150	0.00500	0	0				0	10	
Boron	0.501	0.150	0	0.449				10.8	10	R
Cadmium	<0.00150	0.00500	0	0				0	10	
Chromium	<0.0100	0.0250	0	0				0	10	
Cobalt	<0.0150	0.0250	0	0				0	10	
Iron	<0.150	0.500	0	0				0	10	
Lead	<0.00150	0.00500	0	0				0	10	
Lithium	0.109	0.0500	0	0.101				7.40	10	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_190522D

Sample ID **1905185-06B SD** Batch ID: **90989** TestNo: **SW6020A** Units: **mg/L**
SampType: **SD** Run ID: **ICP-MS4_190522D** Analysis Date: **5/22/2019 2:54:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Molybdenum	<0.0100	0.0250	0	0.00218				0	10	
Potassium	13.4	1.50	0	13.2				1.21	10	
Selenium	<0.0100	0.0250	0	0				0	10	
Thallium	<0.00250	0.00750	0	0				0	10	

Sample ID **1905185-06B PDS** Batch ID: **90989** TestNo: **SW6020A** Units: **mg/L**
SampType: **PDS** Run ID: **ICP-MS4_190522D** Analysis Date: **5/22/2019 3:13:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.201	0.00250	0.200	0	100	80	120			
Arsenic	0.204	0.00500	0.200	0	102	80	120			
Barium	0.218	0.0100	0.200	0.0253	96.3	80	120			
Beryllium	0.174	0.00100	0.200	0	87.2	80	120			
Boron	0.613	0.0300	0.200	0.449	81.7	80	120			
Cadmium	0.183	0.00100	0.200	0	91.4	80	120			
Chromium	0.188	0.00500	0.200	0	94.2	80	120			
Cobalt	0.193	0.00500	0.200	0	96.4	80	120			
Iron	4.70	0.100	5.00	0	94.1	80	120			
Lead	0.186	0.00100	0.200	0	93.0	80	120			
Lithium	0.265	0.0100	0.200	0.101	81.8	80	120			
Molybdenum	0.186	0.00500	0.200	0.00218	91.9	80	120			
Potassium	17.5	0.300	5.00	13.3	84.0	80	120			
Selenium	0.213	0.00500	0.200	0	106	80	120			
Thallium	0.200	0.00150	0.200	0	100	80	120			

Sample ID **1905185-06B MS** Batch ID: **90989** TestNo: **SW6020A** Units: **mg/L**
SampType: **MS** Run ID: **ICP-MS4_190522D** Analysis Date: **5/22/2019 3:15:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.202	0.00250	0.200	0	101	80	120			
Arsenic	0.208	0.00500	0.200	0	104	80	120			
Barium	0.226	0.0100	0.200	0.0253	100	80	120			
Beryllium	0.174	0.00100	0.200	0	87.0	80	120			
Boron	0.654	0.0300	0.200	0.449	103	80	120			
Cadmium	0.185	0.00100	0.200	0	92.7	80	120			
Calcium	197	0.300	5.00	194	64.2	80	120			S
Chromium	0.186	0.00500	0.200	0	93.0	80	120			
Cobalt	0.193	0.00500	0.200	0	96.7	80	120			
Iron	4.82	0.100	5.00	0	96.4	80	120			
Lead	0.187	0.00100	0.200	0	93.7	80	120			
Lithium	0.270	0.0100	0.200	0.101	84.2	80	120			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_190522D

Sample ID **1905185-06B MS**	Batch ID: **90989**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **MS**	Run ID: **ICP-MS4_190522D**	Analysis Date: **5/22/2019 3:15:00 PM**	Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Magnesium	128	0.300	5.00	128	-3.79	80	120			S
Molybdenum	0.195	0.00500	0.200	0.00218	96.2	80	120			
Potassium	18.5	0.300	5.00	13.3	105	80	120			
Selenium	0.214	0.00500	0.200	0	107	80	120			
Sodium	252	0.300	5.00	257	-103	80	120			S
Thallium	0.203	0.00150	0.200	0	101	80	120			

Sample ID **1905185-06B MSD**	Batch ID: **90989**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **MSD**	Run ID: **ICP-MS4_190522D**	Analysis Date: **5/22/2019 3:17:00 PM**	Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.200	0.00250	0.200	0	100	80	120	0.836	15	
Arsenic	0.208	0.00500	0.200	0	104	80	120	0.067	15	
Barium	0.227	0.0100	0.200	0.0253	101	80	120	0.141	15	
Beryllium	0.174	0.00100	0.200	0	86.8	80	120	0.265	15	
Boron	0.618	0.0300	0.200	0.449	84.6	80	120	5.65	15	
Cadmium	0.184	0.00100	0.200	0	92.1	80	120	0.555	15	
Calcium	195	0.300	5.00	194	16.8	80	120	1.21	15	S
Chromium	0.187	0.00500	0.200	0	93.6	80	120	0.569	15	
Cobalt	0.192	0.00500	0.200	0	95.8	80	120	1.00	15	
Iron	4.73	0.100	5.00	0	94.7	80	120	1.78	15	
Lead	0.190	0.00100	0.200	0	94.8	80	120	1.15	15	
Lithium	0.265	0.0100	0.200	0.101	81.8	80	120	1.82	15	
Magnesium	127	0.300	5.00	128	-17.7	80	120	0.544	15	S
Molybdenum	0.197	0.00500	0.200	0.00218	97.5	80	120	1.33	15	
Potassium	18.3	0.300	5.00	13.3	100	80	120	1.25	15	
Selenium	0.213	0.00500	0.200	0	107	80	120	0.639	15	
Sodium	256	0.300	5.00	257	-34.0	80	120	1.36	15	S
Thallium	0.206	0.00150	0.200	0	103	80	120	1.46	15	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_190522D

Sample ID **ICV-190522**	Batch ID: **R104232**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **ICV**	Run ID: **ICP-MS4_190522D**	Analysis Date: **5/22/2019 11:38:00 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.101	0.00250	0.100	0	101	90	110			
Arsenic	0.102	0.00500	0.100	0	102	90	110			
Barium	0.0975	0.0100	0.100	0	97.5	90	110			
Beryllium	0.0986	0.00100	0.100	0	98.6	90	110			
Boron	0.104	0.0300	0.100	0	104	90	110			
Cadmium	0.0995	0.00100	0.100	0	99.5	90	110			
Calcium	2.35	0.300	2.50	0	94.2	90	110			
Chromium	0.104	0.00500	0.100	0	104	90	110			
Cobalt	0.105	0.00500	0.100	0	105	90	110			
Iron	2.57	0.100	2.50	0	103	90	110			
Lead	0.0926	0.00100	0.100	0	92.6	90	110			
Lithium	0.103	0.0100	0.100	0	103	90	110			
Magnesium	2.45	0.300	2.50	0	98.2	90	110			
Molybdenum	0.0911	0.00500	0.100	0	91.1	90	110			
Potassium	2.52	0.300	2.50	0	101	90	110			
Selenium	0.102	0.00500	0.100	0	102	90	110			
Sodium	2.53	0.300	2.50	0	101	90	110			
Thallium	0.0926	0.00150	0.100	0	92.6	90	110			

Sample ID **LCVL-190522**	Batch ID: **R104232**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS4_190522D**	Analysis Date: **5/22/2019 11:43:00 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.00190	0.00250	0.00200	0	95.0	70	130			
Arsenic	0.00497	0.00500	0.00500	0	99.4	70	130			
Barium	0.00463	0.0100	0.00500	0	92.6	70	130			
Beryllium	0.00117	0.00100	0.00100	0	117	70	130			
Boron	0.0197	0.0300	0.0200	0	98.5	70	130			
Cadmium	0.000953	0.00100	0.00100	0	95.3	70	130			
Calcium	0.0981	0.300	0.100	0	98.1	70	130			
Chromium	0.00486	0.00500	0.00500	0	97.2	70	130			
Cobalt	0.00493	0.00500	0.00500	0	98.7	70	130			
Iron	0.111	0.100	0.100	0	111	70	130			
Lead	0.000870	0.00100	0.00100	0	87.0	70	130			
Lithium	0.00926	0.0100	0.0100	0	92.6	70	130			
Magnesium	0.0967	0.300	0.100	0	96.7	70	130			
Molybdenum	0.00458	0.00500	0.00500	0	91.5	70	130			
Potassium	0.0964	0.300	0.100	0	96.4	70	130			
Selenium	0.00494	0.00500	0.00500	0	98.8	70	130			
Sodium	0.0966	0.300	0.100	0	96.6	70	130			
Thallium	0.000843	0.00150	0.00100	0	84.3	70	130			

Qualifiers:				
	B	Analyte detected in the associated Method Blank	DF	Dilution Factor
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
	RL	Reporting Limit	S	Spike Recovery outside control limits
	J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_190522D

Sample ID **CCV4-190522** Batch ID: **R104232** TestNo: **SW6020A** Units: **mg/L**
SampType: **CCV** Run ID: **ICP-MS4_190522D** Analysis Date: **5/22/2019 2:34:00 PM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.203	0.00250	0.200	0	102	90	110			
Arsenic	0.209	0.00500	0.200	0	104	90	110			
Barium	0.202	0.0100	0.200	0	101	90	110			
Beryllium	0.201	0.00100	0.200	0	100	90	110			
Boron	0.215	0.0300	0.200	0	108	90	110			
Cadmium	0.202	0.00100	0.200	0	101	90	110			
Calcium	4.66	0.300	5.00	0	93.3	90	110			
Chromium	0.203	0.00500	0.200	0	102	90	110			
Cobalt	0.208	0.00500	0.200	0	104	90	110			
Iron	5.05	0.100	5.00	0	101	90	110			
Lead	0.193	0.00100	0.200	0	96.7	90	110			
Lithium	0.195	0.0100	0.200	0	97.5	90	110			
Magnesium	5.05	0.300	5.00	0	101	90	110			
Molybdenum	0.193	0.00500	0.200	0	96.4	90	110			
Potassium	5.13	0.300	5.00	0	103	90	110			
Selenium	0.212	0.00500	0.200	0	106	90	110			
Sodium	5.03	0.300	5.00	0	101	90	110			
Thallium	0.205	0.00150	0.200	0	103	90	110			

Sample ID **LCVL4-190522** Batch ID: **R104232** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCVL** Run ID: **ICP-MS4_190522D** Analysis Date: **5/22/2019 2:40:00 PM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.00194	0.00250	0.00200	0	96.9	70	130			
Arsenic	0.00504	0.00500	0.00500	0	101	70	130			
Barium	0.00472	0.0100	0.00500	0	94.5	70	130			
Beryllium	0.00124	0.00100	0.00100	0	124	70	130			
Boron	0.0223	0.0300	0.0200	0	111	70	130			
Cadmium	0.000955	0.00100	0.00100	0	95.5	70	130			
Calcium	0.111	0.300	0.100	0	111	70	130			
Chromium	0.00487	0.00500	0.00500	0	97.4	70	130			
Cobalt	0.00501	0.00500	0.00500	0	100	70	130			
Iron	0.114	0.100	0.100	0	114	70	130			
Lead	0.000846	0.00100	0.00100	0	84.6	70	130			
Lithium	0.00964	0.0100	0.0100	0	96.4	70	130			
Magnesium	0.101	0.300	0.100	0	101	70	130			
Molybdenum	0.00453	0.00500	0.00500	0	90.7	70	130			
Potassium	0.0997	0.300	0.100	0	99.7	70	130			
Selenium	0.00427	0.00500	0.00500	0	85.3	70	130			
Sodium	0.111	0.300	0.100	0	111	70	130			
Thallium	0.000835	0.00150	0.00100	0	83.5	70	130			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_190522D

Sample ID **CCV5-190522**	Batch ID: **R104232**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **CCV**	Run ID: **ICP-MS4_190522D**	Analysis Date: **5/22/2019 3:26:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.205	0.00250	0.200	0	102	90	110			
Arsenic	0.205	0.00500	0.200	0	103	90	110			
Barium	0.200	0.0100	0.200	0	99.8	90	110			
Beryllium	0.200	0.00100	0.200	0	100	90	110			
Boron	0.220	0.0300	0.200	0	110	90	110			
Cadmium	0.202	0.00100	0.200	0	101	90	110			
Calcium	4.68	0.300	5.00	0	93.5	90	110			
Chromium	0.203	0.00500	0.200	0	101	90	110			
Cobalt	0.205	0.00500	0.200	0	102	90	110			
Iron	5.15	0.100	5.00	0	103	90	110			
Lead	0.188	0.00100	0.200	0	93.8	90	110			
Lithium	0.203	0.0100	0.200	0	102	90	110			
Magnesium	5.17	0.300	5.00	0	103	90	110			
Molybdenum	0.195	0.00500	0.200	0	97.3	90	110			
Potassium	5.20	0.300	5.00	0	104	90	110			
Selenium	0.213	0.00500	0.200	0	107	90	110			
Sodium	5.13	0.300	5.00	0	103	90	110			
Thallium	0.201	0.00150	0.200	0	101	90	110			

Sample ID **LCVL5-190522**	Batch ID: **R104232**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS4_190522D**	Analysis Date: **5/22/2019 3:46:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.00186	0.00250	0.00200	0	93.2	70	130			
Arsenic	0.00475	0.00500	0.00500	0	95.0	70	130			
Barium	0.00461	0.0100	0.00500	0	92.3	70	130			
Beryllium	0.000947	0.00100	0.00100	0	94.7	70	130			
Boron	0.0229	0.0300	0.0200	0	115	70	130			
Cadmium	0.000924	0.00100	0.00100	0	92.4	70	130			
Calcium	0.102	0.300	0.100	0	102	70	130			
Chromium	0.00452	0.00500	0.00500	0	90.4	70	130			
Cobalt	0.00479	0.00500	0.00500	0	95.8	70	130			
Iron	0.106	0.100	0.100	0	106	70	130			
Lead	0.000756	0.00100	0.00100	0	75.6	70	130			
Lithium	0.00948	0.0100	0.0100	0	94.8	70	130			
Magnesium	0.0981	0.300	0.100	0	98.1	70	130			
Molybdenum	0.00455	0.00500	0.00500	0	91.0	70	130			
Potassium	0.0951	0.300	0.100	0	95.1	70	130			
Selenium	0.00474	0.00500	0.00500	0	94.7	70	130			
Sodium	0.126	0.300	0.100	0	126	70	130			
Thallium	0.000763	0.00150	0.00100	0	76.3	70	130			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_190522D

Sample ID **CCV6-190522** Batch ID: **R104232** TestNo: **SW6020A** Units: **mg/L**
SampType: **CCV** Run ID: **ICP-MS4_190522D** Analysis Date: **5/22/2019 4:12:00 PM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.208	0.00250	0.200	0	104	90	110			
Arsenic	0.211	0.00500	0.200	0	106	90	110			
Barium	0.208	0.0100	0.200	0	104	90	110			
Beryllium	0.195	0.00100	0.200	0	97.5	90	110			
Boron	0.207	0.0300	0.200	0	104	90	110			
Cadmium	0.202	0.00100	0.200	0	101	90	110			
Chromium	0.202	0.00500	0.200	0	101	90	110			
Cobalt	0.209	0.00500	0.200	0	104	90	110			
Iron	5.12	0.100	5.00	0	102	90	110			
Lead	0.192	0.00100	0.200	0	96.1	90	110			
Lithium	0.197	0.0100	0.200	0	98.7	90	110			
Molybdenum	0.197	0.00500	0.200	0	98.4	90	110			
Potassium	5.17	0.300	5.00	0	103	90	110			
Selenium	0.213	0.00500	0.200	0	107	90	110			
Thallium	0.206	0.00150	0.200	0	103	90	110			

Sample ID **LCVL6-190522** Batch ID: **R104232** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCVL** Run ID: **ICP-MS4_190522D** Analysis Date: **5/22/2019 4:22:00 PM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Antimony	0.00200	0.00250	0.00200	0	100	70	130			
Arsenic	0.00486	0.00500	0.00500	0	97.1	70	130			
Barium	0.00495	0.0100	0.00500	0	99.0	70	130			
Beryllium	0.000939	0.00100	0.00100	0	93.9	70	130			
Boron	0.0216	0.0300	0.0200	0	108	70	130			
Cadmium	0.00101	0.00100	0.00100	0	101	70	130			
Chromium	0.00486	0.00500	0.00500	0	97.1	70	130			
Cobalt	0.00489	0.00500	0.00500	0	97.8	70	130			
Iron	0.113	0.100	0.100	0	113	70	130			
Lead	0.000805	0.00100	0.00100	0	80.5	70	130			
Lithium	0.00903	0.0100	0.0100	0	90.3	70	130			
Molybdenum	0.00464	0.00500	0.00500	0	92.8	70	130			
Potassium	0.0982	0.300	0.100	0	98.2	70	130			
Selenium	0.00531	0.00500	0.00500	0	106	70	130			
Thallium	0.000807	0.00150	0.00100	0	80.7	70	130			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: **ICP-MS4_190523A**

The QC data in batch 90989 applies to the following samples: 1905185-01B, 1905185-02B, 1905185-03B, 1905185-04B, 1905185-05B, 1905185-06B, 1905185-07B, 1905185-08B, 1905185-09B, 1905185-10B, 1905185-11B

Sample ID **1905185-06B SD** Batch ID: **90989** TestNo: **SW6020A** Units: **mg/L**
SampType: **SD** Run ID: **ICP-MS4_190523A** Analysis Date: **5/23/2019 11:20:00 AM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	207	30.0	0	200				3.62	10	
Magnesium	134	30.0	0	130				2.71	10	
Sodium	266	30.0	0	265				0.189	10	

Sample ID **1905185-06B PDS** Batch ID: **90989** TestNo: **SW6020A** Units: **mg/L**
SampType: **PDS** Run ID: **ICP-MS4_190523A** Analysis Date: **5/23/2019 11:40:00 AM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	295	6.00	100	200	95.2	80	120			
Magnesium	227	6.00	100	130	96.8	80	120			
Sodium	365	6.00	100	265	99.6	80	120			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: **ICP-MS4_190523A**

Sample ID **ICV-190523** Batch ID: **R104240** TestNo: **SW6020A** Units: **mg/L**
SampType: **ICV** Run ID: **ICP-MS4_190523A** Analysis Date: **5/23/2019 11:01:00 AM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.104	0.0300	0.100	0	104	90	110			
Calcium	2.39	0.300	2.50	0	95.8	90	110			
Iron	2.56	0.100	2.50	0	102	90	110			
Magnesium	2.53	0.300	2.50	0	101	90	110			
Sodium	2.56	0.300	2.50	0	102	90	110			

Sample ID **LCVL-190523** Batch ID: **R104240** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCVL** Run ID: **ICP-MS4_190523A** Analysis Date: **5/23/2019 11:09:00 AM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.0214	0.0300	0.0200	0	107	70	130			
Calcium	0.0901	0.300	0.100	0	90.1	70	130			
Iron	0.105	0.100	0.100	0	105	70	130			
Magnesium	0.0985	0.300	0.100	0	98.5	70	130			
Sodium	0.0949	0.300	0.100	0	94.9	70	130			

Sample ID **CCV1-190523** Batch ID: **R104240** TestNo: **SW6020A** Units: **mg/L**
SampType: **CCV** Run ID: **ICP-MS4_190523A** Analysis Date: **5/23/2019 11:42:00 AM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.210	0.0300	0.200	0	105	90	110			
Calcium	4.76	0.300	5.00	0	95.2	90	110			
Iron	5.10	0.100	5.00	0	102	90	110			
Magnesium	5.21	0.300	5.00	0	104	90	110			
Sodium	5.14	0.300	5.00	0	103	90	110			

Sample ID **LCVL1-190523** Batch ID: **R104240** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCVL** Run ID: **ICP-MS4_190523A** Analysis Date: **5/23/2019 11:48:00 AM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Boron	0.0248	0.0300	0.0200	0	124	70	130			
Calcium	0.0899	0.300	0.100	0	89.9	70	130			
Iron	0.105	0.100	0.100	0	105	70	130			
Magnesium	0.0985	0.300	0.100	0	98.5	70	130			
Sodium	0.0973	0.300	0.100	0	97.3	70	130			

Sample ID **CCV2-190523** Batch ID: **R104240** TestNo: **SW6020A** Units: **mg/L**
SampType: **CCV** Run ID: **ICP-MS4_190523A** Analysis Date: **5/23/2019 12:21:00 PM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	4.79	0.300	5.00	0	95.7	90	110			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

ANALYTICAL QC SUMMARY REPORT

RunID: **ICP-MS4_190523A**

Sample ID **CCV2-190523**	Batch ID: **R104240**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **CCV**	Run ID: **ICP-MS4_190523A**	Analysis Date: **5/23/2019 12:21:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Magnesium	5.29	0.300	5.00	0	106	90	110			
Sodium	5.22	0.300	5.00	0	104	90	110			

Sample ID **LCVL2-190523**	Batch ID: **R104240**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS4_190523A**	Analysis Date: **5/23/2019 12:29:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	0.101	0.300	0.100	0	101	70	130			
Magnesium	0.0985	0.300	0.100	0	98.5	70	130			
Sodium	0.0994	0.300	0.100	0	99.4	70	130			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: IC2_190516B

The QC data in batch 90934 applies to the following samples: 1905185-01C, 1905185-02C, 1905185-03C, 1905185-04C, 1905185-05C, 1905185-06C, 1905185-07C, 1905185-08C, 1905185-09C, 1905185-10C, 1905185-11C

Sample ID **MB-90934** Batch ID: **90934** TestNo: **E300** Units: **mg/L**
SampType: **MBLK** Run ID: **IC2_190516B** Analysis Date: **5/16/2019 10:26:41 AM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	<0.300	1.00								
Fluoride	<0.100	0.400								
Nitrate-N	<0.100	0.500								
Sulfate	<1.00	3.00								

Sample ID **LCS-90934** Batch ID: **90934** TestNo: **E300** Units: **mg/L**
SampType: **LCS** Run ID: **IC2_190516B** Analysis Date: **5/16/2019 10:42:42 AM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	10.2	1.00	10.00	0	102	90	110			
Fluoride	4.08	0.400	4.000	0	102	90	110			
Nitrate-N	5.10	0.500	5.000	0	102	90	110			
Sulfate	30.6	3.00	30.00	0	102	90	110			

Sample ID **LCSD-90934** Batch ID: **90934** TestNo: **E300** Units: **mg/L**
SampType: **LCSD** Run ID: **IC2_190516B** Analysis Date: **5/16/2019 10:58:41 AM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	10.2	1.00	10.00	0	102	90	110	0.034	20	
Fluoride	4.08	0.400	4.000	0	102	90	110	0.128	20	
Nitrate-N	5.18	0.500	5.000	0	104	90	110	1.47	20	
Sulfate	30.8	3.00	30.00	0	103	90	110	0.343	20	

Sample ID **1905178-02DMS** Batch ID: **90934** TestNo: **E300** Units: **mg/L**
SampType: **MS** Run ID: **IC2_190516B** Analysis Date: **5/16/2019 12:59:35 PM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	21400	1000	20000	0	107	90	110			
Fluoride	21400	400	20000	0	107	90	110			
Nitrate-N	4620	500	4516	0	102	90	110			
Sulfate	20700	3000	20000	0	103	90	110			

Sample ID **1905178-02DMSD** Batch ID: **90934** TestNo: **E300** Units: **mg/L**
SampType: **MSD** Run ID: **IC2_190516B** Analysis Date: **5/16/2019 1:15:35 PM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	21000	1000	20000	0	105	90	110	2.04	20	
Fluoride	21000	400	20000	0	105	90	110	1.92	20	
Nitrate-N	4530	500	4516	0	100	90	110	2.06	20	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: **IC2_190516B**

Sample ID **1905178-02DMSD**	Batch ID: **90934**	TestNo: **E300**	Units: **mg/L**
SampType: **MSD**	Run ID: **IC2_190516B**	Analysis Date: **5/16/2019 1:15:35 PM**	Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	20200	3000	20000	0	101	90	110	2.16	20	

Sample ID **1905178-03DMS**	Batch ID: **90934**	TestNo: **E300**	Units: **mg/L**
SampType: **MS**	Run ID: **IC2_190516B**	Analysis Date: **5/16/2019 1:47:35 PM**	Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	24300	1000	20000	3227	105	90	110			
Fluoride	21100	400	20000	0	106	90	110			
Nitrate-N	4600	500	4516	0	102	90	110			
Sulfate	20400	3000	20000	0	102	90	110			

Sample ID **1905178-03DMSD**	Batch ID: **90934**	TestNo: **E300**	Units: **mg/L**
SampType: **MSD**	Run ID: **IC2_190516B**	Analysis Date: **5/16/2019 2:03:35 PM**	Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	24200	1000	20000	3227	105	90	110	0.381	20	
Fluoride	21100	400	20000	0	106	90	110	0.221	20	
Nitrate-N	4550	500	4516	0	101	90	110	1.04	20	
Sulfate	20100	3000	20000	0	101	90	110	1.20	20	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: IC2_190516B

Sample ID **ICV-190516**	Batch ID: **R104123**	TestNo: **E300**	Units: **mg/L**
SampType: **ICV**	Run ID: **IC2_190516B**	Analysis Date: **5/16/2019 9:54:41 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	26.3	1.00	25.00	0	105	90	110			
Fluoride	10.5	0.400	10.00	0	105	90	110			
Nitrate-N	13.3	0.500	12.50	0	106	90	110			
Sulfate	78.9	3.00	75.00	0	105	90	110			

Sample ID **CCV1-190516**	Batch ID: **R104123**	TestNo: **E300**	Units: **mg/L**
SampType: **CCV**	Run ID: **IC2_190516B**	Analysis Date: **5/16/2019 5:29:14 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	10.5	1.00	10.00	0	105	90	110			
Fluoride	4.18	0.400	4.000	0	104	90	110			
Nitrate-N	5.22	0.500	5.000	0	104	90	110			
Sulfate	31.5	3.00	30.00	0	105	90	110			

Sample ID **CCV2-190516**	Batch ID: **R104123**	TestNo: **E300**	Units: **mg/L**
SampType: **CCV**	Run ID: **IC2_190516B**	Analysis Date: **5/16/2019 9:29:14 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	10.5	1.00	10.00	0	105	90	110			
Fluoride	4.18	0.400	4.000	0	105	90	110			
Nitrate-N	5.22	0.500	5.000	0	104	90	110			
Sulfate	31.9	3.00	30.00	0	106	90	110			

Sample ID **CCV3-190516**	Batch ID: **R104123**	TestNo: **E300**	Units: **mg/L**
SampType: **CCV**	Run ID: **IC2_190516B**	Analysis Date: **5/17/2019 12:41:14 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	10.8	1.00	10.00	0	108	90	110			
Fluoride	4.24	0.400	4.000	0	106	90	110			
Nitrate-N	5.27	0.500	5.000	0	105	90	110			
Sulfate	31.9	3.00	30.00	0	106	90	110			

Sample ID **CCV4-190516**	Batch ID: **R104123**	TestNo: **E300**	Units: **mg/L**
SampType: **CCV**	Run ID: **IC2_190516B**	Analysis Date: **5/17/2019 4:25:14 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	10.6	1.00	10.00	0	106	90	110			
Sulfate	31.6	3.00	30.00	0	105	90	110			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: **IC2_190516B**

Sample ID	**CCV5-190516**	Batch ID:	**R104123**	TestNo:	**E300**	Units:	**mg/L**
SampType:	**CCV**	Run ID:	**IC2_190516B**	Analysis Date:	**5/17/2019 6:49:14 AM**	Prep Date:	

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	10.6	1.00	10.00	0	106	90	110			
Sulfate	31.8	3.00	30.00	0	106	90	110			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: IC2_190517B

The QC data in batch 90964 applies to the following samples: 1905185-08C, 1905185-10C

Sample ID **MB-90964** Batch ID: **90964** TestNo: **E300** Units: **mg/L**
SampType: **MBLK** Run ID: **IC2_190517B** Analysis Date: **5/17/2019 10:29:03 AM** Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	<1.00	3.00								

Sample ID **LCS-90964** Batch ID: **90964** TestNo: **E300** Units: **mg/L**
SampType: **LCS** Run ID: **IC2_190517B** Analysis Date: **5/17/2019 10:45:03 AM** Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	31.5	3.00	30.00	0	105	90	110			

Sample ID **LCSD-90964** Batch ID: **90964** TestNo: **E300** Units: **mg/L**
SampType: **LCSD** Run ID: **IC2_190517B** Analysis Date: **5/17/2019 11:01:03 AM** Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	31.6	3.00	30.00	0	105	90	110	0.320	20	

Sample ID **1905169-06BMS** Batch ID: **90964** TestNo: **E300** Units: **mg/L**
SampType: **MS** Run ID: **IC2_190517B** Analysis Date: **5/17/2019 3:37:12 PM** Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	388	30.0	200.0	177.5	105	90	110			

Sample ID **1905169-06BMSD** Batch ID: **90964** TestNo: **E300** Units: **mg/L**
SampType: **MSD** Run ID: **IC2_190517B** Analysis Date: **5/17/2019 3:53:11 PM** Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	394	30.0	200.0	177.5	108	90	110	1.58	20	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: **IC2_190517B**

Sample ID **ICV-190517**	Batch ID: **R104148**	TestNo: **E300**	Units: **mg/L**
SampType: **ICV**	Run ID: **IC2_190517B**	Analysis Date: **5/17/2019 9:57:03 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	80.5	3.00	75.00	0	107	90	110			

Sample ID **CCV1-190517**	Batch ID: **R104148**	TestNo: **E300**	Units: **mg/L**
SampType: **CCV**	Run ID: **IC2_190517B**	Analysis Date: **5/17/2019 7:21:11 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sulfate	31.9	3.00	30.00	0	106	90	110			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: **TITRATOR_190517A**

The QC data in batch 90967 applies to the following samples: 1905185-01C, 1905185-02C, 1905185-03C, 1905185-04C, 1905185-05C, 1905185-06C, 1905185-07C, 1905185-08C, 1905185-09C, 1905185-10C, 1905185-11C

Sample ID **MB-90967** Batch ID: **90967** TestNo: **M2320 B** Units: **mg/L @ pH 4.18**
SampType: **MBLK** Run ID: **TITRATOR_190517A** Analysis Date: **5/17/2019 10:37:00 AM** Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	<10.0	20.0								
Alkalinity, Carbonate (As CaCO3)	<10.0	20.0								
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0								
Alkalinity, Total (As CaCO3)	<20.0	20.0								

Sample ID **LCS-90967** Batch ID: **90967** TestNo: **M2320 B** Units: **mg/L @ pH 4.07**
SampType: **LCS** Run ID: **TITRATOR_190517A** Analysis Date: **5/17/2019 10:42:00 AM** Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Total (As CaCO3)	52.8	20.0	50.00	0	106	74	129			

Sample ID **LCSD-90967** Batch ID: **90967** TestNo: **M2320 B** Units: **mg/L @ pH 4.09**
SampType: **LCSD** Run ID: **TITRATOR_190517A** Analysis Date: **5/17/2019 11:23:00 AM** Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Total (As CaCO3)	52.7	20.0	50.00	0	105	74	129	0.152	20	

Sample ID **1905178-02D DUP** Batch ID: **90967** TestNo: **M2320 B** Units: **mg/L @ pH 4.53**
SampType: **DUP** Run ID: **TITRATOR_190517A** Analysis Date: **5/17/2019 12:39:00 PM** Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	460	20.0	0	469.5				2.04	20	
Alkalinity, Carbonate (As CaCO3)	<10.0	20.0	0	0				0	20	
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0	0	0				0	20	
Alkalinity, Total (As CaCO3)	460	20.0	0	469.5				2.04	20	

Sample ID **1905185-03C DUP** Batch ID: **90967** TestNo: **M2320 B** Units: **mg/L @ pH 4.54**
SampType: **DUP** Run ID: **TITRATOR_190517A** Analysis Date: **5/17/2019 2:20:00 PM** Prep Date: **5/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	469	20.0	0	473.7				1.06	20	
Alkalinity, Carbonate (As CaCO3)	<10.0	20.0	0	0				0	20	
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0	0	0				0	20	
Alkalinity, Total (As CaCO3)	469	20.0	0	473.7				1.06	20	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

ANALYTICAL QC SUMMARY REPORT

RunID: TITRATOR_190517A

Sample ID ICV-190517	Batch ID: R104143	TestNo: M2320 B	Units: mg/L @ pH 4.21
SampType: ICV	Run ID: TITRATOR_190517A	Analysis Date: 5/17/2019 10:16:00 AM	Prep Date: 5/17/2019

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	10.2	20.0	0							
Alkalinity, Carbonate (As CaCO3)	88.2	20.0	0							
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0	0							
Alkalinity, Total (As CaCO3)	98.3	20.0	100.0	0	98.3	98	102			

Sample ID CCV1-190517	Batch ID: R104143	TestNo: M2320 B	Units: mg/L @ pH 4.25
SampType: CCV	Run ID: TITRATOR_190517A	Analysis Date: 5/17/2019 1:41:00 PM	Prep Date: 5/17/2019

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	25.5	20.0	0							
Alkalinity, Carbonate (As CaCO3)	73.1	20.0	0							
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0	0							
Alkalinity, Total (As CaCO3)	98.6	20.0	100.0	0	98.6	90	110			

Sample ID CCV2-190517	Batch ID: R104143	TestNo: M2320 B	Units: mg/L @ pH 4.22
SampType: CCV	Run ID: TITRATOR_190517A	Analysis Date: 5/17/2019 5:20:00 PM	Prep Date: 5/17/2019

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	14.9	20.0	0							
Alkalinity, Carbonate (As CaCO3)	84.2	20.0	0							
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0	0							
Alkalinity, Total (As CaCO3)	99.0	20.0	100.0	0	99.0	90	110			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: UV/VIS_2_190516B

The QC data in batch 90950 applies to the following samples: 1905185-01C, 1905185-02C, 1905185-03C, 1905185-04C, 1905185-05C, 1905185-06C, 1905185-07C, 1905185-08C, 1905185-09C, 1905185-10C, 1905185-11C

Sample ID **MB-90950** Batch ID: **90950** TestNo: **M4500-P E** Units: **mg/L**
SampType: **MBLK** Run ID: **UV/VIS_2_190516B** Analysis Date: **5/16/2019 2:45:00 PM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	<0.0300	0.100								

Sample ID **LCS-90950** Batch ID: **90950** TestNo: **M4500-P E** Units: **mg/L**
SampType: **LCS** Run ID: **UV/VIS_2_190516B** Analysis Date: **5/16/2019 2:45:00 PM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.523	0.100	0.5000	0	105	80	120			

Sample ID **LCSD-90950** Batch ID: **90950** TestNo: **M4500-P E** Units: **mg/L**
SampType: **LCSD** Run ID: **UV/VIS_2_190516B** Analysis Date: **5/16/2019 2:46:00 PM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.496	0.100	0.5000	0	99.2	80	120	5.30	15	

Sample ID **1905185-01CMS** Batch ID: **90950** TestNo: **M4500-P E** Units: **mg/L**
SampType: **MS** Run ID: **UV/VIS_2_190516B** Analysis Date: **5/16/2019 2:46:00 PM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.647	0.100	0.5000	0.05100	119	80	120			

Sample ID **1905185-01CMSD** Batch ID: **90950** TestNo: **M4500-P E** Units: **mg/L**
SampType: **MSD** Run ID: **UV/VIS_2_190516B** Analysis Date: **5/16/2019 2:47:00 PM** Prep Date: **5/16/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.614	0.100	0.5000	0.05100	113	80	120	5.23	15	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: **UV/VIS_2_190516B**

Sample ID **ICV-190516** Batch ID: **R104109** TestNo: **M4500-P E** Units: **mg/L**
SampType: **ICV** Run ID: **UV/VIS_2_190516B** Analysis Date: **5/16/2019 2:44:00 PM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.204	0.100	0.2000	0	102	85	115			

Sample ID **CCV1-190516** Batch ID: **R104109** TestNo: **M4500-P E** Units: **mg/L**
SampType: **CCV** Run ID: **UV/VIS_2_190516B** Analysis Date: **5/16/2019 2:51:00 PM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.510	0.100	0.5000	0	102	85	115			

Sample ID **CCV2-190516** Batch ID: **R104109** TestNo: **M4500-P E** Units: **mg/L**
SampType: **CCV** Run ID: **UV/VIS_2_190516B** Analysis Date: **5/16/2019 2:53:00 PM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.485	0.100	0.5000	0	97.0	85	115			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: UV/VIS_2_190520A

The QC data in batch 91002 applies to the following samples: 1905185-01A, 1905185-02A, 1905185-03A, 1905185-04A, 1905185-05A, 1905185-06A, 1905185-07A, 1905185-08A, 1905185-09A, 1905185-10A, 1905185-11A

Sample ID **MB-91002** Batch ID: **91002** TestNo: **M3500-Fe D** Units: **mg/L**
SampType: **MBLK** Run ID: **UV/VIS_2_190520A** Analysis Date: **5/20/2019 3:53:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	<0.0500	0.100								N

Sample ID **LCS-91002** Batch ID: **91002** TestNo: **M3500-Fe D** Units: **mg/L**
SampType: **LCS** Run ID: **UV/VIS_2_190520A** Analysis Date: **5/20/2019 3:53:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.0888	0.100	0.1000	0	88.8	85	115			N

Sample ID **LCSD-91002** Batch ID: **91002** TestNo: **M3500-Fe D** Units: **mg/L**
SampType: **LCSD** Run ID: **UV/VIS_2_190520A** Analysis Date: **5/20/2019 3:53:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.0879	0.100	0.1000	0	87.9	85	115	1.05	15	N

Sample ID **1905185-11AMS** Batch ID: **91002** TestNo: **M3500-Fe D** Units: **mg/L**
SampType: **MS** Run ID: **UV/VIS_2_190520A** Analysis Date: **5/20/2019 4:03:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.0860	0.100	0.1000	0	86.0	85	115			N

Sample ID **1905185-11AMSD** Batch ID: **91002** TestNo: **M3500-Fe D** Units: **mg/L**
SampType: **MSD** Run ID: **UV/VIS_2_190520A** Analysis Date: **5/20/2019 4:03:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.0861	0.100	0.1000	0	86.1	85	115	0.116	15	N

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: UV/VIS_2_190520A

Sample ID **ICV-190520**	Batch ID: **R104177**	TestNo: **M3500-Fe D**	Units: **mg/L**
SampType: **ICV**	Run ID: **UV/VIS_2_190520A**	Analysis Date: **5/20/2019 3:52:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.0875	0.100	0.1000	0	87.5	85	115			N

Sample ID **CCV1-190520**	Batch ID: **R104177**	TestNo: **M3500-Fe D**	Units: **mg/L**
SampType: **CCV**	Run ID: **UV/VIS_2_190520A**	Analysis Date: **5/20/2019 3:59:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.197	0.100	0.2000	0	98.4	85	115			N

Sample ID **CCV2-190520**	Batch ID: **R104177**	TestNo: **M3500-Fe D**	Units: **mg/L**
SampType: **CCV**	Run ID: **UV/VIS_2_190520A**	Analysis Date: **5/20/2019 4:12:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.183	0.100	0.2000	0	91.7	85	115			N

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1905185
Project: Luminant-A1 Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: WC_190520A

The QC data in batch 91001 applies to the following samples: 1905185-01C, 1905185-02C, 1905185-03C, 1905185-04C, 1905185-05C, 1905185-06C, 1905185-07C, 1905185-08C, 1905185-09C, 1905185-10C, 1905185-11C

Sample ID **MB-91001** Batch ID: **91001** TestNo: **M2540C** Units: **mg/L**
SampType: **MBLK** Run ID: **WC_190520A** Analysis Date: **5/20/2019 4:45:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids (Residue, Filtera	<10.0	10.0								

Sample ID **LCS-91001** Batch ID: **91001** TestNo: **M2540C** Units: **mg/L**
SampType: **LCS** Run ID: **WC_190520A** Analysis Date: **5/20/2019 4:45:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids (Residue, Filtera	751	10.0	745.6	0	101	90	113			

Sample ID **1905182-01D-DUP** Batch ID: **91001** TestNo: **M2540C** Units: **mg/L**
SampType: **DUP** Run ID: **WC_190520A** Analysis Date: **5/20/2019 4:45:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids (Residue, Filtera	6840	200	0	6820				0.293	5	

Sample ID **1905182-02D-DUP** Batch ID: **91001** TestNo: **M2540C** Units: **mg/L**
SampType: **DUP** Run ID: **WC_190520A** Analysis Date: **5/20/2019 4:45:00 PM** Prep Date: **5/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids (Residue, Filtera	5030	50.0	0	5065				0.693	5	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

Pace Analytical®
National Center for Testing & Innovation

ANALYTICAL REPORT

June 18, 2019

DHL Analytical, Inc.

Sample Delivery Group:	L1100977
Samples Received:	05/21/2019
Project Number:	1905185
Description:	
Report To:	John DuPont 2300 Double Creek Drive Round Rock, TX 78664

Entire Report Reviewed By: D Eidson

Donna Eidson
Project Manager

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by Pace National is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

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BMW-24 L1100977-01 Non-Potable Water

Collected by	Collected date/time	Received date/time
	05/15/19 07:35	05/21/19 10:10

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 904	WG1285651	1	05/24/19 09:05	05/30/19 12:10	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1285448	1	05/28/19 16:20	05/30/19 13:00	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1285448	1	05/28/19 16:20	05/30/19 13:00	RGT	Mt. Juliet, TN

BMW-23 L1100977-02 Non-Potable Water

Collected by	Collected date/time	Received date/time
	05/15/19 08:25	05/21/19 10:10

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 904	WG1285651	1	05/24/19 09:05	06/13/19 16:05	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1285448	1	05/28/19 16:20	06/13/19 16:05	JMR	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1285448	1	05/28/19 16:20	05/30/19 13:00	RGT	Mt. Juliet, TN

BMW-22 L1100977-03 Non-Potable Water

Collected by	Collected date/time	Received date/time
	05/15/19 09:15	05/21/19 10:10

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 904	WG1285651	1	05/24/19 09:05	05/30/19 12:10	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1285448	1	05/28/19 16:20	05/30/19 13:00	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1285448	1	05/28/19 16:20	05/30/19 13:00	RGT	Mt. Juliet, TN

BMW-21 L1100977-04 Non-Potable Water

Collected by	Collected date/time	Received date/time
	05/15/19 09:55	05/21/19 10:10

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 904	WG1285651	1	05/24/19 09:05	05/30/19 12:10	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1285448	1	05/28/19 16:20	05/30/19 13:00	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1285448	1	05/28/19 16:20	05/30/19 13:00	RGT	Mt. Juliet, TN

BMW-27 L1100977-05 Non-Potable Water

Collected by	Collected date/time	Received date/time
	05/15/19 10:55	05/21/19 10:10

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 904	WG1285651	1	05/24/19 09:05	05/30/19 12:10	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1285448	1	05/28/19 16:20	05/30/19 17:30	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1285448	1	05/28/19 16:20	05/30/19 17:30	RGT	Mt. Juliet, TN

BMW-26 L1100977-06 Non-Potable Water

Collected by	Collected date/time	Received date/time
	05/15/19 11:40	05/21/19 10:10

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 904	WG1285651	1	05/24/19 09:05	05/30/19 12:10	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1285448	1	05/28/19 16:20	05/30/19 17:30	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1285448	1	05/28/19 16:20	05/30/19 17:30	RGT	Mt. Juliet, TN

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

BMW-11AR L1100977-07 Non-Potable Water

Collected by | Collected date/time 05/15/19 12:35 | Received date/time 05/21/19 10:10

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 904	WG1285651	1	05/24/19 09:05	05/30/19 12:10	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1285448	1	05/28/19 16:20	05/30/19 17:30	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1285448	1	05/28/19 16:20	05/30/19 17:30	RGT	Mt. Juliet, TN

BMW-19 L1100977-08 Non-Potable Water

Collected by | Collected date/time 05/15/19 13:25 | Received date/time 05/21/19 10:10

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 904	WG1285651	1	05/24/19 09:05	05/30/19 12:10	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1285448	1	05/28/19 16:20	05/30/19 17:30	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1285448	1	05/28/19 16:20	05/30/19 17:30	RGT	Mt. Juliet, TN

BMW-18 L1100977-09 Non-Potable Water

Collected by | Collected date/time 05/15/19 14:10 | Received date/time 05/21/19 10:10

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 904	WG1285651	1	05/24/19 09:05	05/30/19 12:10	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1285448	1	05/28/19 16:20	05/30/19 17:30	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1285448	1	05/28/19 16:20	05/30/19 17:30	RGT	Mt. Juliet, TN

BMW-28 L1100977-10 Non-Potable Water

Collected by | Collected date/time 05/15/19 15:00 | Received date/time 05/21/19 10:10

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 904	WG1285651	1	05/24/19 09:05	05/31/19 11:10	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1285448	1	05/28/19 16:20	05/31/19 11:10	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1285448	1	05/28/19 16:20	05/30/19 17:30	RGT	Mt. Juliet, TN

BMW-20 L1100977-11 Non-Potable Water

Collected by | Collected date/time 05/15/19 16:00 | Received date/time 05/21/19 10:10

Method	Batch	Dilution	Preparation date/time	Analysis date/time	Analyst	Location
Radiochemistry by Method 904	WG1285651	1	05/24/19 09:05	05/31/19 11:10	JMR	Mt. Juliet, TN
Radiochemistry by Method Calculation	WG1285448	1	05/28/19 16:20	05/31/19 11:10	RGT	Mt. Juliet, TN
Radiochemistry by Method SM7500Ra B M	WG1285448	1	05/28/19 16:20	05/30/19 17:30	RGT	Mt. Juliet, TN

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. Where applicable, all MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

DEidson

Donna Eidson
Project Manager

Radiochemistry by Method 904

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	-0.0695		0.728	1.21	05/30/2019 12:10	WG1285651
(T) Barium	*109*			*62.0-143*	*05/30/2019 12:10*	WG1285651
(T) Yttrium	*113*			*79.0-136*	*05/30/2019 12:10*	WG1285651

Radiochemistry by Method Calculation

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
Combined Radium	1.45		1.23	1.48	05/30/2019 13:00	WG1285448

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-226	1.45		0.499	0.265	05/30/2019 13:00	WG1285448
(T) Barium-133	*80.0*			*30.0-143*	*05/30/2019 13:00*	WG1285448

Radiochemistry by Method 904

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	1.00		0.384	0.82	06/13/2019 16:05	WG1285651
(T) Barium	*88.9*			*62.0-143*	*06/13/2019 16:05*	WG1285651
(T) Yttrium	*104*			*79.0-136*	*06/13/2019 16:05*	WG1285651

Radiochemistry by Method Calculation

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
Combined Radium	3.54		1.14	1.55	06/13/2019 16:05	WG1285448

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-226	2.54		0.757	0.731	05/30/2019 13:00	WG1285448
(T) Barium-133	*89.6*			*30.0-143*	*05/30/2019 13:00*	WG1285448

Radiochemistry by Method 904

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	1.64		0.361	0.547	05/30/2019 12:10	WG1285651
(T) Barium	*112*			*62.0-143*	*05/30/2019 12:10*	WG1285651
(T) Yttrium	*113*			*79.0-136*	*05/30/2019 12:10*	WG1285651

Radiochemistry by Method Calculation

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
Combined Radium	5.00		1.19	0.945	05/30/2019 13:00	WG1285448

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-226	3.36		0.831	0.398	05/30/2019 13:00	WG1285448
(T) Barium-133	*79.4*			*30.0-143*	*05/30/2019 13:00*	WG1285448

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Radiochemistry by Method 904

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	1.07		0.398	0.586	05/30/2019 12:10	WG1285651
(T) Barium	*108*			*62.0-143*	*05/30/2019 12:10*	WG1285651
(T) Yttrium	*120*			*79.0-136*	*05/30/2019 12:10*	WG1285651

Radiochemistry by Method Calculation

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
Combined Radium	1.31		0.656	0.908	05/30/2019 13:00	WG1285448

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-226	0.245		0.258	0.322	05/30/2019 13:00	WG1285448
(T) Barium-133	*73.1*			*30.0-143*	*05/30/2019 13:00*	WG1285448

Radiochemistry by Method 904

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.962		0.387	0.609	05/30/2019 12:10	WG1285651
(T) Barium	*112*			*62.0-143*	*05/30/2019 12:10*	WG1285651
(T) Yttrium	*115*			*79.0-136*	*05/30/2019 12:10*	WG1285651

Radiochemistry by Method Calculation

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
Combined Radium	1.02		0.499	0.804	05/30/2019 17:30	WG1285448

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-226	0.0591		0.112	0.195	05/30/2019 17:30	WG1285448
(T) Barium-133	*90.6*			*30.0-143*	*05/30/2019 17:30*	WG1285448

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Radiochemistry by Method 904

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	1.13		0.329	0.524	05/30/2019 12:10	WG1285651
(T) Barium	*114*			*62.0-143*	*05/30/2019 12:10*	WG1285651
(T) Yttrium	*120*			*79.0-136*	*05/30/2019 12:10*	WG1285651

Radiochemistry by Method Calculation

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
Combined Radium	1.59		0.595	0.737	05/30/2019 17:30	WG1285448

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-226	0.457		0.266	0.213	05/30/2019 17:30	WG1285448
(T) Barium-133	*86.2*			*30.0-143*	*05/30/2019 17:30*	WG1285448

Radiochemistry by Method 904

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	4.89		0.423	0.671	05/30/2019 12:10	WG1285651
(T) Barium	*103*			*62.0-143*	*05/30/2019 12:10*	WG1285651
(T) Yttrium	*116*			*79.0-136*	*05/30/2019 12:10*	WG1285651

Radiochemistry by Method Calculation

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
Combined Radium	5.71		0.795	0.964	05/30/2019 17:30	WG1285448

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-226	0.830		0.372	0.293	05/30/2019 17:30	WG1285448
(T) Barium-133	*87.9*			*30.0-143*	*05/30/2019 17:30*	WG1285448

Radiochemistry by Method 904

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	4.66		0.515	0.78	05/30/2019 12:10	WG1285651
(T) Barium	*99.1*			*62.0-143*	*05/30/2019 12:10*	WG1285651
(T) Yttrium	*118*			*79.0-136*	*05/30/2019 12:10*	WG1285651

Radiochemistry by Method Calculation

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
Combined Radium	5.47		1.05	1.23	05/30/2019 17:30	WG1285448

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-226	0.487		0.321	0.268	05/30/2019 17:30	WG1285448
(T) Barium-133	*71.8*			*30.0-143*	*05/30/2019 17:30*	WG1285448

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Radiochemistry by Method 904

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	3.95		0.414	0.603	05/30/2019 12:10	WG1285651
(T) Barium	*96.9*			*62.0-143*	*05/30/2019 12:10*	WG1285651
(T) Yttrium	*118*			*79.0-136*	*05/30/2019 12:10*	WG1285651

Radiochemistry by Method Calculation

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
Combined Radium	4.06		0.584	0.867	05/30/2019 17:30	WG1285448

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-226	0.107		0.170	0.264	05/30/2019 17:30	WG1285448
(T) Barium-133	*84.7*			*30.0-143*	*05/30/2019 17:30*	WG1285448

Radiochemistry by Method 904

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.924		0.410	0.59	05/31/2019 11:10	WG1285651
(T) Barium	*122*			*62.0-143*	*05/31/2019 11:10*	WG1285651
(T) Yttrium	*96.5*			*79.0-136*	*05/31/2019 11:10*	WG1285651

Radiochemistry by Method Calculation

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
Combined Radium	1.12		0.635	0.879	05/31/2019 11:10	WG1285448

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-226	0.197		0.225	0.289	05/30/2019 17:30	WG1285448
(T) Barium-133	*55.5*			*30.0-143*	*05/30/2019 17:30*	WG1285448

Radiochemistry by Method 904

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-228	0.174		0.384	0.657	05/31/2019 11:10	WG1285651
(T) Barium	*85.3*			*62.0-143*	*05/31/2019 11:10*	WG1285651
(T) Yttrium	*108*			*79.0-136*	*05/31/2019 11:10*	WG1285651

Radiochemistry by Method Calculation

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
Combined Radium	1.36		0.877	1.01	05/31/2019 11:10	WG1285448

Radiochemistry by Method SM7500Ra B M

Analyte	Result pCi/l	Qualifier	Uncertainty +/-	MDA pCi/l	Analysis Date date / time	Batch
RADIUM-226	1.18		0.493	0.349	05/30/2019 17:30	WG1285448
(T) Barium-133	*73.8*			*30.0-143*	*05/30/2019 17:30*	WG1285448

1 Cp | 2 Tc | 3 Ss | 4 Cn | 5 Sr | 6 Qc | 7 Gl | 8 Al | 9 Sc

Method Blank (MB)

(MB) R3417363-1 05/30/19 12:10

Analyte	MB Result pCi/l	MB Qualifier	MB MDA pCi/l
Radium-228	-0.0581		0.396
(T) Barium	*105*		
(T) Yttrium	*110*		

L1100977-01 Original Sample (OS) • Duplicate (DUP)

(OS) L1100977-01 05/30/19 12:10 • (DUP) R3417363-5 05/30/19 12:10

Analyte	Original Result pCi/l	DUP Result pCi/l	Dilution	DUP RPD %	DUP RER	DUP Qualifier	DUP RPD Limits %	DUP RER Limit
Radium-228	-0.0695	0.650	1	200	0.741		20	3
(T) Barium	*109*	*111*						
(T) Yttrium	*113*	*107*						

Laboratory Control Sample (LCS)

(LCS) R3417363-2 05/30/19 12:10

Analyte	Spike Amount pCi/l	LCS Result pCi/l	LCS Rec. %	Rec. Limits %	LCS Qualifier
Radium-228	5.00	5.29	106	80.0-120	
(T) Barium			*104*		
(T) Yttrium			*114*		

L1100989-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1100989-01 05/31/19 11:10 • (MS) R3417363-3 05/30/19 12:10 • (MSD) R3417363-4 05/30/19 12:10

Analyte	Spike Amount pCi/l	Original Result pCi/l	MS Result pCi/l	MSD Result pCi/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	MS RER	RPD Limits %
Radium-228	20.0	0.531	20.9	19.5	102	94.8	1	70.0-130			7.08		20
(T) Barium		*120*			*102*	*115*							
(T) Yttrium		*93.0*			*117*	*114*							

WG1285448

Radiochemistry by Method SM7500Ra B M

QUALITY CONTROL SUMMARY

L1100977-01,02,03,04,05,06,07,08,09,10,11

Method Blank (MB)

(MB) R3418748-1 05/30/19 13:00

Analyte	MB Result pCi/l	MB Qualifier	MB MDA pCi/l
Radium-226	0.0330		0.399
(T) Barium-133	*58.0*		

L1102014-01 Original Sample (OS) • Duplicate (DUP)

(OS) L1102014-01 05/30/19 17:30 • (DUP) R3418748-5 05/30/19 13:00

Analyte	Original Result pCi/l	DUP Result pCi/l	Dilution	DUP RPD %	DUP RER	DUP Qualifier	DUP RPD Limits %	DUP RER Limit
Radium-226	0.955	0.488	1	64.8	0.623		20	3
(T) Barium-133	*41.0*	*37.0*						

Laboratory Control Sample (LCS)

(LCS) R3418748-2 05/30/19 13:00

Analyte	Spike Amount pCi/l	LCS Result pCi/l	LCS Rec. %	Rec. Limits %	LCS Qualifier
Radium-226	20.1	19.8	98.4	80.0-120	
(T) Barium-133			*57.4*		

L1102014-02 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L1102014-02 05/30/19 17:30 • (MS) R3418748-3 05/30/19 13:00 • (MSD) R3418748-4 05/30/19 13:00

Analyte	Spike Amount pCi/l	Original Result pCi/l	MS Result pCi/l	MSD Result pCi/l	MS Rec. %	MSD Rec. %	Dilution	Rec. Limits %	MS Qualifier	MSD Qualifier	RPD %	MS RER	RPD Limits %
Radium-226	20.1	0.487	22.6	23.9	110	116	1	75.0-125			5.68		20
(T) Barium-133		*59.1*			*47.0*	*45.7*							

Cp
Tc
Ss
Cn
Sr
Qc
Gl
Al
Sc

Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

Abbreviations and Definitions

MDA	Minimum Detectable Activity.
Rec.	Recovery.
RER	Replicate Error Ratio.
RPD	Relative Percent Difference.
SDG	Sample Delivery Group.
(T)	Tracer - A radioisotope of known concentration added to a solution of chemically equivalent radioisotopes at a known concentration to assist in monitoring the yield of the chemical separation.
Analyte	The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported.
Dilution	If the sample matrix contains an interfering material, the sample preparation volume or weight values differ from the standard, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor.
Limits	These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges.
Original Sample	The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG.
Qualifier	This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable.
Result	The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state "ND" (Not Detected) or "BDL" (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte.
Uncertainty (Radiochemistry)	Confidence level of 2 sigma.
Case Narrative (Cn)	A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report.
Quality Control Summary (Qc)	This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material.
Sample Chain of Custody (Sc)	This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis.
Sample Results (Sr)	This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported.
Sample Summary (Ss)	This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis.

Qualifier	Description
	The remainder of this page intentionally left blank, there are no qualifiers applied to this SDG.

Pace National is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our one location design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be YOUR LAB OF CHOICE.
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.
* Accreditation is only applicable to the test methods specified on each scope of accreditation held by Pace National.

State Accreditations

Alabama	40660	Nebraska	NE-OS-15-05
Alaska	17-026	Nevada	TN-03-2002-34
Arizona	AZ0612	New Hampshire	2975
Arkansas	88-0469	New Jersey–NELAP	TN002
California	2932	New Mexico [1]	n/a
Colorado	TN00003	New York	11742
Connecticut	PH-0197	North Carolina	Env375
Florida	E87487	North Carolina [1]	DW21704
Georgia	NELAP	North Carolina [3]	41
Georgia [1]	923	North Dakota	R-140
Idaho	TN00003	Ohio–VAP	CL0069
Illinois	200008	Oklahoma	9915
Indiana	C-TN-01	Oregon	TN200002
Iowa	364	Pennsylvania	68-02979
Kansas	E-10277	Rhode Island	LAO00356
Kentucky [1 6]	90010	South Carolina	84004
Kentucky [2]	16	South Dakota	n/a
Louisiana	AI30792	Tennessee [1 4]	2006
Louisiana [1]	LA180010	Texas	T104704245-18-15
Maine	TN0002	Texas [5]	LAB0152
Maryland	324	Utah	TN00003
Massachusetts	M-TN003	Vermont	VT2006
Michigan	9958	Virginia	460132
Minnesota	047-999-395	Washington	C847
Mississippi	TN00003	West Virginia	233
Missouri	340	Wisconsin	9980939910
Montana	CERT0086	Wyoming	A2LA

Third Party Federal Accreditations

A2LA – ISO 17025	1461.01	AIHA-LAP,LLC EMLAP	100789
A2LA – ISO 17025 [5]	1461.02	DOD	1461.01
Canada	1461.01	USDA	P330-15-00234
EPA–Crypto	TN00003		

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [6] Wastewater n/a Accreditation not applicable

Our Locations

Pace National has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. Pace National performs all testing at our central laboratory.

Pace Analytical National Center for Testing & Innovation
Cooler Receipt Form

Client: DHCRRTX	SDG#:	1100977	
Cooler Received/Opened On: 5/21/19	Temperature:	Amb	
Received By: Brock Fariss			
Signature: BF Fariss			

Receipt Check List	NP	Yes	No
COC Seal Present / Intact?	✓		
COC Signed / Accurate?		✓	
Bottles arrive intact?		✓	
Correct bottles used?		✓	
Sufficient volume sent?		✓	
If Applicable			
VOA Zero headspace?			
Preservation Correct / Checked?		✓	

Kelsey Stephenson

Pace Analytical®
National Center for Testing & Innovation

Login #:L1100977	Client:DHLRRTX	Date:05/21	Evaluated by:Kelsey S

Non-Conformance (check applicable items)

	Sample Integrity		Chain of Custody Clarification		
	Parameter(s) past holding time		Login Clarification Needed		**If Broken Container:**
	Temperature not in range		Chain of custody is incomplete		Insufficient packing material around container
	Improper container type		Please specify Metals requested.		Insufficient packing material inside cooler
	pH not in range.		Please specify TCLP requested.		Improper handling by carrier (FedEx / UPS / Courier
	Insufficient sample volume.		Received additional samples not listed on coc.		Sample was frozen
	Sample is biphasic.		Sample ids on containers do not match ids on coc		Container lid not intact
	Vials received with headspace.		Trip Blank not received.		**If no Chain of Custody:**
	Broken container		Client did not "X" analysis.		Received by:
	Broken container:		Chain of Custody is missing		Date/Time:
	Sufficient sample remains				Temp./Cont. Rec./pH:
					Carrier:
					Tracking#

Login Comments:
Sample BMW-23,-22,-11AR, and -19 were received ith a pH oh 5
Samples BMW- 21,-27,-26,-28,-20 were received with a pH pf 8

Client informed by:		Call		Email		Voice Mail		Date:	Time:
TSR Initials:	Client Contact:								

Login Instructions:

Noted

DE 5/21/19 1547

1100977

DHL Analytical, Inc.
2300 Double Creek Drive
Round Rock, TX 78664
TEL: *(512) 388-8222* FAX: *(512) 388-8229*
Work Order: 1905185

CHAIN-OF-CUSTODY RECORD

H006

Subcontractor:
Pace Analytical
12065 Lebanon Rd
Mt. Juliet, TN 37122

TEL: (615) 773-5923
FAX:
Acct #: DHLRRTX

16-May-19

Sample Id	Matrix	DHL#	Date Collected	Bottle Type	Ra-228 E904.0 <2	Ra-226 M7500 Ra B M <2	Requested Tests			
BMW-24	Aqueous	-01D	05/15/19 07:35 AM	1LHDPEHNO3		1				-01
BMW-24	Aqueous	-01E	05/15/19 07:35 AM	1LHDPEHNO3	1					
BMW-23	Aqueous	-02D	05/15/19 08:25 AM	1LHDPEHNO3		1				02
BMW-23	Aqueous	-02E	05/15/19 08:25 AM	1LHDPEHNO3	1					1
BMW-22	Aqueous	-03D	05/15/19 09:15 AM	1LHDPEHNO3		1				03
BMW-22	Aqueous	-03E	05/15/19 09:15 AM	1LHDPEHNO3	1					1
BMW-21	Aqueous	-04D	05/15/19 09:55 AM	1LHDPEHNO3		1				04
BMW-21	Aqueous	-04E	05/15/19 09:55 AM	1LHDPEHNO3	1					1
BMW-27	Aqueous	-05D	05/15/19 10:55 AM	1LHDPEHNO3		1				05
BMW-27	Aqueous	-05E	05/15/19 10:55 AM	1LHDPEHNO3	1					1
BMW-26	Aqueous	-06D	05/15/19 11:40 AM	1LHDPEHNO3		1				06
BMW-26	Aqueous	-06E	05/15/19 11:40 AM	1LHDPEHNO3	1					1
BMW-11AR	Aqueous	-07D	05/15/19 12:35 PM	1LHDPEHNO3		1				07
BMW-11AR	Aqueous	-07E	05/15/19 12:35 PM	1LHDPEHNO3	1					1
BMW-19	Aqueous	-08D	05/15/19 01:25 PM	1LHDPEHNO3		1				08
BMW-19	Aqueous	-08E	05/15/19 01:25 PM	1LHDPEHNO3	1					1
BMW-18	Aqueous	-09D	05/15/19 02:10 PM	1LHDPEHNO3		1				09
BMW-18	Aqueous	-09E	05/15/19 02:10 PM	1LHDPEHNO3	1					1

General Comments:
Please analyze these samples with Normal Turnaround Time.
Report RA-226, Ra-228 & Combined per Specs.
Quality Control Package Needed: Standard - NELAC Rad Test compliant
Email to cac@dhlanalytical.com & dupont@dhlanalytical.com

		Date/Time			Date/Time	
Relinquished by:		5/17/19 1700	**Received by:**	Faire	5/21/19 08BF 1010	UPS Rec: 22
Relinquished by:			**Received by:**			

pH adj @ 1457

RAD SCREEN: <0.5 mR/hr

1160977

CHAIN-OF-CUSTODY RECORD

DHL Analytical, Inc.
2300 Double Creek Drive
Round Rock, TX 78664
TEL: *(512) 388-8222* FAX: *(512) 388-8229*

Work Order: 1905185

Subcontractor:
Pace Analytical
12065 Lebanon Rd
Mt. Juliet, TN 37122

TEL: (615) 773-5923
FAX:
Acct #: DHLRRTX

16-May-19

Sample Id	Matrix	DHL#	Date Collected	Bottle Type	Ra-228 E904.0 <2	Ra-226 M7500 Ra B M <2	Requested Tests			
BMW-28	Aqueous	-10D	05/15/19 03:00 PM	1LHDPEHNO3		1				10
BMW-28	Aqueous	-10E	05/15/19 03:00 PM	1LHDPEHNO3	1					1
BMW-20	Aqueous	-11D	05/15/19 04:00 PM	1LHDPEHNO3		1				11
BMW-20	Aqueous	-11E	05/15/19 04:00 PM	1LHDPEHNO3	1					1

General Comments:
Please analyze these samples with Normal Turnaround Time.
Report RA-226, Ra-228 & Combined per Specs.
Quality Control Package Needed: Standard - NELAC Rad Test compliant
Email to cac@dhlanalytical.com & dupont@dhlanalytical.com

Relinquished by:	Date/Time	Received by:	Date/Time
Relinquished by:		Received by:	5/21/19 1010

UPS
Rec: 22

RAD SCREEN: <0.5 mR/hr

DHL ANALYTICAL

June 21, 2019

Will Vienne
Golder
2201 Double Creek Dr #4004
Round Rock, Texas 78664
TEL: (512) 671-3434
FAX (512) 671-3446

Order No.: 1906152

RE: A1 Area Landfill

Dear Will Vienne:

DHL Analytical, Inc. received 6 sample(s) on 6/14/2019 for the analyses presented in the following report.

There were no problems with the analyses and all data met requirements of NELAP except where noted in the Case Narrative. All non-NELAP methods will be identified accordingly in the case narrative and all estimated uncertainties of test results are within method or EPA specifications.

If you have any questions regarding these tests results, please feel free to call. Thank you for using DHL Analytical.

Sincerely,

John DuPont
General Manager

This report was performed under the accreditation of the State of Texas Laboratory Certification Number: T104704211-19-24

NELAP ACCREDITED TNI LABORATORY

Table of Contents

DHL ANALYTICAL

2300 Double Creek Dr. ■ Round Rock, TX 78664
Phone (512) 388-8222 ■ FAX (512) 388-8229
Web: *www.dhlanalytical.com*
E-Mail: *login@dhlanalytical.com*

№ 83013

CHAIN-OF-CUSTODY

CLIENT: Golder Associates
ADDRESS: 5416 Plaza Dr Texarkana TX 75501
PHONE: 903-794-0625 FAX/E-MAIL:
DATA REPORTED TO:
ADDITIONAL REPORT COPIES TO:

DATE: PAGE 1 OF ~~2~~ 1
PO #: 19122434-D DHL WORK ORDER #: 1906152
PROJECT LOCATION OR NAME: A1 Area Landfill
CLENT PROJECT #: 19122434-D COLLECTOR: Alex Gonzales

Authorize 5% surcharge for TRRP Report? ☐ Yes ☐ No

S=SOIL W=WATER A=AIR L=LIQUID SE=SEDIMENT P=PAINT SL=SLUDGE O=OTHER SO=SOLID

ANALYSES: BTEX ☐ MTBE ☐ [METHOD 8021] TPH 1005 ☐ TPH 1006 ☐ HOLD 1006 ☐ GRO [METHOD 8015] ☐ DRO [METHOD 8105] ☐ VOC 8260 ☐ VOC 624 ☐ VOC 8260/5035 ☐ SVOC 8270 ☐ PAH 8270 ☐ HOLD PAH ☐ SVOC 625 ☐ 8270 PEST ☐ 625 PEST/PCB ☐ 608 PCB ☐ 8270 O-P PEST ☐ 8082 PCB ☐ 8270 PCB ☐ 8321 HERB ☐ T PHOS, AMMONIA ☐ METALS 6020 ☐ METALS 200.8 ☐ DISS. METALS ☐ RCRA ☐ TX11 ☐ PH ☐ HEX CHROM ☐ ALKALINITY ☐ COD ☐ CHLORIDE ☐ ANIONS ☐ TCLP-SVOC ☐ VOC ☐ PEST ☐ HERB ☐ TCLP-METALS ☐ RCRA 8 ☐ TX-11 ☐ Pb ☐ RCI ☐ FLASHPOINT ☐ DGAS ☐ TDS ☐ TSS ☐ % MOISTURE ☐ CYANIDE ☐

Field Sample I.D.	DHL Lab #	Date	Time	Matrix	Container Type	# of Containers	HCl	HNO_3	H_2SO_4 ☐ NaOH ☐	ICE	UNPRESERVED	Cobalt, Sulfate, Lithium	Lithium, sulfate	Barium	Arsenic	Alk NO_3 F SO_4 Cl ortho P, TDS	Si Mg K Na Fe	Ferrous, Ferric	FIELD NOTES
BMW-25	01	6/13	0930	W		7		X		X	X	X				X	X	X	
BMW-29	02	6/13	1030	W		7		X		X	X		X			X	X	X	
BMW-30	03	6/13	1250	W		7		X		X	X			X		X	X	X	
BMW-31	04	6/13	1430	W		7		X		X	X		X			X	X	X	
BMW-32	05	6/13	0730	W		7		X		X	X	X				X	X	X	
BMW-33	06	6/13	0815	W		7		X		X	X	X			X	X	X	X	add per Will Vienne (JO) 06/14/19

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)
Alex Gonzales	6/13/19 1730	Fed Ex
Fed Ex	6/14/19 10:08	[signature]

☐ DHL DISPOSAL @ $5.00 each ☐ Return 3

TURN AROUND TIME
RUSH ☐ CALL FIRST
1 DAY ☐ CALL FIRST
2 DAY ☐
NORMAL ☒
OTHER ☐

LABORATORY USE ONLY:
RECEIVING TEMP: 1.8°C/1.6°C THERM #: 78
CUSTODY SEALS: ☐ BROKEN ☒ INTACT ☐ NOT USED
CARRIER: ☐ LONE STAR ☒ FEDEX ☐ UPS ☐ OTHER
☐ COURIER DELIVERY
☐ HAND DELIVERED

DHL COC Rev 1 | FEB 2010

Eric Lau

From: John DuPont
Sent: Tuesday, May 28, 2019 11:35 AM
To: Eric Lau
Subject: FW: CCR Analysis

Appendix III Parameters:
Metals (Ca and B)
Anions (Cl, F, and SO4)
TDS

Appendix IV Parameters:

Metals (As, Ba, Be, Cd, Co, Cr, Hg, Li, Mo, Pb, Sb, Se, and Tl)
Ra-226
Ra-228

From: Vienne, Will [mailto:William_Vienne@golder.com]
Sent: Tuesday, April 09, 2019 12:48 PM
To: John DuPont <dupont@dhlanalytical.com>
Subject: CCR Analysis

ORIGIN ID:GGGA (903) 794-0625
GOLDER ASSOCIATES

5416 PLAZA DR

TEXARKANA, TX 75501
UNITED STATES US

SHIP DATE: 13JUN19
ACTWGT: 39.50 LB
CAD: 006994167/SSFE2002
DIMS: 27x14x14 IN

BILL THIRD PARTY

TO SAMPLE RECEIVING
DHL 19122434 - D FOR A1
2300 DOUBLE CREEK DR

ROUND ROCK TX 78664
(512) 388-8222 REF:
THU:
PO: DEPT:

FedEx
Express

E

FRI - 14 JUN 10:30A
PRIORITY OVERNIGHT

TRK# 0201 7878 7609 9128

A8 BSMA

78664
TX-US AUS

CUSTODY SEAL
DATE
SIGNATURE

QEC
Quality Environmental Containers
800-255-3950 • www.qecusa.com

ORIGIN ID:GGGA (903) 794-0625
GOLDER ASSOCIATES

5416 PLAZA DR

TEXARKANA, TX 75501
UNITED STATES US

SHIP DATE: 13JUN19
ACTWGT: 59.00 LB
CAD: 006994167/SSFE2002
DIMS: 27x14x14 IN

BILL THIRD PARTY

TO SAMPLE RECEIVING
DHL 19122434 – D FOR A1
2300 DOUBLE CREEK DR

ROUND ROCK TX 78664
(512) 388 – 8222 REF:
INV:
PO: DEPT:

FedEx
Express

E

FRI – 14 JUN 10:30A
PRIORITY OVERNIGHT

TRK# 0201 7878 7612 6607

A8 BSMA

78664
TX-US AUS

CUSTODY SEAL
DATE
SIGNATURE

QEC
Quality Environmental Containers
800-255-3950 • www.qecusa.com

DHL Analytical, Inc.

Sample Receipt Checklist

Client Name Golder

Date Received: 6/14/2019

Work Order Number 1906152

Received by EL

Checklist completed by: [signature] (Signature) 6/14/2019 (Date)

Reviewed by (initials) (Initials) 6/14/2019 (Date)

Carrier name FedEx 1day

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shippping container/cooler?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐	1.6 °C
Water - VOA vials have zero headspace?	Yes ☑	No ☐	No VOA vials submitted ☐
Water - pH<2 acceptable upon receipt?	Yes ☑	No ☐	NA ☐ LOT # 11837
	Adjusted? no		Checked by (initials)
Water - ph>9 (S) or ph>10 (CN) acceptable upon receipt?	Yes ☐	No ☐	NA ☑ LOT #
	Adjusted?		Checked by

Any No response must be detailed in the comments section below.

Client contacted ______ Date contacted: ______ Person contacted ______

Contacted by: ______ Regarding: ______

Comments: ______

Corrective Action ______

Page 1 of 1

DHL Analytical, Inc.

Date: *21-Jun-19*

CLIENT: Golder
Project: A1 Area Landfill
Lab Order: 1906152

CASE NARRATIVE

Samples were analyzed using the methods outlined in the following references:

Method SW6020A - Metals Analysis
Method E300 - Anions Analysis
Method M2320 B - Alkalinity Analysis
Method M3500-Fe D - Ferrous Iron Analysis (this parameter is not NELAP certified)
Method M3500-Fe D - Ferric Iron (calculation) (this calculation is not NELAP certified).
Method M4500-P E - Orthophosphate Analysis
Method M2540C - TDS Analysis

LOG IN

The samples were received and log-in performed on 6/14/19. A total of 6 samples were received. On 6/14/19 several test parameters were added to all samples as per the client. These were performed as reque3sted. The samples arrived in good condition and were properly packaged.

METALS ANALYSIS

For Metals analysis performed on 6/19/19 the matrix spike and matrix spike duplicate recoveries were below control limits for Sodium. These are flagged accordingly in the QC summary report. The sample selected for the matrix spike and matrix spike duplicate was not from this work order. The LCS was within control limits for this analyte. No further corrective actions were taken.

For Metals analysis performed on 6/19/19 the PDS recovery was out of control limits for Sodium. This is flagged accordingly. The serial dilution was within control limits for this analyte. No further corrective actions were taken.

FERRIC IRON CALCULATION

The Ferric Iron is calculated as the Total Iron minus the Ferrous Iron.

DHL Analytical, Inc.

Date: *21-Jun-19*

CLIENT: Golder
Project: A1 Area Landfill
Lab Order: 1906152

Work Order Sample Summary

Lab Smp ID	Client Sample ID	Tag Number	Date Collected	Date Recved
1906152-01	BMW-25		06/13/19 09:30 AM	6/14/2019
1906152-02	BMW-29		06/13/19 10:30 AM	6/14/2019
1906152-03	BMW-30		06/13/19 12:50 PM	6/14/2019
1906152-04	BMW-31		06/13/19 02:30 PM	6/14/2019
1906152-05	BMW-32		06/13/19 07:30 AM	6/14/2019
1906152-06	BMW-33		06/13/19 08:15 AM	6/14/2019

Lab Order: 1906152
Client: Golder
Project: A1 Area Landfill

PREP DATES REPORT

Sample ID	Client Sample ID	Collection Date	Matrix	Test Number	Test Name	Prep Date	Batch ID
1906152-01A	BMW-25	06/13/19 09:30 AM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	06/14/19 02:08 PM	91344
1906152-01B	BMW-25	06/13/19 09:30 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	06/18/19 08:21 AM	91364
	BMW-25	06/13/19 09:30 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	06/18/19 08:21 AM	91364
	BMW-25	06/13/19 09:30 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	06/18/19 08:21 AM	91364
1906152-01C	BMW-25	06/13/19 09:30 AM	Aqueous	M2320 B	Alkalinity Preparation	06/17/19 08:32 AM	91346
	BMW-25	06/13/19 09:30 AM	Aqueous	E300	Anion Preparation	06/14/19 11:45 AM	91339
	BMW-25	06/13/19 09:30 AM	Aqueous	E300	Anion Preparation	06/14/19 11:45 AM	91339
	BMW-25	06/13/19 09:30 AM	Aqueous	E300	Anion Preparation	06/14/19 11:45 AM	91339
	BMW-25	06/13/19 09:30 AM	Aqueous	M4500-P E	Orthophosphate Prep	06/14/19 11:55 AM	91343
	BMW-25	06/13/19 09:30 AM	Aqueous	M2540C	TDS Preparation	06/18/19 01:25 PM	91377
1906152-02A	BMW-29	06/13/19 10:30 AM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	06/14/19 02:08 PM	91344
1906152-02B	BMW-29	06/13/19 10:30 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	06/18/19 08:21 AM	91364
	BMW-29	06/13/19 10:30 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	06/18/19 08:21 AM	91364
1906152-02C	BMW-29	06/13/19 10:30 AM	Aqueous	M2320 B	Alkalinity Preparation	06/17/19 08:32 AM	91346
	BMW-29	06/13/19 10:30 AM	Aqueous	E300	Anion Preparation	06/14/19 11:45 AM	91339
	BMW-29	06/13/19 10:30 AM	Aqueous	E300	Anion Preparation	06/14/19 11:45 AM	91339
	BMW-29	06/13/19 10:30 AM	Aqueous	E300	Anion Preparation	06/14/19 11:45 AM	91339
	BMW-29	06/13/19 10:30 AM	Aqueous	M4500-P E	Orthophosphate Prep	06/14/19 11:55 AM	91343
	BMW-29	06/13/19 10:30 AM	Aqueous	M2540C	TDS Preparation	06/18/19 01:25 PM	91377
1906152-03A	BMW-30	06/13/19 12:50 PM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	06/14/19 02:08 PM	91344
1906152-03B	BMW-30	06/13/19 12:50 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	06/18/19 08:21 AM	91364
	BMW-30	06/13/19 12:50 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	06/18/19 08:21 AM	91364
1906152-03C	BMW-30	06/13/19 12:50 PM	Aqueous	M2320 B	Alkalinity Preparation	06/17/19 08:32 AM	91346
	BMW-30	06/13/19 12:50 PM	Aqueous	E300	Anion Preparation	06/14/19 11:45 AM	91339
	BMW-30	06/13/19 12:50 PM	Aqueous	E300	Anion Preparation	06/14/19 11:45 AM	91339
	BMW-30	06/13/19 12:50 PM	Aqueous	E300	Anion Preparation	06/14/19 11:45 AM	91339
	BMW-30	06/13/19 12:50 PM	Aqueous	M4500-P E	Orthophosphate Prep	06/14/19 11:55 AM	91343
	BMW-30	06/13/19 12:50 PM	Aqueous	M2540C	TDS Preparation	06/18/19 01:25 PM	91377

Lab Order: 1906152
Client: Golder
Project: A1 Area Landfill

PREP DATES REPORT

Sample ID	Client Sample ID	Collection Date	Matrix	Test Number	Test Name	Prep Date	Batch ID
1906152-04A	BMW-31	06/13/19 02:30 PM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	06/14/19 02:08 PM	91344
1906152-04B	BMW-31	06/13/19 02:30 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	06/18/19 08:21 AM	91364
	BMW-31	06/13/19 02:30 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	06/18/19 08:21 AM	91364
	BMW-31	06/13/19 02:30 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	06/18/19 08:21 AM	91364
1906152-04C	BMW-31	06/13/19 02:30 PM	Aqueous	M2320 B	Alkalinity Preparation	06/17/19 08:32 AM	91346
	BMW-31	06/13/19 02:30 PM	Aqueous	E300	Anion Preparation	06/14/19 11:45 AM	91339
	BMW-31	06/13/19 02:30 PM	Aqueous	E300	Anion Preparation	06/14/19 11:45 AM	91339
	BMW-31	06/13/19 02:30 PM	Aqueous	E300	Anion Preparation	06/14/19 11:45 AM	91339
	BMW-31	06/13/19 02:30 PM	Aqueous	M4500-P E	Orthophosphate Prep	06/14/19 11:55 AM	91343
	BMW-31	06/13/19 02:30 PM	Aqueous	M2540C	TDS Preparation	06/18/19 01:25 PM	91377
1906152-05A	BMW-32	06/13/19 07:30 AM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	06/14/19 02:08 PM	91344
1906152-05B	BMW-32	06/13/19 07:30 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	06/18/19 08:21 AM	91364
	BMW-32	06/13/19 07:30 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	06/18/19 08:21 AM	91364
	BMW-32	06/13/19 07:30 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	06/18/19 08:21 AM	91364
1906152-05C	BMW-32	06/13/19 07:30 AM	Aqueous	M2320 B	Alkalinity Preparation	06/17/19 08:32 AM	91346
	BMW-32	06/13/19 07:30 AM	Aqueous	E300	Anion Preparation	06/14/19 11:45 AM	91339
	BMW-32	06/13/19 07:30 AM	Aqueous	E300	Anion Preparation	06/14/19 11:45 AM	91339
	BMW-32	06/13/19 07:30 AM	Aqueous	E300	Anion Preparation	06/14/19 11:45 AM	91339
	BMW-32	06/13/19 07:30 AM	Aqueous	M4500-P E	Orthophosphate Prep	06/14/19 11:55 AM	91343
	BMW-32	06/13/19 07:30 AM	Aqueous	M2540C	TDS Preparation	06/18/19 01:25 PM	91377
1906152-06A	BMW-33	06/13/19 08:15 AM	Aqueous	M3500-Fe	Ferrous Iron Prep Water	06/14/19 02:08 PM	91344
1906152-06B	BMW-33	06/13/19 08:15 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	06/18/19 08:21 AM	91364
	BMW-33	06/13/19 08:15 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	06/18/19 08:21 AM	91364
1906152-06C	BMW-33	06/13/19 08:15 AM	Aqueous	M2320 B	Alkalinity Preparation	06/17/19 08:32 AM	91346
	BMW-33	06/13/19 08:15 AM	Aqueous	E300	Anion Preparation	06/14/19 11:45 AM	91339
	BMW-33	06/13/19 08:15 AM	Aqueous	E300	Anion Preparation	06/14/19 11:45 AM	91339
	BMW-33	06/13/19 08:15 AM	Aqueous	E300	Anion Preparation	06/14/19 11:45 AM	91339
	BMW-33	06/13/19 08:15 AM	Aqueous	M4500-P E	Orthophosphate Prep	06/14/19 11:55 AM	91343

Lab Order: 1906152
Client: Golder
Project: A1 Area Landfill

PREP DATES REPORT

Sample ID	Client Sample ID	Collection Date	Matrix	Test Number	Test Name	Prep Date	Batch ID
1906152-06C	BMW-33	06/13/19 08:15 AM	Aqueous	M2540C	TDS Preparation	06/18/19 01:25 PM	91377

Lab Order: 1906152
Client: Golder
Project: A1 Area Landfill

ANALYTICAL DATES REPORT

Sample ID	Client Sample ID	Matrix	Test Number	Test Name	Batch ID	Dilution	Analysis Date	Run ID
1906152-01A	BMW-25	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91344	1	06/21/19	UV/VIS_2_190621A
	BMW-25	Aqueous	M3500-Fe D	Ferrous Iron	91344	1	06/14/19 02:57 PM	UV/VIS_2_190614C
1906152-01B	BMW-25	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	91364	10	06/19/19 02:34 PM	ICP-MS4_190619B
	BMW-25	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	91364	20	06/19/19 02:37 PM	ICP-MS4_190619B
	BMW-25	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	91364	1	06/19/19 12:25 PM	ICP-MS5_190619B
1906152-01C	BMW-25	Aqueous	M2320 B	Alkalinity	91346	1	06/17/19 10:31 AM	TITRATOR_190617A
	BMW-25	Aqueous	E300	Anions by IC method - Water	91339	100	06/14/19 12:17 PM	IC2_190614A
	BMW-25	Aqueous	E300	Anions by IC method - Water	91339	10	06/14/19 02:57 PM	IC2_190614A
	BMW-25	Aqueous	E300	Anions by IC method - Water	91339	1	06/14/19 05:37 PM	IC2_190614A
	BMW-25	Aqueous	M4500-P E	Orthophosphate	91343	1	06/14/19 12:26 PM	UV/VIS_2_190614B
	BMW-25	Aqueous	M2540C	Total Dissolved Solids	91377	1	06/18/19 03:40 PM	WC_190618A
1906152-02A	BMW-29	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91344	1	06/21/19	UV/VIS_2_190621A
	BMW-29	Aqueous	M3500-Fe D	Ferrous Iron	91344	1	06/14/19 02:57 PM	UV/VIS_2_190614C
1906152-02B	BMW-29	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	91364	1	06/19/19 12:27 PM	ICP-MS5_190619B
	BMW-29	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	91364	20	06/19/19 02:39 PM	ICP-MS4_190619B
1906152-02C	BMW-29	Aqueous	M2320 B	Alkalinity	91346	1	06/17/19 11:00 AM	TITRATOR_190617A
	BMW-29	Aqueous	E300	Anions by IC method - Water	91339	100	06/14/19 12:33 PM	IC2_190614A
	BMW-29	Aqueous	E300	Anions by IC method - Water	91339	10	06/14/19 03:13 PM	IC2_190614A
	BMW-29	Aqueous	E300	Anions by IC method - Water	91339	1	06/14/19 05:53 PM	IC2_190614A
	BMW-29	Aqueous	M4500-P E	Orthophosphate	91343	1	06/14/19 12:27 PM	UV/VIS_2_190614B
	BMW-29	Aqueous	M2540C	Total Dissolved Solids	91377	1	06/18/19 03:40 PM	WC_190618A
1906152-03A	BMW-30	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91344	1	06/21/19	UV/VIS_2_190621A
	BMW-30	Aqueous	M3500-Fe D	Ferrous Iron	91344	1	06/14/19 02:57 PM	UV/VIS_2_190614C
1906152-03B	BMW-30	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	91364	10	06/19/19 02:41 PM	ICP-MS4_190619B
	BMW-30	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	91364	1	06/19/19 12:29 PM	ICP-MS5_190619B
1906152-03C	BMW-30	Aqueous	M2320 B	Alkalinity	91346	1	06/17/19 11:15 AM	TITRATOR_190617A
	BMW-30	Aqueous	E300	Anions by IC method - Water	91339	100	06/14/19 12:49 PM	IC2_190614A
	BMW-30	Aqueous	E300	Anions by IC method - Water	91339	10	06/14/19 03:29 PM	IC2_190614A

Lab Order: 1906152
Client: Golder
Project: A1 Area Landfill

ANALYTICAL DATES REPORT

Sample ID	Client Sample ID	Matrix	Test Number	Test Name	Batch ID	Dilution	Analysis Date	Run ID
1906152-03C	BMW-30	Aqueous	E300	Anions by IC method - Water	91339	1	06/14/19 06:09 PM	IC2_190614A
	BMW-30	Aqueous	M4500-P E	Orthophosphate	91343	1	06/14/19 12:27 PM	UV/VIS_2_190614B
	BMW-30	Aqueous	M2540C	Total Dissolved Solids	91377	1	06/18/19 03:40 PM	WC_190618A
1906152-04A	BMW-31	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91344	1	06/21/19	UV/VIS_2_190621A
	BMW-31	Aqueous	M3500-Fe D	Ferrous Iron	91344	1	06/14/19 02:58 PM	UV/VIS_2_190614C
1906152-04B	BMW-31	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	91364	1	06/19/19 02:43 PM	ICP-MS4_190619B
	BMW-31	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	91364	10	06/19/19 02:45 PM	ICP-MS4_190619B
	BMW-31	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	91364	1	06/19/19 12:31 PM	ICP-MS5_190619B
1906152-04C	BMW-31	Aqueous	M2320 B	Alkalinity	91346	1	06/17/19 11:19 AM	TITRATOR_190617A
	BMW-31	Aqueous	E300	Anions by IC method - Water	91339	10	06/14/19 03:45 PM	IC2_190614A
	BMW-31	Aqueous	E300	Anions by IC method - Water	91339	1	06/14/19 06:25 PM	IC2_190614A
	BMW-31	Aqueous	E300	Anions by IC method - Water	91339	100	06/14/19 01:05 PM	IC2_190614A
	BMW-31	Aqueous	M4500-P E	Orthophosphate	91343	1	06/14/19 12:28 PM	UV/VIS_2_190614B
	BMW-31	Aqueous	M2540C	Total Dissolved Solids	91377	1	06/18/19 03:40 PM	WC_190618A
1906152-05A	BMW-32	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91344	1	06/21/19	UV/VIS_2_190621A
	BMW-32	Aqueous	M3500-Fe D	Ferrous Iron	91344	1	06/14/19 02:58 PM	UV/VIS_2_190614C
1906152-05B	BMW-32	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	91364	1	06/19/19 12:34 PM	ICP-MS5_190619B
	BMW-32	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	91364	10	06/19/19 02:47 PM	ICP-MS4_190619B
	BMW-32	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	91364	20	06/19/19 03:12 PM	ICP-MS4_190619B
1906152-05C	BMW-32	Aqueous	M2320 B	Alkalinity	91346	1	06/17/19 11:46 AM	TITRATOR_190617A
	BMW-32	Aqueous	E300	Anions by IC method - Water	91339	100	06/14/19 01:21 PM	IC2_190614A
	BMW-32	Aqueous	E300	Anions by IC method - Water	91339	10	06/14/19 04:01 PM	IC2_190614A
	BMW-32	Aqueous	E300	Anions by IC method - Water	91339	1	06/14/19 06:41 PM	IC2_190614A
	BMW-32	Aqueous	M4500-P E	Orthophosphate	91343	1	06/14/19 12:28 PM	UV/VIS_2_190614B
	BMW-32	Aqueous	M2540C	Total Dissolved Solids	91377	1	06/18/19 03:40 PM	WC_190618A
1906152-06A	BMW-33	Aqueous	M3500-Fe D	Ferric Iron (Calculated)	91344	1	06/21/19	UV/VIS_2_190621A
	BMW-33	Aqueous	M3500-Fe D	Ferrous Iron	91344	1	06/14/19 02:59 PM	UV/VIS_2_190614C
1906152-06B	BMW-33	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	91364	10	06/19/19 02:51 PM	ICP-MS4_190619B

Lab Order: 1906152
Client: Golder
Project: A1 Area Landfill

ANALYTICAL DATES REPORT

Sample ID	Client Sample ID	Matrix	Test Number	Test Name	Batch ID	Dilution	Analysis Date	Run ID
1906152-06B	BMW-33	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	91364	1	06/19/19 12:36 PM	ICP-MS5_190619B
1906152-06C	BMW-33	Aqueous	M2320 B	Alkalinity	91346	1	06/17/19 12:05 PM	TITRATOR_190617A
	BMW-33	Aqueous	E300	Anions by IC method - Water	91339	100	06/14/19 01:37 PM	IC2_190614A
	BMW-33	Aqueous	E300	Anions by IC method - Water	91339	10	06/14/19 04:17 PM	IC2_190614A
	BMW-33	Aqueous	E300	Anions by IC method - Water	91339	1	06/14/19 06:57 PM	IC2_190614A
	BMW-33	Aqueous	M4500-P E	Orthophosphate	91343	1	06/14/19 12:28 PM	UV/VIS_2_190614B
	BMW-33	Aqueous	M2540C	Total Dissolved Solids	91377	1	06/18/19 03:40 PM	WC_190618A

DHL Analytical, Inc.

Date: *21-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-25
Project:	A1 Area Landfill	**Lab ID:**	1906152-01
Project No:	19122434-D	**Collection Date:**	06/13/19 09:30 AM
Lab Order:	1906152	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **SP**
Calcium	167	1.00	3.00		mg/L	10	06/19/19 02:34 PM
Cobalt	0.0130	0.00300	0.00500		mg/L	1	06/19/19 12:25 PM
Iron	0.354	0.0300	0.100		mg/L	1	06/19/19 12:25 PM
Lithium	0.0501	0.00500	0.0100		mg/L	1	06/19/19 12:25 PM
Magnesium	106	1.00	3.00		mg/L	10	06/19/19 02:34 PM
Potassium	7.77	1.00	3.00		mg/L	10	06/19/19 02:34 PM
Sodium	253	2.00	6.00		mg/L	20	06/19/19 02:37 PM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	65.0	3.00	10.0		mg/L	10	06/14/19 02:57 PM
Fluoride	0.142	0.100	0.400	J	mg/L	1	06/14/19 05:37 PM
Nitrate-N	<0.100	0.100	0.500		mg/L	1	06/14/19 05:37 PM
Sulfate	556	10.0	30.0		mg/L	10	06/14/19 02:57 PM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	771	10.0	20.0		mg/L @ pH 4.54	1	06/17/19 10:31 AM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	06/17/19 10:31 AM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	06/17/19 10:31 AM
Alkalinity, Total (As CaCO3)	771	20.0	20.0		mg/L @ pH 4.54	1	06/17/19 10:31 AM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	0.354	0.0500	0.100	N	mg/L	1	06/21/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	06/14/19 02:57 PM
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **BTJ**
Phosphorus, Total Orthophosphate (As P)	<0.0300	0.0300	0.100		mg/L	1	06/14/19 12:26 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	1650	50.0	50.0		mg/L	1	06/18/19 03:40 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *21-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-29
Project:	A1 Area Landfill	**Lab ID:**	1906152-02
Project No:	19122434-D	**Collection Date:**	06/13/19 10:30 AM
Lab Order:	1906152	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **SP**
Calcium	176	2.00	6.00		mg/L	20	06/19/19 02:39 PM
Iron	1.01	0.0300	0.100		mg/L	1	06/19/19 12:27 PM
Lithium	0.114	0.00500	0.0100		mg/L	1	06/19/19 12:27 PM
Magnesium	94.5	2.00	6.00		mg/L	20	06/19/19 02:39 PM
Potassium	15.3	2.00	6.00		mg/L	20	06/19/19 02:39 PM
Sodium	429	2.00	6.00		mg/L	20	06/19/19 02:39 PM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	36.6	3.00	10.0		mg/L	10	06/14/19 03:13 PM
Fluoride	<0.100	0.100	0.400		mg/L	1	06/14/19 05:53 PM
Nitrate-N	<0.100	0.100	0.500		mg/L	1	06/14/19 05:53 PM
Sulfate	867	10.0	30.0		mg/L	10	06/14/19 03:13 PM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	819	10.0	20.0		mg/L @ pH 4.54	1	06/17/19 11:00 AM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	06/17/19 11:00 AM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	06/17/19 11:00 AM
Alkalinity, Total (As CaCO3)	819	20.0	20.0		mg/L @ pH 4.54	1	06/17/19 11:00 AM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	0.668	0.0500	0.100	N	mg/L	1	06/21/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	0.342	0.0500	0.100	N	mg/L	1	06/14/19 02:57 PM
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **BTJ**
Phosphorus, Total Orthophosphate (As P)	<0.0300	0.0300	0.100		mg/L	1	06/14/19 12:27 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	2100	50.0	50.0		mg/L	1	06/18/19 03:40 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *21-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-30
Project:	A1 Area Landfill	**Lab ID:**	1906152-03
Project No:	19122434-D	**Collection Date:**	06/13/19 12:50 PM
Lab Order:	1906152	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **SP**
Barium	0.0982	0.00300	0.0100		mg/L	1	06/19/19 12:29 PM
Calcium	147	1.00	3.00		mg/L	10	06/19/19 02:41 PM
Iron	3.01	0.0300	0.100		mg/L	1	06/19/19 12:29 PM
Magnesium	65.9	1.00	3.00		mg/L	10	06/19/19 02:41 PM
Potassium	7.05	1.00	3.00		mg/L	10	06/19/19 02:41 PM
Sodium	158	1.00	3.00		mg/L	10	06/19/19 02:41 PM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	79.5	3.00	10.0		mg/L	10	06/14/19 03:29 PM
Fluoride	<0.100	0.100	0.400		mg/L	1	06/14/19 06:09 PM
Nitrate-N	<0.100	0.100	0.500		mg/L	1	06/14/19 06:09 PM
Sulfate	574	10.0	30.0		mg/L	10	06/14/19 03:29 PM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	315	10.0	20.0		mg/L @ pH 4.53	1	06/17/19 11:15 AM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.53	1	06/17/19 11:15 AM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.53	1	06/17/19 11:15 AM
Alkalinity, Total (As CaCO3)	315	20.0	20.0		mg/L @ pH 4.53	1	06/17/19 11:15 AM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	3.01	0.0500	0.100	N	mg/L	1	06/21/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	06/14/19 02:57 PM
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **BTJ**
Phosphorus, Total Orthophosphate (As P)	<0.0300	0.0300	0.100		mg/L	1	06/14/19 12:27 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	1320	50.0	50.0		mg/L	1	06/18/19 03:40 PM

Qualifiers:	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *21-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-31
Project:	A1 Area Landfill	**Lab ID:**	1906152-04
Project No:	19122434-D	**Collection Date:**	06/13/19 02:30 PM
Lab Order:	1906152	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **SP**
Calcium	1.70	0.100	0.300		mg/L	1	06/19/19 02:43 PM
Iron	0.102	0.0300	0.100		mg/L	1	06/19/19 12:31 PM
Lithium	0.0203	0.00500	0.0100		mg/L	1	06/19/19 12:31 PM
Magnesium	1.52	0.100	0.300		mg/L	1	06/19/19 12:31 PM
Potassium	0.238	0.100	0.300	J	mg/L	1	06/19/19 02:43 PM
Sodium	43.3	1.00	3.00		mg/L	10	06/19/19 02:45 PM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	24.7	0.300	1.00		mg/L	1	06/14/19 06:25 PM
Fluoride	0.255	0.100	0.400	J	mg/L	1	06/14/19 06:25 PM
Nitrate-N	<0.100	0.100	0.500		mg/L	1	06/14/19 06:25 PM
Sulfate	34.4	1.00	3.00		mg/L	1	06/14/19 06:25 PM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	30.4	10.0	20.0		mg/L @ pH 4.49	1	06/17/19 11:19 AM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.49	1	06/17/19 11:19 AM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.49	1	06/17/19 11:19 AM
Alkalinity, Total (As CaCO3)	30.4	20.0	20.0		mg/L @ pH 4.49	1	06/17/19 11:19 AM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	0.102	0.0500	0.100	N	mg/L	1	06/21/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	06/14/19 02:58 PM
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **BTJ**
Phosphorus, Total Orthophosphate (As P)	<0.0300	0.0300	0.100		mg/L	1	06/14/19 12:28 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	327	10.0	10.0		mg/L	1	06/18/19 03:40 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *21-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-32
Project:	A1 Area Landfill	**Lab ID:**	1906152-05
Project No:	19122434-D	**Collection Date:**	06/13/19 07:30 AM
Lab Order:	1906152	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **SP**
Calcium	134	1.00	3.00		mg/L	10	06/19/19 02:47 PM
Cobalt	0.00705	0.00300	0.00500		mg/L	1	06/19/19 12:34 PM
Iron	4.61	0.0300	0.100		mg/L	1	06/19/19 12:34 PM
Lithium	0.115	0.00500	0.0100		mg/L	1	06/19/19 12:34 PM
Magnesium	102	1.00	3.00		mg/L	10	06/19/19 02:47 PM
Potassium	4.56	1.00	3.00		mg/L	10	06/19/19 02:47 PM
Sodium	266	2.00	6.00		mg/L	20	06/19/19 03:12 PM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	364	3.00	10.0		mg/L	10	06/14/19 04:01 PM
Fluoride	0.822	0.100	0.400		mg/L	1	06/14/19 06:41 PM
Nitrate-N	<0.100	0.100	0.500		mg/L	1	06/14/19 06:41 PM
Sulfate	446	10.0	30.0		mg/L	10	06/14/19 04:01 PM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	456	10.0	20.0		mg/L @ pH 4.54	1	06/17/19 11:46 AM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	06/17/19 11:46 AM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.54	1	06/17/19 11:46 AM
Alkalinity, Total (As CaCO3)	456	20.0	20.0		mg/L @ pH 4.54	1	06/17/19 11:46 AM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	4.61	0.0500	0.100	N	mg/L	1	06/21/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	06/14/19 02:58 PM
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **BTJ**
Phosphorus, Total Orthophosphate (As P)	0.0340	0.0300	0.100	J	mg/L	1	06/14/19 12:28 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	1720	50.0	50.0		mg/L	1	06/18/19 03:40 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *21-Jun-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-33
Project:	A1 Area Landfill	**Lab ID:**	1906152-06
Project No:	19122434-D	**Collection Date:**	06/13/19 08:15 AM
Lab Order:	1906152	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **SP**
Arsenic	<0.00200	0.00200	0.00500		mg/L	1	06/19/19 12:36 PM
Calcium	97.5	1.00	3.00		mg/L	10	06/19/19 02:51 PM
Cobalt	0.0176	0.00300	0.00500		mg/L	1	06/19/19 12:36 PM
Iron	2.83	0.0300	0.100		mg/L	1	06/19/19 12:36 PM
Lithium	0.0206	0.00500	0.0100		mg/L	1	06/19/19 12:36 PM
Magnesium	56.5	1.00	3.00		mg/L	10	06/19/19 02:51 PM
Potassium	6.29	1.00	3.00		mg/L	10	06/19/19 02:51 PM
Sodium	207	1.00	3.00		mg/L	10	06/19/19 02:51 PM
ANIONS BY IC METHOD - WATER		**E300**					Analyst: **JL**
Chloride	83.8	3.00	10.0		mg/L	10	06/14/19 04:17 PM
Fluoride	0.342	0.100	0.400	J	mg/L	1	06/14/19 06:57 PM
Nitrate-N	<0.100	0.100	0.500		mg/L	1	06/14/19 06:57 PM
Sulfate	256	10.0	30.0		mg/L	10	06/14/19 04:17 PM
ALKALINITY		**M2320 B**					Analyst: **CC**
Alkalinity, Bicarbonate (As CaCO3)	528	10.0	20.0		mg/L @ pH 4.53	1	06/17/19 12:05 PM
Alkalinity, Carbonate (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.53	1	06/17/19 12:05 PM
Alkalinity, Hydroxide (As CaCO3)	<10.0	10.0	20.0		mg/L @ pH 4.53	1	06/17/19 12:05 PM
Alkalinity, Total (As CaCO3)	528	20.0	20.0		mg/L @ pH 4.53	1	06/17/19 12:05 PM
FERRIC IRON (CALCULATED)		**M3500-FE D**					Analyst: **CAC**
Iron, Ferric	2.83	0.0500	0.100	N	mg/L	1	06/21/19
FERROUS IRON		**M3500-FE D**					Analyst: **BTJ**
Iron, Ferrous	<0.0500	0.0500	0.100	N	mg/L	1	06/14/19 02:59 PM
ORTHOPHOSPHATE		**M4500-P E**					Analyst: **BTJ**
Phosphorus, Total Orthophosphate (As P)	<0.0300	0.0300	0.100		mg/L	1	06/14/19 12:28 PM
TOTAL DISSOLVED SOLIDS		**M2540C**					Analyst: **JS**
Total Dissolved Solids (Residue, Filterable)	1100	50.0	50.0		mg/L	1	06/18/19 03:40 PM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1906152
Project: A1 Area Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: **ICP-MS4_190619B**

The QC data in batch 91364 applies to the following samples: 1906152-01B, 1906152-02B, 1906152-03B, 1906152-04B, 1906152-05B, 1906152-06B

Sample ID **MB-91364** Batch ID: **91364** TestNo: **SW6020A** Units: **mg/L**
SampType: **MBLK** Run ID: **ICP-MS4_190619B** Analysis Date: **6/19/2019 2:20:00 PM** Prep Date: **6/18/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	<0.100	0.300								
Potassium	<0.100	0.300								
Sodium	<0.100	0.300								

Sample ID **LCS-91364** Batch ID: **91364** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCS** Run ID: **ICP-MS4_190619B** Analysis Date: **6/19/2019 2:22:00 PM** Prep Date: **6/18/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	4.85	0.300	5.00	0	97.0	80	120			
Potassium	4.93	0.300	5.00	0	98.6	80	120			
Sodium	5.25	0.300	5.00	0	105	80	120			

Sample ID **LCSD-91364** Batch ID: **91364** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCSD** Run ID: **ICP-MS4_190619B** Analysis Date: **6/19/2019 2:24:00 PM** Prep Date: **6/18/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	4.83	0.300	5.00	0	96.6	80	120	0.496	15	
Potassium	5.07	0.300	5.00	0	101	80	120	2.80	15	
Sodium	5.32	0.300	5.00	0	106	80	120	1.32	15	

Sample ID **1906156-01A SD** Batch ID: **91364** TestNo: **SW6020A** Units: **mg/L**
SampType: **SD** Run ID: **ICP-MS4_190619B** Analysis Date: **6/19/2019 2:32:00 PM** Prep Date: **6/18/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	8.18	1.50	0	8.11				0.846	10	
Potassium	2.17	1.50	0	2.15				0.715	10	
Sodium	76.4	1.50	0	73.6				3.77	10	

Sample ID **1906156-01A PDS** Batch ID: **91364** TestNo: **SW6020A** Units: **mg/L**
SampType: **PDS** Run ID: **ICP-MS4_190619B** Analysis Date: **6/19/2019 2:53:00 PM** Prep Date: **6/18/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	12.4	0.300	5.00	8.11	86.2	80	120			
Potassium	6.91	0.300	5.00	2.15	95.1	80	120			
Sodium	73.3	0.300	5.00	73.6	-5.52	80	120			S

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1906152
Project: A1 Area Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_190619B

Sample ID **1906156-01A MS**	Batch ID: **91364**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **MS**	Run ID: **ICP-MS4_190619B**	Analysis Date: **6/19/2019 2:55:00 PM**	Prep Date: **6/18/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	12.8	0.300	5.00	8.11	92.9	80	120			
Potassium	7.18	0.300	5.00	2.15	100	80	120			
Sodium	76.9	0.300	5.00	73.6	67.1	80	120			S

Sample ID **1906156-01A MSD**	Batch ID: **91364**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **MSD**	Run ID: **ICP-MS4_190619B**	Analysis Date: **6/19/2019 2:57:00 PM**	Prep Date: **6/18/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	12.7	0.300	5.00	8.11	92.7	80	120	0.075	15	
Potassium	7.12	0.300	5.00	2.15	99.2	80	120	0.869	15	
Sodium	75.0	0.300	5.00	73.6	29.2	80	120	2.49	15	S

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1906152
Project: A1 Area Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS4_190619B

Sample ID **ICV-190619**	Batch ID: **R104661**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **ICV**	Run ID: **ICP-MS4_190619B**	Analysis Date: **6/19/2019 11:08:00 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	2.53	0.300	2.50	0	101	90	110			
Magnesium	2.44	0.300	2.50	0	97.7	90	110			
Potassium	2.53	0.300	2.50	0	101	90	110			
Sodium	2.61	0.300	2.50	0	104	90	110			

Sample ID **LCVL-190619**	Batch ID: **R104661**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS4_190619B**	Analysis Date: **6/19/2019 11:12:00 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	0.101	0.300	0.100	0	101	70	130			
Magnesium	0.0980	0.300	0.100	0	98.0	70	130			
Potassium	0.0981	0.300	0.100	0	98.1	70	130			
Sodium	0.104	0.300	0.100	0	104	70	130			

Sample ID **CCV1-190619**	Batch ID: **R104661**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **CCV**	Run ID: **ICP-MS4_190619B**	Analysis Date: **6/19/2019 11:46:00 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	4.77	0.300	5.00	0	95.3	90	110			
Magnesium	4.91	0.300	5.00	0	98.2	90	110			
Potassium	4.90	0.300	5.00	0	98.0	90	110			
Sodium	5.18	0.300	5.00	0	104	90	110			

Sample ID **LCVL1-190619**	Batch ID: **R104661**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS4_190619B**	Analysis Date: **6/19/2019 11:53:00 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	0.101	0.300	0.100	0	101	70	130			
Magnesium	0.0993	0.300	0.100	0	99.3	70	130			
Potassium	0.0994	0.300	0.100	0	99.4	70	130			
Sodium	0.124	0.300	0.100	0	124	70	130			

Sample ID **CCV2-190619**	Batch ID: **R104661**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **CCV**	Run ID: **ICP-MS4_190619B**	Analysis Date: **6/19/2019 2:59:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	4.77	0.300	5.00	0	95.4	90	110			
Magnesium	4.95	0.300	5.00	0	99.1	90	110			
Potassium	4.94	0.300	5.00	0	98.9	90	110			
Sodium	5.19	0.300	5.00	0	104	90	110			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1906152
Project: A1 Area Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: **ICP-MS4_190619B**

Sample ID **LCVL2-190619**	Batch ID: **R104661**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS4_190619B**	Analysis Date: **6/19/2019 3:06:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	0.0955	0.300	0.100	0	95.5	70	130			
Magnesium	0.0994	0.300	0.100	0	99.4	70	130			
Potassium	0.0956	0.300	0.100	0	95.6	70	130			
Sodium	0.112	0.300	0.100	0	112	70	130			

Sample ID **CCV3-190619**	Batch ID: **R104661**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **CCV**	Run ID: **ICP-MS4_190619B**	Analysis Date: **6/19/2019 3:14:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sodium	5.12	0.300	5.00	0	102	90	110			

Sample ID **LCVL3-190619**	Batch ID: **R104661**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS4_190619B**	Analysis Date: **6/19/2019 3:21:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Sodium	0.109	0.300	0.100	0	109	70	130			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1906152
Project: A1 Area Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS5_190619B

The QC data in batch 91364 applies to the following samples: 1906152-01B, 1906152-02B, 1906152-03B, 1906152-04B, 1906152-05B, 1906152-06B

Sample ID **MB-91364** Batch ID: **91364** TestNo: **SW6020A** Units: **mg/L**
SampType: **MBLK** Run ID: **ICP-MS5_190619B** Analysis Date: **6/19/2019 12:04:00 PM** Prep Date: **6/18/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Arsenic	<0.00200	0.00500								
Barium	<0.00300	0.0100								
Cobalt	<0.00300	0.00500								
Iron	<0.0300	0.100								
Lithium	<0.00500	0.0100								
Magnesium	<0.100	0.300								

Sample ID **LCS-91364** Batch ID: **91364** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCS** Run ID: **ICP-MS5_190619B** Analysis Date: **6/19/2019 12:07:00 PM** Prep Date: **6/18/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Arsenic	0.206	0.00500	0.200	0	103	80	120			
Barium	0.202	0.0100	0.200	0	101	80	120			
Cobalt	0.211	0.00500	0.200	0	105	80	120			
Iron	5.08	0.100	5.00	0	102	80	120			
Lithium	0.203	0.0100	0.200	0	102	80	120			
Magnesium	4.99	0.300	5.00	0	99.9	80	120			

Sample ID **LCSD-91364** Batch ID: **91364** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCSD** Run ID: **ICP-MS5_190619B** Analysis Date: **6/19/2019 12:09:00 PM** Prep Date: **6/18/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Arsenic	0.208	0.00500	0.200	0	104	80	120	0.963	15	
Barium	0.201	0.0100	0.200	0	101	80	120	0.125	15	
Cobalt	0.210	0.00500	0.200	0	105	80	120	0.544	15	
Iron	5.10	0.100	5.00	0	102	80	120	0.434	15	
Lithium	0.201	0.0100	0.200	0	101	80	120	0.963	15	
Magnesium	5.10	0.300	5.00	0	102	80	120	2.20	15	

Sample ID **1906156-01A SD** Batch ID: **91364** TestNo: **SW6020A** Units: **mg/L**
SampType: **SD** Run ID: **ICP-MS5_190619B** Analysis Date: **6/19/2019 12:16:00 PM** Prep Date: **6/18/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Arsenic	<0.0100	0.0250	0	0				0	10	
Barium	0.190	0.0500	0	0.188				1.33	10	
Cobalt	0.0257	0.0250	0	0.0256				0.487	10	
Iron	0.159	0.500	0	0.161				1.10	10	
Lithium	<0.0250	0.0500	0	0.0130				0	10	
Magnesium	4.47	1.50	0	4.44				0.596	10	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1906152
Project: A1 Area Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS5_190619B

Sample ID **1906156-01A PDS**	Batch ID: **91364**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **PDS**	Run ID: **ICP-MS5_190619B**	Analysis Date: **6/19/2019 12:38:00 PM**	Prep Date: **6/18/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Arsenic	0.187	0.00500	0.200	0	93.5	80	120			
Barium	0.374	0.0100	0.200	0.188	93.3	80	120			
Cobalt	0.221	0.00500	0.200	0.0256	97.5	80	120			
Iron	5.30	0.100	5.00	0.161	103	80	120			
Lithium	0.218	0.0100	0.200	0.0130	102	80	120			
Magnesium	9.48	0.300	5.00	4.44	101	80	120			

Sample ID **1906156-01A MS**	Batch ID: **91364**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **MS**	Run ID: **ICP-MS5_190619B**	Analysis Date: **6/19/2019 12:40:00 PM**	Prep Date: **6/18/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Arsenic	0.193	0.00500	0.200	0	96.6	80	120			
Barium	0.384	0.0100	0.200	0.188	97.9	80	120			
Cobalt	0.225	0.00500	0.200	0.0256	99.6	80	120			
Iron	5.29	0.100	5.00	0.161	103	80	120			
Lithium	0.216	0.0100	0.200	0.0130	102	80	120			
Magnesium	9.65	0.300	5.00	4.44	104	80	120			

Sample ID **1906156-01A MSD**	Batch ID: **91364**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **MSD**	Run ID: **ICP-MS5_190619B**	Analysis Date: **6/19/2019 12:42:00 PM**	Prep Date: **6/18/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Arsenic	0.194	0.00500	0.200	0	96.9	80	120	0.339	15	
Barium	0.387	0.0100	0.200	0.188	99.8	80	120	0.972	15	
Cobalt	0.226	0.00500	0.200	0.0256	100	80	120	0.650	15	
Iron	5.29	0.100	5.00	0.161	103	80	120	0.019	15	
Lithium	0.216	0.0100	0.200	0.0130	101	80	120	0.236	15	
Magnesium	9.55	0.300	5.00	4.44	102	80	120	0.948	15	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1906152
Project: A1 Area Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS5_190619B

Sample ID **ICV-190619** Batch ID: **R104660** TestNo: **SW6020A** Units: **mg/L**
SampType: **ICV** Run ID: **ICP-MS5_190619B** Analysis Date: **6/19/2019 10:49:00 AM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Arsenic	0.102	0.00500	0.100	0	102	90	110			
Barium	0.0979	0.0100	0.100	0	97.9	90	110			
Cobalt	0.102	0.00500	0.100	0	102	90	110			
Iron	2.48	0.100	2.50	0	99.4	90	110			
Lithium	0.101	0.0100	0.100	0	101	90	110			
Magnesium	2.45	0.300	2.50	0	98.2	90	110			

Sample ID **LCVL-190619** Batch ID: **R104660** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCVL** Run ID: **ICP-MS5_190619B** Analysis Date: **6/19/2019 11:01:00 AM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Arsenic	0.00481	0.00500	0.00500	0	96.2	70	130			
Barium	0.00509	0.0100	0.00500	0	102	70	130			
Cobalt	0.00504	0.00500	0.00500	0	101	70	130			
Iron	0.0961	0.100	0.100	0	96.1	70	130			
Lithium	0.0101	0.0100	0.0100	0	101	70	130			
Magnesium	0.0951	0.300	0.100	0	95.1	70	130			

Sample ID **CCV1-190619** Batch ID: **R104660** TestNo: **SW6020A** Units: **mg/L**
SampType: **CCV** Run ID: **ICP-MS5_190619B** Analysis Date: **6/19/2019 11:50:00 AM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Arsenic	0.203	0.00500	0.200	0	102	90	110			
Barium	0.202	0.0100	0.200	0	101	90	110			
Cobalt	0.207	0.00500	0.200	0	103	90	110			
Iron	5.05	0.100	5.00	0	101	90	110			
Lithium	0.201	0.0100	0.200	0	100	90	110			
Magnesium	5.02	0.300	5.00	0	100	90	110			

Sample ID **LCVL1-190619** Batch ID: **R104660** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCVL** Run ID: **ICP-MS5_190619B** Analysis Date: **6/19/2019 11:56:00 AM** Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Arsenic	0.00500	0.00500	0.00500	0	100	70	130			
Barium	0.00470	0.0100	0.00500	0	94.1	70	130			
Cobalt	0.00498	0.00500	0.00500	0	99.5	70	130			
Iron	0.0962	0.100	0.100	0	96.2	70	130			
Lithium	0.0101	0.0100	0.0100	0	101	70	130			
Magnesium	0.100	0.300	0.100	0	100	70	130			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1906152
Project: A1 Area Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: **ICP-MS5_190619B**

Sample ID **CCV2-190619**	Batch ID: **R104660**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **CCV**	Run ID: **ICP-MS5_190619B**	Analysis Date: **6/19/2019 12:45:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Arsenic	0.202	0.00500	0.200	0	101	90	110			
Barium	0.201	0.0100	0.200	0	101	90	110			
Cobalt	0.209	0.00500	0.200	0	105	90	110			
Iron	5.12	0.100	5.00	0	102	90	110			
Lithium	0.203	0.0100	0.200	0	101	90	110			
Magnesium	5.09	0.300	5.00	0	102	90	110			

Sample ID **LCVL2-190619**	Batch ID: **R104660**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS5_190619B**	Analysis Date: **6/19/2019 12:50:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Arsenic	0.00496	0.00500	0.00500	0	99.3	70	130			
Barium	0.00514	0.0100	0.00500	0	103	70	130			
Cobalt	0.00512	0.00500	0.00500	0	102	70	130			
Iron	0.0963	0.100	0.100	0	96.3	70	130			
Lithium	0.0104	0.0100	0.0100	0	104	70	130			
Magnesium	0.0964	0.300	0.100	0	96.4	70	130			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1906152
Project: A1 Area Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: IC2_190614A

The QC data in batch 91339 applies to the following samples: 1906152-01C, 1906152-02C, 1906152-03C, 1906152-04C, 1906152-05C, 1906152-06C

Sample ID **MB-91339** Batch ID: **91339** TestNo: **E300** Units: **mg/L**
SampType: **MBLK** Run ID: **IC2_190614A** Analysis Date: **6/14/2019 10:18:32 AM** Prep Date: **6/14/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	<0.300	1.00								
Fluoride	<0.100	0.400								
Nitrate-N	<0.100	0.500								
Sulfate	<1.00	3.00								

Sample ID **LCS-91339** Batch ID: **91339** TestNo: **E300** Units: **mg/L**
SampType: **LCS** Run ID: **IC2_190614A** Analysis Date: **6/14/2019 10:34:32 AM** Prep Date: **6/14/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	10.0	1.00	10.00	0	100	90	110			
Fluoride	3.99	0.400	4.000	0	99.8	90	110			
Nitrate-N	5.09	0.500	5.000	0	102	90	110			
Sulfate	30.3	3.00	30.00	0	101	90	110			

Sample ID **LCSD-91339** Batch ID: **91339** TestNo: **E300** Units: **mg/L**
SampType: **LCSD** Run ID: **IC2_190614A** Analysis Date: **6/14/2019 10:50:32 AM** Prep Date: **6/14/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	10.1	1.00	10.00	0	101	90	110	0.555	20	
Fluoride	4.01	0.400	4.000	0	100	90	110	0.489	20	
Nitrate-N	5.10	0.500	5.000	0	102	90	110	0.295	20	
Sulfate	30.5	3.00	30.00	0	102	90	110	0.758	20	

Sample ID **1906110-04BMS** Batch ID: **91339** TestNo: **E300** Units: **mg/L**
SampType: **MS** Run ID: **IC2_190614A** Analysis Date: **6/14/2019 11:26:46 AM** Prep Date: **6/14/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	2380	100	2000	317.4	103	90	110			
Fluoride	2080	40.0	2000	0	104	90	110			
Nitrate-N	451	50.0	451.6	0	99.8	90	110			
Sulfate	4020	300	2000	2016	100	90	110			

Sample ID **1906110-04BMSD** Batch ID: **91339** TestNo: **E300** Units: **mg/L**
SampType: **MSD** Run ID: **IC2_190614A** Analysis Date: **6/14/2019 11:42:46 AM** Prep Date: **6/14/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	2390	100	2000	317.4	103	90	110	0.283	20	
Fluoride	2090	40.0	2000	0	104	90	110	0.334	20	
Nitrate-N	452	50.0	451.6	0	100	90	110	0.221	20	
Sulfate	4040	300	2000	2016	101	90	110	0.513	20	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1906152
Project: A1 Area Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: IC2_190614A

Sample ID **ICV-190614**	Batch ID: **R104590**	TestNo: **E300**	Units: **mg/L**
SampType: **ICV**	Run ID: **IC2_190614A**	Analysis Date: **6/14/2019 9:46:32 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	25.7	1.00	25.00	0	103	90	110			
Fluoride	10.2	0.400	10.00	0	102	90	110			
Nitrate-N	13.1	0.500	12.50	0	105	90	110			
Sulfate	77.5	3.00	75.00	0	103	90	110			

Sample ID **CCV1-190614**	Batch ID: **R104590**	TestNo: **E300**	Units: **mg/L**
SampType: **CCV**	Run ID: **IC2_190614A**	Analysis Date: **6/14/2019 2:25:37 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	10.2	1.00	10.00	0	102	90	110			
Fluoride	4.09	0.400	4.000	0	102	90	110			
Nitrate-N	5.17	0.500	5.000	0	103	90	110			
Sulfate	30.9	3.00	30.00	0	103	90	110			

Sample ID **CCV2-190614**	Batch ID: **R104590**	TestNo: **E300**	Units: **mg/L**
SampType: **CCV**	Run ID: **IC2_190614A**	Analysis Date: **6/14/2019 5:05:37 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	10.3	1.00	10.00	0	103	90	110			
Fluoride	4.13	0.400	4.000	0	103	90	110			
Nitrate-N	5.22	0.500	5.000	0	104	90	110			
Sulfate	31.2	3.00	30.00	0	104	90	110			

Sample ID **CCV3-190614**	Batch ID: **R104590**	TestNo: **E300**	Units: **mg/L**
SampType: **CCV**	Run ID: **IC2_190614A**	Analysis Date: **6/14/2019 7:45:37 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	10.4	1.00	10.00	0	104	90	110			
Fluoride	4.17	0.400	4.000	0	104	90	110			
Nitrate-N	5.25	0.500	5.000	0	105	90	110			
Sulfate	31.6	3.00	30.00	0	105	90	110			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1906152
Project: A1 Area Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: **TITRATOR_190617A**

The QC data in batch 91346 applies to the following samples: 1906152-01C, 1906152-02C, 1906152-03C, 1906152-04C, 1906152-05C, 1906152-06C

Sample ID **MB-91346** Batch ID: **91346** TestNo: **M2320 B** Units: **mg/L @ pH 4.53**
SampType: **MBLK** Run ID: **TITRATOR_190617A** Analysis Date: **6/17/2019 9:13:00 AM** Prep Date: **6/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	<10.0	20.0								
Alkalinity, Carbonate (As CaCO3)	<10.0	20.0								
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0								
Alkalinity, Total (As CaCO3)	<20.0	20.0								

Sample ID **LCS-91346** Batch ID: **91346** TestNo: **M2320 B** Units: **mg/L @ pH 4.23**
SampType: **LCS** Run ID: **TITRATOR_190617A** Analysis Date: **6/17/2019 9:17:00 AM** Prep Date: **6/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Total (As CaCO3)	51.5	20.0	50.00	0	103	74	129			

Sample ID **1906152-04C DUP** Batch ID: **91346** TestNo: **M2320 B** Units: **mg/L @ pH 4.5**
SampType: **DUP** Run ID: **TITRATOR_190617A** Analysis Date: **6/17/2019 11:22:00 AM** Prep Date: **6/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	30.3	20.0	0	30.40				0.329	20	
Alkalinity, Carbonate (As CaCO3)	<10.0	20.0	0	0				0	20	
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0	0	0				0	20	
Alkalinity, Total (As CaCO3)	30.3	20.0	0	30.40				0.329	20	

Sample ID **1906152-06C DUP** Batch ID: **91346** TestNo: **M2320 B** Units: **mg/L @ pH 4.53**
SampType: **DUP** Run ID: **TITRATOR_190617A** Analysis Date: **6/17/2019 12:24:00 PM** Prep Date: **6/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	525	20.0	0	527.6				0.418	20	
Alkalinity, Carbonate (As CaCO3)	<10.0	20.0	0	0				0	20	
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0	0	0				0	20	
Alkalinity, Total (As CaCO3)	525	20.0	0	527.6				0.418	20	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1906152
Project: A1 Area Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: TITRATOR_190617A

Sample ID **ICV-190617** | Batch ID: **R104621** | TestNo: **M2320 B** | Units: **mg/L @ pH 4.34**
SampType: **ICV** | Run ID: **TITRATOR_190617A** | Analysis Date: **6/17/2019 9:10:00 AM** | Prep Date: **6/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	7.60	20.0	0							
Alkalinity, Carbonate (As CaCO3)	92.5	20.0	0							
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0	0							
Alkalinity, Total (As CaCO3)	100	20.0	100.0	0	100	98	102			

Sample ID **CCV1-190617** | Batch ID: **R104621** | TestNo: **M2320 B** | Units: **mg/L @ pH 4.33**
SampType: **CCV** | Run ID: **TITRATOR_190617A** | Analysis Date: **6/17/2019 11:27:00 AM** | Prep Date: **6/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	24.5	20.0	0							
Alkalinity, Carbonate (As CaCO3)	74.1	20.0	0							
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0	0							
Alkalinity, Total (As CaCO3)	98.6	20.0	100.0	0	98.6	90	110			

Sample ID **CCV2-190617** | Batch ID: **R104621** | TestNo: **M2320 B** | Units: **mg/L @ pH 4.37**
SampType: **CCV** | Run ID: **TITRATOR_190617A** | Analysis Date: **6/17/2019 12:53:00 PM** | Prep Date: **6/17/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Alkalinity, Bicarbonate (As CaCO3)	33.0	20.0	0							
Alkalinity, Carbonate (As CaCO3)	65.8	20.0	0							
Alkalinity, Hydroxide (As CaCO3)	<10.0	20.0	0							
Alkalinity, Total (As CaCO3)	98.8	20.0	100.0	0	98.8	90	110			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1906152
Project: A1 Area Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: UV/VIS_2_190614B

The QC data in batch 91343 applies to the following samples: 1906152-01C, 1906152-02C, 1906152-03C, 1906152-04C, 1906152-05C, 1906152-06C

Sample ID **MB-91343** Batch ID: **91343** TestNo: **M4500-P E** Units: **mg/L**
SampType: **MBLK** Run ID: **UV/VIS_2_190614B** Analysis Date: **6/14/2019 12:25:00 PM** Prep Date: **6/14/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	<0.0300	0.100								

Sample ID **LCS-91343** Batch ID: **91343** TestNo: **M4500-P E** Units: **mg/L**
SampType: **LCS** Run ID: **UV/VIS_2_190614B** Analysis Date: **6/14/2019 12:25:00 PM** Prep Date: **6/14/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.479	0.100	0.5000	0	95.8	80	120			

Sample ID **LCSD-91343** Batch ID: **91343** TestNo: **M4500-P E** Units: **mg/L**
SampType: **LCSD** Run ID: **UV/VIS_2_190614B** Analysis Date: **6/14/2019 12:25:00 PM** Prep Date: **6/14/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.477	0.100	0.5000	0	95.4	80	120	0.418	15	

Sample ID **1906152-01CMS** Batch ID: **91343** TestNo: **M4500-P E** Units: **mg/L**
SampType: **MS** Run ID: **UV/VIS_2_190614B** Analysis Date: **6/14/2019 12:26:00 PM** Prep Date: **6/14/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.514	0.100	0.5000	0	103	80	120			

Sample ID **1906152-01CMSD** Batch ID: **91343** TestNo: **M4500-P E** Units: **mg/L**
SampType: **MSD** Run ID: **UV/VIS_2_190614B** Analysis Date: **6/14/2019 12:26:00 PM** Prep Date: **6/14/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.516	0.100	0.5000	0	103	80	120	0.388	15	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1906152
Project: A1 Area Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: **UV/VIS_2_190614B**

Sample ID **ICV-190614**	Batch ID: **R104598**	TestNo: **M4500-P E**	Units: **mg/L**
SampType: **ICV**	Run ID: **UV/VIS_2_190614B**	Analysis Date: **6/14/2019 12:24:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.197	0.100	0.2000	0	98.5	85	115			

Sample ID **CCV1-190614**	Batch ID: **R104598**	TestNo: **M4500-P E**	Units: **mg/L**
SampType: **CCV**	Run ID: **UV/VIS_2_190614B**	Analysis Date: **6/14/2019 12:29:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Phosphorus, Total Orthophosphate (As	0.547	0.100	0.5000	0	109	85	115			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1906152
Project: A1 Area Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: UV/VIS_2_190614C

The QC data in batch 91344 applies to the following samples: 1906152-01A, 1906152-02A, 1906152-03A, 1906152-04A, 1906152-05A, 1906152-06A

Sample ID **MB-91344** Batch ID: **91344** TestNo: **M3500-Fe D** Units: **mg/L**
SampType: **MBLK** Run ID: **UV/VIS_2_190614C** Analysis Date: **6/14/2019 2:51:00 PM** Prep Date: **6/14/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	<0.0500	0.100								N

Sample ID **LCS-91344** Batch ID: **91344** TestNo: **M3500-Fe D** Units: **mg/L**
SampType: **LCS** Run ID: **UV/VIS_2_190614C** Analysis Date: **6/14/2019 2:52:00 PM** Prep Date: **6/14/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.0968	0.100	0.1000	0	96.8	85	115			N

Sample ID **LCSD-91344** Batch ID: **91344** TestNo: **M3500-Fe D** Units: **mg/L**
SampType: **LCSD** Run ID: **UV/VIS_2_190614C** Analysis Date: **6/14/2019 2:52:00 PM** Prep Date: **6/14/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.0877	0.100	0.1000	0	87.7	85	115	9.92	15	N

Sample ID **1906089-01AMS** Batch ID: **91344** TestNo: **M3500-Fe D** Units: **mg/L**
SampType: **MS** Run ID: **UV/VIS_2_190614C** Analysis Date: **6/14/2019 2:54:00 PM** Prep Date: **6/14/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.0880	0.100	0.1000	0	88.0	85	115			N

Sample ID **1906089-01AMSD** Batch ID: **91344** TestNo: **M3500-Fe D** Units: **mg/L**
SampType: **MSD** Run ID: **UV/VIS_2_190614C** Analysis Date: **6/14/2019 2:54:00 PM** Prep Date: **6/14/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.0896	0.100	0.1000	0	89.6	85	115	1.77	15	N

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1906152
Project: A1 Area Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: UV/VIS_2_190614C

Sample ID **ICV-190614**	Batch ID: **R104612**	TestNo: **M3500-Fe D**	Units: **mg/L**
SampType: **ICV**	Run ID: **UV/VIS_2_190614C**	Analysis Date: **6/14/2019 2:50:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.0902	0.100	0.1000	0	90.2	85	115			N

Sample ID **CCV1-190614**	Batch ID: **R104612**	TestNo: **M3500-Fe D**	Units: **mg/L**
SampType: **CCV**	Run ID: **UV/VIS_2_190614C**	Analysis Date: **6/14/2019 3:01:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Iron, Ferrous	0.192	0.100	0.2000	0	96.1	85	115			N

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1906152
Project: A1 Area Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: WC_190618A

The QC data in batch 91377 applies to the following samples: 1906152-01C, 1906152-02C, 1906152-03C, 1906152-04C, 1906152-05C, 1906152-06C

Sample ID **MB-91377** Batch ID: **91377** TestNo: **M2540C** Units: **mg/L**
SampType: **MBLK** Run ID: **WC_190618A** Analysis Date: **6/18/2019 3:40:00 PM** Prep Date: **6/18/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids (Residue, Filtera	<10.0	10.0								

Sample ID **LCS-91377** Batch ID: **91377** TestNo: **M2540C** Units: **mg/L**
SampType: **LCS** Run ID: **WC_190618A** Analysis Date: **6/18/2019 3:40:00 PM** Prep Date: **6/18/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids (Residue, Filtera	756	10.0	745.6	0	101	90	113			

Sample ID **1906152-01C-DUP** Batch ID: **91377** TestNo: **M2540C** Units: **mg/L**
SampType: **DUP** Run ID: **WC_190618A** Analysis Date: **6/18/2019 3:40:00 PM** Prep Date: **6/18/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids (Residue, Filtera	1620	50.0	0	1645				1.84	5	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

July 19, 2019

Will Vienne
Golder
2201 Double Creek Dr #4004
Round Rock, Texas 78664
TEL: (512) 671-3434
FAX (512) 671-3446

Order No.: 1907114

RE: Luminant-MLSES-A1 Area Landfill

Dear Will Vienne:

DHL Analytical, Inc. received 4 sample(s) on 7/10/2019 for the analyses presented in the following report.

There were no problems with the analyses and all data met requirements of NELAP except where noted in the Case Narrative. All non-NELAP methods will be identified accordingly in the case narrative and all estimated uncertainties of test results are within method or EPA specifications.

If you have any questions regarding these tests results, please feel free to call. Thank you for using DHL Analytical.

Sincerely,

John DuPont
General Manager

This report was performed under the accreditation of the State of Texas Laboratory Certification Number: T104704211-19-24

Table of Contents

DHL ANALYTICAL

2300 Double Creek Dr. ■ Round Rock, TX 78664
Phone (512) 388-8222 ■ FAX (512) 388-8229
Web: www.dhlanalytical.com
E-Mail: login@dhlanalytical.com

№ 83671

CHAIN-OF-CUSTODY

CLIENT: GOLDER
ADDRESS: 2201 DOUBLE CREEK DR ROUND ROCK, TX 78664
PHONE: 512-671-3434 FAX/E-MAIL: 512-671-3446
DATA REPORTED TO: WILL VIENNE
ADDITIONAL REPORT COPIES TO:

DATE: 7-9-19 PAGE 1 OF 1
PO #: 19122262-D DHL WORK ORDER #: 1907114
PROJECT LOCATION OR NAME: LUMINANT-MLSES- A1 AREA LANDFILL
CLENT PROJECT #: 19122262-D COLLECTOR: J. BRAYTON

Authorize 5% surcharge for TRRP Report? ☐ Yes ☐ No

S=SOIL W=WATER A=AIR L=LIQUID SE=SEDIMENT P=PAINT SL=SLUDGE O=OTHER SO=SOLID

ANALYSES: BTEX ☐ MTBE ☐ TPH 1005 ☐ TPH 1006 ☐ GRO [METHOD 8015] ☐ DRO [METHOD 8015] ☐ [METHOD 8021] ☐ HOLD 1006 ☐ VOC 8260 ☐ VOC 624 ☐ VOC 8260/5035 ☐ SVOC 8270 ☐ PAH 8270 ☐ HOLD PAH ☐ SVOC 625 ☐ 8270 PEST ☐ 625 PEST/PCB ☐ 608 PCB ☐ 8270 O-P PEST ☐ 8082 PCB ☐ 8270 PCB ☐ 8321 HERB ☐ T PHOS, AMMONIA ☐ METALS 6020 ☐ METALS 200.8 ☐ DISS. METALS ☐ RCRA ☐ TX11 ☐ PH ☐ HEX CHROM ☐ ALKALINITY ☐ COD ☐ CHLORIDE ☐ ANIONS ☐ TCLP-SVOC ☐ VOC ☐ PEST ☐ HERB ☐ TCLP-METALS ☐ RCRA 8 ☐ TX-11 ☐ Pb ☐ RCI ☐ FLASHPOINT ☐ DGAS ☐ TDS ☐ TSS ☐ % MOISTURE ☐ CYANIDE ☐ LITHIUM COBALT

Field Sample I.D.	DHL Lab #	Date	Time	Matrix	Container Type	# of Containers	HCl	HNO_3	H_2SO_4 ☐ NaOH ☐	ICE	UNPRESERVED	LITHIUM	COBALT	FIELD NOTES
BMW-29	01	7-8-19	0945	W	P	1		X		X		X		
BMW-32	02	↓	1420	W	P	1		X		X		X		
BMW-25	03	↓	1255	W	P	1		X		X			X	
AIV-18-OB-95	04	↓	1135	W	P	1		X		X		X		

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)
[signature]	7-9-19 1800	FedEx
FedEx	7/10/19 1011	[signature]

☐ DHL DISPOSAL @ $5.00 each ☐ Return

TURN AROUND TIME
RUSH ☐ CALL FIRST
1 DAY ☐ CALL FIRST
2 DAY ☐
NORMAL ☒
OTHER ☐

LABORATORY USE ONLY:
RECEIVING TEMP: 1.4°C THERM #: 28
CUSTODY SEALS: ☐ BROKEN ☐ INTACT ☑ NOT USED
CARRIER: ☐ LONE STAR ☑ FEDEX ☐ UPS ☐ OTHER
☐ COURIER DELIVERY
☐ HAND DELIVERED

DHL COC Rev 1 | FEB 2010

ORIGIN ID:NQIA (512) 671-3434
J BRAYTON
GOLDER
2201 DOUBLE CREEK DR STE 4004

ROUND ROCK, TX 78664
UNITED STATES US

SHIP DATE: 09JUL19
ACTWGT: 32.00 LB
CAD: 6995621/SSFO2002
DIMS: 20x20x13 IN

BILL THIRD PARTY

Part # 156297-435 RRDB EXP 06/20

TO

DHL
2300 DOUBLE CREEK DR

ROUND ROCK TX 78664

(512) 388-8222 REF:
INV:
PO: DEPT:

FedEx
Express

E

J191019012301uv

WED - 10 JUL 10:30A
PRIORITY OVERNIGHT

TRK# 0201 **7883 8012 4530**

A8 BSMA

78664
TX-US **AUS**

DHL Analytical, Inc.

Sample Receipt Checklist

Client Name Golder — Date Received: 7/10/2019

Work Order Number 1907114 — Received by JW

Checklist completed by: [signature] (Signature) 7/10/2019 (Date) — Reviewed by DJ (Initials) 7/10/2019 (Date)

Carrier name FedEx 1day

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shippping container/cooler?	Yes ☐	No ☐	Not Present ☑
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐	1.4 °C
Water - VOA vials have zero headspace?	Yes ☑	No ☐	No VOA vials submitted ☐
Water - pH<2 acceptable upon receipt?	Yes ☐	No ☐	NA ☑ LOT #
	Adjusted?		Checked by
Water - ph>9 (S) or ph>10 (CN) acceptable upon receipt?	Yes ☐	No ☐	NA ☑ LOT #
	Adjusted?		Checked by

Any No response must be detailed in the comments section below.

Client contacted ______ Date contacted: ______ Person contacted ______

Contacted by: ______ Regarding: ______

Comments: ______

Corrective Action ______

Page 1 of 1

DHL Analytical, Inc.

Date: *19-Jul-19*

CLIENT: Golder
Project: Luminant-MLSES-A1 Area Landfill
Lab Order: 1907114

CASE NARRATIVE

Samples were analyzed using the methods outlined in the following references:

Method SW6020A - Metals Analysis

LOG IN

The samples were received and log-in performed on 7/10/2019. A total of 4 samples were received and analyzed. The samples arrived in good condition and were properly packaged. All method blanks, laboratory spikes, and/or matrix spikes met quality assurance objectives.

DHL Analytical, Inc.

Date: *19-Jul-19*

CLIENT: Golder
Project: Luminant-MLSES-A1 Area Landfill
Lab Order: 1907114

Work Order Sample Summary

Lab Smp ID	Client Sample ID	Tag Number	Date Collected	Date Recved
1907114-01	BMW-29		07/08/19 09:45 AM	7/10/2019
1907114-02	BMW-32		07/08/19 02:20 PM	7/10/2019
1907114-03	BMW-25		07/08/19 12:55 PM	7/10/2019
1907114-04	A1V-18-OB-95		07/08/19 11:35 AM	7/10/2019

Lab Order: 1907114
Client: Golder
Project: Luminant-MLSES-A1 Area Landfi

PREP DATES REPORT

Sample ID	Client Sample ID	Collection Date	Matrix	Test Number	Test Name	Prep Date	Batch ID
1907114-01A	BMW-29	07/08/19 09:45 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	07/12/19 10:48 AM	91752
1907114-02A	BMW-32	07/08/19 02:20 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	07/12/19 10:48 AM	91752
1907114-03A	BMW-25	07/08/19 12:55 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	07/12/19 10:48 AM	91752
1907114-04A	A1V-18-OB-95	07/08/19 11:35 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	07/12/19 10:48 AM	91752
	A1V-18-OB-95	07/08/19 11:35 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	07/12/19 10:48 AM	91752

Lab Order: 1907114
Client: Golder
Project: Luminant-MLSES-A1 Area Landfi

ANALYTICAL DATES REPORT

Sample ID	Client Sample ID	Matrix	Test Number	Test Name	Batch ID	Dilution	Analysis Date	Run ID
1907114-01A	BMW-29	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	91752	1	07/15/19 11:41 AM	ICP-MS5_190715A
1907114-02A	BMW-32	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	91752	1	07/15/19 11:43 AM	ICP-MS5_190715A
1907114-03A	BMW-25	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	91752	1	07/15/19 11:45 AM	ICP-MS5_190715A
1907114-04A	A1V-18-OB-95	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	91752	1	07/15/19 11:32 AM	ICP-MS5_190715A
	A1V-18-OB-95	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	91752	1	07/16/19 11:00 AM	ICP-MS4_190716A

DHL Analytical, Inc.

Date: *19-Jul-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-29
Project:	Luminant-MLSES-A1 Area Landfill	**Lab ID:**	1907114-01
Project No:	19122262-D	**Collection Date:**	07/08/19 09:45 AM
Lab Order:	1907114	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **SP**
Lithium	0.104	0.00500	0.0100		mg/L	1	07/15/19 11:41 AM

Qualifiers:			
*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *19-Jul-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-32
Project:	Luminant-MLSES-A1 Area Landfill	**Lab ID:**	1907114-02
Project No:	19122262-D	**Collection Date:**	07/08/19 02:20 PM
Lab Order:	1907114	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **SP**
Lithium	0.116	0.00500	0.0100		mg/L	1	07/15/19 11:43 AM

Qualifiers:				
	*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
	DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
	J	Analyte detected between MDL and RL	MDL	Method Detection Limit
	ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
	S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *19-Jul-19*

CLIENT:	Golder	**Client Sample ID:**	BMW-25
Project:	Luminant-MLSES-A1 Area Landfill	**Lab ID:**	1907114-03
Project No:	19122262-D	**Collection Date:**	07/08/19 12:55 PM
Lab Order:	1907114	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **SP**
Cobalt	0.00514	0.00300	0.00500		mg/L	1	07/15/19 11:45 AM

Qualifiers:

*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
S	Spike Recovery outside control limits	N	Parameter not NELAP certified

DHL Analytical, Inc.

Date: *19-Jul-19*

CLIENT:	Golder	**Client Sample ID:**	A1V-18-OB-95
Project:	Luminant-MLSES-A1 Area Landfill	**Lab ID:**	1907114-04
Project No:	19122262-D	**Collection Date:**	07/08/19 11:35 AM
Lab Order:	1907114	**Matrix:**	AQUEOUS

Analyses	Result	MDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **SP**
Lithium	0.0454	0.00500	0.0100		mg/L	1	07/15/19 11:32 AM

Qualifiers:			
*	Value exceeds TCLP Maximum Concentration Level	C	Sample Result or QC discussed in the Case Narrative
DF	Dilution Factor	E	TPH pattern not Gas or Diesel Range Pattern
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	RL	Reporting Limit
S	Spike Recovery outside control limits	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1907114
Project: Luminant-MLSES-A1 Area Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: **ICP-MS5_190715A**

The QC data in batch 91752 applies to the following samples: 1907114-01A, 1907114-02A, 1907114-03A, 1907114-04A

Sample ID **MB-91752** Batch ID: **91752** TestNo: **SW6020A** Units: **mg/L**
SampType: **MBLK** Run ID: **ICP-MS5_190715A** Analysis Date: **7/15/2019 11:23:00 AM** Prep Date: **7/12/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	<0.00300	0.00500								
Lithium	<0.00500	0.0100								

Sample ID **LCS-91752** Batch ID: **91752** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCS** Run ID: **ICP-MS5_190715A** Analysis Date: **7/15/2019 11:26:00 AM** Prep Date: **7/12/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	0.205	0.00500	0.200	0	102	80	120			
Lithium	0.201	0.0100	0.200	0	100	80	120			

Sample ID **LCSD-91752** Batch ID: **91752** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCSD** Run ID: **ICP-MS5_190715A** Analysis Date: **7/15/2019 11:28:00 AM** Prep Date: **7/12/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	0.205	0.00500	0.200	0	102	80	120	0.097	15	
Lithium	0.200	0.0100	0.200	0	100	80	120	0.171	15	

Sample ID **1907114-04A SD** Batch ID: **91752** TestNo: **SW6020A** Units: **mg/L**
SampType: **SD** Run ID: **ICP-MS5_190715A** Analysis Date: **7/15/2019 11:34:00 AM** Prep Date: **7/12/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	<0.0150	0.0250	0	0				0	10	
Lithium	0.0460	0.0500	0	0.0454				1.23	10	

Sample ID **1907114-04A PDS** Batch ID: **91752** TestNo: **SW6020A** Units: **mg/L**
SampType: **PDS** Run ID: **ICP-MS5_190715A** Analysis Date: **7/15/2019 11:56:00 AM** Prep Date: **7/12/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	0.189	0.00500	0.200	0	94.7	80	120			
Lithium	0.247	0.0100	0.200	0.0454	101	80	120			

Sample ID **1907114-04A MS** Batch ID: **91752** TestNo: **SW6020A** Units: **mg/L**
SampType: **MS** Run ID: **ICP-MS5_190715A** Analysis Date: **7/15/2019 11:58:00 AM** Prep Date: **7/12/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	0.191	0.00500	0.200	0	95.3	80	120			
Lithium	0.244	0.0100	0.200	0.0454	99.4	80	120			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1907114
Project: Luminant-MLSES-A1 Area Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: ICP-MS5_190715A

Sample ID **1907114-04A MSD**	Batch ID: **91752**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **MSD**	Run ID: **ICP-MS5_190715A**	Analysis Date: **7/15/2019 12:01:00 PM**	Prep Date: **7/12/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	0.190	0.00500	0.200	0	94.9	80	120	0.463	15	
Lithium	0.242	0.0100	0.200	0.0454	98.1	80	120	1.07	15	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1907114
Project: Luminant-MLSES-A1 Area Landfill

ANALYTICAL QC SUMMARY REPORT

RunID: **ICP-MS5_190715A**

Sample ID **ICV-190715**	Batch ID: **R105116**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **ICV**	Run ID: **ICP-MS5_190715A**	Analysis Date: **7/15/2019 11:07:00 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	0.101	0.00500	0.100	0	101	90	110			
Lithium	0.103	0.0100	0.100	0	103	90	110			

Sample ID **LCVL-190715**	Batch ID: **R105116**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS5_190715A**	Analysis Date: **7/15/2019 11:15:00 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	0.00489	0.00500	0.00500	0	97.7	70	130			
Lithium	0.0103	0.0100	0.0100	0	103	70	130			

Sample ID **CCV1-190715**	Batch ID: **R105116**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **CCV**	Run ID: **ICP-MS5_190715A**	Analysis Date: **7/15/2019 12:03:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	0.192	0.00500	0.200	0	96.1	90	110			
Lithium	0.197	0.0100	0.200	0	98.7	90	110			

Sample ID **LCVL1-190715**	Batch ID: **R105116**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS5_190715A**	Analysis Date: **7/15/2019 12:08:00 PM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	0.00495	0.00500	0.00500	0	98.9	70	130			
Lithium	0.00992	0.0100	0.0100	0	99.2	70	130			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

August 20, 2019

Will Vienne
Golder
2201 Double Creek Dr #4004
Round Rock, Texas 78664
TEL: (512) 671-3434
FAX (512) 671-3446

Order No.: 1908174

RE: Luminant-A1 Area

Dear Will Vienne:

DHL Analytical, Inc. received 2 sample(s) on 8/16/2019 for the analyses presented in the following report.

There were no problems with the analyses and all data met requirements of NELAP except where noted in the Case Narrative. All non-NELAP methods will be identified accordingly in the case narrative and all estimated uncertainties of test results are within method or EPA specifications.

If you have any questions regarding these tests results, please feel free to call. Thank you for using DHL Analytical.

Sincerely,

John DuPont
General Manager

This report was performed under the accreditation of the State of Texas Laboratory Certification Number: T104704211-19-24

Table of Contents

DHL ANALYTICAL
2300 Double Creek Dr. ■ Round Rock, TX 78664
Phone (512) 388-8222 ■ FAX (512) 388-8229
Web: www.dhlanalytical.com
E-Mail: login@dhlanalytical.com

№ 85327

CHAIN-OF-CUSTODY

CLIENT: GOLDER
ADDRESS: 2201 DOUBLE CREEK DR ROUND ROCK, TX 78664
PHONE: 512-671-3434 FAX/E-MAIL: 512-671-3446
DATA REPORTED TO: WILL VIENNE
ADDITIONAL REPORT COPIES TO:

DATE: 8-14-19 PAGE 1 OF 1
PO #: 19122262-C DHL WORK ORDER #: 1908174
PROJECT LOCATION OR NAME: LUMINANT- A1 AREA
CLENT PROJECT #: 19122262-C COLLECTOR: J. BRAYTON

Authorize 5% surcharge for TRRP Report? ☐ Yes ☐ No

S=SOIL P=PAINT
W=WATER SL=SLUDGE
A=AIR O=OTHER
L=LIQUID SO=SOLID
SE=SEDIMENT

ANALYSES: BTEX ☐ MTBE ☐ [METHOD 8021] ☐; TPH 1005 ☐ TPH 1006 ☐ HOLD 1006 ☐; GRO [METHOD 8015] ☐ DRO [METHOD 8015] ☐; VOC 8260 ☐ VOC 624 ☐ VOC 8260/5035 ☐; SVOC 8270 ☐ PAH 8270 ☐ HOLD PAH ☐ SVOC 625 ☐; 8270 PEST ☐ 625 PEST/PCB ☐ 608 PCB ☐; 8270 O-P PEST ☐ 8082 PCB ☐ 8270 PCB ☐; 8321 HERB ☐ T PHOS, AMMONIA ☐; METALS 6020 ☐ METALS 200.8 ☐ DISS. METALS ☐; RCRA ☐ TX11 ☐ ☐; PH ☐ HEX CHROM ☐ ALKALINITY ☐ COD ☐; CHLORIDE ☐ ANIONS ☐; TCLP-SVOC ☐ VOC ☐ PEST ☐ HERB ☐; TCLP-METALS ☐ RCRA 8 ☐ TX-11 ☐ Pb ☐; RCI ☐ FLASHPOINT ☐ DGAS ☐; TDS ☐ TSS ☐ % MOISTURE ☐ CYANIDE ☐; COBALT; LITHIUM

Field Sample I.D.	DHL Lab #	Date	Time	Matrix	Container Type	# of Containers	HCl	HNO_3	H_2SO_4 ☐ NaOH ☐	ICE	UNPRESERVED	COBALT	LITHIUM	FIELD NOTES
A1-2-DB	01	8-14-19	1100		P	1		X				X	X	
A1-17-SPOIL	02	8-14-19	1205		P	1		X				X	X	

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)
[signature]	8-15-19 1730	Fed Ex
Fed Ex	8/16/19 0943	[signature]

☐ DHL DISPOSAL @ $5.00 each ☐ Return

TURN AROUND TIME
RUSH ☒ CALL FIRST
1 DAY ☐ CALL FIRST
2 DAY ☐ Per Will cc 8/16/19
~~NORMAL~~ ☒
OTHER ☐

LABORATORY USE ONLY:
RECEIVING TEMP: 1.4°C THERM #: 78
CUSTODY SEALS: ☐ BROKEN ☐ INTACT ☒ NOT USED
CARRIER: ☐ LONE STAR ☒ FEDEX ☐ UPS ☐ OTHER
☐ COURIER DELIVERY
☐ HAND DELIVERED

DHL COC Rev 1 | FEB 2010

ORIGIN ID:FWHA (512) 671-3434
JIBRAYTON
GOLDER
2201 DOUBLE CREECK DR

ROUND ROCK, TX 78664
UNITED STATES US

SHIP DATE: 15AUG19
ACTWGT: 18.30 LB
CAD: 6995323/SSFO2002
DIMS: 13x15x10 IN

BILL THIRD PARTY

TO **DHL ANALYTICAL**
DHL ANALYTICAL
2300 DOUBLE CREEK DR

ROUND ROCK TX 78664
(512) 388-8222 REF:
INV:
PO: DEPT:

FedEx
Express

E

FRI - 16 AUG 10:30A
PRIORITY OVERNIGHT

TRK# 0201 **7891 6544 7941**

A8 BSMA

78664
TX-US **AUS**

DHL Analytical, Inc.

Sample Receipt Checklist

Client Name Golder

Date Received: 8/16/2019

Work Order Number 1908174

Received by

Checklist completed by: [signature] 8/16/2019
Signature Date

Reviewed by JD 8/16/2019
Initials Date

Carrier name FedEx 1day

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shippping container/cooler?	Yes ☐	No ☐	Not Present ☑
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container/Temp Blank temperature in compliance?	Yes ☑	No ☐	1.4 °C
Water - VOA vials have zero headspace?	Yes ☐	No ☐	No VOA vials submitted ☑
Water - pH<2 acceptable upon receipt?	Yes ☑	No ☐	NA ☐ LOT # 13171
	Adjusted? no		Checked by EL
Water - ph>9 (S) or ph>10 (CN) acceptable upon receipt?	Yes ☐	No ☐	NA ☑ LOT #
	Adjusted?		Checked by

Any No response must be detailed in the comments section below.

Client contacted Date contacted: Person contacted

Contacted by: Regarding:

Comments:

Corrective Action

Laboratory Name: DHL Analytical, Inc.

Laboratory Review Checklist: Reportable Data

Project Name: Luminant-A1 Area	**LRC Date:** 8/20/2019
Reviewer Name: Angie O'Donnell	**Laboratory Work Order: 1908174**
Prep Batch Number(s): See Prep Dates Report	**Run Batch:** See Analytical Dates Report

#[1]	A[2]	Description	Yes	No	NA[3]	NR[4]	ER#[5]
		Chain-of-Custody (C-O-C)					
R1	OI	**1)** Did samples meet the laboratory's standard conditions of sample acceptability upon receipt?	X				**R1-01**
		2) Were all departures from standard conditions described in an exception report?			X		
R2	OI	**Sample and Quality Control (QC) Identification**					
		1) Are all field sample ID numbers cross-referenced to the laboratory ID numbers?	X				
		2) Are all laboratory ID numbers cross-referenced to the corresponding QC data?	X				
R3	OI	**Test Reports**					
		1) Were all samples prepared and analyzed within holding times?	X				
		2) Other than those results < MQL, were all other raw values bracketed by calibration standards?	X				
		3) Were calculations checked by a peer or supervisor?	X				
		4) Were all analyte identifications checked by a peer or supervisor?	X				
		5) Were sample detection limits reported for all analytes not detected?	X				
		6) Were all results for soil and sediment samples reported on a dry weight basis?			X		
		7) Were % moisture (or solids) reported for all soil and sediment samples?			X		
		8) Were bulk soils/solids samples for volatile analysis extracted with methanol per EPA Method 5035?			X		
		9) If required for the project, TICs reported?			X		
R4	O	**Surrogate Recovery Data**					
		1) Were surrogates added prior to extraction?			X		
		2) Were surrogate percent recoveries in all samples within the laboratory QC limits?			X		
R5	OI	**Test Reports/Summary Forms for Blank Samples**					
		1) Were appropriate type(s) of blanks analyzed?	X				
		2) Were blanks analyzed at the appropriate frequency?	X				
		3) Where method blanks taken through the entire analytical process, including preparation and, if applicable, cleanup procedures?	X				
		4) Were blank concentrations < MDL?	X				
		5) For analyte(s) detected in a blank sample, was the concentration, unadjusted for sample specific factors, in all associated field samples, **greater than** 10 times the concentration in the blank sample?			X		
R6	OI	**Laboratory Control Samples (LCS):**					
		1) Were all COCs included in the LCS?	X				
		2) Was each LCS taken through the entire analytical procedure, including prep and cleanup steps?	X				
		3) Were LCSs analyzed at the required frequency?	X				
		4) Were LCS (and LCSD, if applicable) %Rs within the laboratory QC limits?	X				
		5) Does the detectability data document the laboratory's capability to detect the COCs at the MDL used to calculate the SDLs?	X				
		6) Was the LCSD RPD within QC limits (if applicable)?	X				
R7	OI	**Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Data**					
		1) Were the project/method specified analytes included in the MS and MSD?	X				
		2) Were MS/MSD analyzed at the appropriate frequency?	X				
		3) Were MS (and MSD, if applicable) %Rs within the laboratory QC limits?		X			**R7-03**
		4) Were MS/MSD RPDs within laboratory QC limits?	X				
R8	OI	**Analytical Duplicate Data**					
		1) Were appropriate analytical duplicates analyzed for each matrix?			X		
		2) Were analytical duplicates analyzed at the appropriate frequency?			X		
		3) Were RPDs or relative standard deviations within the laboratory QC limits?			X		
R9	OI	**Method Quantitation Limits (MQLs):**					
		1) Are the MQLs for each method analyte included in the laboratory data package?	X				
		2) Do the MQLs correspond to the concentration of the lowest non-zero calibration standard?	X				
		3) Are unadjusted MQLs and DCSs included in the laboratory data package?	X				
R10	OI	**Other Problems/Anomalies**					
		1) Are all known problems/anomalies/special conditions noted in this LRC and ER?	X				
		2) Was applicable and available technology used to lower the SDL to minimize the matrix interference affects on the sample results?	X				
		3) Is the laboratory NELAC-accredited under the Texas Laboratory Accreditation Program for the analytes, matrices and methods associated with this laboratory data package?	X				

Laboratory Name: DHL Analytical, Inc.

Laboratory Review Checklist (continued): Supporting Data

Project Name: Luminant-A1 Area	**LRC Date:** 8/20/2019
Reviewer Name: Angie O'Donnell	**Laboratory Work Order: 1908174**
Prep Batch Number(s): See Prep Dates Report	**Run Batch:** See Analytical Dates Report

#[1]	A[2]	Description	Yes	No	NA[3]	NR[4]	ER#[5]
S1	OI	**Initial Calibration (ICAL)**					
		1) Were response factors and/or relative response factors for each analyte within QC limits?	X				
		2) Were percent RSDs or correlation coefficient criteria met?	X				
		3) Was the number of standards recommended in the method used for all analytes?	X				
		4) Were all points generated between the lowest and highest standard used to calculate the curve?	X				
		5) Are ICAL data available for all instruments used?	X				
		6) Has the initial calibration curve been verified using an appropriate second source standard?	X				
S2	OI	**Initial and Continuing calibration Verification (ICCV and CCV) and Continuing Calibration blank (CCB):**					
		1) Was the CCV analyzed at the method-required frequency?	X				
		2) Were percent differences for each analyte within the method-required QC limits?	X				
		3) Was the ICAL curve verified for each analyte?	X				
		4) Was the absolute value of the analyte concentration in the inorganic CCB < MDL?	X				
S3	O	**Mass Spectral Tuning:**					
		1) Was the appropriate compound for the method used for tuning?	X				
		2) Were ion abundance data within the method-required QC limits?	X				
S4	O	**Internal Standards (IS):**					
		1) Were IS area counts and retention times within the method-required QC limits?	X				
S5	OI	**Raw Data (NELAC Section 5.5.10)**					
		1) Were the raw data (for example, chromatograms, spectral data) reviewed by an analyst?	X				
		2) Were data associated with manual integrations flagged on the raw data?	X				
S6	O	**Dual Column Confirmation**					
		1) Did dual column confirmation results meet the method-required QC?			X		
S7	O	**Tentatively Identified Compounds (TICs):**					
		1) If TICs were requested, were the mass spectra and TIC data subject to appropriate checks?			X		
S8	I	**Interference Check Sample (ICS) Results:**					
		1) Were percent recoveries within method QC limits?	X				
S9	I	**Serial Dilutions, Post Digestion Spikes, and Method of Standard Additions**					
		1) Were percent differences, recoveries, and the linearity within the QC limits specified in the method?	X				
S10	OI	**Method Detection Limit (MDL) Studies**					
		1) Was a MDL study performed for each reported analyte?	X				
		2) Is the MDL either adjusted or supported by the analysis of DCSs?	X				
S11	OI	**Proficiency Test Reports:**					
		1) Was the lab's performance acceptable on the applicable proficiency tests or evaluation studies?	X				
S12	OI	**Standards Documentation**					
		1) Are all standards used in the analyses NIST-traceable or obtained from other appropriate sources?	X				
S13	OI	**Compound/Analyte Identification Procedures**					
		1) Are the procedures for compound/analyte identification documented?	X				
S14	OI	**Demonstration of Analyst Competency (DOC)**					
		1) Was DOC conducted consistent with NELAC Chapter 5 – Appendix C?	X				
		2) Is documentation of the analyst's competency up-to-date and on file?	X				
S15	OI	**Verification/Validation Documentation for Methods** (NELAC Chapter 5)					
		1) Are all the methods used to generate the data documented, verified, and validated, where applicable?	X				
S16	OI	**Laboratory Standard Operating Procedures (SOPs):**					
		1) Are laboratory SOPs current and on file for each method performed?	X				

1 Items identified by the letter "R" should be included in the laboratory data package submitted to the TCEQ in the TRRP-required report(s). Items identified by the letter "S" should be retained and made available upon request for the appropriate retention period.
2 O = organic analyses; I = inorganic analyses (and general chemistry, when applicable).
3 NA = Not applicable.
4 NR = Not Reviewed.
5 ER# = Exception Report identification number (an Exception Report should be completed for an item if "NR" or "No" is checked).

Laboratory Data Package Signature Page – RG-366/TRRP-13

This data package consists of:

This signature page, the laboratory review checklist, and the following reportable data:

R1 Field chain-of-custody documentation;
R2 Sample identification cross-reference;
R3 Test reports (analytical data sheets) for each environmental sample that includes:
- a) Items consistent with NELAC Chapter 5,
- b) dilution factors,
- c) preparation methods,
- d) cleanup methods, and
- e) if required for the project, tentatively identified compounds (TICs).

R4 Surrogate recovery data including:
- a) Calculated recovery (%R), and
- b) The laboratory's surrogate QC limits.

R5 Test reports/summary forms for blank samples;
R6 Test reports/summary forms for laboratory control samples (LCSs) including:
- a) LCS spiking amounts,
- b) Calculated %R for each analyte, and
- c) The laboratory's LCS QC limits.

R7 Test reports for project matrix spike/matrix spike duplicates (MS/MSDs) including:
- a) Samples associated with the MS/MSD clearly identified,
- b) MS/MSD spiking amounts,
- c) Concentration of each MS/MSD analyte measured in the parent and spiked samples,
- d) Calculated %Rs and relative percent differences (RPDs), and
- e) The laboratory's MS/MSD QC limits

R8 Laboratory analytical duplicate (if applicable) recovery and precision:
- a) The amount of analyte measured in the duplicate,
- b) The calculated RPD, and
- c) The laboratory's QC limits for analytical duplicates.

R9 List of method quantitation limits (MQLs) and detectability check sample results for each analyte for each method and matrix;
R10 Other problems or anomalies.

The Exception Report for each "No" or "Not Reviewed (NR)" item in the Laboratory Review Checklist and for each analyte, matrix, and method for which the laboratory is not accredited under the Texas Laboratory Accreditation Program.

Release Statement: I am responsible for the release of this laboratory data package. This laboratory is accredited under the Texas Laboratory Accreditation Program for all the methods, analytes, and matrices reported in this data package except as noted in the Exception Reports. The data have been reviewed and are technically compliant with the requirements of the methods used, except where noted by the laboratory in the Exception Reports. By my signature below, I affirm to the best of my knowledge that all problems/anomalies observed by the laboratory have been identified in the Laboratory Review Checklist, and no information or data affecting the quality of the data has been knowingly withheld.

This laboratory was last inspected by TCEQ on February 25-28, 2019. Any findings affecting the data in this laboratory data package are noted in the Exception Reports herein. The official signing the cover page of the report in which these data are used is responsible for releasing this data package and is by signature affirming the above release statement is true.

Name: John DuPont
Official Title: General Manager

Name: Dr. Derhsing Luu
Official Title: Technical Director

[signature]
Signature

08/20/19
Date

DHL Analytical, Inc.

Date: *20-Aug-19*

CLIENT: Golder
Project: Luminant-A1 Area
Lab Order: 1908174

CASE NARRATIVE

Samples were analyzed using the following references:

Method SW6020A - Metals Analysis

Exception Report R1-01

The samples were received and log-in performed on 8/16/2019. A total of 2 samples were received and analyzed. The samples arrived in good condition and were properly packaged.

Exception Report R7-03

For Metals Analysis, the recovery of Lithium for the Matrix Spike and Matrix Spike Duplicate (1908175-03 MS/MSD) was outside of the method control limits. This is flagged accordingly in the QC Summary Report. This analyte was within method control limits in the associated LCS. No further corrective action was taken.

DHL Analytical, Inc.

Date: *20-Aug-19*

CLIENT: Golder
Project: Luminant-A1 Area
Lab Order: 1908174

Work Order Sample Summary

Lab Smp ID	Client Sample ID	Tag Number	Date Collected	Date Recved
1908174-01	A1-2-OB		08/14/19 11:00 AM	8/16/2019
1908174-02	A1-17-Spoil		08/14/19 12:05 PM	8/16/2019

DHL Analytical, Inc.

20-Aug-19

Lab Order: 1908174
Client: Golder
Project: Luminant-A1 Area

PREP DATES REPORT

Sample ID	Client Sample ID	Collection Date	Matrix	Test Number	Test Name	Prep Date	Batch ID
1908174-01A	A1-2-OB	08/14/19 11:00 AM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	08/19/19 08:43 AM	92407
1908174-02A	A1-17-Spoil	08/14/19 12:05 PM	Aqueous	SW3005A	Aq Prep Metals : ICP-MS	08/19/19 08:43 AM	92407

Lab Order: 1908174
Client: Golder
Project: Luminant-A1 Area

ANALYTICAL DATES REPORT

Sample ID	Client Sample ID	Matrix	Test Number	Test Name	Batch ID	Dilution	Analysis Date	Run ID
1908174-01A	A1-2-OB	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	92407	1	08/20/19 11:17 AM	ICP-MS5_190820A
1908174-02A	A1-17-Spoil	Aqueous	SW6020A	Trace Metals: ICP-MS - Water	92407	1	08/20/19 11:19 AM	ICP-MS5_190820A

DHL Analytical, Inc. **Date:** *20-Aug-19*

CLIENT:	Golder	**Client Sample ID:**	A1-2-OB
Project:	Luminant-A1 Area	**Lab ID:**	1908174-01
Project No:	19122262-C	**Collection Date:**	08/14/19 11:00 AM
Lab Order:	1908174	**Matrix:**	AQUEOUS

Analyses	Result	SDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **SP**
Cobalt	<0.00300	0.00300	0.00500		mg/L	1	08/20/19 11:17 AM
Lithium	<0.00500	0.00500	0.0100		mg/L	1	08/20/19 11:17 AM

Qualifiers:

ND - Not Detected at the SDL
J - Analyte detected between SDL and RL
B - Analyte detected in the associated Method Blank
DF- Dilution Factor
N - Parameter not NELAP certified
See Final Page of Report for MQLs and MDLs

S - Spike Recovery outside control limits
C - Sample Result or QC discussed in Case Narrative
RL - Reporting Limit (MQL adjusted for moisture and sample size)
SDL - Sample Detection Limit
E - TPH pattern not Gas or Diesel Range Pattern

DHL Analytical, Inc.

Date: *20-Aug-19*

CLIENT:	Golder	**Client Sample ID:**	A1-17-Spoil
Project:	Luminant-A1 Area	**Lab ID:**	1908174-02
Project No:	19122262-C	**Collection Date:**	08/14/19 12:05 PM
Lab Order:	1908174	**Matrix:**	AQUEOUS

Analyses	Result	SDL	RL	Qual	Units	DF	Date Analyzed
TRACE METALS: ICP-MS - WATER		**SW6020A**					Analyst: **SP**
Cobalt	<0.00300	0.00300	0.00500		mg/L	1	08/20/19 11:19 AM
Lithium	0.0394	0.00500	0.0100		mg/L	1	08/20/19 11:19 AM

Qualifiers:

ND - Not Detected at the SDL
J - Analyte detected between SDL and RL
B - Analyte detected in the associated Method Blank
DF- Dilution Factor
N - Parameter not NELAP certified
See Final Page of Report for MQLs and MDLs

S - Spike Recovery outside control limits
C - Sample Result or QC discussed in Case Narrative
RL - Reporting Limit (MQL adjusted for moisture and sample size)
SDL - Sample Detection Limit
E - TPH pattern not Gas or Diesel Range Pattern

DHL Analytical, Inc. **Date:** *20-Aug-19*

CLIENT: Golder
Work Order: 1908174
Project: Luminant-A1 Area

ANALYTICAL QC SUMMARY REPORT

RunID: **ICP-MS5_190621A**

Sample ID **DCS3-91398**	Batch ID: **91398**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **DCS3**	Run ID: **ICP-MS5_190621A**	Analysis Date: **6/21/2019 11:16:00 AM**	Prep Date: **6/20/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	0.00516	0.00500	0.00500	0	103	70	130	0	0	
Lithium	0.00535	0.0100	0.00500	0	107	70	130	0	0	

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1908174
Project: Luminant-A1 Area

ANALYTICAL QC SUMMARY REPORT

RunID: **ICP-MS5_190820A**

The QC data in batch 92407 applies to the following samples: 1908174-01A, 1908174-02A

Sample ID **MB-92407** Batch ID: **92407** TestNo: **SW6020A** Units: **mg/L**
SampType: **MBLK** Run ID: **ICP-MS5_190820A** Analysis Date: **8/20/2019 11:00:00 AM** Prep Date: **8/19/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	<0.00300	0.00500								
Lithium	<0.00500	0.0100								

Sample ID **LCS-92407** Batch ID: **92407** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCS** Run ID: **ICP-MS5_190820A** Analysis Date: **8/20/2019 11:03:00 AM** Prep Date: **8/19/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	0.194	0.00500	0.200	0	97.1	80	120			
Lithium	0.201	0.0100	0.200	0	100	80	120			

Sample ID **LCSD-92407** Batch ID: **92407** TestNo: **SW6020A** Units: **mg/L**
SampType: **LCSD** Run ID: **ICP-MS5_190820A** Analysis Date: **8/20/2019 11:05:00 AM** Prep Date: **8/19/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	0.191	0.00500	0.200	0	95.5	80	120	1.60	15	
Lithium	0.201	0.0100	0.200	0	101	80	120	0.137	15	

Sample ID **1908175-03A SD** Batch ID: **92407** TestNo: **SW6020A** Units: **mg/L**
SampType: **SD** Run ID: **ICP-MS5_190820A** Analysis Date: **8/20/2019 11:12:00 AM** Prep Date: **8/19/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	0.101	0.0250	0	0.0985				2.91	10	
Lithium	1.17	0.0500	0	1.10				6.21	10	

Sample ID **1908175-03A PDS** Batch ID: **92407** TestNo: **SW6020A** Units: **mg/L**
SampType: **PDS** Run ID: **ICP-MS5_190820A** Analysis Date: **8/20/2019 11:26:00 AM** Prep Date: **8/19/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	0.270	0.00500	0.200	0.0985	85.9	80	120			
Lithium	1.29	0.0100	0.200	1.10	94.0	80	120			

Sample ID **1908175-03A MS** Batch ID: **92407** TestNo: **SW6020A** Units: **mg/L**
SampType: **MS** Run ID: **ICP-MS5_190820A** Analysis Date: **8/20/2019 11:28:00 AM** Prep Date: **8/19/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	0.274	0.00500	0.200	0.0985	87.5	80	120			
Lithium	1.36	0.0100	0.200	1.10	131	80	120			S

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1908174
Project: Luminant-A1 Area

ANALYTICAL QC SUMMARY REPORT

RunID: **ICP-MS5_190820A**

Sample ID **1908175-03A MSD**	Batch ID: **92407**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **MSD**	Run ID: **ICP-MS5_190820A**	Analysis Date: **8/20/2019 11:30:00 AM**	Prep Date: **8/19/2019**

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	0.263	0.00500	0.200	0.0985	82.5	80	120	3.78	15	
Lithium	1.24	0.0100	0.200	1.10	71.2	80	120	9.15	15	S

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1908174
Project: Luminant-A1 Area

ANALYTICAL QC SUMMARY REPORT

RunID: **ICP-MS5_190820A**

Sample ID **ICV-190820**	Batch ID: **R105890**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **ICV**	Run ID: **ICP-MS5_190820A**	Analysis Date: **8/20/2019 10:46:00 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	0.0990	0.00500	0.100	0	99.0	90	110			
Lithium	0.106	0.0100	0.100	0	106	90	110			

Sample ID **LCVL-190820**	Batch ID: **R105890**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS5_190820A**	Analysis Date: **8/20/2019 10:54:00 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	0.00494	0.00500	0.00500	0	98.7	70	130			
Lithium	0.0107	0.0100	0.0100	0	107	70	130			

Sample ID **CCV1-190820**	Batch ID: **R105890**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **CCV**	Run ID: **ICP-MS5_190820A**	Analysis Date: **8/20/2019 11:41:00 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	0.198	0.00500	0.200	0	98.9	90	110			
Lithium	0.215	0.0100	0.200	0	108	90	110			

Sample ID **LCVL1-190820**	Batch ID: **R105890**	TestNo: **SW6020A**	Units: **mg/L**
SampType: **LCVL**	Run ID: **ICP-MS5_190820A**	Analysis Date: **8/20/2019 11:50:00 AM**	Prep Date:

Analyte	Result	RL	SPK value	Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	0.00510	0.00500	0.00500	0	102	70	130			
Lithium	0.0122	0.0100	0.0100	0	122	70	130			

Qualifiers:

B	Analyte detected in the associated Method Blank	DF	Dilution Factor
J	Analyte detected between MDL and RL	MDL	Method Detection Limit
ND	Not Detected at the Method Detection Limit	R	RPD outside accepted control limits
RL	Reporting Limit	S	Spike Recovery outside control limits
J	Analyte detected between SDL and RL	N	Parameter not NELAP certified

CLIENT: Golder
Work Order: 1908174
Project: Luminant-A1 Area

MQL SUMMARY REPORT

TestNo: SW6020A Analyte	MDL mg/L	MQL mg/L
Cobalt	0.00300	0.00500
Lithium	0.00500	0.0100

Qualifiers: MQL -Method Quantitation Limit as defined by TRRP
MDL -Method Detection Limit as defined by TRRP

Quantitative X-Ray Diffraction by Rietveld Refinement

Report Prepared for:	*Golder Associates - Will Vienne*
Project Number/ LIMS No.	*17431-01 / MI7013-JUN19*
Batch:	*Martin Lake A1 Area Landfill*
Sample Receipt:	*June 13, 2019*
Sample Analysis:	*June 28, 2019*
Reporting Date:	*July 19, 2019*
Instrument:	Panalytical X'pert Pro Diffractometer
Test Conditions:	Co radiation, 40 kV, 45 mA Regular Scanning: Step: 0.033°, Step time:0.15s, 2θ range: 6-70°
Interpretations :	HighScore Plus software using Crystallography Open Database (COD) and Joint Committee on Powder Diffraction Standards -International Center for Diffraction Data (JCPDS-ICDD).
Detection Limit :	0.5-2%. Strongly dependent on crystallinity.

Contents:

BEaton

Ben Eaton
Junior Mineralogist

Lain Glossop H.B.Sc
Senior Mineralogist

SGS Minerals
a division of SGS Canada Inc.
3260 Production Way, Burnaby, British Columbia, Canada V5A 4W4
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Member of the SGS Group (SGS SA)

Method Summary

Mineral Identification and Interpretation:

Mineral identification and interpretation involve matching the diffraction pattern of a test sample material to patterns of single-phase reference materials. The reference patterns from the Crystallography Open Database (COD) and the Joint Committee on Powder Diffraction Standards - International Center for Diffraction Data (JCPDS-ICDD).

Interpretations do not reflect the presence of non-crystalline and/or amorphous compounds, except when internal standards have been added by request. Mineral proportions may be strongly influenced by crystallinity, crystal structure and preferred orientations. Mineral or compound identification and quantitative analysis results should be accompanied by supporting chemical assay data or other additional tests.

Quantitative Rietveld Analysis:

Panalytical HighScore Plus software was used to perform the quantitative Rietveld Analysis. This software uses a graphics based profile analysis program built around a non-linear least squares fitting system, to quantitatively determine the amount of different phases present in a multicomponent sample. Whole pattern analyses are predicated by the fact that the X-ray diffraction pattern is a total sum of both instrumental and specimen factors. Unlike other peak intensity-based methods, the Rietveld method uses a least squares approach to refine a theoretical line profile (shown as a blue pattern in the analyses plots) until it matches the obtained experimental patterns (shown as the coloured pattern in the analyses plots).

Rietveld refinement is completed with a set of minerals specifically identified for the sample. Zero values indicate that the mineral was included in the refinement calculations, but the calculated concentration was less than 0.5 wt%. Minerals not identified by the analyst are not included in refinement calculations for specific samples and are indicated with a dash.

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Summary of Rietveld Quantitative Analysis X-ray Diffraction Results

Quantitative X-ray Diffraction Results

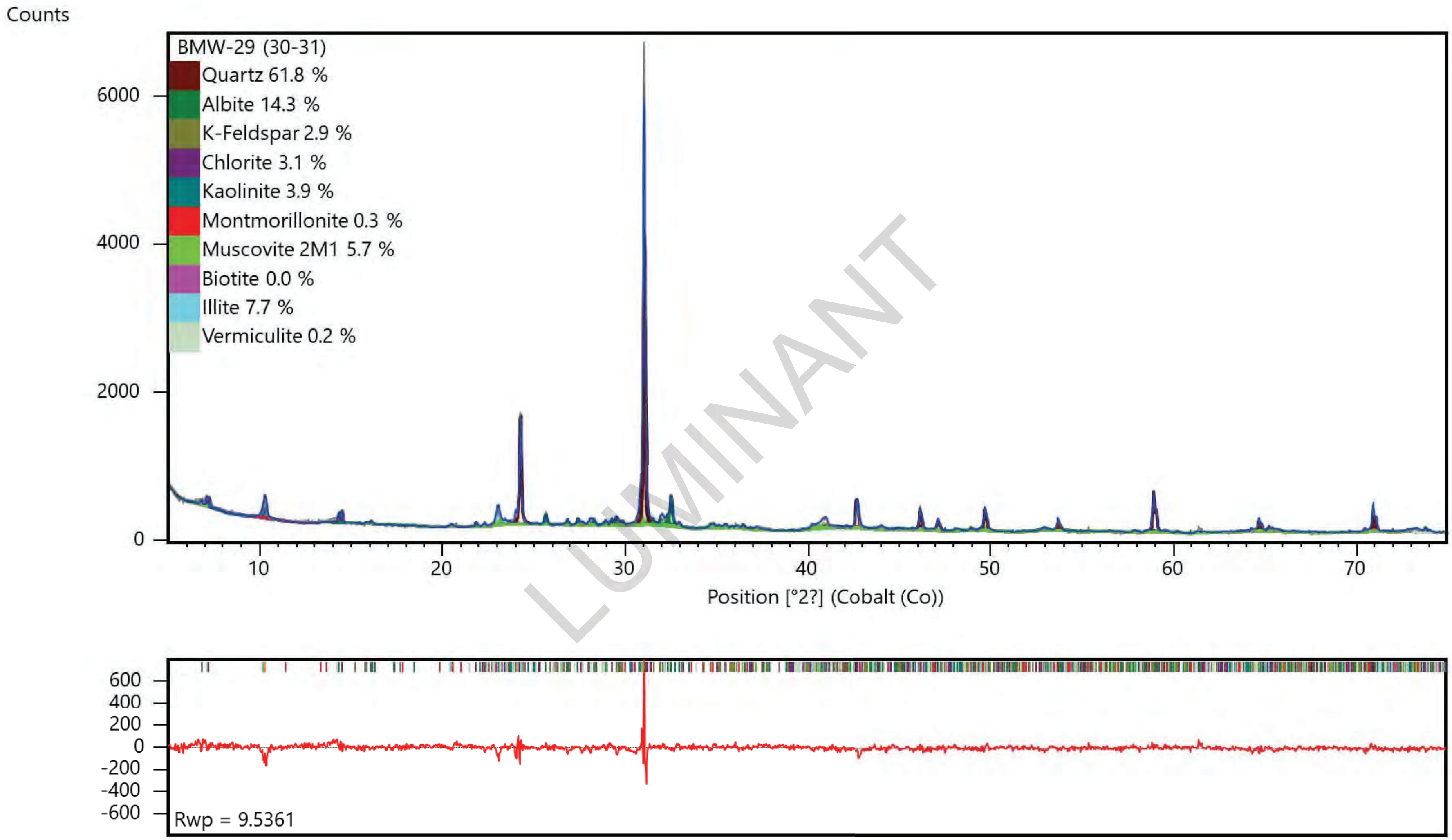
Mineral/Compound	1 BMW-29 (30-31) (wt %)	2 BMW-30 (40-41) (wt %)	3 BMW-31 (14-15) (wt %)	4 BMW-32 (25-26) (wt %)	5 BMW-33 (38-39) (wt %)
Quartz	61.8	82.3	90.3	81.7	68.0
Albite	14.3	0.0	2.1	6.6	17.1
K-Feldspar	2.9	7.3	5.6	7.6	3.0
Chlorite	3.1	1.6	0.1	0.0	1.7
*Kaolinite	3.9	3.9	0.0	2.5	3.4
*Montmorillonite	0.3	0.0	0.1	0.0	0.6
Muscovite	5.7	1.5	0.7	0.8	4.0
Biotite	0.0	0.0	0.0	0.0	0.0
Illite	7.7	2.1	1.0	0.6	2.1
*Vermiculite	0.2	0.0	0.1	0.1	0.2
Titanomagnetite	--	0.2	--	--	--
Ilmenite	--	1.0	--	--	--
TOTAL	100	100	100	100	100

Zero values indicate that the mineral was included in the refinement, but the calculated concentration is below a measurable value.

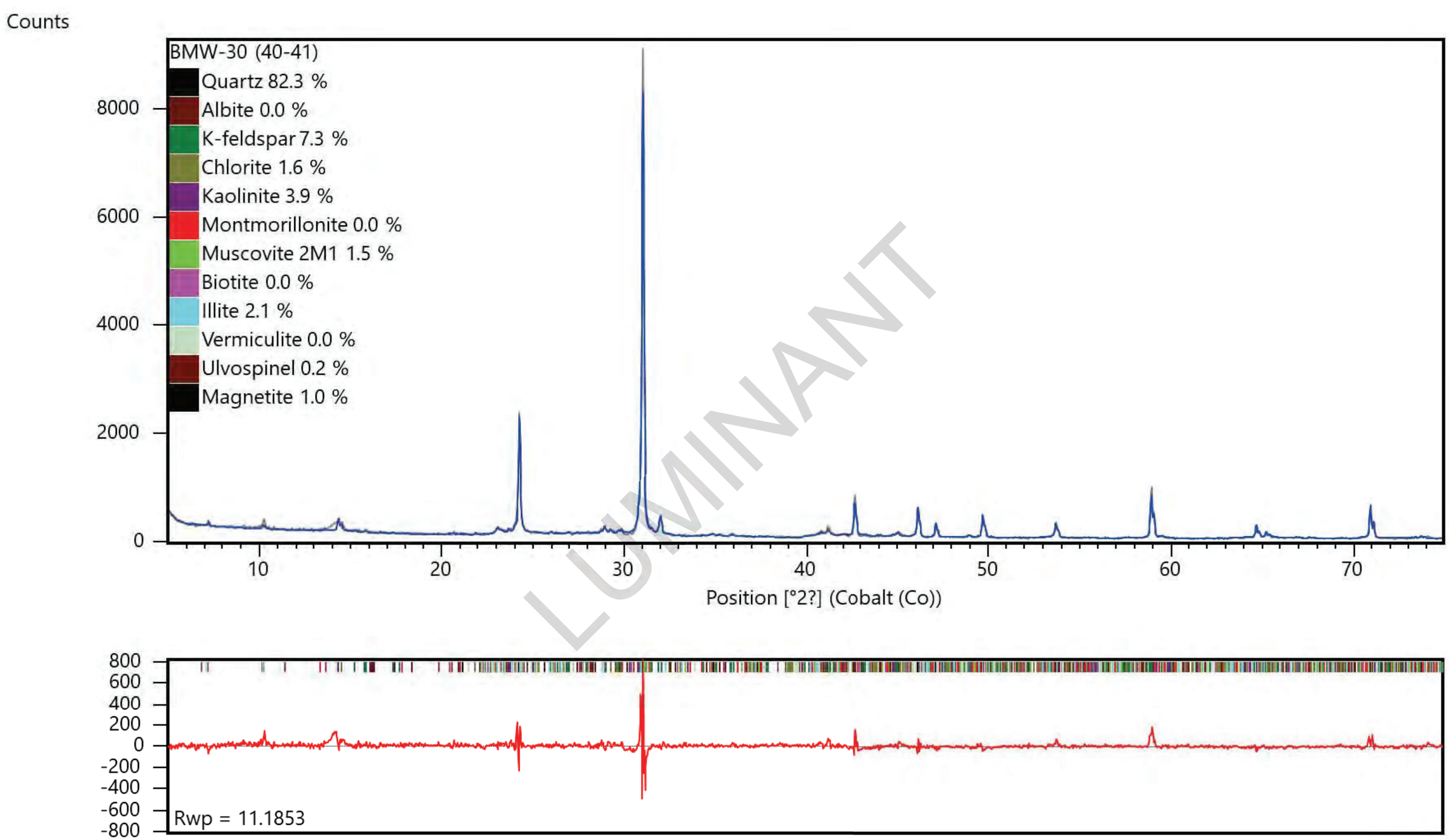
Dashes indicate that the mineral was not identified by the analyst and not included in the refinement calculation for the sample.

** Tentative identification of clays only, further clay XRD analysis will be required for positive identification.*

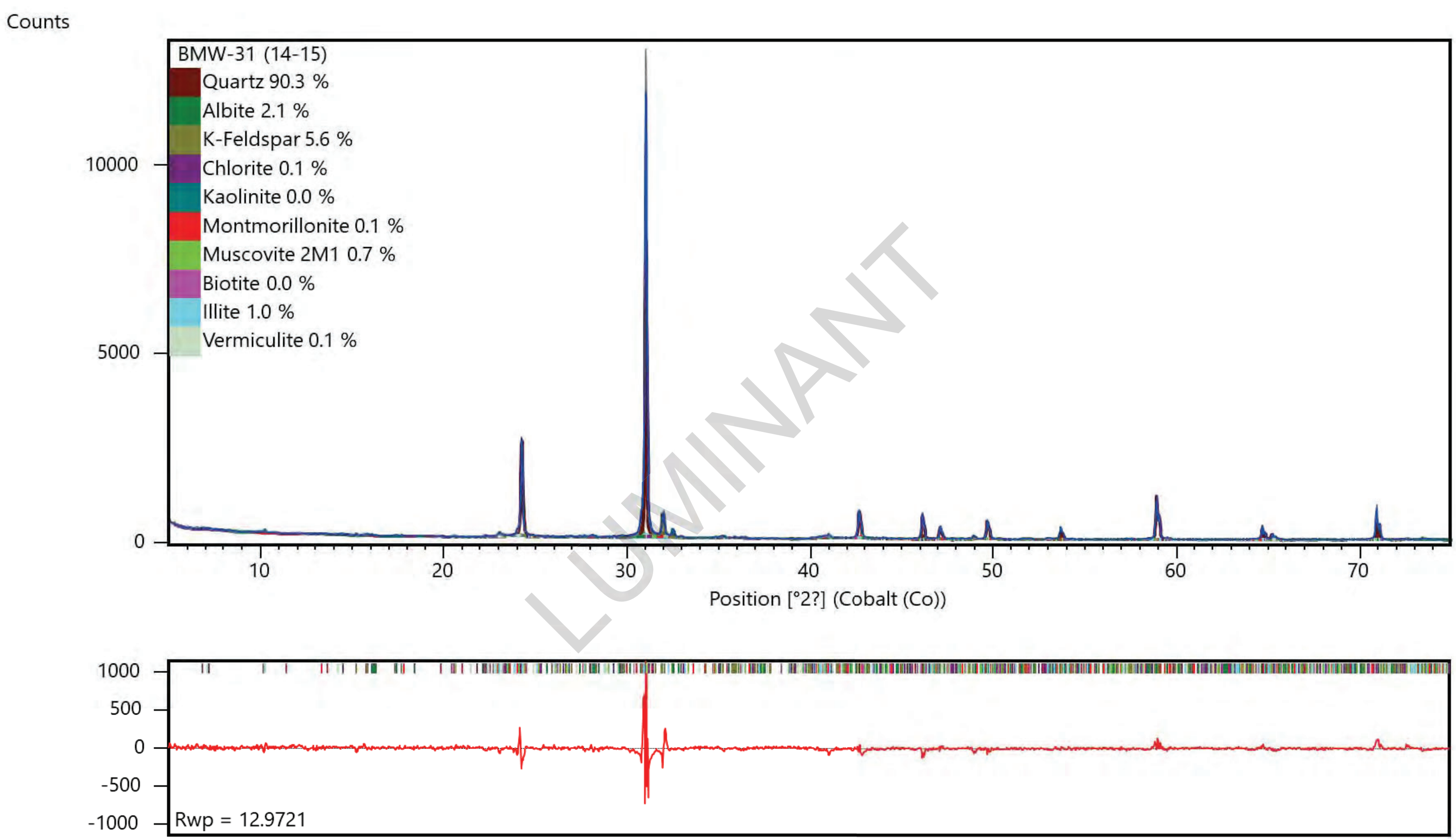
Mineral/Compound	Formula
Quartz	SiO_2
Albite	$NaAlSi_3O_8$
K-Feldspar	$KAlSi_3O_8$
Chlorite	$(Mg_3,Fe_2)Al(AlSi_3)O_{10}(OH)_8$
Kaolinite	$Al_2Si_2O_5(OH)_4$
Montmorillonite	$Na_{0.2}Ca_{0.1}Al_{1.5}Mg_{0.5}Si_4O_{10}(OH)_2 \cdot 4(H_2O)$
Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$
Biotite	$KMg_{2.5}Fe_{0.5}AlSi_3O_{10}(OH)_{1.75}F_{0.25}$
Illite	$(K,H_3O)(Al,Mg,Fe)_2(Si,Al)_4O_{10}[(OH)_2,(H_2O)]$
Vermiculite	$(Mg,Fe,Al)_2(Al,Si)_4O_{10}(OH)_2 \cdot 4(H_2O)$
Titanomagnetite	Fe_2TiO_4
Magnetite	Fe_2O_4



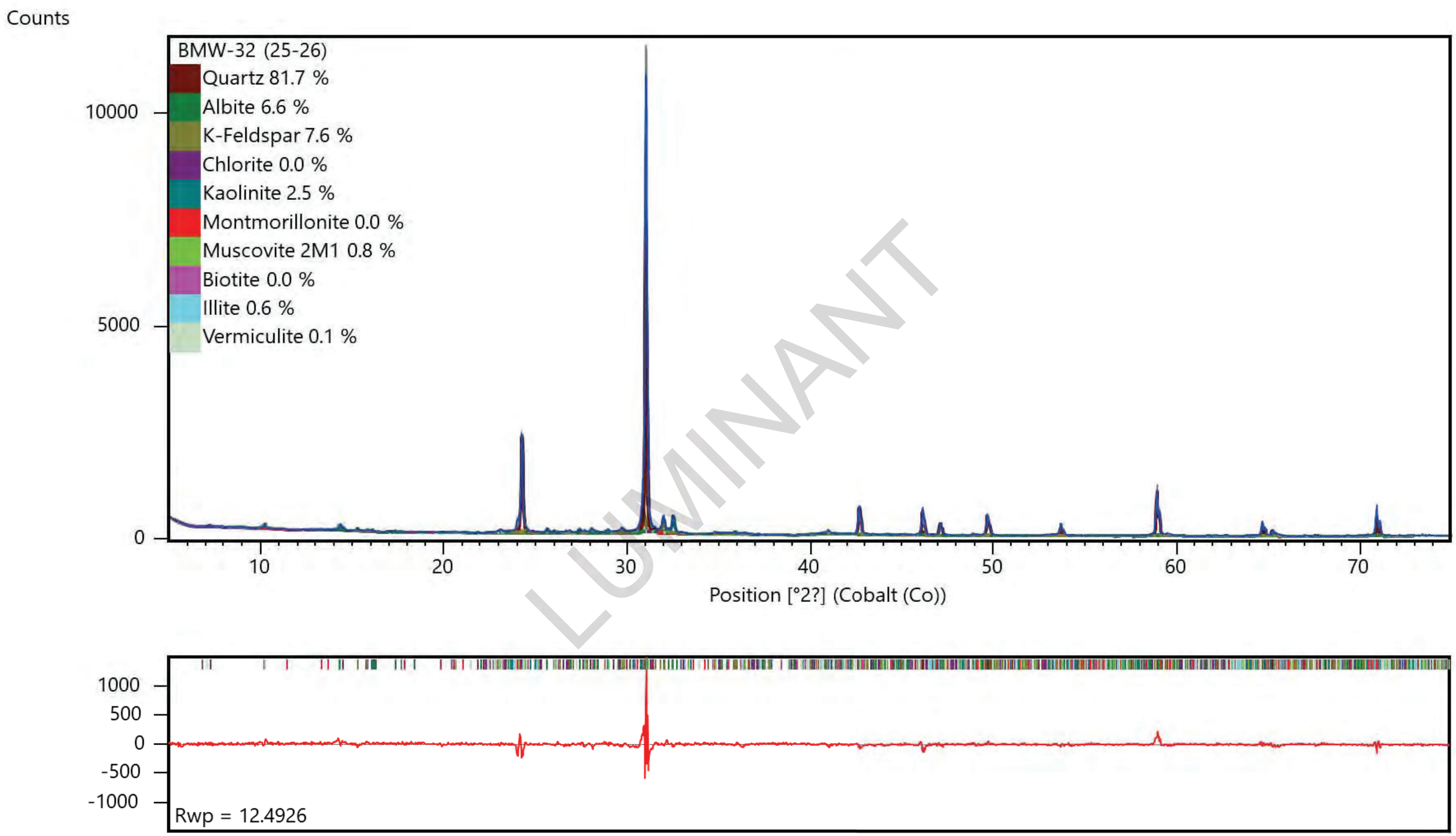
X-ray diffractogram. The upper pattern is the measured diffractogram, the blue curve is the calculated pattern from the Rietveld Refinement and the lower red curve is the difference plot.



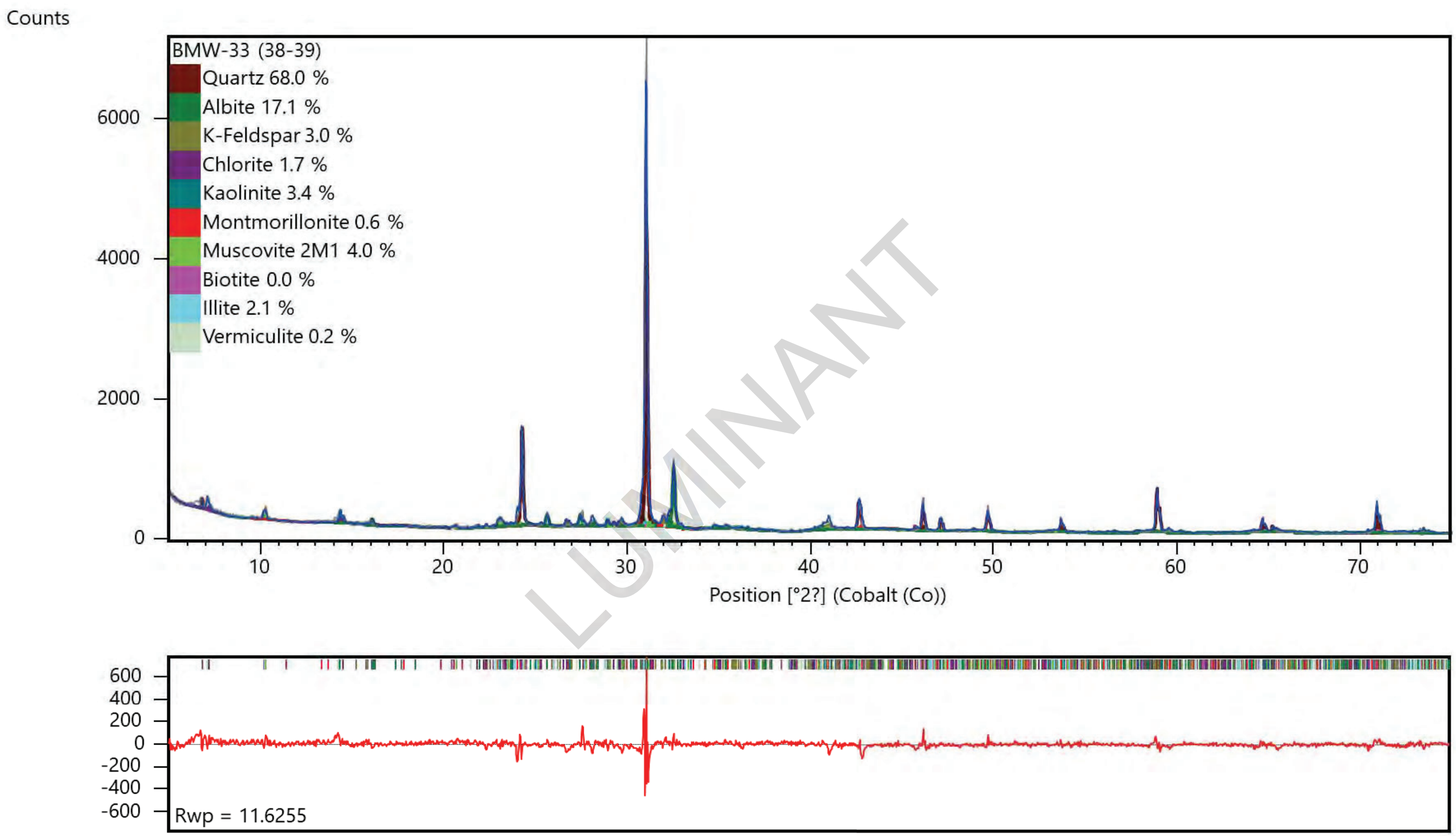
X-ray diffractogram. The upper pattern is the measured diffractogram, the blue curve is the calculated pattern from the Rietveld Refinement and the lower red curve is the difference plot.



X-ray diffractogram. The upper pattern is the measured diffractogram, the blue curve is the calculated pattern from the Rietveld Refinement and the lower red curve is the difference plot.



X-ray diffractogram. The upper pattern is the measured diffractogram, the blue curve is the calculated pattern from the Rietveld Refinement and the lower red curve is the difference plot.



X-ray diffractogram. The upper pattern is the measured diffractogram, the blue curve is the calculated pattern from the Rietveld Refinement and the lower red curve is the difference plot.

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ANALYTICAL REPORT

Eurofins TestAmerica, Knoxville
5815 Middlebrook Pike
Knoxville, TN 37921
Tel: (865)291-3000

Laboratory Job ID: 140-15492-1
Client Project/Site: Martin Lake A1 Area LF SEP + Totals

For:
Golder Associates Inc.
2201 Double Creek Dr
Suite 4004
Round Rock, Texas 78664

Attn: Will Vienne

Terry Walker Wasmund

Authorized for release by:
7/18/2019 6:22:20 PM

Terry Walker Wasmund, Project Manager II
(865)291-3000
terry.wasmund@testamericainc.com

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Definitions/Glossary

Client: Golder Associates Inc.
Project/Site: Martin Lake A1 Area LF SEP + Totals

Job ID: 140-15492-1

Qualifiers

Metals

Qualifier	Qualifier Description
*	LCS or LCSD is outside acceptance limits.
*	RPD of the LCS and LCSD exceeds the control limits
B	Compound was found in the blank and sample.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Job ID: 140-15492-1

Laboratory: Eurofins TestAmerica, Knoxville

Narrative

Job Narrative
140-15492-1

Receipt
The samples were received on 6/5/2019 at 9:20 AM. The samples arrived in good condition, properly preserved, and on ice. The temperature of the cooler at receipt was 1.4° C.

Metals
7 Step Sequential Extraction Procedure

These soil samples were prepared and analyzed using Eurofins TestAmerica Knoxville standard operating procedure KNOX-MT-0008, “7 Step Sequential Extraction Procedure”. SW-846 Method 6010B as incorporated in Eurofins TestAmerica Knoxville standard operating procedure KNOX-MT-0007 was used to perform the final instrument analyses.

An aliquot of each sample was sequentially extracted using the steps listed below:

· ***Step 1 - Exchangeable Fraction***: A 5 gram aliquot of sample was extracted with 25 mL of 1M magnesium sulfate (MgSO4), centrifuged and filtered. 5 mL of the resulting leachate was digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
· ***Step 2 - Carbonate Fraction:*** The sample residue from step 1 was extracted with 25 mL of 1M sodium acetate/acetic acid (NaOAc/HOAc) at pH 5, centrifuged and filtered. 5 mL of the resulting leachate was digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
· ***Step 3 - Non-crystalline Materials Fraction:*** The sample residue from step 2 was extracted with 25 mL of 0.2M ammonium oxalate (pH 3), centrifuged and filtered. 5 mL of the resulting leachate was digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
· ***Step 4 - Metal Hydroxide Fraction:*** The sample residue from step 3 was extracted with 25 mL of 1M hydroxylamine hydrochloride solution in 25% v/v acetic acid, centrifuged and filtered. 5 mL of the resulting leachate was digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
· ***Step 5 - Organic-bound Fraction:*** The sample residue from step 4 was extracted three times with 25 mL of 5% sodium hypochlorite (NaClO) at pH 9.5, centrifuged and filtered. The resulting leachates were combined and 5 mL were digested using method 3010A and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
· ***Step 6 - Acid/Sulfide Fraction***: The sample residue from step 5 was extracted with 25 mL of a 3:1:2 v/v solution of HCl-HNO3-H2O, centrifuged and filtered. 5 mL of the resulting leachate was diluted to 50 mL with reagent water and analyzed by method 6010B. Results are reported in mg/kg on a dry weight basis.
· ***Step 7 - Residual Fraction:*** A 1.0 g aliquot of the sample residue from step 6 was digested using HF, HNO3, HCl and H3BO3. The digestate was analyzed by ICP using method 6010B. Results are reported in mg/kg on a dry weight basis.

In addition, a 1.0 g aliquot of the original sample was digested using HF, HNO3, HCl and H3BO3. The digestate was analyzed by ICP using method 6010B. Total metal results are reported in mg/kg on a dry weight basis.

Results were calculated using the following equation:

Result, µg/g or mg/Kg, dry weight = $(C \times V \times V1 \times D) / (W \times S \times V2)$

Where:
C = Concentration from instrument readout, µg/mL
V = Final volume of digestate, mL
D = Instrument dilution factor
V1 = Total volume of leachate, mL
V2 = Volume of leachate digested, mL
W = Wet weight of sample, g
S = Percent solids/100

A method blank, laboratory control sample and laboratory control sample duplicate were prepared and analyzed with each SEP step in order to provide information about both the presence of elements of interest in the extraction solutions, and the recovery of elements of

Job ID: 140-15492-1 (Continued)

Laboratory: Eurofins TestAmerica, Knoxville (Continued)

interest from the extraction solutions. Results outside of laboratory QC limits do not reflect out of control performance, but rather the effect of the extraction solution upon the analyte.

A laboratory sample duplicate was prepared and analyzed with each batch of samples in order to provide information regarding the reproducibility of the procedure.

SEP Report Notes
The final report lists the results for each step, the result for the total digestion of the sample, and a sum of the results of steps 1 through 7 by element.

Magnesium was not reported for step 1 because the extraction solution for this step (magnesium sulfate) contains high levels of magnesium. Sodium was not reported for steps 2 and 5 since the extraction solutions for these steps contain high levels of sodium. The sum of steps 1 through 7 is much higher than the total result for sodium and magnesium due to the magnesium and sodium introduced by the extraction solutions.

The step 1 digestates were reanalyzed for vanadium at a 1/10 dilution due to positive interelement interferences resulting from the high magnesium results. The reporting limits were adjusted accordingly.

The digestates for steps 1, 2 and 5 were analyzed at a dilution due to instrument problems caused by the high solids content of the digestates. The reporting limits were adjusted accordingly.

Samples BMW-29 (30-31) (140-15492-1), BMW-30 (40-41) (140-15492-2), BMW-31 (14-15) (140-15492-3), BMW-32 (25-26) (140-15492-4) and BMW-33 (38-39) (140-15492-5) were diluted due to the presence of Silicon or Titanium which interferes with Arsenic, Cobalt, Selenium and Thallium: Elevated reporting limits (RLs) are provided.

Samples BMW-29 (30-31) (140-15492-1), BMW-30 (40-41) (140-15492-2), BMW-31 (14-15) (140-15492-3), BMW-32 (25-26) (140-15492-4) and BMW-33 (38-39) (140-15492-5) were diluted for Aluminum and Barium due to the nature of the sample matrix. Elevated reporting limits (RLs) are provided.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

General Chemistry - % Moisture
The samples were analyzed for percent moisture using SOP number KNOX-WC-0012 (based on Modified MCAWW 160.3 and SM2540B and on the percent moisture determinations described in methods 3540C and 3550B).

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Comments
No additional comments.

Detection Summary

Client: Golder Associates Inc. | Job ID: 140-15492-1

Project/Site: Martin Lake A1 Area LF SEP + Totals

Client Sample ID: BMW-29 (30-31) | Lab Sample ID: 140-15492-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Manganese	3.8	J	4.1	0.17	mg/Kg	4	☼	6010B SEP	Step 1
Aluminum	16	J *	41	6.5	mg/Kg	3	☼	6010B SEP	Step 2
Barium	1.1	J *	10	0.49	mg/Kg	3	☼	6010B SEP	Step 2
Cobalt	1.4	J	10	0.26	mg/Kg	3	☼	6010B SEP	Step 2
Iron	48	*	20	12	mg/Kg	3	☼	6010B SEP	Step 2
Manganese	35		3.1	1.1	mg/Kg	3	☼	6010B SEP	Step 2
Selenium	1.2	J B	2.0	0.69	mg/Kg	3	☼	6010B SEP	Step 2
Aluminum	170		14	2.9	mg/Kg	1	☼	6010B SEP	Step 3
Arsenic	1.4		0.68	0.18	mg/Kg	1	☼	6010B SEP	Step 3
Barium	4.3	B	3.4	0.16	mg/Kg	1	☼	6010B SEP	Step 3
Beryllium	0.11	J	0.34	0.020	mg/Kg	1	☼	6010B SEP	Step 3
Cobalt	1.5	J	3.4	0.061	mg/Kg	1	☼	6010B SEP	Step 3
Iron	4200		6.8	3.9	mg/Kg	1	☼	6010B SEP	Step 3
Manganese	95	B	1.0	0.037	mg/Kg	1	☼	6010B SEP	Step 3
Mo	0.14	J	2.7	0.11	mg/Kg	1	☼	6010B SEP	Step 3
Selenium	0.28	J B	0.68	0.23	mg/Kg	1	☼	6010B SEP	Step 3
Aluminum	2600		14	2.2	mg/Kg	1	☼	6010B SEP	Step 4
Arsenic	0.87	B	0.68	0.30	mg/Kg	1	☼	6010B SEP	Step 4
Barium	19		3.4	0.16	mg/Kg	1	☼	6010B SEP	Step 4
Beryllium	0.23	J	0.34	0.022	mg/Kg	1	☼	6010B SEP	Step 4
Cobalt	3.2	J	3.4	0.072	mg/Kg	1	☼	6010B SEP	Step 4
Iron	8300		6.8	3.9	mg/Kg	1	☼	6010B SEP	Step 4
Li	6.7		3.4	0.20	mg/Kg	1	☼	6010B SEP	Step 4
Manganese	180		1.0	0.18	mg/Kg	1	☼	6010B SEP	Step 4
Aluminum	500	*	200	32	mg/Kg	5	☼	6010B SEP	Step 5
Barium	17	J *	51	2.4	mg/Kg	5	☼	6010B SEP	Step 5
Cobalt	1.0	J *	51	0.82	mg/Kg	5	☼	6010B SEP	Step 5
Iron	530	*	100	60	mg/Kg	5	☼	6010B SEP	Step 5
Manganese	33	*	15	2.5	mg/Kg	5	☼	6010B SEP	Step 5
Aluminum	3500		14	2.2	mg/Kg	1	☼	6010B SEP	Step 6
Arsenic	1.1		0.68	0.20	mg/Kg	1	☼	6010B SEP	Step 6
Barium	30		3.4	0.16	mg/Kg	1	☼	6010B SEP	Step 6
Beryllium	0.11	J	0.34	0.016	mg/Kg	1	☼	6010B SEP	Step 6
Cobalt	1.2	J	3.4	0.063	mg/Kg	1	☼	6010B SEP	Step 6
Iron	4800		6.8	3.9	mg/Kg	1	☼	6010B SEP	Step 6
Li	4.0		3.4	0.20	mg/Kg	1	☼	6010B SEP	Step 6
Manganese	38		1.0	0.34	mg/Kg	1	☼	6010B SEP	Step 6
Aluminum	34000		140	22	mg/Kg	10	☼	6010B SEP	Step 7
Arsenic	0.59	J	0.68	0.18	mg/Kg	1	☼	6010B SEP	Step 7
Barium	340		34	1.6	mg/Kg	10	☼	6010B SEP	Step 7
Beryllium	0.69		0.34	0.010	mg/Kg	1	☼	6010B SEP	Step 7
Cobalt	0.90	J	6.8	0.41	mg/Kg	2	☼	6010B SEP	Step 7
Iron	6700		6.8	5.6	mg/Kg	1	☼	6010B SEP	Step 7
Li	14		3.4	0.20	mg/Kg	1	☼	6010B SEP	Step 7
Manganese	36		1.0	0.071	mg/Kg	1	☼	6010B SEP	Step 7
Mo	0.20	J	2.7	0.11	mg/Kg	1	☼	6010B SEP	Step 7
Thallium	0.74	J	4.8	0.49	mg/Kg	2	☼	6010B SEP	Step 7
Aluminum	41000		10	1.6	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Arsenic	4.0		0.50	0.13	mg/Kg	1		6010B SEP	Sum of Steps 1-7

This Detection Summary does not include radiochemical test results.

Client Sample ID: BMW-29 (30-31) (Continued) Lab Sample ID: 140-15492-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Barium	410		2.5	0.12	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Beryllium	1.1		0.25	0.0075	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Cobalt	9.2		2.5	0.023	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Iron	25000		5.0	4.1	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Li	25		2.5	0.15	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Manganese	420		0.75	0.052	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Mo	0.33	J	2.0	0.082	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Selenium	1.5		0.50	0.17	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Thallium	0.74	J	1.8	0.18	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Boron	15	J	25	13	mg/Kg	1	☼	6010B	Total/NA
Chromium	19		1.9	0.28	mg/Kg	1	☼	6010B	Total/NA
Lead	9.7		1.9	0.35	mg/Kg	1	☼	6010B	Total/NA
Aluminum	72000		140	22	mg/Kg	10	☼	6010B	Total/NA
Arsenic	3.8		0.68	0.18	mg/Kg	1	☼	6010B	Total/NA
Barium	630		34	1.6	mg/Kg	10	☼	6010B	Total/NA
Beryllium	1.2		0.34	0.010	mg/Kg	1	☼	6010B	Total/NA
Cobalt	10	J	17	1.0	mg/Kg	5	☼	6010B	Total/NA
Iron	26000		6.8	5.6	mg/Kg	1	☼	6010B	Total/NA
Lithium	31		3.4	0.20	mg/Kg	1	☼	6010B	Total/NA
Manganese	490		1.0	0.071	mg/Kg	1	☼	6010B	Total/NA
Molybdenum	0.70	J	2.7	0.11	mg/Kg	1	☼	6010B	Total/NA
Thallium	1.4	J	12	1.2	mg/Kg	5	☼	6010B	Total/NA
Hg	0.078	J	0.14	0.054	mg/Kg	1	☼	7470A	Total/NA

Client Sample ID: BMW-30 (40-41) Lab Sample ID: 140-15492-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Cobalt	0.82	J	12	0.21	mg/Kg	4	☼	6010B SEP	Step 1
Manganese	1.5	J	3.6	0.15	mg/Kg	4	☼	6010B SEP	Step 1
Aluminum	7.3	J *	36	5.7	mg/Kg	3	☼	6010B SEP	Step 2
Barium	0.52	J *	8.9	0.43	mg/Kg	3	☼	6010B SEP	Step 2
Cobalt	0.28	J	8.9	0.22	mg/Kg	3	☼	6010B SEP	Step 2
Iron	24	*	18	10	mg/Kg	3	☼	6010B SEP	Step 2
Selenium	0.67	J B	1.8	0.61	mg/Kg	3	☼	6010B SEP	Step 2
Aluminum	35		12	2.5	mg/Kg	1	☼	6010B SEP	Step 3
Arsenic	1.3		0.59	0.15	mg/Kg	1	☼	6010B SEP	Step 3
Barium	2.0	J B	3.0	0.14	mg/Kg	1	☼	6010B SEP	Step 3
Cobalt	0.28	J	3.0	0.053	mg/Kg	1	☼	6010B SEP	Step 3
Iron	190		5.9	3.4	mg/Kg	1	☼	6010B SEP	Step 3
Manganese	0.29	J B	0.89	0.032	mg/Kg	1	☼	6010B SEP	Step 3
Selenium	0.38	J B	0.59	0.20	mg/Kg	1	☼	6010B SEP	Step 3
Aluminum	1100		12	1.9	mg/Kg	1	☼	6010B SEP	Step 4
Arsenic	0.78	B	0.59	0.26	mg/Kg	1	☼	6010B SEP	Step 4
Barium	7.4		3.0	0.14	mg/Kg	1	☼	6010B SEP	Step 4
Beryllium	0.062	J	0.30	0.019	mg/Kg	1	☼	6010B SEP	Step 4

This Detection Summary does not include radiochemical test results.

Client Sample ID: BMW-30 (40-41) (Continued) Lab Sample ID: 140-15492-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Cobalt	0.50	J	3.0	0.063	mg/Kg	1	☼	6010B SEP	Step 4
Iron	1000		5.9	3.4	mg/Kg	1	☼	6010B SEP	Step 4
Li	1.7	J	3.0	0.18	mg/Kg	1	☼	6010B SEP	Step 4
Manganese	8.7		0.89	0.15	mg/Kg	1	☼	6010B SEP	Step 4
Selenium	0.76	B *	0.59	0.56	mg/Kg	1	☼	6010B SEP	Step 4
Aluminum	66	J *	180	28	mg/Kg	5	☼	6010B SEP	Step 5
Aluminum	1300		12	1.9	mg/Kg	1	☼	6010B SEP	Step 6
Arsenic	0.75		0.59	0.18	mg/Kg	1	☼	6010B SEP	Step 6
Barium	4.0		3.0	0.14	mg/Kg	1	☼	6010B SEP	Step 6
Beryllium	0.043	J	0.30	0.014	mg/Kg	1	☼	6010B SEP	Step 6
Cobalt	0.46	J	3.0	0.055	mg/Kg	1	☼	6010B SEP	Step 6
Iron	1800		5.9	3.4	mg/Kg	1	☼	6010B SEP	Step 6
Li	0.91	J	3.0	0.18	mg/Kg	1	☼	6010B SEP	Step 6
Manganese	8.0		0.89	0.30	mg/Kg	1	☼	6010B SEP	Step 6
Aluminum	37000		120	19	mg/Kg	10	☼	6010B SEP	Step 7
Arsenic	1.3		1.2	0.31	mg/Kg	2	☼	6010B SEP	Step 7
Barium	380		30	1.4	mg/Kg	10	☼	6010B SEP	Step 7
Beryllium	0.36		0.30	0.0089	mg/Kg	1	☼	6010B SEP	Step 7
Cobalt	0.76	J	5.9	0.36	mg/Kg	2	☼	6010B SEP	Step 7
Iron	2800		5.9	4.9	mg/Kg	1	☼	6010B SEP	Step 7
Li	14		3.0	0.18	mg/Kg	1	☼	6010B SEP	Step 7
Manganese	38		0.89	0.062	mg/Kg	1	☼	6010B SEP	Step 7
Thallium	0.87	J	4.2	0.43	mg/Kg	2	☼	6010B SEP	Step 7
Aluminum	39000		10	1.6	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Arsenic	4.1		0.50	0.13	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Barium	390		2.5	0.12	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Beryllium	0.46		0.25	0.0075	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Cobalt	3.1		2.5	0.023	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Iron	5800		5.0	4.1	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Li	17		2.5	0.15	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Manganese	57		0.75	0.052	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Selenium	1.8		0.50	0.17	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Thallium	0.87	J	1.8	0.18	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Chromium	7.9		1.7	0.25	mg/Kg	1	☼	6010B	Total/NA
Lead	5.9		1.7	0.32	mg/Kg	1	☼	6010B	Total/NA
Aluminum	48000		120	19	mg/Kg	10	☼	6010B	Total/NA
Arsenic	4.8		0.59	0.15	mg/Kg	1	☼	6010B	Total/NA
Barium	490		30	1.4	mg/Kg	10	☼	6010B	Total/NA
Beryllium	0.46		0.30	0.0089	mg/Kg	1	☼	6010B	Total/NA
Cobalt	3.4	J	15	0.89	mg/Kg	5	☼	6010B	Total/NA
Iron	5800		5.9	4.9	mg/Kg	1	☼	6010B	Total/NA
Lithium	18		3.0	0.18	mg/Kg	1	☼	6010B	Total/NA
Manganese	60		0.89	0.062	mg/Kg	1	☼	6010B	Total/NA

This Detection Summary does not include radiochemical test results.

Detection Summary

Client: Golder Associates Inc.
Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Client Sample ID: BMW-30 (40-41) (Continued)
Lab Sample ID: 140-15492-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Molybdenum	0.17	J	2.4	0.097	mg/Kg	1	☼	6010B	Total/NA
Selenium	1.1		0.59	0.20	mg/Kg	1	☼	6010B	Total/NA
Hg	0.054	J	0.12	0.048	mg/Kg	1	☼	7470A	Total/NA

Client Sample ID: BMW-31 (14-15)
Lab Sample ID: 140-15492-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Barium	0.58	J	12	0.57	mg/Kg	4	☼	6010B SEP	Step 1
Manganese	11		3.6	0.15	mg/Kg	4	☼	6010B SEP	Step 1
Barium	0.46	J *	8.9	0.43	mg/Kg	3	☼	6010B SEP	Step 2
Manganese	2.4	J	2.7	1.0	mg/Kg	3	☼	6010B SEP	Step 2
Selenium	0.77	J B	1.8	0.61	mg/Kg	3	☼	6010B SEP	Step 2
Aluminum	59		12	2.5	mg/Kg	1	☼	6010B SEP	Step 3
Arsenic	0.29	J	0.59	0.15	mg/Kg	1	☼	6010B SEP	Step 3
Barium	14	B	3.0	0.14	mg/Kg	1	☼	6010B SEP	Step 3
Beryllium	0.069	J	0.30	0.018	mg/Kg	1	☼	6010B SEP	Step 3
Cobalt	16		3.0	0.053	mg/Kg	1	☼	6010B SEP	Step 3
Iron	120		5.9	3.4	mg/Kg	1	☼	6010B SEP	Step 3
Manganese	260	B	0.89	0.032	mg/Kg	1	☼	6010B SEP	Step 3
Selenium	0.23	J B	0.59	0.20	mg/Kg	1	☼	6010B SEP	Step 3
Aluminum	1600		12	1.9	mg/Kg	1	☼	6010B SEP	Step 4
Arsenic	1.8	B	0.59	0.26	mg/Kg	1	☼	6010B SEP	Step 4
Barium	33		3.0	0.14	mg/Kg	1	☼	6010B SEP	Step 4
Beryllium	0.24	J	0.30	0.019	mg/Kg	1	☼	6010B SEP	Step 4
Cobalt	2.8	J	3.0	0.063	mg/Kg	1	☼	6010B SEP	Step 4
Iron	5600		5.9	3.4	mg/Kg	1	☼	6010B SEP	Step 4
Li	2.2	J	3.0	0.18	mg/Kg	1	☼	6010B SEP	Step 4
Manganese	63		0.89	0.15	mg/Kg	1	☼	6010B SEP	Step 4
Selenium	1.1	B *	0.59	0.56	mg/Kg	1	☼	6010B SEP	Step 4
Aluminum	67	J *	180	28	mg/Kg	5	☼	6010B SEP	Step 5
Barium	3.9	J *	45	2.1	mg/Kg	5	☼	6010B SEP	Step 5
Aluminum	1800		12	1.9	mg/Kg	1	☼	6010B SEP	Step 6
Arsenic	0.54	J	0.59	0.18	mg/Kg	1	☼	6010B SEP	Step 6
Barium	4.4		3.0	0.14	mg/Kg	1	☼	6010B SEP	Step 6
Beryllium	0.059	J	0.30	0.014	mg/Kg	1	☼	6010B SEP	Step 6
Cobalt	0.46	J	3.0	0.055	mg/Kg	1	☼	6010B SEP	Step 6
Iron	1700		5.9	3.4	mg/Kg	1	☼	6010B SEP	Step 6
Li	1.3	J	3.0	0.18	mg/Kg	1	☼	6010B SEP	Step 6
Manganese	10		0.89	0.30	mg/Kg	1	☼	6010B SEP	Step 6
Aluminum	26000		120	19	mg/Kg	10	☼	6010B SEP	Step 7
Arsenic	0.58	J	1.2	0.31	mg/Kg	2	☼	6010B SEP	Step 7
Barium	320		30	1.4	mg/Kg	10	☼	6010B SEP	Step 7
Beryllium	0.30		0.30	0.0089	mg/Kg	1	☼	6010B SEP	Step 7
Cobalt	0.82	J	5.9	0.36	mg/Kg	2	☼	6010B SEP	Step 7
Iron	3600		5.9	4.9	mg/Kg	1	☼	6010B SEP	Step 7
Li	15		3.0	0.18	mg/Kg	1	☼	6010B SEP	Step 7
Manganese	24		0.89	0.062	mg/Kg	1	☼	6010B SEP	Step 7
Mo	0.16	J	2.4	0.097	mg/Kg	1	☼	6010B SEP	Step 7
Thallium	0.52	J	4.2	0.43	mg/Kg	2	☼	6010B SEP	Step 7
Aluminum	30000		10	1.6	mg/Kg	1		6010B SEP	Sum of Steps 1-7

This Detection Summary does not include radiochemical test results.

Detection Summary

Client: Golder Associates Inc. Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Client Sample ID: BMW-31 (14-15) (Continued) Lab Sample ID: 140-15492-3

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Arsenic	3.2		0.50	0.13	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Barium	370		2.5	0.12	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Beryllium	0.67		0.25	0.0075	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Cobalt	20		2.5	0.023	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Iron	11000		5.0	4.1	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Li	19		2.5	0.15	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Manganese	370		0.75	0.052	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Mo	0.16	J	2.0	0.082	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Selenium	2.1		0.50	0.17	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Thallium	0.52	J	1.8	0.18	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Chromium	7.3		1.8	0.26	mg/Kg	1	☼	6010B	Total/NA
Lead	6.8		1.8	0.33	mg/Kg	1	☼	6010B	Total/NA
Aluminum	30000		120	19	mg/Kg	10	☼	6010B	Total/NA
Arsenic	3.0		0.59	0.15	mg/Kg	1	☼	6010B	Total/NA
Barium	430		30	1.4	mg/Kg	10	☼	6010B	Total/NA
Beryllium	0.66		0.30	0.0089	mg/Kg	1	☼	6010B	Total/NA
Cobalt	18		5.9	0.36	mg/Kg	2	☼	6010B	Total/NA
Iron	10000		5.9	4.9	mg/Kg	1	☼	6010B	Total/NA
Lithium	18		3.0	0.18	mg/Kg	1	☼	6010B	Total/NA
Manganese	280		0.89	0.062	mg/Kg	1	☼	6010B	Total/NA
Molybdenum	0.29	J	2.4	0.097	mg/Kg	1	☼	6010B	Total/NA
Thallium	0.67	J	4.2	0.43	mg/Kg	2	☼	6010B	Total/NA

Client Sample ID: BMW-32 (25-26) Lab Sample ID: 140-15492-4

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Manganese	1.0	J	3.6	0.15	mg/Kg	4	☼	6010B SEP	Step 1
Aluminum	17	J *	36	5.7	mg/Kg	3	☼	6010B SEP	Step 2
Iron	36	*	18	10	mg/Kg	3	☼	6010B SEP	Step 2
Selenium	0.78	J B	1.8	0.61	mg/Kg	3	☼	6010B SEP	Step 2
Aluminum	81		12	2.5	mg/Kg	1	☼	6010B SEP	Step 3
Arsenic	0.60		0.59	0.15	mg/Kg	1	☼	6010B SEP	Step 3
Barium	1.3	J B	3.0	0.14	mg/Kg	1	☼	6010B SEP	Step 3
Cobalt	0.060	J	3.0	0.053	mg/Kg	1	☼	6010B SEP	Step 3
Iron	500		5.9	3.4	mg/Kg	1	☼	6010B SEP	Step 3
Manganese	0.60	J B	0.89	0.032	mg/Kg	1	☼	6010B SEP	Step 3
Selenium	0.21	J B	0.59	0.20	mg/Kg	1	☼	6010B SEP	Step 3
Aluminum	1200		12	1.9	mg/Kg	1	☼	6010B SEP	Step 4
Arsenic	0.78	B	0.59	0.26	mg/Kg	1	☼	6010B SEP	Step 4
Barium	17		3.0	0.14	mg/Kg	1	☼	6010B SEP	Step 4
Beryllium	0.025	J	0.30	0.019	mg/Kg	1	☼	6010B SEP	Step 4
Cobalt	0.60	J	3.0	0.063	mg/Kg	1	☼	6010B SEP	Step 4
Iron	2000		5.9	3.4	mg/Kg	1	☼	6010B SEP	Step 4
Li	2.5	J	3.0	0.18	mg/Kg	1	☼	6010B SEP	Step 4

This Detection Summary does not include radiochemical test results.

Client: Golder Associates Inc. Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Client Sample ID: BMW-32 (25-26) (Continued) Lab Sample ID: 140-15492-4

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Manganese	13		0.89	0.15	mg/Kg	1	☼	6010B SEP	Step 4
Selenium	0.62	B *	0.59	0.56	mg/Kg	1	☼	6010B SEP	Step 4
Aluminum	58	J *	180	28	mg/Kg	5	☼	6010B SEP	Step 5
Barium	3.3	J *	45	2.1	mg/Kg	5	☼	6010B SEP	Step 5
Aluminum	1100		12	1.9	mg/Kg	1	☼	6010B SEP	Step 6
Arsenic	0.42	J	0.59	0.18	mg/Kg	1	☼	6010B SEP	Step 6
Barium	6.4		3.0	0.14	mg/Kg	1	☼	6010B SEP	Step 6
Beryllium	0.033	J	0.30	0.014	mg/Kg	1	☼	6010B SEP	Step 6
Cobalt	0.28	J	3.0	0.055	mg/Kg	1	☼	6010B SEP	Step 6
Iron	890		5.9	3.4	mg/Kg	1	☼	6010B SEP	Step 6
Li	1.0	J	3.0	0.18	mg/Kg	1	☼	6010B SEP	Step 6
Manganese	10		0.89	0.30	mg/Kg	1	☼	6010B SEP	Step 6
Aluminum	32000		120	19	mg/Kg	10	☼	6010B SEP	Step 7
Arsenic	1.2		0.59	0.15	mg/Kg	1	☼	6010B SEP	Step 7
Barium	430		30	1.4	mg/Kg	10	☼	6010B SEP	Step 7
Beryllium	0.50		0.30	0.0089	mg/Kg	1	☼	6010B SEP	Step 7
Cobalt	0.76	J	5.9	0.36	mg/Kg	2	☼	6010B SEP	Step 7
Iron	2800		5.9	4.9	mg/Kg	1	☼	6010B SEP	Step 7
Li	8.2		3.0	0.18	mg/Kg	1	☼	6010B SEP	Step 7
Manganese	42		0.89	0.062	mg/Kg	1	☼	6010B SEP	Step 7
Aluminum	35000		10	1.6	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Arsenic	3.0		0.50	0.13	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Barium	460		2.5	0.12	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Beryllium	0.56		0.25	0.0075	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Cobalt	1.7	J	2.5	0.023	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Iron	6200		5.0	4.1	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Li	12		2.5	0.15	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Manganese	67		0.75	0.052	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Selenium	1.6		0.50	0.17	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Chromium	7.6		1.7	0.25	mg/Kg	1	☼	6010B	Total/NA
Lead	3.9		1.7	0.31	mg/Kg	1	☼	6010B	Total/NA
Aluminum	45000		120	19	mg/Kg	10	☼	6010B	Total/NA
Arsenic	3.2		0.59	0.15	mg/Kg	1	☼	6010B	Total/NA
Barium	570		30	1.4	mg/Kg	10	☼	6010B	Total/NA
Beryllium	0.53		0.30	0.0089	mg/Kg	1	☼	6010B	Total/NA
Cobalt	1.6	J	5.9	0.36	mg/Kg	2	☼	6010B	Total/NA
Iron	5600		5.9	4.9	mg/Kg	1	☼	6010B	Total/NA
Lithium	11		3.0	0.18	mg/Kg	1	☼	6010B	Total/NA
Manganese	70		0.89	0.062	mg/Kg	1	☼	6010B	Total/NA
Molybdenum	0.33	J	2.4	0.097	mg/Kg	1	☼	6010B	Total/NA
Selenium	0.54	J	0.59	0.20	mg/Kg	1	☼	6010B	Total/NA
Thallium	0.44	J	4.2	0.43	mg/Kg	2	☼	6010B	Total/NA
Hg	0.053	J	0.12	0.047	mg/Kg	1	☼	7470A	Total/NA

This Detection Summary does not include radiochemical test results.

Detection Summary

Client: Golder Associates Inc. Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Client Sample ID: BMW-33 (38-39) Lab Sample ID: 140-15492-5

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Barium	1.5	J	13	0.62	mg/Kg	4	☼	6010B SEP	Step 1
Cobalt	0.29	J	13	0.23	mg/Kg	4	☼	6010B SEP	Step 1
Manganese	17		3.9	0.16	mg/Kg	4	☼	6010B SEP	Step 1
Aluminum	10	J *	39	6.2	mg/Kg	3	☼	6010B SEP	Step 2
Barium	0.90	J *	9.7	0.46	mg/Kg	3	☼	6010B SEP	Step 2
Cobalt	0.74	J	9.7	0.24	mg/Kg	3	☼	6010B SEP	Step 2
Iron	14	J *	19	11	mg/Kg	3	☼	6010B SEP	Step 2
Manganese	25		2.9	1.1	mg/Kg	3	☼	6010B SEP	Step 2
Aluminum	94		13	2.7	mg/Kg	1	☼	6010B SEP	Step 3
Arsenic	0.47	J	0.65	0.17	mg/Kg	1	☼	6010B SEP	Step 3
Barium	7.5	B	3.2	0.15	mg/Kg	1	☼	6010B SEP	Step 3
Beryllium	0.028	J	0.32	0.019	mg/Kg	1	☼	6010B SEP	Step 3
Cobalt	1.9	J	3.2	0.058	mg/Kg	1	☼	6010B SEP	Step 3
Iron	510		6.5	3.7	mg/Kg	1	☼	6010B SEP	Step 3
Manganese	85	B	0.97	0.035	mg/Kg	1	☼	6010B SEP	Step 3
Selenium	0.25	J B	0.65	0.22	mg/Kg	1	☼	6010B SEP	Step 3
Aluminum	1800		13	2.1	mg/Kg	1	☼	6010B SEP	Step 4
Arsenic	1.2	B	0.65	0.28	mg/Kg	1	☼	6010B SEP	Step 4
Barium	20		3.2	0.15	mg/Kg	1	☼	6010B SEP	Step 4
Beryllium	0.20	J	0.32	0.021	mg/Kg	1	☼	6010B SEP	Step 4
Cobalt	1.5	J	3.2	0.068	mg/Kg	1	☼	6010B SEP	Step 4
Iron	4900		6.5	3.7	mg/Kg	1	☼	6010B SEP	Step 4
Li	2.1	J	3.2	0.19	mg/Kg	1	☼	6010B SEP	Step 4
Manganese	55		0.97	0.17	mg/Kg	1	☼	6010B SEP	Step 4
Selenium	0.71	B *	0.65	0.61	mg/Kg	1	☼	6010B SEP	Step 4
Aluminum	64	J *	190	30	mg/Kg	5	☼	6010B SEP	Step 5
Barium	4.1	J *	48	2.3	mg/Kg	5	☼	6010B SEP	Step 5
Aluminum	3400		13	2.1	mg/Kg	1	☼	6010B SEP	Step 6
Arsenic	0.85		0.65	0.19	mg/Kg	1	☼	6010B SEP	Step 6
Barium	13		3.2	0.15	mg/Kg	1	☼	6010B SEP	Step 6
Beryllium	0.11	J	0.32	0.015	mg/Kg	1	☼	6010B SEP	Step 6
Cobalt	1.1	J	3.2	0.059	mg/Kg	1	☼	6010B SEP	Step 6
Iron	3900		6.5	3.7	mg/Kg	1	☼	6010B SEP	Step 6
Li	2.1	J	3.2	0.19	mg/Kg	1	☼	6010B SEP	Step 6
Manganese	22		0.97	0.32	mg/Kg	1	☼	6010B SEP	Step 6
Aluminum	48000		130	21	mg/Kg	10	☼	6010B SEP	Step 7
Arsenic	0.64	J	0.65	0.17	mg/Kg	1	☼	6010B SEP	Step 7
Barium	550		32	1.5	mg/Kg	10	☼	6010B SEP	Step 7
Beryllium	0.69		0.32	0.0097	mg/Kg	1	☼	6010B SEP	Step 7
Cobalt	0.57	J	6.5	0.39	mg/Kg	2	☼	6010B SEP	Step 7
Iron	6100		6.5	5.3	mg/Kg	1	☼	6010B SEP	Step 7
Li	9.1		3.2	0.19	mg/Kg	1	☼	6010B SEP	Step 7
Manganese	30		0.97	0.067	mg/Kg	1	☼	6010B SEP	Step 7
Aluminum	54000		10	1.6	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Arsenic	3.2		0.50	0.13	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Barium	590		2.5	0.12	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Beryllium	1.0		0.25	0.0075	mg/Kg	1		6010B SEP	Sum of Steps 1-7

This Detection Summary does not include radiochemical test results.

Client Sample ID: BMW-33 (38-39) (Continued) Lab Sample ID: 140-15492-5

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Cobalt	6.1		2.5	0.023	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Iron	15000		5.0	4.1	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Li	13		2.5	0.15	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Manganese	230		0.75	0.052	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Selenium	0.95		0.50	0.17	mg/Kg	1		6010B SEP	Sum of Steps 1-7
Chromium	14		1.8	0.27	mg/Kg	1	☼	6010B	Total/NA
Lead	5.9		1.8	0.34	mg/Kg	1	☼	6010B	Total/NA
Aluminum	73000		130	21	mg/Kg	10	☼	6010B	Total/NA
Arsenic	3.2		0.65	0.17	mg/Kg	1	☼	6010B	Total/NA
Barium	830		32	1.5	mg/Kg	10	☼	6010B	Total/NA
Beryllium	1.0		0.32	0.0097	mg/Kg	1	☼	6010B	Total/NA
Cobalt	4.6	J	16	0.97	mg/Kg	5	☼	6010B	Total/NA
Iron	13000		6.5	5.3	mg/Kg	1	☼	6010B	Total/NA
Lithium	14		3.2	0.19	mg/Kg	1	☼	6010B	Total/NA
Manganese	130		0.97	0.067	mg/Kg	1	☼	6010B	Total/NA
Molybdenum	0.22	J	2.6	0.11	mg/Kg	1	☼	6010B	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: BMW-29 (30-31)
Lab Sample ID: 140-15492-1

Date Collected: 05/31/19 16:45
Matrix: Solid
Date Received: 06/05/19 09:20
Percent Solids: 73.5

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		54	8.7	mg/Kg	☼	06/29/19 08:00	07/11/19 13:09	4
Antimony	ND		16	1.5	mg/Kg	☼	06/29/19 08:00	07/11/19 13:09	4
Arsenic	ND		2.7	0.71	mg/Kg	☼	06/29/19 08:00	07/11/19 13:09	4
Barium	ND		14	0.65	mg/Kg	☼	06/29/19 08:00	07/11/19 13:09	4
Beryllium	ND		1.4	0.42	mg/Kg	☼	06/29/19 08:00	07/11/19 13:09	4
Cobalt	ND		14	0.24	mg/Kg	☼	06/29/19 08:00	07/11/19 13:09	4
Iron	ND		27	16	mg/Kg	☼	06/29/19 08:00	07/11/19 13:09	4
Li	ND		14	0.82	mg/Kg	☼	06/29/19 08:00	07/11/19 13:09	4
Manganese	**3.8**	**J**	4.1	0.17	mg/Kg	☼	06/29/19 08:00	07/11/19 13:09	4
Mo	ND		11	0.45	mg/Kg	☼	06/29/19 08:00	07/11/19 13:09	4
Selenium	ND		2.7	0.93	mg/Kg	☼	06/29/19 08:00	07/11/19 13:09	4
Thallium	ND		9.5	1.1	mg/Kg	☼	06/29/19 08:00	07/11/19 13:09	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**16**	**J ***	41	6.5	mg/Kg	☼	06/30/19 08:00	07/11/19 14:53	3
Antimony	ND		12	1.1	mg/Kg	☼	06/30/19 08:00	07/11/19 14:53	3
Arsenic	ND		2.0	0.53	mg/Kg	☼	06/30/19 08:00	07/11/19 14:53	3
Barium	**1.1**	**J ***	10	0.49	mg/Kg	☼	06/30/19 08:00	07/11/19 14:53	3
Beryllium	ND	*	1.0	0.065	mg/Kg	☼	06/30/19 08:00	07/11/19 14:53	3
Cobalt	**1.4**	**J**	10	0.26	mg/Kg	☼	06/30/19 08:00	07/11/19 14:53	3
Iron	**48**	*****	20	12	mg/Kg	☼	06/30/19 08:00	07/11/19 14:53	3
Li	ND		10	0.61	mg/Kg	☼	06/30/19 08:00	07/11/19 14:53	3
Manganese	**35**		3.1	1.1	mg/Kg	☼	06/30/19 08:00	07/11/19 14:53	3
Mo	ND		8.2	0.33	mg/Kg	☼	06/30/19 08:00	07/11/19 14:53	3
Selenium	**1.2**	**J B**	2.0	0.69	mg/Kg	☼	06/30/19 08:00	07/11/19 14:53	3
Thallium	ND		7.1	0.86	mg/Kg	☼	06/30/19 08:00	07/11/19 14:53	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**170**		14	2.9	mg/Kg	☼	07/02/19 08:00	07/11/19 16:42	1
Antimony	ND		4.1	0.38	mg/Kg	☼	07/02/19 08:00	07/11/19 16:42	1
Arsenic	**1.4**		0.68	0.18	mg/Kg	☼	07/02/19 08:00	07/11/19 16:42	1
Barium	**4.3**	**B**	3.4	0.16	mg/Kg	☼	07/02/19 08:00	07/11/19 16:42	1
Beryllium	**0.11**	**J**	0.34	0.020	mg/Kg	☼	07/02/19 08:00	07/11/19 16:42	1
Cobalt	**1.5**	**J**	3.4	0.061	mg/Kg	☼	07/02/19 08:00	07/11/19 16:42	1
Iron	**4200**		6.8	3.9	mg/Kg	☼	07/02/19 08:00	07/11/19 16:42	1
Li	ND		3.4	0.20	mg/Kg	☼	07/02/19 08:00	07/11/19 16:42	1
Manganese	**95**	**B**	1.0	0.037	mg/Kg	☼	07/02/19 08:00	07/11/19 16:42	1
Mo	**0.14**	**J**	2.7	0.11	mg/Kg	☼	07/02/19 08:00	07/11/19 16:42	1
Selenium	**0.28**	**J B**	0.68	0.23	mg/Kg	☼	07/02/19 08:00	07/11/19 16:42	1
Thallium	ND		2.4	0.29	mg/Kg	☼	07/02/19 08:00	07/11/19 16:42	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**2600**		14	2.2	mg/Kg	☼	07/03/19 08:00	07/11/19 18:09	1
Antimony	ND		4.1	0.61	mg/Kg	☼	07/03/19 08:00	07/11/19 18:09	1
Arsenic	**0.87**	**B**	0.68	0.30	mg/Kg	☼	07/03/19 08:00	07/11/19 18:09	1
Barium	**19**		3.4	0.16	mg/Kg	☼	07/03/19 08:00	07/11/19 18:09	1
Beryllium	**0.23**	**J**	0.34	0.022	mg/Kg	☼	07/03/19 08:00	07/11/19 18:09	1

Client Sample ID: BMW-29 (30-31) | **Lab Sample ID: 140-15492-1**
Date Collected: 05/31/19 16:45 | **Matrix: Solid**
Date Received: 06/05/19 09:20 | **Percent Solids: 73.5**

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cobalt	**3.2**	**J**	3.4	0.072	mg/Kg	☼	07/03/19 08:00	07/11/19 18:09	1
Iron	**8300**		6.8	3.9	mg/Kg	☼	07/03/19 08:00	07/11/19 18:09	1
Li	**6.7**		3.4	0.20	mg/Kg	☼	07/03/19 08:00	07/11/19 18:09	1
Manganese	**180**		1.0	0.18	mg/Kg	☼	07/03/19 08:00	07/11/19 18:09	1
Mo	ND		2.7	0.11	mg/Kg	☼	07/03/19 08:00	07/11/19 18:09	1
Selenium	ND	*	0.68	0.64	mg/Kg	☼	07/03/19 08:00	07/11/19 18:09	1
Thallium	ND		2.4	0.39	mg/Kg	☼	07/03/19 08:00	07/11/19 18:09	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**500**	*****	200	32	mg/Kg	☼	07/10/19 08:00	07/12/19 12:16	5
Antimony	ND		61	5.7	mg/Kg	☼	07/10/19 08:00	07/12/19 12:16	5
Arsenic	ND		10	2.6	mg/Kg	☼	07/10/19 08:00	07/12/19 12:16	5
Barium	**17**	**J ***	51	2.4	mg/Kg	☼	07/10/19 08:00	07/12/19 12:16	5
Beryllium	ND	*	5.1	0.43	mg/Kg	☼	07/10/19 08:00	07/12/19 12:16	5
Cobalt	**1.0**	**J ***	51	0.82	mg/Kg	☼	07/10/19 08:00	07/12/19 12:16	5
Iron	**530**	*****	100	60	mg/Kg	☼	07/10/19 08:00	07/12/19 12:16	5
Li	ND		51	3.0	mg/Kg	☼	07/10/19 08:00	07/12/19 12:16	5
Manganese	**33**	*****	15	2.5	mg/Kg	☼	07/10/19 08:00	07/12/19 12:16	5
Mo	ND		41	1.7	mg/Kg	☼	07/10/19 08:00	07/12/19 12:16	5
Selenium	ND		10	3.5	mg/Kg	☼	07/10/19 08:00	07/12/19 12:16	5
Thallium	ND	*	36	4.8	mg/Kg	☼	07/10/19 08:00	07/12/19 12:16	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**3500**		14	2.2	mg/Kg	☼	07/10/19 08:00	07/12/19 14:00	1
Antimony	ND		4.1	0.38	mg/Kg	☼	07/10/19 08:00	07/12/19 14:00	1
Arsenic	**1.1**		0.68	0.20	mg/Kg	☼	07/10/19 08:00	07/12/19 14:00	1
Barium	**30**		3.4	0.16	mg/Kg	☼	07/10/19 08:00	07/12/19 14:00	1
Beryllium	**0.11**	**J**	0.34	0.016	mg/Kg	☼	07/10/19 08:00	07/12/19 14:00	1
Cobalt	**1.2**	**J**	3.4	0.063	mg/Kg	☼	07/10/19 08:00	07/12/19 14:00	1
Iron	**4800**		6.8	3.9	mg/Kg	☼	07/10/19 08:00	07/12/19 14:00	1
Li	**4.0**		3.4	0.20	mg/Kg	☼	07/10/19 08:00	07/12/19 14:00	1
Manganese	**38**		1.0	0.34	mg/Kg	☼	07/10/19 08:00	07/12/19 14:00	1
Mo	ND		2.7	0.13	mg/Kg	☼	07/10/19 08:00	07/12/19 14:00	1
Selenium	ND		0.68	0.23	mg/Kg	☼	07/10/19 08:00	07/12/19 14:00	1
Thallium	ND		2.4	0.29	mg/Kg	☼	07/10/19 08:00	07/12/19 14:00	1

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**34000**		140	22	mg/Kg	☼	07/12/19 09:08	07/15/19 13:29	10
Antimony	ND		4.1	0.19	mg/Kg	☼	07/12/19 09:08	07/15/19 12:16	1
Arsenic	**0.59**	**J**	0.68	0.18	mg/Kg	☼	07/12/19 09:08	07/15/19 12:16	1
Barium	**340**		34	1.6	mg/Kg	☼	07/12/19 09:08	07/15/19 13:29	10
Beryllium	**0.69**		0.34	0.010	mg/Kg	☼	07/12/19 09:08	07/15/19 12:16	1
Cobalt	**0.90**	**J**	6.8	0.41	mg/Kg	☼	07/12/19 09:08	07/15/19 17:32	2
Iron	**6700**		6.8	5.6	mg/Kg	☼	07/12/19 09:08	07/15/19 12:16	1
Li	**14**		3.4	0.20	mg/Kg	☼	07/12/19 09:08	07/15/19 12:16	1
Manganese	**36**		1.0	0.071	mg/Kg	☼	07/12/19 09:08	07/15/19 12:16	1
Mo	**0.20**	**J**	2.7	0.11	mg/Kg	☼	07/12/19 09:08	07/15/19 12:16	1

Client Sample Results

Client: Golder Associates Inc. Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Client Sample ID: BMW-29 (30-31) Lab Sample ID: 140-15492-1
Date Collected: 05/31/19 16:45 **Matrix: Solid**
Date Received: 06/05/19 09:20 **Percent Solids: 73.5**

Method: 6010B SEP - SEP Metals (ICP) - Step 7 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	ND		0.68	0.23	mg/Kg	☼	07/12/19 09:08	07/15/19 12:16	1
Thallium	0.74	J	4.8	0.49	mg/Kg	☼	07/12/19 09:08	07/15/19 17:32	2

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	41000		10	1.6	mg/Kg			07/16/19 17:31	1
Antimony	ND		3.0	0.14	mg/Kg			07/16/19 17:31	1
Arsenic	4.0		0.50	0.13	mg/Kg			07/16/19 17:31	1
Barium	410		2.5	0.12	mg/Kg			07/16/19 17:31	1
Beryllium	1.1		0.25	0.0075	mg/Kg			07/16/19 17:31	1
Cobalt	9.2		2.5	0.023	mg/Kg			07/16/19 17:31	1
Iron	25000		5.0	4.1	mg/Kg			07/16/19 17:31	1
Li	25		2.5	0.15	mg/Kg			07/16/19 17:31	1
Manganese	420		0.75	0.052	mg/Kg			07/16/19 17:31	1
Mo	0.33	J	2.0	0.082	mg/Kg			07/16/19 17:31	1
Selenium	1.5		0.50	0.17	mg/Kg			07/16/19 17:31	1
Thallium	0.74	J	1.8	0.18	mg/Kg			07/16/19 17:31	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	15	J	25	13	mg/Kg	☼	06/26/19 08:00	07/10/19 12:23	1
Chromium	19		1.9	0.28	mg/Kg	☼	06/26/19 08:00	07/10/19 12:23	1
Lead	9.7		1.9	0.35	mg/Kg	☼	06/26/19 08:00	07/10/19 12:23	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	72000		140	22	mg/Kg	☼	06/11/19 08:00	07/15/19 16:20	10
Antimony	ND		4.1	0.19	mg/Kg	☼	06/11/19 08:00	07/15/19 14:46	1
Arsenic	3.8		0.68	0.18	mg/Kg	☼	06/11/19 08:00	07/15/19 14:46	1
Barium	630		34	1.6	mg/Kg	☼	06/11/19 08:00	07/15/19 16:20	10
Beryllium	1.2		0.34	0.010	mg/Kg	☼	06/11/19 08:00	07/15/19 14:46	1
Cobalt	10	J	17	1.0	mg/Kg	☼	06/11/19 08:00	07/15/19 18:48	5
Iron	26000		6.8	5.6	mg/Kg	☼	06/11/19 08:00	07/15/19 14:46	1
Lithium	31		3.4	0.20	mg/Kg	☼	06/11/19 08:00	07/15/19 14:46	1
Manganese	490		1.0	0.071	mg/Kg	☼	06/11/19 08:00	07/15/19 14:46	1
Molybdenum	0.70	J	2.7	0.11	mg/Kg	☼	06/11/19 08:00	07/15/19 14:46	1
Selenium	ND		0.68	0.23	mg/Kg	☼	06/11/19 08:00	07/15/19 14:46	1
Thallium	1.4	J	12	1.2	mg/Kg	☼	06/11/19 08:00	07/15/19 18:48	5

Method: 7470A - SEP Mercury (CVAA) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Hg	0.078	J	0.14	0.054	mg/Kg	☼	06/11/19 08:00	06/16/19 14:19	1

Client Sample Results

Client: Golder Associates Inc. Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Client Sample ID: BMW-30 (40-41) Lab Sample ID: 140-15492-2

Date Collected: 05/30/19 15:55 **Matrix: Solid**
Date Received: 06/05/19 09:20 **Percent Solids: 84.1**

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		48	7.6	mg/Kg	☼	06/29/19 08:00	07/11/19 13:14	4
Antimony	ND		14	1.3	mg/Kg	☼	06/29/19 08:00	07/11/19 13:14	4
Arsenic	ND		2.4	0.62	mg/Kg	☼	06/29/19 08:00	07/11/19 13:14	4
Barium	ND		12	0.57	mg/Kg	☼	06/29/19 08:00	07/11/19 13:14	4
Beryllium	ND		1.2	0.37	mg/Kg	☼	06/29/19 08:00	07/11/19 13:14	4
Cobalt	**0.82**	**J**	12	0.21	mg/Kg	☼	06/29/19 08:00	07/11/19 13:14	4
Iron	ND		24	14	mg/Kg	☼	06/29/19 08:00	07/11/19 13:14	4
Li	ND		12	0.71	mg/Kg	☼	06/29/19 08:00	07/11/19 13:14	4
Manganese	**1.5**	**J**	3.6	0.15	mg/Kg	☼	06/29/19 08:00	07/11/19 13:14	4
Mo	ND		9.5	0.39	mg/Kg	☼	06/29/19 08:00	07/11/19 13:14	4
Selenium	ND		2.4	0.81	mg/Kg	☼	06/29/19 08:00	07/11/19 13:14	4
Thallium	ND		8.3	1.0	mg/Kg	☼	06/29/19 08:00	07/11/19 13:14	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**7.3**	**J ***	36	5.7	mg/Kg	☼	06/30/19 08:00	07/11/19 14:58	3
Antimony	ND		11	1.0	mg/Kg	☼	06/30/19 08:00	07/11/19 14:58	3
Arsenic	ND		1.8	0.46	mg/Kg	☼	06/30/19 08:00	07/11/19 14:58	3
Barium	**0.52**	**J ***	8.9	0.43	mg/Kg	☼	06/30/19 08:00	07/11/19 14:58	3
Beryllium	ND	*	0.89	0.057	mg/Kg	☼	06/30/19 08:00	07/11/19 14:58	3
Cobalt	**0.28**	**J**	8.9	0.22	mg/Kg	☼	06/30/19 08:00	07/11/19 14:58	3
Iron	**24**	*****	18	10	mg/Kg	☼	06/30/19 08:00	07/11/19 14:58	3
Li	ND		8.9	0.53	mg/Kg	☼	06/30/19 08:00	07/11/19 14:58	3
Manganese	ND		2.7	1.0	mg/Kg	☼	06/30/19 08:00	07/11/19 14:58	3
Mo	ND		7.1	0.29	mg/Kg	☼	06/30/19 08:00	07/11/19 14:58	3
Selenium	**0.67**	**J B**	1.8	0.61	mg/Kg	☼	06/30/19 08:00	07/11/19 14:58	3
Thallium	ND		6.2	0.75	mg/Kg	☼	06/30/19 08:00	07/11/19 14:58	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**35**		12	2.5	mg/Kg	☼	07/02/19 08:00	07/11/19 16:47	1
Antimony	ND		3.6	0.33	mg/Kg	☼	07/02/19 08:00	07/11/19 16:47	1
Arsenic	**1.3**		0.59	0.15	mg/Kg	☼	07/02/19 08:00	07/11/19 16:47	1
Barium	**2.0**	**J B**	3.0	0.14	mg/Kg	☼	07/02/19 08:00	07/11/19 16:47	1
Beryllium	ND		0.30	0.018	mg/Kg	☼	07/02/19 08:00	07/11/19 16:47	1
Cobalt	**0.28**	**J**	3.0	0.053	mg/Kg	☼	07/02/19 08:00	07/11/19 16:47	1
Iron	**190**		5.9	3.4	mg/Kg	☼	07/02/19 08:00	07/11/19 16:47	1
Li	ND		3.0	0.18	mg/Kg	☼	07/02/19 08:00	07/11/19 16:47	1
Manganese	**0.29**	**J B**	0.89	0.032	mg/Kg	☼	07/02/19 08:00	07/11/19 16:47	1
Mo	ND		2.4	0.097	mg/Kg	☼	07/02/19 08:00	07/11/19 16:47	1
Selenium	**0.38**	**J B**	0.59	0.20	mg/Kg	☼	07/02/19 08:00	07/11/19 16:47	1
Thallium	ND		2.1	0.25	mg/Kg	☼	07/02/19 08:00	07/11/19 16:47	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**1100**		12	1.9	mg/Kg	☼	07/03/19 08:00	07/11/19 18:15	1
Antimony	ND		3.6	0.53	mg/Kg	☼	07/03/19 08:00	07/11/19 18:15	1
Arsenic	**0.78**	**B**	0.59	0.26	mg/Kg	☼	07/03/19 08:00	07/11/19 18:15	1
Barium	**7.4**		3.0	0.14	mg/Kg	☼	07/03/19 08:00	07/11/19 18:15	1
Beryllium	**0.062**	**J**	0.30	0.019	mg/Kg	☼	07/03/19 08:00	07/11/19 18:15	1

Client: Golder Associates Inc.
Project/Site: Martin Lake A1 Area LF SEP + Totals

Job ID: 140-15492-1

Client Sample ID: BMW-30 (40-41)

Date Collected: 05/30/19 15:55
Date Received: 06/05/19 09:20

Lab Sample ID: 140-15492-2
Matrix: Solid
Percent Solids: 84.1

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cobalt	0.50	J	3.0	0.063	mg/Kg	☼	07/03/19 08:00	07/11/19 18:15	1
Iron	1000		5.9	3.4	mg/Kg	☼	07/03/19 08:00	07/11/19 18:15	1
Li	1.7	J	3.0	0.18	mg/Kg	☼	07/03/19 08:00	07/11/19 18:15	1
Manganese	8.7		0.89	0.15	mg/Kg	☼	07/03/19 08:00	07/11/19 18:15	1
Mo	ND		2.4	0.097	mg/Kg	☼	07/03/19 08:00	07/11/19 18:15	1
Selenium	0.76	B *	0.59	0.56	mg/Kg	☼	07/03/19 08:00	07/11/19 18:15	1
Thallium	ND		2.1	0.34	mg/Kg	☼	07/03/19 08:00	07/11/19 18:15	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	66	J *	180	28	mg/Kg	☼	07/10/19 08:00	07/12/19 12:21	5
Antimony	ND		53	5.0	mg/Kg	☼	07/10/19 08:00	07/12/19 12:21	5
Arsenic	ND		8.9	2.3	mg/Kg	☼	07/10/19 08:00	07/12/19 12:21	5
Barium	ND	*	45	2.1	mg/Kg	☼	07/10/19 08:00	07/12/19 12:21	5
Beryllium	ND	*	4.5	0.37	mg/Kg	☼	07/10/19 08:00	07/12/19 12:21	5
Cobalt	ND	*	45	0.71	mg/Kg	☼	07/10/19 08:00	07/12/19 12:21	5
Iron	ND	*	89	52	mg/Kg	☼	07/10/19 08:00	07/12/19 12:21	5
Li	ND		45	2.6	mg/Kg	☼	07/10/19 08:00	07/12/19 12:21	5
Manganese	ND	*	13	2.2	mg/Kg	☼	07/10/19 08:00	07/12/19 12:21	5
Mo	ND		36	1.5	mg/Kg	☼	07/10/19 08:00	07/12/19 12:21	5
Selenium	ND		8.9	3.1	mg/Kg	☼	07/10/19 08:00	07/12/19 12:21	5
Thallium	ND	*	31	4.2	mg/Kg	☼	07/10/19 08:00	07/12/19 12:21	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	1300		12	1.9	mg/Kg	☼	07/10/19 08:00	07/12/19 14:05	1
Antimony	ND		3.6	0.33	mg/Kg	☼	07/10/19 08:00	07/12/19 14:05	1
Arsenic	0.75		0.59	0.18	mg/Kg	☼	07/10/19 08:00	07/12/19 14:05	1
Barium	4.0		3.0	0.14	mg/Kg	☼	07/10/19 08:00	07/12/19 14:05	1
Beryllium	0.043	J	0.30	0.014	mg/Kg	☼	07/10/19 08:00	07/12/19 14:05	1
Cobalt	0.46	J	3.0	0.055	mg/Kg	☼	07/10/19 08:00	07/12/19 14:05	1
Iron	1800		5.9	3.4	mg/Kg	☼	07/10/19 08:00	07/12/19 14:05	1
Li	0.91	J	3.0	0.18	mg/Kg	☼	07/10/19 08:00	07/12/19 14:05	1
Manganese	8.0		0.89	0.30	mg/Kg	☼	07/10/19 08:00	07/12/19 14:05	1
Mo	ND		2.4	0.12	mg/Kg	☼	07/10/19 08:00	07/12/19 14:05	1
Selenium	ND		0.59	0.20	mg/Kg	☼	07/10/19 08:00	07/12/19 14:05	1
Thallium	ND		2.1	0.25	mg/Kg	☼	07/10/19 08:00	07/12/19 14:05	1

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	37000		120	19	mg/Kg	☼	07/12/19 09:08	07/15/19 13:34	10
Antimony	ND		3.6	0.17	mg/Kg	☼	07/12/19 09:08	07/15/19 12:21	1
Arsenic	1.3		1.2	0.31	mg/Kg	☼	07/12/19 09:08	07/15/19 17:37	2
Barium	380		30	1.4	mg/Kg	☼	07/12/19 09:08	07/15/19 13:34	10
Beryllium	0.36		0.30	0.0089	mg/Kg	☼	07/12/19 09:08	07/15/19 12:21	1
Cobalt	0.76	J	5.9	0.36	mg/Kg	☼	07/12/19 09:08	07/15/19 17:37	2
Iron	2800		5.9	4.9	mg/Kg	☼	07/12/19 09:08	07/15/19 12:21	1
Li	14		3.0	0.18	mg/Kg	☼	07/12/19 09:08	07/15/19 12:21	1
Manganese	38		0.89	0.062	mg/Kg	☼	07/12/19 09:08	07/15/19 12:21	1
Mo	ND		2.4	0.097	mg/Kg	☼	07/12/19 09:08	07/15/19 12:21	1

Client Sample ID: BMW-30 (40-41)
Lab Sample ID: 140-15492-2
Date Collected: 05/30/19 15:55 **Matrix: Solid**
Date Received: 06/05/19 09:20 **Percent Solids: 84.1**

Method: 6010B SEP - SEP Metals (ICP) - Step 7 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	ND		1.2	0.40	mg/Kg	☼	07/12/19 09:08	07/15/19 17:37	2
Thallium	**0.87**	**J**	4.2	0.43	mg/Kg	☼	07/12/19 09:08	07/15/19 17:37	2

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**39000**		10	1.6	mg/Kg			07/16/19 17:31	1
Antimony	ND		3.0	0.14	mg/Kg			07/16/19 17:31	1
Arsenic	**4.1**		0.50	0.13	mg/Kg			07/16/19 17:31	1
Barium	**390**		2.5	0.12	mg/Kg			07/16/19 17:31	1
Beryllium	**0.46**		0.25	0.0075	mg/Kg			07/16/19 17:31	1
Cobalt	**3.1**		2.5	0.023	mg/Kg			07/16/19 17:31	1
Iron	**5800**		5.0	4.1	mg/Kg			07/16/19 17:31	1
Li	**17**		2.5	0.15	mg/Kg			07/16/19 17:31	1
Manganese	**57**		0.75	0.052	mg/Kg			07/16/19 17:31	1
Mo	ND		2.0	0.082	mg/Kg			07/16/19 17:31	1
Selenium	**1.8**		0.50	0.17	mg/Kg			07/16/19 17:31	1
Thallium	**0.87**	**J**	1.8	0.18	mg/Kg			07/16/19 17:31	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	ND		23	11	mg/Kg	☼	06/26/19 08:00	07/10/19 12:28	1
Chromium	**7.9**		1.7	0.25	mg/Kg	☼	06/26/19 08:00	07/10/19 12:28	1
Lead	**5.9**		1.7	0.32	mg/Kg	☼	06/26/19 08:00	07/10/19 12:28	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**48000**		120	19	mg/Kg	☼	06/11/19 08:00	07/15/19 16:25	10
Antimony	ND		3.6	0.17	mg/Kg	☼	06/11/19 08:00	07/15/19 15:07	1
Arsenic	**4.8**		0.59	0.15	mg/Kg	☼	06/11/19 08:00	07/15/19 15:07	1
Barium	**490**		30	1.4	mg/Kg	☼	06/11/19 08:00	07/15/19 16:25	10
Beryllium	**0.46**		0.30	0.0089	mg/Kg	☼	06/11/19 08:00	07/15/19 15:07	1
Cobalt	**3.4**	**J**	15	0.89	mg/Kg	☼	06/11/19 08:00	07/15/19 18:53	5
Iron	**5800**		5.9	4.9	mg/Kg	☼	06/11/19 08:00	07/15/19 15:07	1
Lithium	**18**		3.0	0.18	mg/Kg	☼	06/11/19 08:00	07/15/19 15:07	1
Manganese	**60**		0.89	0.062	mg/Kg	☼	06/11/19 08:00	07/15/19 15:07	1
Molybdenum	**0.17**	**J**	2.4	0.097	mg/Kg	☼	06/11/19 08:00	07/15/19 15:07	1
Selenium	**1.1**		0.59	0.20	mg/Kg	☼	06/11/19 08:00	07/15/19 15:07	1
Thallium	ND		10	1.1	mg/Kg	☼	06/11/19 08:00	07/15/19 18:53	5

Method: 7470A - SEP Mercury (CVAA) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Hg	**0.054**	**J**	0.12	0.048	mg/Kg	☼	06/11/19 08:00	06/16/19 14:21	1

Client Sample Results

Client: Golder Associates Inc. Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Client Sample ID: BMW-31 (14-15) Lab Sample ID: 140-15492-3

Date Collected: 05/31/19 11:15 **Matrix: Solid**
Date Received: 06/05/19 09:20 **Percent Solids: 84.2**

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		47	7.6	mg/Kg	☼	06/29/19 08:00	07/11/19 13:35	4
Antimony	ND		14	1.3	mg/Kg	☼	06/29/19 08:00	07/11/19 13:35	4
Arsenic	ND		2.4	0.62	mg/Kg	☼	06/29/19 08:00	07/11/19 13:35	4
Barium	**0.58**	**J**	12	0.57	mg/Kg	☼	06/29/19 08:00	07/11/19 13:35	4
Beryllium	ND		1.2	0.37	mg/Kg	☼	06/29/19 08:00	07/11/19 13:35	4
Cobalt	ND		12	0.21	mg/Kg	☼	06/29/19 08:00	07/11/19 13:35	4
Iron	ND		24	14	mg/Kg	☼	06/29/19 08:00	07/11/19 13:35	4
Li	ND		12	0.71	mg/Kg	☼	06/29/19 08:00	07/11/19 13:35	4
Manganese	**11**		3.6	0.15	mg/Kg	☼	06/29/19 08:00	07/11/19 13:35	4
Mo	ND		9.5	0.39	mg/Kg	☼	06/29/19 08:00	07/11/19 13:35	4
Selenium	ND		2.4	0.81	mg/Kg	☼	06/29/19 08:00	07/11/19 13:35	4
Thallium	ND		8.3	1.0	mg/Kg	☼	06/29/19 08:00	07/11/19 13:35	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND	*	36	5.7	mg/Kg	☼	06/30/19 08:00	07/11/19 15:03	3
Antimony	ND		11	1.0	mg/Kg	☼	06/30/19 08:00	07/11/19 15:03	3
Arsenic	ND		1.8	0.46	mg/Kg	☼	06/30/19 08:00	07/11/19 15:03	3
Barium	**0.46**	**J ***	8.9	0.43	mg/Kg	☼	06/30/19 08:00	07/11/19 15:03	3
Beryllium	ND	*	0.89	0.057	mg/Kg	☼	06/30/19 08:00	07/11/19 15:03	3
Cobalt	ND		8.9	0.22	mg/Kg	☼	06/30/19 08:00	07/11/19 15:03	3
Iron	ND	*	18	10	mg/Kg	☼	06/30/19 08:00	07/11/19 15:03	3
Li	ND		8.9	0.53	mg/Kg	☼	06/30/19 08:00	07/11/19 15:03	3
Manganese	**2.4**	**J**	2.7	1.0	mg/Kg	☼	06/30/19 08:00	07/11/19 15:03	3
Mo	ND		7.1	0.29	mg/Kg	☼	06/30/19 08:00	07/11/19 15:03	3
Selenium	**0.77**	**J B**	1.8	0.61	mg/Kg	☼	06/30/19 08:00	07/11/19 15:03	3
Thallium	ND		6.2	0.75	mg/Kg	☼	06/30/19 08:00	07/11/19 15:03	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**59**		12	2.5	mg/Kg	☼	07/02/19 08:00	07/11/19 16:52	1
Antimony	ND		3.6	0.33	mg/Kg	☼	07/02/19 08:00	07/11/19 16:52	1
Arsenic	**0.29**	**J**	0.59	0.15	mg/Kg	☼	07/02/19 08:00	07/11/19 16:52	1
Barium	**14**	**B**	3.0	0.14	mg/Kg	☼	07/02/19 08:00	07/11/19 16:52	1
Beryllium	**0.069**	**J**	0.30	0.018	mg/Kg	☼	07/02/19 08:00	07/11/19 16:52	1
Cobalt	**16**		3.0	0.053	mg/Kg	☼	07/02/19 08:00	07/11/19 16:52	1
Iron	**120**		5.9	3.4	mg/Kg	☼	07/02/19 08:00	07/11/19 16:52	1
Li	ND		3.0	0.18	mg/Kg	☼	07/02/19 08:00	07/11/19 16:52	1
Manganese	**260**	**B**	0.89	0.032	mg/Kg	☼	07/02/19 08:00	07/11/19 16:52	1
Mo	ND		2.4	0.097	mg/Kg	☼	07/02/19 08:00	07/11/19 16:52	1
Selenium	**0.23**	**J B**	0.59	0.20	mg/Kg	☼	07/02/19 08:00	07/11/19 16:52	1
Thallium	ND		2.1	0.25	mg/Kg	☼	07/02/19 08:00	07/11/19 16:52	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**1600**		12	1.9	mg/Kg	☼	07/03/19 08:00	07/11/19 18:20	1
Antimony	ND		3.6	0.53	mg/Kg	☼	07/03/19 08:00	07/11/19 18:20	1
Arsenic	**1.8**	**B**	0.59	0.26	mg/Kg	☼	07/03/19 08:00	07/11/19 18:20	1
Barium	**33**		3.0	0.14	mg/Kg	☼	07/03/19 08:00	07/11/19 18:20	1
Beryllium	**0.24**	**J**	0.30	0.019	mg/Kg	☼	07/03/19 08:00	07/11/19 18:20	1

Client Sample Results

Client: Golder Associates Inc. — Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Client Sample ID: BMW-31 (14-15) — Lab Sample ID: 140-15492-3

Date Collected: 05/31/19 11:15 — **Matrix: Solid**
Date Received: 06/05/19 09:20 — **Percent Solids: 84.2**

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cobalt	**2.8**	**J**	3.0	0.063	mg/Kg	☼	07/03/19 08:00	07/11/19 18:20	1
Iron	**5600**		5.9	3.4	mg/Kg	☼	07/03/19 08:00	07/11/19 18:20	1
Li	**2.2**	**J**	3.0	0.18	mg/Kg	☼	07/03/19 08:00	07/11/19 18:20	1
Manganese	**63**		0.89	0.15	mg/Kg	☼	07/03/19 08:00	07/11/19 18:20	1
Mo	ND		2.4	0.097	mg/Kg	☼	07/03/19 08:00	07/11/19 18:20	1
Selenium	**1.1**	**B ***	0.59	0.56	mg/Kg	☼	07/03/19 08:00	07/11/19 18:20	1
Thallium	ND		2.1	0.34	mg/Kg	☼	07/03/19 08:00	07/11/19 18:20	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**67**	**J ***	180	28	mg/Kg	☼	07/10/19 08:00	07/12/19 12:42	5
Antimony	ND		53	5.0	mg/Kg	☼	07/10/19 08:00	07/12/19 12:42	5
Arsenic	ND		8.9	2.3	mg/Kg	☼	07/10/19 08:00	07/12/19 12:42	5
Barium	**3.9**	**J ***	45	2.1	mg/Kg	☼	07/10/19 08:00	07/12/19 12:42	5
Beryllium	ND	*	4.5	0.37	mg/Kg	☼	07/10/19 08:00	07/12/19 12:42	5
Cobalt	ND	*	45	0.71	mg/Kg	☼	07/10/19 08:00	07/12/19 12:42	5
Iron	ND	*	89	52	mg/Kg	☼	07/10/19 08:00	07/12/19 12:42	5
Li	ND		45	2.6	mg/Kg	☼	07/10/19 08:00	07/12/19 12:42	5
Manganese	ND	*	13	2.2	mg/Kg	☼	07/10/19 08:00	07/12/19 12:42	5
Mo	ND		36	1.5	mg/Kg	☼	07/10/19 08:00	07/12/19 12:42	5
Selenium	ND		8.9	3.1	mg/Kg	☼	07/10/19 08:00	07/12/19 12:42	5
Thallium	ND	*	31	4.2	mg/Kg	☼	07/10/19 08:00	07/12/19 12:42	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**1800**		12	1.9	mg/Kg	☼	07/10/19 08:00	07/12/19 14:10	1
Antimony	ND		3.6	0.33	mg/Kg	☼	07/10/19 08:00	07/12/19 14:10	1
Arsenic	**0.54**	**J**	0.59	0.18	mg/Kg	☼	07/10/19 08:00	07/12/19 14:10	1
Barium	**4.4**		3.0	0.14	mg/Kg	☼	07/10/19 08:00	07/12/19 14:10	1
Beryllium	**0.059**	**J**	0.30	0.014	mg/Kg	☼	07/10/19 08:00	07/12/19 14:10	1
Cobalt	**0.46**	**J**	3.0	0.055	mg/Kg	☼	07/10/19 08:00	07/12/19 14:10	1
Iron	**1700**		5.9	3.4	mg/Kg	☼	07/10/19 08:00	07/12/19 14:10	1
Li	**1.3**	**J**	3.0	0.18	mg/Kg	☼	07/10/19 08:00	07/12/19 14:10	1
Manganese	**10**		0.89	0.30	mg/Kg	☼	07/10/19 08:00	07/12/19 14:10	1
Mo	ND		2.4	0.12	mg/Kg	☼	07/10/19 08:00	07/12/19 14:10	1
Selenium	ND		0.59	0.20	mg/Kg	☼	07/10/19 08:00	07/12/19 14:10	1
Thallium	ND		2.1	0.25	mg/Kg	☼	07/10/19 08:00	07/12/19 14:10	1

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**26000**		120	19	mg/Kg	☼	07/12/19 09:08	07/15/19 13:39	10
Antimony	ND		3.6	0.17	mg/Kg	☼	07/12/19 09:08	07/15/19 12:26	1
Arsenic	**0.58**	**J**	1.2	0.31	mg/Kg	☼	07/12/19 09:08	07/15/19 17:42	2
Barium	**320**		30	1.4	mg/Kg	☼	07/12/19 09:08	07/15/19 13:39	10
Beryllium	**0.30**		0.30	0.0089	mg/Kg	☼	07/12/19 09:08	07/15/19 12:26	1
Cobalt	**0.82**	**J**	5.9	0.36	mg/Kg	☼	07/12/19 09:08	07/15/19 17:42	2
Iron	**3600**		5.9	4.9	mg/Kg	☼	07/12/19 09:08	07/15/19 12:26	1
Li	**15**		3.0	0.18	mg/Kg	☼	07/12/19 09:08	07/15/19 12:26	1
Manganese	**24**		0.89	0.062	mg/Kg	☼	07/12/19 09:08	07/15/19 12:26	1
Mo	**0.16**	**J**	2.4	0.097	mg/Kg	☼	07/12/19 09:08	07/15/19 12:26	1

Client Sample ID: BMW-31 (14-15)

Lab Sample ID: 140-15492-3

Date Collected: 05/31/19 11:15
Matrix: Solid
Date Received: 06/05/19 09:20
Percent Solids: 84.2

Method: 6010B SEP - SEP Metals (ICP) - Step 7 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	ND		1.2	0.40	mg/Kg	☼	07/12/19 09:08	07/15/19 17:42	2
Thallium	**0.52**	**J**	4.2	0.43	mg/Kg	☼	07/12/19 09:08	07/15/19 17:42	2

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**30000**		10	1.6	mg/Kg			07/16/19 17:31	1
Antimony	ND		3.0	0.14	mg/Kg			07/16/19 17:31	1
Arsenic	**3.2**		0.50	0.13	mg/Kg			07/16/19 17:31	1
Barium	**370**		2.5	0.12	mg/Kg			07/16/19 17:31	1
Beryllium	**0.67**		0.25	0.0075	mg/Kg			07/16/19 17:31	1
Cobalt	**20**		2.5	0.023	mg/Kg			07/16/19 17:31	1
Iron	**11000**		5.0	4.1	mg/Kg			07/16/19 17:31	1
Li	**19**		2.5	0.15	mg/Kg			07/16/19 17:31	1
Manganese	**370**		0.75	0.052	mg/Kg			07/16/19 17:31	1
Mo	**0.16**	**J**	2.0	0.082	mg/Kg			07/16/19 17:31	1
Selenium	**2.1**		0.50	0.17	mg/Kg			07/16/19 17:31	1
Thallium	**0.52**	**J**	1.8	0.18	mg/Kg			07/16/19 17:31	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	ND		24	12	mg/Kg	☼	06/26/19 08:00	07/10/19 12:43	1
Chromium	**7.3**		1.8	0.26	mg/Kg	☼	06/26/19 08:00	07/10/19 12:43	1
Lead	**6.8**		1.8	0.33	mg/Kg	☼	06/26/19 08:00	07/10/19 12:43	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**30000**		120	19	mg/Kg	☼	06/11/19 08:00	07/15/19 16:30	10
Antimony	ND		3.6	0.17	mg/Kg	☼	06/11/19 08:00	07/15/19 15:12	1
Arsenic	**3.0**		0.59	0.15	mg/Kg	☼	06/11/19 08:00	07/15/19 15:12	1
Barium	**430**		30	1.4	mg/Kg	☼	06/11/19 08:00	07/15/19 16:30	10
Beryllium	**0.66**		0.30	0.0089	mg/Kg	☼	06/11/19 08:00	07/15/19 15:12	1
Cobalt	**18**		5.9	0.36	mg/Kg	☼	06/11/19 08:00	07/15/19 19:14	2
Iron	**10000**		5.9	4.9	mg/Kg	☼	06/11/19 08:00	07/15/19 15:12	1
Lithium	**18**		3.0	0.18	mg/Kg	☼	06/11/19 08:00	07/15/19 15:12	1
Manganese	**280**		0.89	0.062	mg/Kg	☼	06/11/19 08:00	07/15/19 15:12	1
Molybdenum	**0.29**	**J**	2.4	0.097	mg/Kg	☼	06/11/19 08:00	07/15/19 15:12	1
Selenium	ND		0.59	0.20	mg/Kg	☼	06/11/19 08:00	07/15/19 15:12	1
Thallium	**0.67**	**J**	4.2	0.43	mg/Kg	☼	06/11/19 08:00	07/15/19 19:14	2

Method: 7470A - SEP Mercury (CVAA) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Hg	ND		0.12	0.047	mg/Kg	☼	06/11/19 08:00	06/16/19 14:24	1

Client Sample ID: BMW-32 (25-26)

Lab Sample ID: 140-15492-4
Date Collected: 05/29/19 15:45
Matrix: Solid
Date Received: 06/05/19 09:20
Percent Solids: 84.2

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		47	7.6	mg/Kg	☼	06/29/19 08:00	07/11/19 13:40	4
Antimony	ND		14	1.3	mg/Kg	☼	06/29/19 08:00	07/11/19 13:40	4
Arsenic	ND		2.4	0.62	mg/Kg	☼	06/29/19 08:00	07/11/19 13:40	4
Barium	ND		12	0.57	mg/Kg	☼	06/29/19 08:00	07/11/19 13:40	4
Beryllium	ND		1.2	0.37	mg/Kg	☼	06/29/19 08:00	07/11/19 13:40	4
Cobalt	ND		12	0.21	mg/Kg	☼	06/29/19 08:00	07/11/19 13:40	4
Iron	ND		24	14	mg/Kg	☼	06/29/19 08:00	07/11/19 13:40	4
Li	ND		12	0.71	mg/Kg	☼	06/29/19 08:00	07/11/19 13:40	4
Manganese	**1.0**	**J**	3.6	0.15	mg/Kg	☼	06/29/19 08:00	07/11/19 13:40	4
Mo	ND		9.5	0.39	mg/Kg	☼	06/29/19 08:00	07/11/19 13:40	4
Selenium	ND		2.4	0.81	mg/Kg	☼	06/29/19 08:00	07/11/19 13:40	4
Thallium	ND		8.3	1.0	mg/Kg	☼	06/29/19 08:00	07/11/19 13:40	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**17**	**J ***	36	5.7	mg/Kg	☼	06/30/19 08:00	07/11/19 15:09	3
Antimony	ND		11	1.0	mg/Kg	☼	06/30/19 08:00	07/11/19 15:09	3
Arsenic	ND		1.8	0.46	mg/Kg	☼	06/30/19 08:00	07/11/19 15:09	3
Barium	ND	*	8.9	0.43	mg/Kg	☼	06/30/19 08:00	07/11/19 15:09	3
Beryllium	ND	*	0.89	0.057	mg/Kg	☼	06/30/19 08:00	07/11/19 15:09	3
Cobalt	ND		8.9	0.22	mg/Kg	☼	06/30/19 08:00	07/11/19 15:09	3
Iron	**36**	*****	18	10	mg/Kg	☼	06/30/19 08:00	07/11/19 15:09	3
Li	ND		8.9	0.53	mg/Kg	☼	06/30/19 08:00	07/11/19 15:09	3
Manganese	ND		2.7	1.0	mg/Kg	☼	06/30/19 08:00	07/11/19 15:09	3
Mo	ND		7.1	0.29	mg/Kg	☼	06/30/19 08:00	07/11/19 15:09	3
Selenium	**0.78**	**J B**	1.8	0.61	mg/Kg	☼	06/30/19 08:00	07/11/19 15:09	3
Thallium	ND		6.2	0.75	mg/Kg	☼	06/30/19 08:00	07/11/19 15:09	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**81**		12	2.5	mg/Kg	☼	07/02/19 08:00	07/11/19 16:58	1
Antimony	ND		3.6	0.33	mg/Kg	☼	07/02/19 08:00	07/11/19 16:58	1
Arsenic	**0.60**		0.59	0.15	mg/Kg	☼	07/02/19 08:00	07/11/19 16:58	1
Barium	**1.3**	**J B**	3.0	0.14	mg/Kg	☼	07/02/19 08:00	07/11/19 16:58	1
Beryllium	ND		0.30	0.018	mg/Kg	☼	07/02/19 08:00	07/11/19 16:58	1
Cobalt	**0.060**	**J**	3.0	0.053	mg/Kg	☼	07/02/19 08:00	07/11/19 16:58	1
Iron	**500**		5.9	3.4	mg/Kg	☼	07/02/19 08:00	07/11/19 16:58	1
Li	ND		3.0	0.18	mg/Kg	☼	07/02/19 08:00	07/11/19 16:58	1
Manganese	**0.60**	**J B**	0.89	0.032	mg/Kg	☼	07/02/19 08:00	07/11/19 16:58	1
Mo	ND		2.4	0.097	mg/Kg	☼	07/02/19 08:00	07/11/19 16:58	1
Selenium	**0.21**	**J B**	0.59	0.20	mg/Kg	☼	07/02/19 08:00	07/11/19 16:58	1
Thallium	ND		2.1	0.25	mg/Kg	☼	07/02/19 08:00	07/11/19 16:58	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**1200**		12	1.9	mg/Kg	☼	07/03/19 08:00	07/11/19 18:25	1
Antimony	ND		3.6	0.53	mg/Kg	☼	07/03/19 08:00	07/11/19 18:25	1
Arsenic	**0.78**	**B**	0.59	0.26	mg/Kg	☼	07/03/19 08:00	07/11/19 18:25	1
Barium	**17**		3.0	0.14	mg/Kg	☼	07/03/19 08:00	07/11/19 18:25	1
Beryllium	**0.025**	**J**	0.30	0.019	mg/Kg	☼	07/03/19 08:00	07/11/19 18:25	1

Client Sample ID: BMW-32 (25-26) **Lab Sample ID: 140-15492-4**
Date Collected: 05/29/19 15:45 **Matrix: Solid**
Date Received: 06/05/19 09:20 **Percent Solids: 84.2**

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cobalt	0.60	J	3.0	0.063	mg/Kg	☼	07/03/19 08:00	07/11/19 18:25	1
Iron	2000		5.9	3.4	mg/Kg	☼	07/03/19 08:00	07/11/19 18:25	1
Li	2.5	J	3.0	0.18	mg/Kg	☼	07/03/19 08:00	07/11/19 18:25	1
Manganese	13		0.89	0.15	mg/Kg	☼	07/03/19 08:00	07/11/19 18:25	1
Mo	ND		2.4	0.097	mg/Kg	☼	07/03/19 08:00	07/11/19 18:25	1
Selenium	0.62	B *	0.59	0.56	mg/Kg	☼	07/03/19 08:00	07/11/19 18:25	1
Thallium	ND		2.1	0.34	mg/Kg	☼	07/03/19 08:00	07/11/19 18:25	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	58	J *	180	28	mg/Kg	☼	07/10/19 08:00	07/12/19 12:47	5
Antimony	ND		53	5.0	mg/Kg	☼	07/10/19 08:00	07/12/19 12:47	5
Arsenic	ND		8.9	2.3	mg/Kg	☼	07/10/19 08:00	07/12/19 12:47	5
Barium	3.3	J *	45	2.1	mg/Kg	☼	07/10/19 08:00	07/12/19 12:47	5
Beryllium	ND	*	4.5	0.37	mg/Kg	☼	07/10/19 08:00	07/12/19 12:47	5
Cobalt	ND	*	45	0.71	mg/Kg	☼	07/10/19 08:00	07/12/19 12:47	5
Iron	ND	*	89	52	mg/Kg	☼	07/10/19 08:00	07/12/19 12:47	5
Li	ND		45	2.6	mg/Kg	☼	07/10/19 08:00	07/12/19 12:47	5
Manganese	ND	*	13	2.2	mg/Kg	☼	07/10/19 08:00	07/12/19 12:47	5
Mo	ND		36	1.5	mg/Kg	☼	07/10/19 08:00	07/12/19 12:47	5
Selenium	ND		8.9	3.1	mg/Kg	☼	07/10/19 08:00	07/12/19 12:47	5
Thallium	ND	*	31	4.2	mg/Kg	☼	07/10/19 08:00	07/12/19 12:47	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	1100		12	1.9	mg/Kg	☼	07/10/19 08:00	07/12/19 14:15	1
Antimony	ND		3.6	0.33	mg/Kg	☼	07/10/19 08:00	07/12/19 14:15	1
Arsenic	0.42	J	0.59	0.18	mg/Kg	☼	07/10/19 08:00	07/12/19 14:15	1
Barium	6.4		3.0	0.14	mg/Kg	☼	07/10/19 08:00	07/12/19 14:15	1
Beryllium	0.033	J	0.30	0.014	mg/Kg	☼	07/10/19 08:00	07/12/19 14:15	1
Cobalt	0.28	J	3.0	0.055	mg/Kg	☼	07/10/19 08:00	07/12/19 14:15	1
Iron	890		5.9	3.4	mg/Kg	☼	07/10/19 08:00	07/12/19 14:15	1
Li	1.0	J	3.0	0.18	mg/Kg	☼	07/10/19 08:00	07/12/19 14:15	1
Manganese	10		0.89	0.30	mg/Kg	☼	07/10/19 08:00	07/12/19 14:15	1
Mo	ND		2.4	0.12	mg/Kg	☼	07/10/19 08:00	07/12/19 14:15	1
Selenium	ND		0.59	0.20	mg/Kg	☼	07/10/19 08:00	07/12/19 14:15	1
Thallium	ND		2.1	0.25	mg/Kg	☼	07/10/19 08:00	07/12/19 14:15	1

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	32000		120	19	mg/Kg	☼	07/12/19 09:08	07/15/19 13:44	10
Antimony	ND		3.6	0.17	mg/Kg	☼	07/12/19 09:08	07/15/19 12:32	1
Arsenic	1.2		0.59	0.15	mg/Kg	☼	07/12/19 09:08	07/15/19 12:32	1
Barium	430		30	1.4	mg/Kg	☼	07/12/19 09:08	07/15/19 13:44	10
Beryllium	0.50		0.30	0.0089	mg/Kg	☼	07/12/19 09:08	07/15/19 12:32	1
Cobalt	0.76	J	5.9	0.36	mg/Kg	☼	07/12/19 09:08	07/15/19 17:47	2
Iron	2800		5.9	4.9	mg/Kg	☼	07/12/19 09:08	07/15/19 12:32	1
Li	8.2		3.0	0.18	mg/Kg	☼	07/12/19 09:08	07/15/19 12:32	1
Manganese	42		0.89	0.062	mg/Kg	☼	07/12/19 09:08	07/15/19 12:32	1
Mo	ND		2.4	0.097	mg/Kg	☼	07/12/19 09:08	07/15/19 12:32	1

Client Sample ID: BMW-32 (25-26) **Lab Sample ID: 140-15492-4**
Date Collected: 05/29/19 15:45 **Matrix: Solid**
Date Received: 06/05/19 09:20 **Percent Solids: 84.2**

Method: 6010B SEP - SEP Metals (ICP) - Step 7 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	ND		0.59	0.20	mg/Kg	☼	07/12/19 09:08	07/15/19 12:32	1
Thallium	ND		4.2	0.43	mg/Kg	☼	07/12/19 09:08	07/15/19 17:47	2

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**35000**		10	1.6	mg/Kg			07/16/19 17:31	1
Antimony	ND		3.0	0.14	mg/Kg			07/16/19 17:31	1
Arsenic	**3.0**		0.50	0.13	mg/Kg			07/16/19 17:31	1
Barium	**460**		2.5	0.12	mg/Kg			07/16/19 17:31	1
Beryllium	**0.56**		0.25	0.0075	mg/Kg			07/16/19 17:31	1
Cobalt	**1.7**	**J**	2.5	0.023	mg/Kg			07/16/19 17:31	1
Iron	**6200**		5.0	4.1	mg/Kg			07/16/19 17:31	1
Li	**12**		2.5	0.15	mg/Kg			07/16/19 17:31	1
Manganese	**67**		0.75	0.052	mg/Kg			07/16/19 17:31	1
Mo	ND		2.0	0.082	mg/Kg			07/16/19 17:31	1
Selenium	**1.6**		0.50	0.17	mg/Kg			07/16/19 17:31	1
Thallium	ND		1.8	0.18	mg/Kg			07/16/19 17:31	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	ND		22	11	mg/Kg	☼	06/26/19 08:00	07/10/19 12:49	1
Chromium	**7.6**		1.7	0.25	mg/Kg	☼	06/26/19 08:00	07/10/19 12:49	1
Lead	**3.9**		1.7	0.31	mg/Kg	☼	06/26/19 08:00	07/10/19 12:49	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**45000**		120	19	mg/Kg	☼	06/11/19 08:00	07/15/19 16:35	10
Antimony	ND		3.6	0.17	mg/Kg	☼	06/11/19 08:00	07/15/19 15:18	1
Arsenic	**3.2**		0.59	0.15	mg/Kg	☼	06/11/19 08:00	07/15/19 15:18	1
Barium	**570**		30	1.4	mg/Kg	☼	06/11/19 08:00	07/15/19 16:35	10
Beryllium	**0.53**		0.30	0.0089	mg/Kg	☼	06/11/19 08:00	07/15/19 15:18	1
Cobalt	**1.6**	**J**	5.9	0.36	mg/Kg	☼	06/11/19 08:00	07/15/19 19:19	2
Iron	**5600**		5.9	4.9	mg/Kg	☼	06/11/19 08:00	07/15/19 15:18	1
Lithium	**11**		3.0	0.18	mg/Kg	☼	06/11/19 08:00	07/15/19 15:18	1
Manganese	**70**		0.89	0.062	mg/Kg	☼	06/11/19 08:00	07/15/19 15:18	1
Molybdenum	**0.33**	**J**	2.4	0.097	mg/Kg	☼	06/11/19 08:00	07/15/19 15:18	1
Selenium	**0.54**	**J**	0.59	0.20	mg/Kg	☼	06/11/19 08:00	07/15/19 15:18	1
Thallium	**0.44**	**J**	4.2	0.43	mg/Kg	☼	06/11/19 08:00	07/15/19 19:19	2

Method: 7470A - SEP Mercury (CVAA) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Hg	**0.053**	**J**	0.12	0.047	mg/Kg	☼	06/11/19 08:00	06/16/19 14:27	1

Client Sample Results

Client: Golder Associates Inc. Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Client Sample ID: BMW-33 (38-39) Lab Sample ID: 140-15492-5

Date Collected: 05/30/19 11:35 **Matrix: Solid**
Date Received: 06/05/19 09:20 **Percent Solids: 77.5**

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		52	8.3	mg/Kg	☼	06/29/19 08:00	07/11/19 13:45	4
Antimony	ND		15	1.4	mg/Kg	☼	06/29/19 08:00	07/11/19 13:45	4
Arsenic	ND		2.6	0.67	mg/Kg	☼	06/29/19 08:00	07/11/19 13:45	4
Barium	**1.5**	**J**	13	0.62	mg/Kg	☼	06/29/19 08:00	07/11/19 13:45	4
Beryllium	ND		1.3	0.40	mg/Kg	☼	06/29/19 08:00	07/11/19 13:45	4
Cobalt	**0.29**	**J**	13	0.23	mg/Kg	☼	06/29/19 08:00	07/11/19 13:45	4
Iron	ND		26	15	mg/Kg	☼	06/29/19 08:00	07/11/19 13:45	4
Li	ND		13	0.77	mg/Kg	☼	06/29/19 08:00	07/11/19 13:45	4
Manganese	**17**		3.9	0.16	mg/Kg	☼	06/29/19 08:00	07/11/19 13:45	4
Mo	ND		10	0.42	mg/Kg	☼	06/29/19 08:00	07/11/19 13:45	4
Selenium	ND		2.6	0.88	mg/Kg	☼	06/29/19 08:00	07/11/19 13:45	4
Thallium	ND		9.0	1.1	mg/Kg	☼	06/29/19 08:00	07/11/19 13:45	4

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**10**	**J ***	39	6.2	mg/Kg	☼	06/30/19 08:00	07/11/19 15:14	3
Antimony	ND		12	1.1	mg/Kg	☼	06/30/19 08:00	07/11/19 15:14	3
Arsenic	ND		1.9	0.50	mg/Kg	☼	06/30/19 08:00	07/11/19 15:14	3
Barium	**0.90**	**J ***	9.7	0.46	mg/Kg	☼	06/30/19 08:00	07/11/19 15:14	3
Beryllium	ND	*	0.97	0.062	mg/Kg	☼	06/30/19 08:00	07/11/19 15:14	3
Cobalt	**0.74**	**J**	9.7	0.24	mg/Kg	☼	06/30/19 08:00	07/11/19 15:14	3
Iron	**14**	**J ***	19	11	mg/Kg	☼	06/30/19 08:00	07/11/19 15:14	3
Li	ND		9.7	0.58	mg/Kg	☼	06/30/19 08:00	07/11/19 15:14	3
Manganese	**25**		2.9	1.1	mg/Kg	☼	06/30/19 08:00	07/11/19 15:14	3
Mo	ND		7.7	0.32	mg/Kg	☼	06/30/19 08:00	07/11/19 15:14	3
Selenium	ND		1.9	0.66	mg/Kg	☼	06/30/19 08:00	07/11/19 15:14	3
Thallium	ND		6.8	0.81	mg/Kg	☼	06/30/19 08:00	07/11/19 15:14	3

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**94**		13	2.7	mg/Kg	☼	07/02/19 08:00	07/11/19 17:03	1
Antimony	ND		3.9	0.36	mg/Kg	☼	07/02/19 08:00	07/11/19 17:03	1
Arsenic	**0.47**	**J**	0.65	0.17	mg/Kg	☼	07/02/19 08:00	07/11/19 17:03	1
Barium	**7.5**	**B**	3.2	0.15	mg/Kg	☼	07/02/19 08:00	07/11/19 17:03	1
Beryllium	**0.028**	**J**	0.32	0.019	mg/Kg	☼	07/02/19 08:00	07/11/19 17:03	1
Cobalt	**1.9**	**J**	3.2	0.058	mg/Kg	☼	07/02/19 08:00	07/11/19 17:03	1
Iron	**510**		6.5	3.7	mg/Kg	☼	07/02/19 08:00	07/11/19 17:03	1
Li	ND		3.2	0.19	mg/Kg	☼	07/02/19 08:00	07/11/19 17:03	1
Manganese	**85**	**B**	0.97	0.035	mg/Kg	☼	07/02/19 08:00	07/11/19 17:03	1
Mo	ND		2.6	0.11	mg/Kg	☼	07/02/19 08:00	07/11/19 17:03	1
Selenium	**0.25**	**J B**	0.65	0.22	mg/Kg	☼	07/02/19 08:00	07/11/19 17:03	1
Thallium	ND		2.3	0.27	mg/Kg	☼	07/02/19 08:00	07/11/19 17:03	1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**1800**		13	2.1	mg/Kg	☼	07/03/19 08:00	07/11/19 18:45	1
Antimony	ND		3.9	0.58	mg/Kg	☼	07/03/19 08:00	07/11/19 18:45	1
Arsenic	**1.2**	**B**	0.65	0.28	mg/Kg	☼	07/03/19 08:00	07/11/19 18:45	1
Barium	**20**		3.2	0.15	mg/Kg	☼	07/03/19 08:00	07/11/19 18:45	1
Beryllium	**0.20**	**J**	0.32	0.021	mg/Kg	☼	07/03/19 08:00	07/11/19 18:45	1

Client Sample Results

Client: Golder Associates Inc. Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Client Sample ID: BMW-33 (38-39) Lab Sample ID: 140-15492-5

Date Collected: 05/30/19 11:35 **Matrix: Solid**
Date Received: 06/05/19 09:20 **Percent Solids: 77.5**

Method: 6010B SEP - SEP Metals (ICP) - Step 4 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Cobalt	**1.5**	**J**	3.2	0.068	mg/Kg	☼	07/03/19 08:00	07/11/19 18:45	1
Iron	**4900**		6.5	3.7	mg/Kg	☼	07/03/19 08:00	07/11/19 18:45	1
Li	**2.1**	**J**	3.2	0.19	mg/Kg	☼	07/03/19 08:00	07/11/19 18:45	1
Manganese	**55**		0.97	0.17	mg/Kg	☼	07/03/19 08:00	07/11/19 18:45	1
Mo	ND		2.6	0.11	mg/Kg	☼	07/03/19 08:00	07/11/19 18:45	1
Selenium	**0.71**	**B ***	0.65	0.61	mg/Kg	☼	07/03/19 08:00	07/11/19 18:45	1
Thallium	ND		2.3	0.37	mg/Kg	☼	07/03/19 08:00	07/11/19 18:45	1

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**64**	**J ***	190	30	mg/Kg	☼	07/10/19 08:00	07/12/19 12:53	5
Antimony	ND		58	5.4	mg/Kg	☼	07/10/19 08:00	07/12/19 12:53	5
Arsenic	ND		9.7	2.5	mg/Kg	☼	07/10/19 08:00	07/12/19 12:53	5
Barium	**4.1**	**J ***	48	2.3	mg/Kg	☼	07/10/19 08:00	07/12/19 12:53	5
Beryllium	ND	*	4.8	0.41	mg/Kg	☼	07/10/19 08:00	07/12/19 12:53	5
Cobalt	ND	*	48	0.77	mg/Kg	☼	07/10/19 08:00	07/12/19 12:53	5
Iron	ND	*	97	57	mg/Kg	☼	07/10/19 08:00	07/12/19 12:53	5
Li	ND		48	2.8	mg/Kg	☼	07/10/19 08:00	07/12/19 12:53	5
Manganese	ND	*	15	2.4	mg/Kg	☼	07/10/19 08:00	07/12/19 12:53	5
Mo	ND		39	1.6	mg/Kg	☼	07/10/19 08:00	07/12/19 12:53	5
Selenium	ND		9.7	3.4	mg/Kg	☼	07/10/19 08:00	07/12/19 12:53	5
Thallium	ND	*	34	4.5	mg/Kg	☼	07/10/19 08:00	07/12/19 12:53	5

Method: 6010B SEP - SEP Metals (ICP) - Step 6

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**3400**		13	2.1	mg/Kg	☼	07/10/19 08:00	07/12/19 14:21	1
Antimony	ND		3.9	0.36	mg/Kg	☼	07/10/19 08:00	07/12/19 14:21	1
Arsenic	**0.85**		0.65	0.19	mg/Kg	☼	07/10/19 08:00	07/12/19 14:21	1
Barium	**13**		3.2	0.15	mg/Kg	☼	07/10/19 08:00	07/12/19 14:21	1
Beryllium	**0.11**	**J**	0.32	0.015	mg/Kg	☼	07/10/19 08:00	07/12/19 14:21	1
Cobalt	**1.1**	**J**	3.2	0.059	mg/Kg	☼	07/10/19 08:00	07/12/19 14:21	1
Iron	**3900**		6.5	3.7	mg/Kg	☼	07/10/19 08:00	07/12/19 14:21	1
Li	**2.1**	**J**	3.2	0.19	mg/Kg	☼	07/10/19 08:00	07/12/19 14:21	1
Manganese	**22**		0.97	0.32	mg/Kg	☼	07/10/19 08:00	07/12/19 14:21	1
Mo	ND		2.6	0.13	mg/Kg	☼	07/10/19 08:00	07/12/19 14:21	1
Selenium	ND		0.65	0.22	mg/Kg	☼	07/10/19 08:00	07/12/19 14:21	1
Thallium	ND		2.3	0.27	mg/Kg	☼	07/10/19 08:00	07/12/19 14:21	1

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**48000**		130	21	mg/Kg	☼	07/12/19 09:08	07/15/19 14:04	10
Antimony	ND		3.9	0.18	mg/Kg	☼	07/12/19 09:08	07/15/19 12:37	1
Arsenic	**0.64**	**J**	0.65	0.17	mg/Kg	☼	07/12/19 09:08	07/15/19 12:37	1
Barium	**550**		32	1.5	mg/Kg	☼	07/12/19 09:08	07/15/19 14:04	10
Beryllium	**0.69**		0.32	0.0097	mg/Kg	☼	07/12/19 09:08	07/15/19 12:37	1
Cobalt	**0.57**	**J**	6.5	0.39	mg/Kg	☼	07/12/19 09:08	07/15/19 17:52	2
Iron	**6100**		6.5	5.3	mg/Kg	☼	07/12/19 09:08	07/15/19 12:37	1
Li	**9.1**		3.2	0.19	mg/Kg	☼	07/12/19 09:08	07/15/19 12:37	1
Manganese	**30**		0.97	0.067	mg/Kg	☼	07/12/19 09:08	07/15/19 12:37	1
Mo	ND		2.6	0.11	mg/Kg	☼	07/12/19 09:08	07/15/19 12:37	1

1 2 3 4 5 6 7 8 9 10 11 12 13

Client Sample ID: BMW-33 (38-39) — Lab Sample ID: 140-15492-5

Date Collected: 05/30/19 11:35 — **Matrix: Solid**
Date Received: 06/05/19 09:20 — **Percent Solids: 77.5**

Method: 6010B SEP - SEP Metals (ICP) - Step 7 (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Selenium	ND		0.65	0.22	mg/Kg	☼	07/12/19 09:08	07/15/19 12:37	1
Thallium	ND		4.5	0.46	mg/Kg	☼	07/12/19 09:08	07/15/19 17:52	2

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**54000**		10	1.6	mg/Kg			07/16/19 17:31	1
Antimony	ND		3.0	0.14	mg/Kg			07/16/19 17:31	1
Arsenic	**3.2**		0.50	0.13	mg/Kg			07/16/19 17:31	1
Barium	**590**		2.5	0.12	mg/Kg			07/16/19 17:31	1
Beryllium	**1.0**		0.25	0.0075	mg/Kg			07/16/19 17:31	1
Cobalt	**6.1**		2.5	0.023	mg/Kg			07/16/19 17:31	1
Iron	**15000**		5.0	4.1	mg/Kg			07/16/19 17:31	1
Li	**13**		2.5	0.15	mg/Kg			07/16/19 17:31	1
Manganese	**230**		0.75	0.052	mg/Kg			07/16/19 17:31	1
Mo	ND		2.0	0.082	mg/Kg			07/16/19 17:31	1
Selenium	**0.95**		0.50	0.17	mg/Kg			07/16/19 17:31	1
Thallium	ND		1.8	0.18	mg/Kg			07/16/19 17:31	1

Method: 6010B - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	ND		24	12	mg/Kg	☼	06/26/19 08:00	07/10/19 12:54	1
Chromium	**14**		1.8	0.27	mg/Kg	☼	06/26/19 08:00	07/10/19 12:54	1
Lead	**5.9**		1.8	0.34	mg/Kg	☼	06/26/19 08:00	07/10/19 12:54	1

Method: 6010B - SEP Metals (ICP) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**73000**		130	21	mg/Kg	☼	06/11/19 08:00	07/15/19 16:40	10
Antimony	ND		3.9	0.18	mg/Kg	☼	06/11/19 08:00	07/15/19 15:23	1
Arsenic	**3.2**		0.65	0.17	mg/Kg	☼	06/11/19 08:00	07/15/19 15:23	1
Barium	**830**		32	1.5	mg/Kg	☼	06/11/19 08:00	07/15/19 16:40	10
Beryllium	**1.0**		0.32	0.0097	mg/Kg	☼	06/11/19 08:00	07/15/19 15:23	1
Cobalt	**4.6**	**J**	16	0.97	mg/Kg	☼	06/11/19 08:00	07/15/19 19:24	5
Iron	**13000**		6.5	5.3	mg/Kg	☼	06/11/19 08:00	07/15/19 15:23	1
Lithium	**14**		3.2	0.19	mg/Kg	☼	06/11/19 08:00	07/15/19 15:23	1
Manganese	**130**		0.97	0.067	mg/Kg	☼	06/11/19 08:00	07/15/19 15:23	1
Molybdenum	**0.22**	**J**	2.6	0.11	mg/Kg	☼	06/11/19 08:00	07/15/19 15:23	1
Selenium	ND		0.65	0.22	mg/Kg	☼	06/11/19 08:00	07/15/19 15:23	1
Thallium	ND		11	1.2	mg/Kg	☼	06/11/19 08:00	07/15/19 19:24	5

Method: 7470A - SEP Mercury (CVAA) - Total

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Hg	ND		0.13	0.052	mg/Kg	☼	06/11/19 08:00	06/16/19 14:29	1

Default Detection Limits

Client: Golder Associates Inc.
Project/Site: Martin Lake A1 Area LF SEP + Totals

Job ID: 140-15492-1

Method: 6010B SEP - SEP Metals (ICP) - Step 1

Prep: 3010A

SEP: Exchangeable

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Antimony	3.0	0.28	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Barium	2.5	0.12	mg/Kg
Beryllium	0.25	0.077	mg/Kg
Cobalt	2.5	0.045	mg/Kg
Iron	5.0	2.9	mg/Kg
Li	2.5	0.15	mg/Kg
Manganese	0.75	0.031	mg/Kg
Mo	2.0	0.082	mg/Kg
Selenium	0.50	0.17	mg/Kg
Thallium	1.8	0.21	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 2

Prep: 3010A

SEP: Carbonate

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Antimony	3.0	0.28	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Barium	2.5	0.12	mg/Kg
Beryllium	0.25	0.016	mg/Kg
Cobalt	2.5	0.063	mg/Kg
Iron	5.0	2.9	mg/Kg
Li	2.5	0.15	mg/Kg
Manganese	0.75	0.28	mg/Kg
Mo	2.0	0.082	mg/Kg
Selenium	0.50	0.17	mg/Kg
Thallium	1.8	0.21	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 3

Prep: 3010A

SEP: Non-Crystalline

Analyte	RL	MDL	Units
Aluminum	10	2.1	mg/Kg
Antimony	3.0	0.28	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Barium	2.5	0.12	mg/Kg
Beryllium	0.25	0.015	mg/Kg
Cobalt	2.5	0.045	mg/Kg
Iron	5.0	2.9	mg/Kg
Li	2.5	0.15	mg/Kg
Manganese	0.75	0.027	mg/Kg
Mo	2.0	0.082	mg/Kg
Selenium	0.50	0.17	mg/Kg
Thallium	1.8	0.21	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Prep: 3010A

SEP: Metal Hydroxide

Client: Golder Associates Inc.
Project/Site: Martin Lake A1 Area LF SEP + Totals

Job ID: 140-15492-1

Method: 6010B SEP - SEP Metals (ICP) - Step 4

Prep: 3010A
SEP: Metal Hydroxide

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Antimony	3.0	0.45	mg/Kg
Arsenic	0.50	0.22	mg/Kg
Barium	2.5	0.12	mg/Kg
Beryllium	0.25	0.016	mg/Kg
Cobalt	2.5	0.053	mg/Kg
Iron	5.0	2.9	mg/Kg
Li	2.5	0.15	mg/Kg
Manganese	0.75	0.13	mg/Kg
Mo	2.0	0.082	mg/Kg
Selenium	0.50	0.47	mg/Kg
Thallium	1.8	0.29	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 5

Prep: 3010A
SEP: Organic-Bound

Analyte	RL	MDL	Units
Aluminum	30	4.7	mg/Kg
Antimony	9.0	0.84	mg/Kg
Arsenic	1.5	0.38	mg/Kg
Barium	7.5	0.36	mg/Kg
Beryllium	0.75	0.063	mg/Kg
Cobalt	7.5	0.12	mg/Kg
Iron	15	8.8	mg/Kg
Li	7.5	0.44	mg/Kg
Manganese	2.3	0.37	mg/Kg
Mo	6.0	0.25	mg/Kg
Selenium	1.5	0.52	mg/Kg
Thallium	5.3	0.70	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 6

SEP: Acid/Sulfide

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Antimony	3.0	0.28	mg/Kg
Arsenic	0.50	0.15	mg/Kg
Barium	2.5	0.12	mg/Kg
Beryllium	0.25	0.012	mg/Kg
Cobalt	2.5	0.046	mg/Kg
Iron	5.0	2.9	mg/Kg
Li	2.5	0.15	mg/Kg
Manganese	0.75	0.25	mg/Kg
Mo	2.0	0.099	mg/Kg
Selenium	0.50	0.17	mg/Kg
Thallium	1.8	0.21	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Step 7

Prep: Residual

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg

Client: Golder Associates Inc.
Project/Site: Martin Lake A1 Area LF SEP + Totals

Job ID: 140-15492-1

Method: 6010B SEP - SEP Metals (ICP) - Step 7 (Continued)

Prep: Residual

Analyte	RL	MDL	Units
Antimony	3.0	0.14	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Barium	2.5	0.12	mg/Kg
Beryllium	0.25	0.0075	mg/Kg
Cobalt	2.5	0.15	mg/Kg
Iron	5.0	4.1	mg/Kg
Li	2.5	0.15	mg/Kg
Manganese	0.75	0.052	mg/Kg
Mo	2.0	0.082	mg/Kg
Selenium	0.50	0.17	mg/Kg
Thallium	1.8	0.18	mg/Kg

Method: 6010B SEP - SEP Metals (ICP) - Sum of Steps 1-7

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Antimony	3.0	0.14	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Barium	2.5	0.12	mg/Kg
Beryllium	0.25	0.0075	mg/Kg
Cobalt	2.5	0.023	mg/Kg
Iron	5.0	4.1	mg/Kg
Li	2.5	0.15	mg/Kg
Manganese	0.75	0.052	mg/Kg
Mo	2.0	0.082	mg/Kg
Selenium	0.50	0.17	mg/Kg
Thallium	1.8	0.18	mg/Kg

Method: 6010B - Metals (ICP)

Prep: 3050B

Analyte	RL	MDL	Units
Boron	20	10	mg/Kg
Chromium	1.5	0.22	mg/Kg
Lead	1.5	0.28	mg/Kg

Method: 6010B - SEP Metals (ICP) - Total

Prep: Total

Analyte	RL	MDL	Units
Aluminum	10	1.6	mg/Kg
Antimony	3.0	0.14	mg/Kg
Arsenic	0.50	0.13	mg/Kg
Barium	2.5	0.12	mg/Kg
Beryllium	0.25	0.0075	mg/Kg
Cobalt	2.5	0.15	mg/Kg
Iron	5.0	4.1	mg/Kg
Lithium	2.5	0.15	mg/Kg
Manganese	0.75	0.052	mg/Kg
Molybdenum	2.0	0.082	mg/Kg
Selenium	0.50	0.17	mg/Kg
Thallium	1.8	0.18	mg/Kg

Method: 7470A - SEP Mercury (CVAA) - Total

Default Detection Limits

Client: Golder Associates Inc.
Project/Site: Martin Lake A1 Area LF SEP + Totals

Job ID: 140-15492-1

Method: 7470A - SEP Mercury (CVAA) - Total

Prep: Total

Analyte	RL	MDL	Units
Hg	0.10	0.040	mg/Kg

QC Sample Results

Client: Golder Associates Inc. | Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Method: 6010B - Metals (ICP)

Lab Sample ID: MB 140-31128/14-A
Matrix: Solid
Analysis Batch: 31553

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 31128

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
uoron	mD		20	10	N8/78		0g/2g/19 0K:00	06/10/19 11:42	1
C3roNiyN	mD		1.5	0.22	N8/78		0g/2g/19 0K:00	06/10/19 11:42	1
Lead	mD		1.5	0.2K	N8/78		0g/2g/19 0K:00	06/10/19 11:42	1

Lab Sample ID: LCS 140-31128/15-A
Matrix: Solid
Analysis Batch: 31553

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 31128

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
uoron	100	101		N8/78		101	K0 - 120
C3roNiyN	20.0	20.B		N8/78		101	90 - 110
Lead	10.0	10.1		N8/78		101	90 - 110

Method: 6010B - SEP Metals (ICP) - Total

Lab Sample ID: MB 140-30683/13-A
Matrix: Solid
Analysis Batch: 31713

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 30683

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
AlyNinyN	mD		10	1.g	N8/78		0g/11/19 0K:00	06/15/19 11:1B	1
AntiNonh	mD		B.0	0.14	N8/78		0g/11/19 0K:00	06/15/19 11:1B	1
Arsenic	mD		0.50	0.1B	N8/78		0g/11/19 0K:00	06/15/19 11:1B	1
uariyN	mD		2.5	0.12	N8/78		0g/11/19 0K:00	06/15/19 11:1B	1
uerhlliyN	mD		0.25	0.0065	N8/78		0g/11/19 0K:00	06/15/19 11:1B	1
Cobalt	mD		2.5	0.15	N8/78		0g/11/19 0K:00	06/15/19 11:1B	1
Iron	mD		5.0	4.1	N8/78		0g/11/19 0K:00	06/15/19 11:1B	1
Lit3iyN	mD		2.5	0.15	N8/78		0g/11/19 0K:00	06/15/19 11:1B	1
Man8anese	mD		0.65	0.052	N8/78		0g/11/19 0K:00	06/15/19 11:1B	1
MolhbdenyN	mD		2.0	0.0K2	N8/78		0g/11/19 0K:00	06/15/19 11:1B	1
SeleniyN	mD		0.50	0.16	N8/78		0g/11/19 0K:00	06/15/19 11:1B	1
T3alliyN	mD		1.K	0.1K	N8/78		0g/11/19 0K:00	06/15/19 11:1B	1

Lab Sample ID: LCS 140-30683/14-A
Matrix: Solid
Analysis Batch: 31713

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 30683

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
AlyNinyN	100	96.g		N8/78		9K	65 - 125
AntiNonh	25.0	25.9		N8/78		10B	65 - 125
Arsenic	5.00	5.29		N8/78		10g	65 - 125
uariyN	5.00	4.99		N8/78		100	65 - 125
uerhlliyN	2.50	2.51		N8/78		100	65 - 125
Cobalt	5.00	5.20		N8/78		104	65 - 125
Iron	50.0	51.1		N8/78		102	65 - 125
Lit3iyN	5.00	5.12		N8/78		102	65 - 125
Man8anese	5.00	5.21		N8/78		104	65 - 125
MolhbdenyN	25.0	2g.g		N8/78		10g	65 - 125
SeleniyN	6.50	6.55		N8/78		101	65 - 125

QC Sample Results

Client: Golder Associates Inc. Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Method: 6010B - SEP Metals (ICP) - Total (Continued)

Lab Sample ID: LCS 140-30683/14-A **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 31713 **Prep Batch: 30683**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
T3alliyN	20.0	21.2		N8/78		10g	65 - 125

Lab Sample ID: LCSD 140-30683/15-A **Client Sample ID: Lab Control Sample Dup**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 31713 **Prep Batch: 30683**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
AlyNinyN	100	96.0		N8/78		96	65 - 125	1	B0
AntiNonh	25.0	25.9		N8/78		104	65 - 125	0	B0
Arsenic	5.00	5.24		N8/78		105	65 - 125	1	B0
uariyN	5.00	4.95		N8/78		99	65 - 125	1	B0
uerhlliyN	2.50	2.4K		N8/78		99	65 - 125	1	B0
Cobalt	5.00	5.1g		N8/78		10B	65 - 125	1	B0
Iron	50.0	50.4		N8/78		101	65 - 125	1	B0
Lit3iyN	5.00	5.04		N8/78		101	65 - 125	2	B0
Man8anese	5.00	5.1g		N8/78		10B	65 - 125	1	B0
MolhbdenyN	25.0	2g.5		N8/78		10g	65 - 125	0	B0
SeleniyN	6.50	6.46		N8/78		100	65 - 125	1	B0
T3alliyN	20.0	21.2		N8/78		10g	65 - 125	0	B0

Method: 6010B SEP - SEP Metals (ICP)

Lab Sample ID: MB 140-31148/13-B ^4 **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: Step 1**
Analysis Batch: 31604 **Prep Batch: 31252**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
AlyNinyN	mD		40	g.4	N8/78		0g/29/19 0K:00	06/11/19 12:BB	4
AntiNonh	mD		12	1.1	N8/78		0g/29/19 0K:00	06/11/19 12:BB	4
Arsenic	mD		2.0	0.52	N8/78		0g/29/19 0K:00	06/11/19 12:BB	4
uariyN	mD		10	0.4K	N8/78		0g/29/19 0K:00	06/11/19 12:BB	4
uerhlliyN	mD		1.0	0.B1	N8/78		0g/29/19 0K:00	06/11/19 12:BB	4
Cobalt	mD		10	0.1K	N8/78		0g/29/19 0K:00	06/11/19 12:BB	4
Iron	mD		20	12	N8/78		0g/29/19 0K:00	06/11/19 12:BB	4
Li	mD		10	0.g0	N8/78		0g/29/19 0K:00	06/11/19 12:BB	4
Man8anese	mD		B.0	0.12	N8/78		0g/29/19 0K:00	06/11/19 12:BB	4
Mo	mD		K.0	0.BB	N8/78		0g/29/19 0K:00	06/11/19 12:BB	4
SeleniyN	mD		2.0	0.gK	N8/78		0g/29/19 0K:00	06/11/19 12:BB	4
T3alliyN	mD		6.0	0.K4	N8/78		0g/29/19 0K:00	06/11/19 12:BB	4

Lab Sample ID: LCS 140-31148/14-B ^5 **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Step 1**
Analysis Batch: 31604 **Prep Batch: 31252**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
AlyNinyN	100	96.0		N8/78		96	65 - 125
AntiNonh	25.0	24.5		N8/78		9K	65 - 125
Arsenic	5.00	4.K9		N8/78		9K	65 - 125
uariyN	5.00	4.B5	J	N8/78		K6	65 - 125
uerhlliyN	2.50	2.5K		N8/78		10B	65 - 125

QC Sample Results

Client: Golder Associates Inc. Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: LCS 140-31148/14-B ^5 **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Step 1**
Analysis Batch: 31604 **Prep Batch: 31252**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Cobalt	5.00	4.9B	J	N8/78		99	65 - 125
Iron	50.0	49.g		N8/78		99	65 - 125
Li	5.00	4.62	J	N8/78		94	65 - 125
Man8anese	5.00	5.09		N8/78		102	65 - 125
Mo	25.0	25.0		N8/78		100	65 - 125
SeleniyN	6.50	6.K2		N8/78		104	65 - 125
T3alliyN	20.0	19.6		N8/78		9K	65 - 125

Lab Sample ID: LCSD 140-31148/15-B ^5 **Client Sample ID: Lab Control Sample Dup**
Matrix: Solid **Prep Type: Step 1**
Analysis Batch: 31604 **Prep Batch: 31252**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
AlyNinyN	100	99.5		N8/78		100	65 - 125	B	B0
AntiNonh	25.0	24.6		N8/78		99	65 - 125	1	B0
Arsenic	5.00	4.6K		N8/78		9g	65 - 125	2	B0
uariyN	5.00	4.B0	J	N8/78		Kg	65 - 125	1	B0
uerhlliyN	2.50	2.59		N8/78		104	65 - 125	0	B0
Cobalt	5.00	4.K9	J	N8/78		9K	65 - 125	1	B0
Iron	50.0	49.5		N8/78		99	65 - 125	0	B0
Li	5.00	4.K4	J	N8/78		96	65 - 125	B	B0
Man8anese	5.00	5.0g		N8/78		101	65 - 125	1	B0
Mo	25.0	25.1		N8/78		100	65 - 125	0	B0
SeleniyN	6.50	K.0g		N8/78		10K	65 - 125	B	B0
T3alliyN	20.0	20.1		N8/78		101	65 - 125	2	B0

Lab Sample ID: MB 140-31253/13-B ^3 **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: Step 2**
Analysis Batch: 31604 **Prep Batch: 31256**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
AlyNinyN	mD		B0	4.K	N8/78		0g/B0/19 0K:00	06/11/19 14:0g	B
AntiNonh	mD		9.0	0.K4	N8/78		0g/B0/19 0K:00	06/11/19 14:0g	B
Arsenic	mD		1.5	0.B9	N8/78		0g/B0/19 0K:00	06/11/19 14:0g	B
uariyN	mD		6.5	0.Bg	N8/78		0g/B0/19 0K:00	06/11/19 14:0g	B
uerhlliyN	mD		0.65	0.04K	N8/78		0g/B0/19 0K:00	06/11/19 14:0g	B
Cobalt	mD		6.5	0.19	N8/78		0g/B0/19 0K:00	06/11/19 14:0g	B
Iron	mD		15	K.6	N8/78		0g/B0/19 0K:00	06/11/19 14:0g	B
Li	mD		6.5	0.45	N8/78		0g/B0/19 0K:00	06/11/19 14:0g	B
Man8anese	mD		2.B	0.K4	N8/78		0g/B0/19 0K:00	06/11/19 14:0g	B
Mo	mD		g.0	0.25	N8/78		0g/B0/19 0K:00	06/11/19 14:0g	B
SeleniyN	0.5K6	J	1.5	0.51	N8/78		0g/B0/19 0K:00	06/11/19 14:0g	B
T3alliyN	mD		5.B	0.gB	N8/78		0g/B0/19 0K:00	06/11/19 14:0g	B

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: LCS 140-31253/14-B ^5
Matrix: Solid
Analysis Batch: 31604

Client Sample ID: Lab Control Sample
Prep Type: Step 2
Prep Batch: 31256

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
AlyNinyN	100	mD	v	N8/78		1	65 - 125
AntiNonh	25.0	21.1		N8/78		K4	65 - 125
Arsenic	5.00	B.95		N8/78		69	65 - 125
uariyN	5.00	2.2K	J v	N8/78		4g	65 - 125
uerhlliyN	2.50	1.B5	v	N8/78		54	65 - 125
Cobalt	5.00	4.g2	J	N8/78		92	65 - 125
Iron	50.0	mD	v	N8/78		2	65 - 125
Li	5.00	4.14	J	N8/78		KB	65 - 125
Man8anese	5.00	4.69		N8/78		9g	65 - 125
Mo	25.0	20.6		N8/78		KB	65 - 125
SeleniyN	6.50	6.B4		N8/78		9K	65 - 125
T3alliyN	20.0	1K.4		N8/78		92	65 - 125

Lab Sample ID: LCSD 140-31253/15-B ^5
Matrix: Solid
Analysis Batch: 31604

Client Sample ID: Lab Control Sample Dup
Prep Type: Step 2
Prep Batch: 31256

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
AlyNinyN	100	mD	v	N8/78		-0.B	65 - 125	2K9	B0
AntiNonh	25.0	21.4		N8/78		Kg	65 - 125	1	B0
Arsenic	5.00	4.00		N8/78		K0	65 - 125	1	B0
uariyN	5.00	2.2K	J v	N8/78		4g	65 - 125	0	B0
uerhlliyN	2.50	1.B2	v	N8/78		5B	65 - 125	2	B0
Cobalt	5.00	4.g2	J	N8/78		92	65 - 125	0	B0
Iron	50.0	mD	v	N8/78		B	65 - 125	2K	B0
Li	5.00	4.15	J	N8/78		KB	65 - 125	0	B0
Man8anese	5.00	4.6g		N8/78		95	65 - 125	1	B0
Mo	25.0	20.9		N8/78		K4	65 - 125	1	B0
SeleniyN	6.50	g.gK		N8/78		K9	65 - 125	10	B0
T3alliyN	20.0	1Kg		N8/78		9B	65 - 125	1	B0

Lab Sample ID: MB 140-31257/13-B
Matrix: Solid
Analysis Batch: 31604

Client Sample ID: Method Blank
Prep Type: Step 3
Prep Batch: 31338

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
AlyNinyN	mD		10	2.1	N8/78		06/02/19 0K:00	06/11/19 15:50	1
AntiNonh	mD		B.0	0.2K	N8/78		06/02/19 0K:00	06/11/19 15:50	1
Arsenic	mD		0.50	0.1B	N8/78		06/02/19 0K:00	06/11/19 15:50	1
uariyN	0.151	J	2.5	0.12	N8/78		06/02/19 0K:00	06/11/19 15:50	1
uerhlliyN	mD		0.25	0.015	N8/78		06/02/19 0K:00	06/11/19 15:50	1
Cobalt	mD		2.5	0.045	N8/78		06/02/19 0K:00	06/11/19 15:50	1
Iron	mD		5.0	2.9	N8/78		06/02/19 0K:00	06/11/19 15:50	1
Li	mD		2.5	0.15	N8/78		06/02/19 0K:00	06/11/19 15:50	1
Man8anese	0.0515	J	0.65	0.026	N8/78		06/02/19 0K:00	06/11/19 15:50	1
Mo	mD		2.0	0.0K2	N8/78		06/02/19 0K:00	06/11/19 15:50	1
SeleniyN	0.196	J	0.50	0.16	N8/78		06/02/19 0K:00	06/11/19 15:50	1
T3alliyN	mD		1.K	0.21	N8/78		06/02/19 0K:00	06/11/19 15:50	1

QC Sample Results

Client: Golder Associates Inc. Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: LCS 140-31257/14-B **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Step 3**
Analysis Batch: 31604 **Prep Batch: 31338**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
AlyNinyN	100	95.K		N8/78		9g	65 - 125
AntiNonh	25.0	24.B		N8/78		96	65 - 125
Arsenic	5.00	4.90		N8/78		9K	65 - 125
uariyN	5.00	4.B4		N8/78		K6	65 - 125
uerhlliyN	2.50	2.5g		N8/78		102	65 - 125
Cobalt	5.00	4.90		N8/78		9K	65 - 125
Iron	50.0	54.0		N8/78		10K	65 - 125
Li	5.00	4.K6		N8/78		96	65 - 125
Man8anese	5.00	5.0B		N8/78		101	65 - 125
Mo	25.0	24.K		N8/78		99	65 - 125
SeleniyN	6.50	6.B6		N8/78		9K	65 - 125
T3alliyN	20.0	20.2		N8/78		101	65 - 125

Lab Sample ID: LCSD 140-31257/15-B **Client Sample ID: Lab Control Sample Dup**
Matrix: Solid **Prep Type: Step 3**
Analysis Batch: 31604 **Prep Batch: 31338**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
AlyNinyN	100	9K.1		N8/78		9K	65 - 125	2	B0
AntiNonh	25.0	24.g		N8/78		9K	65 - 125	1	B0
Arsenic	5.00	5.0g		N8/78		101	65 - 125	B	B0
uariyN	5.00	4.49		N8/78		90	65 - 125	B	B0
uerhlliyN	2.50	2.g1		N8/78		104	65 - 125	2	B0
Cobalt	5.00	4.96		N8/78		99	65 - 125	1	B0
Iron	50.0	51.0		N8/78		102	65 - 125	g	B0
Li	5.00	4.95		N8/78		99	65 - 125	2	B0
Man8anese	5.00	5.0g		N8/78		101	65 - 125	1	B0
Mo	25.0	24.9		N8/78		100	65 - 125	0	B0
SeleniyN	6.50	6.gB		N8/78		102	65 - 125	B	B0
T3alliyN	20.0	20.5		N8/78		10B	65 - 125	2	B0

Lab Sample ID: MB 140-31341/13-B **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: Step 4**
Analysis Batch: 31604 **Prep Batch: 31360**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
AlyNinyN	mD		10	1.g	N8/78		06/0B/19 0K:00	06/11/19 16:24	1
AntiNonh	mD		B.0	0.45	N8/78		06/0B/19 0K:00	06/11/19 16:24	1
Arsenic	0.2g0	J	0.50	0.22	N8/78		06/0B/19 0K:00	06/11/19 16:24	1
uariyN	mD		2.5	0.12	N8/78		06/0B/19 0K:00	06/11/19 16:24	1
uerhlliyN	mD		0.25	0.01g	N8/78		06/0B/19 0K:00	06/11/19 16:24	1
Cobalt	mD		2.5	0.05B	N8/78		06/0B/19 0K:00	06/11/19 16:24	1
Iron	mD		5.0	2.9	N8/78		06/0B/19 0K:00	06/11/19 16:24	1
Li	mD		2.5	0.15	N8/78		06/0B/19 0K:00	06/11/19 16:24	1
Man8anese	mD		0.65	0.1B	N8/78		06/0B/19 0K:00	06/11/19 16:24	1
Mo	mD		2.0	0.0K2	N8/78		06/0B/19 0K:00	06/11/19 16:24	1
SeleniyN	0.5g1		0.50	0.46	N8/78		06/0B/19 0K:00	06/11/19 16:24	1
T3alliyN	mD		1.K	0.29	N8/78		06/0B/19 0K:00	06/11/19 16:24	1

QC Sample Results

Client: Golder Associates Inc. Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: LCS 140-31341/14-B **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Step 4**
Analysis Batch: 31604 **Prep Batch: 31360**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
AlyNinyN	100	9K4		N8/78		9K	65 - 125
AntiNonh	25.0	25.g		N8/78		102	65 - 125
Arsenic	5.00	5.4K		N8/78		110	65 - 125
uariyN	5.00	4.90		N8/78		9K	65 - 125
uerhlliyN	2.50	2.gg		N8/78		10g	65 - 125
Cobalt	5.00	4.92		N8/78		9K	65 - 125
Iron	50.0	50.0		N8/78		100	65 - 125
Li	5.00	4.92		N8/78		9K	65 - 125
Man8anese	5.00	4.9K		N8/78		100	65 - 125
Mo	25.0	25.6		N8/78		10B	65 - 125
SeleniyN	6.50	0.6g2	v	N8/78		10	65 - 125
T3alliyN	20.0	16.2		N8/78		Kg	65 - 125

Lab Sample ID: LCSD 140-31341/15-B **Client Sample ID: Lab Control Sample Dup**
Matrix: Solid **Prep Type: Step 4**
Analysis Batch: 31604 **Prep Batch: 31360**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
AlyNinyN	100	101		N8/78		101	65 - 125	B	B0
AntiNonh	25.0	25.9		N8/78		10B	65 - 125	1	B0
Arsenic	5.00	5.55		N8/78		111	65 - 125	1	B0
uariyN	5.00	5.04		N8/78		101	65 - 125	B	B0
uerhlliyN	2.50	2.64		N8/78		109	65 - 125	B	B0
Cobalt	5.00	5.06		N8/78		101	65 - 125	B	B0
Iron	50.0	51.5		N8/78		10B	65 - 125	B	B0
Li	5.00	5.09		N8/78		102	65 - 125	B	B0
Man8anese	5.00	5.1B		N8/78		10B	65 - 125	B	B0
Mo	25.0	25.9		N8/78		104	65 - 125	1	B0
SeleniyN	6.50	0.gB1	v	N8/78		K	65 - 125	19	B0
T3alliyN	20.0	16.9		N8/78		K9	65 - 125	4	B0

Lab Sample ID: MB 140-31436/13-B ^5 **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: Step 5**
Analysis Batch: 31651 **Prep Batch: 31500**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
AlyNinyN	mD		150	24	N8/78		06/10/19 0K:00	06/12/19 11:B9	5
AntiNonh	mD		45	4.2	N8/78		06/10/19 0K:00	06/12/19 11:B9	5
Arsenic	mD		6.5	1.9	N8/78		06/10/19 0K:00	06/12/19 11:B9	5
uariyN	mD		BK	1.K	N8/78		06/10/19 0K:00	06/12/19 11:B9	5
uerhlliyN	mD		B.K	0.B2	N8/78		06/10/19 0K:00	06/12/19 11:B9	5
Cobalt	mD		BK	0.g0	N8/78		06/10/19 0K:00	06/12/19 11:B9	5
Iron	mD		65	44	N8/78		06/10/19 0K:00	06/12/19 11:B9	5
Li	mD		BK	2.2	N8/78		06/10/19 0K:00	06/12/19 11:B9	5
Man8anese	mD		11	1.9	N8/78		06/10/19 0K:00	06/12/19 11:B9	5
Mo	mD		B0	1.B	N8/78		06/10/19 0K:00	06/12/19 11:B9	5
SeleniyN	mD		6.5	2.g	N8/78		06/10/19 0K:00	06/12/19 11:B9	5
T3alliyN	mD		2g	B.5	N8/78		06/10/19 0K:00	06/12/19 11:B9	5

QC Sample Results

Client: Golder Associates Inc. Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: LCS 140-31436/14-B ^5 **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Step 5**
Analysis Batch: 31651 **Prep Batch: 31500**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
AlyNinyN	B00	mD	v	N8/78		g	65 - 125
AntiNonh	65.0	K1.2		N8/78		10K	65 - 125
Arsenic	15.0	12.B		N8/78		K2	65 - 125
uariyN	15.0	6.K0	J v	N8/78		52	65 - 125
uerhlliyN	6.50	4.2B	v	N8/78		5g	65 - 125
Cobalt	15.0	4.Kg	J v	N8/78		B2	65 - 125
Iron	150	mD	v	N8/78		2	65 - 125
Li	15.0	1g.4	J	N8/78		109	65 - 125
Man8anese	15.0	4.K2	J v	N8/78		B2	65 - 125
Mo	65.0	g4.6		N8/78		Kg	65 - 125
SeleniyN	22.5	24.K		N8/78		110	65 - 125
T3alliyN	g0.0	mD	v	N8/78		2	65 - 125

Lab Sample ID: LCSD 140-31436/15-B ^5 **Client Sample ID: Lab Control Sample Dup**
Matrix: Solid **Prep Type: Step 5**
Analysis Batch: 31651 **Prep Batch: 31500**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
AlyNinyN	B00	mD	v	N8/78		6	65 - 125	14	B0
AntiNonh	65.0	K2.5		N8/78		110	65 - 125	2	B0
Arsenic	15.0	12.5		N8/78		KB	65 - 125	2	B0
uariyN	15.0	6.6B	J v	N8/78		52	65 - 125	1	B0
uerhlliyN	6.50	4.B4	v	N8/78		5K	65 - 125	2	B0
Cobalt	15.0	5.05	J v	N8/78		B4	65 - 125	4	B0
Iron	150	mD	v	N8/78		B	65 - 125	55	B0
Li	15.0	1g.1	J	N8/78		106	65 - 125	2	B0
Man8anese	15.0	4.96	J v	N8/78		BB	65 - 125	B	B0
Mo	65.0	g4.0		N8/78		K5	65 - 125	1	B0
SeleniyN	22.5	2g.2		N8/78		11g	65 - 125	g	B0
T3alliyN	g0.0	mD	v	N8/78		0.9	65 - 125	g0	B0

Lab Sample ID: MB 140-31502/13-A **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: Step 6**
Analysis Batch: 31651 **Prep Batch: 31502**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
AlyNinyN	mD		10	1.g	N8/78		06/10/19 0K:00	06/12/19 1B:14	1
AntiNonh	mD		B.0	0.2K	N8/78		06/10/19 0K:00	06/12/19 1B:14	1
Arsenic	mD		0.50	0.15	N8/78		06/10/19 0K:00	06/12/19 1B:14	1
uariyN	mD		2.5	0.12	N8/78		06/10/19 0K:00	06/12/19 1B:14	1
uerhlliyN	mD		0.25	0.012	N8/78		06/10/19 0K:00	06/12/19 1B:14	1
Cobalt	mD		2.5	0.04g	N8/78		06/10/19 0K:00	06/12/19 1B:14	1
Iron	mD		5.0	2.9	N8/78		06/10/19 0K:00	06/12/19 1B:14	1
Li	mD		2.5	0.15	N8/78		06/10/19 0K:00	06/12/19 1B:14	1
Man8anese	mD		0.65	0.25	N8/78		06/10/19 0K:00	06/12/19 1B:14	1
Mo	mD		2.0	0.099	N8/78		06/10/19 0K:00	06/12/19 1B:14	1
SeleniyN	mD		0.50	0.16	N8/78		06/10/19 0K:00	06/12/19 1B:14	1
T3alliyN	mD		1.K	0.21	N8/78		06/10/19 0K:00	06/12/19 1B:14	1

Client: Golder Associates Inc. Job ID: 140-15492-1

Project/Site: Martin Lake A1 Area LF SEP + Totals

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: LCS 140-31502/14-A **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Step 6**
Analysis Batch: 31651 **Prep Batch: 31502**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
AlyNinyN	100	95.4		N8/78		95	65 - 125
AntiNonh	25.0	24.K		N8/78		99	65 - 125
Arsenic	5.00	4.94		N8/78		99	65 - 125
uariyN	5.00	4.5K		N8/78		92	65 - 125
uerhlliyN	2.50	2.56		N8/78		10B	65 - 125
Cobalt	5.00	4.6K		N8/78		9g	65 - 125
Iron	50.0	46.4		N8/78		95	65 - 125
Li	5.00	4.61		N8/78		94	65 - 125
Man8anese	5.00	4.KB		N8/78		96	65 - 125
Mo	25.0	24.6		N8/78		99	65 - 125
SeleniyN	6.50	6.B2		N8/78		9K	65 - 125
T3alliyN	20.0	19.K		N8/78		99	65 - 125

Lab Sample ID: LCSD 140-31502/15-A **Client Sample ID: Lab Control Sample Dup**
Matrix: Solid **Prep Type: Step 6**
Analysis Batch: 31651 **Prep Batch: 31502**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
AlyNinyN	100	9K.K		N8/78		99	65 - 125	4	B0
AntiNonh	25.0	25.5		N8/78		102	65 - 125	B	B0
Arsenic	5.00	5.1g		N8/78		10B	65 - 125	4	B0
uariyN	5.00	4.66		N8/78		95	65 - 125	4	B0
uerhlliyN	2.50	2.g6		N8/78		106	65 - 125	4	B0
Cobalt	5.00	4.96		N8/78		99	65 - 125	4	B0
Iron	50.0	49.5		N8/78		99	65 - 125	4	B0
Li	5.00	4.90		N8/78		9K	65 - 125	4	B0
Man8anese	5.00	5.02		N8/78		100	65 - 125	4	B0
Mo	25.0	25.2		N8/78		101	65 - 125	2	B0
SeleniyN	6.50	6.50		N8/78		100	65 - 125	2	B0
T3alliyN	20.0	20.g		N8/78		10B	65 - 125	4	B0

Lab Sample ID: MB 140-31615/13-A **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: Step 7**
Analysis Batch: 31713 **Prep Batch: 31615**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
AlyNinyN	mD		10	1.g	N8/78		06/12/19 09:0K	06/15/19 10:5K	1
AntiNonh	mD		B.0	0.14	N8/78		06/12/19 09:0K	06/15/19 10:5K	1
Arsenic	mD		0.50	0.1B	N8/78		06/12/19 09:0K	06/15/19 10:5K	1
uariyN	mD		2.5	0.12	N8/78		06/12/19 09:0K	06/15/19 10:5K	1
uerhlliyN	mD		0.25	0.0065	N8/78		06/12/19 09:0K	06/15/19 10:5K	1
Cobalt	mD		2.5	0.15	N8/78		06/12/19 09:0K	06/15/19 10:5K	1
Iron	mD		5.0	4.1	N8/78		06/12/19 09:0K	06/15/19 10:5K	1
Li	mD		2.5	0.15	N8/78		06/12/19 09:0K	06/15/19 10:5K	1
Man8anese	mD		0.65	0.052	N8/78		06/12/19 09:0K	06/15/19 10:5K	1
Mo	mD		2.0	0.0K2	N8/78		06/12/19 09:0K	06/15/19 10:5K	1
SeleniyN	mD		0.50	0.16	N8/78		06/12/19 09:0K	06/15/19 10:5K	1
T3alliyN	mD		1.K	0.1K	N8/78		06/12/19 09:0K	06/15/19 10:5K	1

QC Sample Results

Client: Golder Associates Inc. Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Method: 6010B SEP - SEP Metals (ICP) (Continued)

Lab Sample ID: LCS 140-31615/14-A **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Step 7**
Analysis Batch: 31713 **Prep Batch: 31615**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
AlyNinyN	100	9g.K		N8/78		96	65 - 125
AntiNonh	25.0	25.6		N8/78		10B	65 - 125
Arsenic	5.00	5.2B		N8/78		105	65 - 125
uariyN	5.00	4.99		N8/78		100	65 - 125
uerhlliyN	2.50	2.52		N8/78		101	65 - 125
Cobalt	5.00	5.20		N8/78		104	65 - 125
Iron	50.0	51.6		N8/78		10B	65 - 125
Li	5.00	5.15		N8/78		10B	65 - 125
Man8anese	5.00	5.21		N8/78		104	65 - 125
Mo	25.0	2g.5		N8/78		10g	65 - 125
SeleniyN	6.50	6.52		N8/78		100	65 - 125
T3alliyN	20.0	21.2		N8/78		10g	65 - 125

Lab Sample ID: LCSD 140-31615/15-A **Client Sample ID: Lab Control Sample Dup**
Matrix: Solid **Prep Type: Step 7**
Analysis Batch: 31713 **Prep Batch: 31615**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
AlyNinyN	100	9K.0		N8/78		9K	65 - 125	1	B0
AntiNonh	25.0	25.K		N8/78		10B	65 - 125	0	B0
Arsenic	5.00	5.B0		N8/78		10g	65 - 125	1	B0
uariyN	5.00	4.99		N8/78		100	65 - 125	0	B0
uerhlliyN	2.50	2.50		N8/78		100	65 - 125	1	B0
Cobalt	5.00	5.21		N8/78		104	65 - 125	0	B0
Iron	50.0	51.5		N8/78		10B	65 - 125	0	B0
Li	5.00	5.1K		N8/78		104	65 - 125	1	B0
Man8anese	5.00	5.21		N8/78		104	65 - 125	0	B0
Mo	25.0	2g.6		N8/78		106	65 - 125	1	B0
SeleniyN	6.50	6.55		N8/78		101	65 - 125	0	B0
T3alliyN	20.0	21.B		N8/78		106	65 - 125	1	B0

Method: 7470A - SEP Mercury (CVAA) - Total

Lab Sample ID: MB 140-30683/13-B **Client Sample ID: Method Blank**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 30868 **Prep Batch: 30683**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
H8	mD		0.10	0.040	N8/78		0g/11/19 0K:00	0g/1g/19 1B:5g	1

Lab Sample ID: LCS 140-30683/14-B **Client Sample ID: Lab Control Sample**
Matrix: Solid **Prep Type: Total/NA**
Analysis Batch: 30868 **Prep Batch: 30683**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
H8	2.50	2.60		N8/78		10K	65 - 125

Method: 7470A - SEP Mercury (CVAA) - Total (Continued)

Lab Sample ID: LCSD 140-30683/15-B
Matrix: Solid
Analysis Batch: 30868

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 30683

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
H8			2.50	2.61		N8/78		10K	65 - 125	0	B0

Client: Golder Associates Inc.
Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Metals

Prep Batch: 30683

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Total/NA	Solid	Total	
140-15492-2	BMW-30 (40-41)	Total/NA	Solid	Total	
140-15492-3	BMW-31 (14-15)	Total/NA	Solid	Total	
140-15492-4	BMW-32 (25-26)	Total/NA	Solid	Total	
140-15492-5	BMW-33 (38-39)	Total/NA	Solid	Total	
MB 140-30683/13-A	Method Blank	Total/NA	Solid	Total	
MB 140-30683/13-B	Method Blank	Total/NA	Solid	Total	
LCS 140-30683/14-A	Lab Control Sample	Total/NA	Solid	Total	
LCS 140-30683/14-B	Lab Control Sample	Total/NA	Solid	Total	
LCSD 140-30683/15-A	Lab Control Sample Dup	Total/NA	Solid	Total	
LCSD 140-30683/15-B	Lab Control Sample Dup	Total/NA	Solid	Total	

Prep Batch: 30859

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Total/NA	Solid	7470A	30683
140-15492-2	BMW-30 (40-41)	Total/NA	Solid	7470A	30683
140-15492-3	BMW-31 (14-15)	Total/NA	Solid	7470A	30683
140-15492-4	BMW-32 (25-26)	Total/NA	Solid	7470A	30683
140-15492-5	BMW-33 (38-39)	Total/NA	Solid	7470A	30683
MB 140-30683/13-B	Method Blank	Total/NA	Solid	7470A	30683
LCS 140-30683/14-B	Lab Control Sample	Total/NA	Solid	7470A	30683
LCSD 140-30683/15-B	Lab Control Sample Dup	Total/NA	Solid	7470A	30683

Analysis Batch: 30868

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Total/NA	Solid	7470A	30859
140-15492-2	BMW-30 (40-41)	Total/NA	Solid	7470A	30859
140-15492-3	BMW-31 (14-15)	Total/NA	Solid	7470A	30859
140-15492-4	BMW-32 (25-26)	Total/NA	Solid	7470A	30859
140-15492-5	BMW-33 (38-39)	Total/NA	Solid	7470A	30859
MB 140-30683/13-B	Method Blank	Total/NA	Solid	7470A	30859
LCS 140-30683/14-B	Lab Control Sample	Total/NA	Solid	7470A	30859
LCSD 140-30683/15-B	Lab Control Sample Dup	Total/NA	Solid	7470A	30859

Prep Batch: 31128

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Total/NA	Solid	3050B	
140-15492-2	BMW-30 (40-41)	Total/NA	Solid	3050B	
140-15492-3	BMW-31 (14-15)	Total/NA	Solid	3050B	
140-15492-4	BMW-32 (25-26)	Total/NA	Solid	3050B	
140-15492-5	BMW-33 (38-39)	Total/NA	Solid	3050B	
MB 140-31128/14-A	Method Blank	Total/NA	Solid	3050B	
LCS 140-31128/15-A	Lab Control Sample	Total/NA	Solid	3050B	

SEP Batch: 31148

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Step 1	Solid	Exchangeable	
140-15492-2	BMW-30 (40-41)	Step 1	Solid	Exchangeable	
140-15492-3	BMW-31 (14-15)	Step 1	Solid	Exchangeable	
140-15492-4	BMW-32 (25-26)	Step 1	Solid	Exchangeable	
140-15492-5	BMW-33 (38-39)	Step 1	Solid	Exchangeable	

Metals (Continued)

SEP Batch: 31148 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
MB 140-31148/13-B ^4	Method Blank	Step 1	Solid	Exchangeable	
LCS 140-31148/14-B ^5	Lab Control Sample	Step 1	Solid	Exchangeable	
LCSD 140-31148/15-B ^5	Lab Control Sample Dup	Step 1	Solid	Exchangeable	

Prep Batch: 31252

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Step 1	Solid	3010A	31148
140-15492-2	BMW-30 (40-41)	Step 1	Solid	3010A	31148
140-15492-3	BMW-31 (14-15)	Step 1	Solid	3010A	31148
140-15492-4	BMW-32 (25-26)	Step 1	Solid	3010A	31148
140-15492-5	BMW-33 (38-39)	Step 1	Solid	3010A	31148
MB 140-31148/13-B ^4	Method Blank	Step 1	Solid	3010A	31148
LCS 140-31148/14-B ^5	Lab Control Sample	Step 1	Solid	3010A	31148
LCSD 140-31148/15-B ^5	Lab Control Sample Dup	Step 1	Solid	3010A	31148

SEP Batch: 31253

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Step 2	Solid	Carbonate	
140-15492-2	BMW-30 (40-41)	Step 2	Solid	Carbonate	
140-15492-3	BMW-31 (14-15)	Step 2	Solid	Carbonate	
140-15492-4	BMW-32 (25-26)	Step 2	Solid	Carbonate	
140-15492-5	BMW-33 (38-39)	Step 2	Solid	Carbonate	
MB 140-31253/13-B ^3	Method Blank	Step 2	Solid	Carbonate	
LCS 140-31253/14-B ^5	Lab Control Sample	Step 2	Solid	Carbonate	
LCSD 140-31253/15-B ^5	Lab Control Sample Dup	Step 2	Solid	Carbonate	

Prep Batch: 31256

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Step 2	Solid	3010A	31253
140-15492-2	BMW-30 (40-41)	Step 2	Solid	3010A	31253
140-15492-3	BMW-31 (14-15)	Step 2	Solid	3010A	31253
140-15492-4	BMW-32 (25-26)	Step 2	Solid	3010A	31253
140-15492-5	BMW-33 (38-39)	Step 2	Solid	3010A	31253
MB 140-31253/13-B ^3	Method Blank	Step 2	Solid	3010A	31253
LCS 140-31253/14-B ^5	Lab Control Sample	Step 2	Solid	3010A	31253
LCSD 140-31253/15-B ^5	Lab Control Sample Dup	Step 2	Solid	3010A	31253

SEP Batch: 31257

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Step 3	Solid	Non-Crystalline	
140-15492-2	BMW-30 (40-41)	Step 3	Solid	Non-Crystalline	
140-15492-3	BMW-31 (14-15)	Step 3	Solid	Non-Crystalline	
140-15492-4	BMW-32 (25-26)	Step 3	Solid	Non-Crystalline	
140-15492-5	BMW-33 (38-39)	Step 3	Solid	Non-Crystalline	
MB 140-31257/13-B	Method Blank	Step 3	Solid	Non-Crystalline	
LCS 140-31257/14-B	Lab Control Sample	Step 3	Solid	Non-Crystalline	
LCSD 140-31257/15-B	Lab Control Sample Dup	Step 3	Solid	Non-Crystalline	

Prep Batch: 31338

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Step 3	Solid	3010A	31257

Metals (Continued)

Prep Batch: 31338 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-2	BMW-30 (40-41)	Step 3	Solid	3010A	31257
140-15492-3	BMW-31 (14-15)	Step 3	Solid	3010A	31257
140-15492-4	BMW-32 (25-26)	Step 3	Solid	3010A	31257
140-15492-5	BMW-33 (38-39)	Step 3	Solid	3010A	31257
MB 140-31257/13-B	Method Blank	Step 3	Solid	3010A	31257
LCS 140-31257/14-B	Lab Control Sample	Step 3	Solid	3010A	31257
LCSD 140-31257/15-B	Lab Control Sample Dup	Step 3	Solid	3010A	31257

SEP Batch: 31341

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Step 4	Solid	Metal Hydroxide	
140-15492-2	BMW-30 (40-41)	Step 4	Solid	Metal Hydroxide	
140-15492-3	BMW-31 (14-15)	Step 4	Solid	Metal Hydroxide	
140-15492-4	BMW-32 (25-26)	Step 4	Solid	Metal Hydroxide	
140-15492-5	BMW-33 (38-39)	Step 4	Solid	Metal Hydroxide	
MB 140-31341/13-B	Method Blank	Step 4	Solid	Metal Hydroxide	
LCS 140-31341/14-B	Lab Control Sample	Step 4	Solid	Metal Hydroxide	
LCSD 140-31341/15-B	Lab Control Sample Dup	Step 4	Solid	Metal Hydroxide	

Prep Batch: 31360

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Step 4	Solid	3010A	31341
140-15492-2	BMW-30 (40-41)	Step 4	Solid	3010A	31341
140-15492-3	BMW-31 (14-15)	Step 4	Solid	3010A	31341
140-15492-4	BMW-32 (25-26)	Step 4	Solid	3010A	31341
140-15492-5	BMW-33 (38-39)	Step 4	Solid	3010A	31341
MB 140-31341/13-B	Method Blank	Step 4	Solid	3010A	31341
LCS 140-31341/14-B	Lab Control Sample	Step 4	Solid	3010A	31341
LCSD 140-31341/15-B	Lab Control Sample Dup	Step 4	Solid	3010A	31341

SEP Batch: 31436

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Step 5	Solid	Organic-Bound	
140-15492-2	BMW-30 (40-41)	Step 5	Solid	Organic-Bound	
140-15492-3	BMW-31 (14-15)	Step 5	Solid	Organic-Bound	
140-15492-4	BMW-32 (25-26)	Step 5	Solid	Organic-Bound	
140-15492-5	BMW-33 (38-39)	Step 5	Solid	Organic-Bound	
MB 140-31436/13-B ^5	Method Blank	Step 5	Solid	Organic-Bound	
LCS 140-31436/14-B ^5	Lab Control Sample	Step 5	Solid	Organic-Bound	
LCSD 140-31436/15-B ^5	Lab Control Sample Dup	Step 5	Solid	Organic-Bound	

Prep Batch: 31500

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Step 5	Solid	3010A	31436
140-15492-2	BMW-30 (40-41)	Step 5	Solid	3010A	31436
140-15492-3	BMW-31 (14-15)	Step 5	Solid	3010A	31436
140-15492-4	BMW-32 (25-26)	Step 5	Solid	3010A	31436
140-15492-5	BMW-33 (38-39)	Step 5	Solid	3010A	31436
MB 140-31436/13-B ^5	Method Blank	Step 5	Solid	3010A	31436
LCS 140-31436/14-B ^5	Lab Control Sample	Step 5	Solid	3010A	31436
LCSD 140-31436/15-B ^5	Lab Control Sample Dup	Step 5	Solid	3010A	31436

Client: Golder Associates Inc. Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Metals

SEP Batch: 31502

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Step 6	Solid	Acid/Sulfide	
140-15492-2	BMW-30 (40-41)	Step 6	Solid	Acid/Sulfide	
140-15492-3	BMW-31 (14-15)	Step 6	Solid	Acid/Sulfide	
140-15492-4	BMW-32 (25-26)	Step 6	Solid	Acid/Sulfide	
140-15492-5	BMW-33 (38-39)	Step 6	Solid	Acid/Sulfide	
MB 140-31502/13-A	Method Blank	Step 6	Solid	Acid/Sulfide	
LCS 140-31502/14-A	Lab Control Sample	Step 6	Solid	Acid/Sulfide	
LCSD 140-31502/15-A	Lab Control Sample Dup	Step 6	Solid	Acid/Sulfide	

Analysis Batch: 31553

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Total/NA	Solid	6010B	31128
140-15492-2	BMW-30 (40-41)	Total/NA	Solid	6010B	31128
140-15492-3	BMW-31 (14-15)	Total/NA	Solid	6010B	31128
140-15492-4	BMW-32 (25-26)	Total/NA	Solid	6010B	31128
140-15492-5	BMW-33 (38-39)	Total/NA	Solid	6010B	31128
MB 140-31128/14-A	Method Blank	Total/NA	Solid	6010B	31128
LCS 140-31128/15-A	Lab Control Sample	Total/NA	Solid	6010B	31128

Analysis Batch: 31604

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Step 1	Solid	6010B SEP	31252
140-15492-1	BMW-29 (30-31)	Step 2	Solid	6010B SEP	31256
140-15492-1	BMW-29 (30-31)	Step 3	Solid	6010B SEP	31338
140-15492-1	BMW-29 (30-31)	Step 4	Solid	6010B SEP	31360
140-15492-2	BMW-30 (40-41)	Step 1	Solid	6010B SEP	31252
140-15492-2	BMW-30 (40-41)	Step 2	Solid	6010B SEP	31256
140-15492-2	BMW-30 (40-41)	Step 3	Solid	6010B SEP	31338
140-15492-2	BMW-30 (40-41)	Step 4	Solid	6010B SEP	31360
140-15492-3	BMW-31 (14-15)	Step 1	Solid	6010B SEP	31252
140-15492-3	BMW-31 (14-15)	Step 2	Solid	6010B SEP	31256
140-15492-3	BMW-31 (14-15)	Step 3	Solid	6010B SEP	31338
140-15492-3	BMW-31 (14-15)	Step 4	Solid	6010B SEP	31360
140-15492-4	BMW-32 (25-26)	Step 1	Solid	6010B SEP	31252
140-15492-4	BMW-32 (25-26)	Step 2	Solid	6010B SEP	31256
140-15492-4	BMW-32 (25-26)	Step 3	Solid	6010B SEP	31338
140-15492-4	BMW-32 (25-26)	Step 4	Solid	6010B SEP	31360
140-15492-5	BMW-33 (38-39)	Step 1	Solid	6010B SEP	31252
140-15492-5	BMW-33 (38-39)	Step 2	Solid	6010B SEP	31256
140-15492-5	BMW-33 (38-39)	Step 3	Solid	6010B SEP	31338
140-15492-5	BMW-33 (38-39)	Step 4	Solid	6010B SEP	31360
MB 140-31148/13-B ^4	Method Blank	Step 1	Solid	6010B SEP	31252
MB 140-31253/13-B ^3	Method Blank	Step 2	Solid	6010B SEP	31256
MB 140-31257/13-B	Method Blank	Step 3	Solid	6010B SEP	31338
MB 140-31341/13-B	Method Blank	Step 4	Solid	6010B SEP	31360
LCS 140-31148/14-B ^5	Lab Control Sample	Step 1	Solid	6010B SEP	31252
LCS 140-31253/14-B ^5	Lab Control Sample	Step 2	Solid	6010B SEP	31256
LCS 140-31257/14-B	Lab Control Sample	Step 3	Solid	6010B SEP	31338
LCS 140-31341/14-B	Lab Control Sample	Step 4	Solid	6010B SEP	31360
LCSD 140-31148/15-B ^5	Lab Control Sample Dup	Step 1	Solid	6010B SEP	31252
LCSD 140-31253/15-B ^5	Lab Control Sample Dup	Step 2	Solid	6010B SEP	31256

Metals (Continued)

Analysis Batch: 31604 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
LCSD 140-31257/15-B	Lab Control Sample Dup	Step 3	Solid	6010B SEP	31338
LCSD 140-31341/15-B	Lab Control Sample Dup	Step 4	Solid	6010B SEP	31360

Prep Batch: 31615

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Step 7	Solid	Residual	
140-15492-2	BMW-30 (40-41)	Step 7	Solid	Residual	
140-15492-3	BMW-31 (14-15)	Step 7	Solid	Residual	
140-15492-4	BMW-32 (25-26)	Step 7	Solid	Residual	
140-15492-5	BMW-33 (38-39)	Step 7	Solid	Residual	
MB 140-31615/13-A	Method Blank	Step 7	Solid	Residual	
LCS 140-31615/14-A	Lab Control Sample	Step 7	Solid	Residual	
LCSD 140-31615/15-A	Lab Control Sample Dup	Step 7	Solid	Residual	

Analysis Batch: 31651

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Step 5	Solid	6010B SEP	31500
140-15492-1	BMW-29 (30-31)	Step 6	Solid	6010B SEP	31502
140-15492-2	BMW-30 (40-41)	Step 5	Solid	6010B SEP	31500
140-15492-2	BMW-30 (40-41)	Step 6	Solid	6010B SEP	31502
140-15492-3	BMW-31 (14-15)	Step 5	Solid	6010B SEP	31500
140-15492-3	BMW-31 (14-15)	Step 6	Solid	6010B SEP	31502
140-15492-4	BMW-32 (25-26)	Step 5	Solid	6010B SEP	31500
140-15492-4	BMW-32 (25-26)	Step 6	Solid	6010B SEP	31502
140-15492-5	BMW-33 (38-39)	Step 5	Solid	6010B SEP	31500
140-15492-5	BMW-33 (38-39)	Step 6	Solid	6010B SEP	31502
MB 140-31436/13-B ^5	Method Blank	Step 5	Solid	6010B SEP	31500
MB 140-31502/13-A	Method Blank	Step 6	Solid	6010B SEP	31502
LCS 140-31436/14-B ^5	Lab Control Sample	Step 5	Solid	6010B SEP	31500
LCS 140-31502/14-A	Lab Control Sample	Step 6	Solid	6010B SEP	31502
LCSD 140-31436/15-B ^5	Lab Control Sample Dup	Step 5	Solid	6010B SEP	31500
LCSD 140-31502/15-A	Lab Control Sample Dup	Step 6	Solid	6010B SEP	31502

Analysis Batch: 31713

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Step 7	Solid	6010B SEP	31615
140-15492-1	BMW-29 (30-31)	Step 7	Solid	6010B SEP	31615
140-15492-1	BMW-29 (30-31)	Step 7	Solid	6010B SEP	31615
140-15492-1	BMW-29 (30-31)	Total/NA	Solid	6010B	30683
140-15492-1	BMW-29 (30-31)	Total/NA	Solid	6010B	30683
140-15492-1	BMW-29 (30-31)	Total/NA	Solid	6010B	30683
140-15492-2	BMW-30 (40-41)	Step 7	Solid	6010B SEP	31615
140-15492-2	BMW-30 (40-41)	Step 7	Solid	6010B SEP	31615
140-15492-2	BMW-30 (40-41)	Step 7	Solid	6010B SEP	31615
140-15492-2	BMW-30 (40-41)	Total/NA	Solid	6010B	30683
140-15492-2	BMW-30 (40-41)	Total/NA	Solid	6010B	30683
140-15492-2	BMW-30 (40-41)	Total/NA	Solid	6010B	30683
140-15492-3	BMW-31 (14-15)	Step 7	Solid	6010B SEP	31615
140-15492-3	BMW-31 (14-15)	Step 7	Solid	6010B SEP	31615
140-15492-3	BMW-31 (14-15)	Step 7	Solid	6010B SEP	31615
140-15492-3	BMW-31 (14-15)	Total/NA	Solid	6010B	30683

Metals (Continued)

Analysis Batch: 31713 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-3	BMW-31 (14-15)	Total/NA	Solid	6010B	30683
140-15492-3	BMW-31 (14-15)	Total/NA	Solid	6010B	30683
140-15492-4	BMW-32 (25-26)	Step 7	Solid	6010B SEP	31615
140-15492-4	BMW-32 (25-26)	Step 7	Solid	6010B SEP	31615
140-15492-4	BMW-32 (25-26)	Step 7	Solid	6010B SEP	31615
140-15492-4	BMW-32 (25-26)	Total/NA	Solid	6010B	30683
140-15492-4	BMW-32 (25-26)	Total/NA	Solid	6010B	30683
140-15492-4	BMW-32 (25-26)	Total/NA	Solid	6010B	30683
140-15492-5	BMW-33 (38-39)	Step 7	Solid	6010B SEP	31615
140-15492-5	BMW-33 (38-39)	Step 7	Solid	6010B SEP	31615
140-15492-5	BMW-33 (38-39)	Step 7	Solid	6010B SEP	31615
140-15492-5	BMW-33 (38-39)	Total/NA	Solid	6010B	30683
140-15492-5	BMW-33 (38-39)	Total/NA	Solid	6010B	30683
140-15492-5	BMW-33 (38-39)	Total/NA	Solid	6010B	30683
MB 140-30683/13-A	Method Blank	Total/NA	Solid	6010B	30683
MB 140-31615/13-A	Method Blank	Step 7	Solid	6010B SEP	31615
LCS 140-30683/14-A	Lab Control Sample	Total/NA	Solid	6010B	30683
LCS 140-31615/14-A	Lab Control Sample	Step 7	Solid	6010B SEP	31615
LCSD 140-30683/15-A	Lab Control Sample Dup	Total/NA	Solid	6010B	30683
LCSD 140-31615/15-A	Lab Control Sample Dup	Step 7	Solid	6010B SEP	31615

Analysis Batch: 31744

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Sum of Steps 1-7	Solid	6010B SEP	
140-15492-2	BMW-30 (40-41)	Sum of Steps 1-7	Solid	6010B SEP	
140-15492-3	BMW-31 (14-15)	Sum of Steps 1-7	Solid	6010B SEP	
140-15492-4	BMW-32 (25-26)	Sum of Steps 1-7	Solid	6010B SEP	
140-15492-5	BMW-33 (38-39)	Sum of Steps 1-7	Solid	6010B SEP	

General Chemistry

Analysis Batch: 30602

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15492-1	BMW-29 (30-31)	Total/NA	Solid	Moisture	
140-15492-2	BMW-30 (40-41)	Total/NA	Solid	Moisture	
140-15492-3	BMW-31 (14-15)	Total/NA	Solid	Moisture	
140-15492-4	BMW-32 (25-26)	Total/NA	Solid	Moisture	
140-15492-5	BMW-33 (38-39)	Total/NA	Solid	Moisture	

Client: Golder Associates Inc. Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Client Sample ID: BMW-29 (30-31) **Lab Sample ID: 140-15492-1**
Date Collected: 05/31/19 16:45 **Matrix: Solid**
Date Received: 06/05/19 09:20

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			31744	07/16/19 17:31	CLJ	TAL KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			30602	06/06/19 14:52	BKD	TAL KNX
	Instrument ID: W3									

Client Sample ID: BMW-29 (30-31) **Lab Sample ID: 140-15492-1**
Date Collected: 05/31/19 16:45 **Matrix: Solid**
Date Received: 06/05/19 09:20 **Percent Solids: 73.5**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.539 g	50 mL	31128	06/26/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31553	07/10/19 12:23	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31713	07/15/19 14:46	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		10			31713	07/15/19 16:20	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		5			31713	07/15/19 18:48	KNC	TAL KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5.000 g	25 mL	31148	06/26/19 09:47	KNC	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	31252	06/29/19 08:00	KNC	TAL KNX
Step 1	Analysis	6010B SEP		4			31604	07/11/19 13:09	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5.000 g	25 mL	31253	06/29/19 08:00	KNC	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	31256	06/30/19 08:00	KNC	TAL KNX
Step 2	Analysis	6010B SEP		3			31604	07/11/19 14:53	KNC	TAL KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5.000 g	25 mL	31257	06/30/19 08:00	KNC	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	31338	07/02/19 08:00	KNC	TAL KNX
Step 3	Analysis	6010B SEP		1			31604	07/11/19 16:42	KNC	TAL KNX
	Instrument ID: DUO									
Step 4	SEP	Metal Hydroxide			5.000 g	25 mL	31341	07/02/19 09:00	KNC	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	31360	07/03/19 08:00	KNC	TAL KNX
Step 4	Analysis	6010B SEP		1			31604	07/11/19 18:09	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5.000 g	75 mL	31436	07/08/19 07:00	KNC	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	31500	07/10/19 08:00	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			31651	07/12/19 12:16	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5.000 g	250 mL	31502	07/10/19 08:00	KNC	TAL KNX
Step 6	Analysis	6010B SEP		1			31651	07/12/19 14:00	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: BMW-29 (30-31) **Lab Sample ID: 140-15492-1**
Date Collected: 05/31/19 16:45 **Matrix: Solid**
Date Received: 06/05/19 09:20 **Percent Solids: 73.5**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		1			31713	07/15/19 12:16	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		10			31713	07/15/19 13:29	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		2			31713	07/15/19 17:32	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Prep	7470A			5.0 mL	50.0 mL	30859	06/16/19 08:00	DKW	TAL KNX
Total/NA	Analysis	7470A		1			30868	06/16/19 14:19	DKW	TAL KNX
	Instrument ID: HG									

Client Sample ID: BMW-30 (40-41) **Lab Sample ID: 140-15492-2**
Date Collected: 05/30/19 15:55 **Matrix: Solid**
Date Received: 06/05/19 09:20

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			31744	07/16/19 17:31	CLJ	TAL KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			30602	06/06/19 14:52	BKD	TAL KNX
	Instrument ID: W3									

Client Sample ID: BMW-30 (40-41) **Lab Sample ID: 140-15492-2**
Date Collected: 05/30/19 15:55 **Matrix: Solid**
Date Received: 06/05/19 09:20 **Percent Solids: 84.1**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.528 g	50 mL	31128	06/26/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31553	07/10/19 12:28	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31713	07/15/19 15:07	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		10			31713	07/15/19 16:25	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		5			31713	07/15/19 18:53	KNC	TAL KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5.000 g	25 mL	31148	06/26/19 09:47	KNC	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	31252	06/29/19 08:00	KNC	TAL KNX
Step 1	Analysis	6010B SEP		4			31604	07/11/19 13:14	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc. — Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Client Sample ID: BMW-30 (40-41) — Lab Sample ID: 140-15492-2

Date Collected: 05/30/19 15:55 — **Matrix: Solid**
Date Received: 06/05/19 09:20 — **Percent Solids: 84.1**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 2	SEP	Carbonate			5.000 g	25 mL	31253	06/29/19 08:00	KNC	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	31256	06/30/19 08:00	KNC	TAL KNX
Step 2	Analysis	6010B SEP		3			31604	07/11/19 14:58	KNC	TAL KNX
	Instrument ID:	DUO								
Step 3	SEP	Non-Crystalline			5.000 g	25 mL	31257	06/30/19 08:00	KNC	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	31338	07/02/19 08:00	KNC	TAL KNX
Step 3	Analysis	6010B SEP		1			31604	07/11/19 16:47	KNC	TAL KNX
	Instrument ID:	DUO								
Step 4	SEP	Metal Hydroxide			5.000 g	25 mL	31341	07/02/19 09:00	KNC	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	31360	07/03/19 08:00	KNC	TAL KNX
Step 4	Analysis	6010B SEP		1			31604	07/11/19 18:15	KNC	TAL KNX
	Instrument ID:	DUO								
Step 5	SEP	Organic-Bound			5.000 g	75 mL	31436	07/08/19 07:00	KNC	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	31500	07/10/19 08:00	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			31651	07/12/19 12:21	KNC	TAL KNX
	Instrument ID:	DUO								
Step 6	SEP	Acid/Sulfide			5.000 g	250 mL	31502	07/10/19 08:00	KNC	TAL KNX
Step 6	Analysis	6010B SEP		1			31651	07/12/19 14:05	KNC	TAL KNX
	Instrument ID:	DUO								
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		1			31713	07/15/19 12:21	KNC	TAL KNX
	Instrument ID:	DUO								
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		10			31713	07/15/19 13:34	KNC	TAL KNX
	Instrument ID:	DUO								
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		2			31713	07/15/19 17:37	KNC	TAL KNX
	Instrument ID:	DUO								
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Prep	7470A			5.0 mL	50.0 mL	30859	06/16/19 08:00	DKW	TAL KNX
Total/NA	Analysis	7470A		1			30868	06/16/19 14:21	DKW	TAL KNX
	Instrument ID:	HG								

Client Sample ID: BMW-31 (14-15) — Lab Sample ID: 140-15492-3

Date Collected: 05/31/19 11:15 — **Matrix: Solid**
Date Received: 06/05/19 09:20

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			31744	07/16/19 17:31	CLJ	TAL KNX
	Instrument ID:	NOEQUIP								
Total/NA	Analysis	Moisture		1			30602	06/06/19 14:52	BKD	TAL KNX
	Instrument ID:	W3								

Lab Chronicle

Client: Golder Associates Inc. Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Client Sample ID: BMW-31 (14-15) **Lab Sample ID: 140-15492-3**
Date Collected: 05/31/19 11:15 **Matrix: Solid**
Date Received: 06/05/19 09:20 **Percent Solids: 84.2**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.502 g	50 mL	31128	06/26/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31553	07/10/19 12:43	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31713	07/15/19 15:12	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		10			31713	07/15/19 16:30	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		2			31713	07/15/19 19:14	KNC	TAL KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5.000 g	25 mL	31148	06/26/19 09:47	KNC	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	31252	06/29/19 08:00	KNC	TAL KNX
Step 1	Analysis	6010B SEP		4			31604	07/11/19 13:35	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5.000 g	25 mL	31253	06/29/19 08:00	KNC	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	31256	06/30/19 08:00	KNC	TAL KNX
Step 2	Analysis	6010B SEP		3			31604	07/11/19 15:03	KNC	TAL KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5.000 g	25 mL	31257	06/30/19 08:00	KNC	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	31338	07/02/19 08:00	KNC	TAL KNX
Step 3	Analysis	6010B SEP		1			31604	07/11/19 16:52	KNC	TAL KNX
	Instrument ID: DUO									
Step 4	SEP	Metal Hydroxide			5.000 g	25 mL	31341	07/02/19 09:00	KNC	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	31360	07/03/19 08:00	KNC	TAL KNX
Step 4	Analysis	6010B SEP		1			31604	07/11/19 18:20	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5.000 g	75 mL	31436	07/08/19 07:00	KNC	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	31500	07/10/19 08:00	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			31651	07/12/19 12:42	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5.000 g	250 mL	31502	07/10/19 08:00	KNC	TAL KNX
Step 6	Analysis	6010B SEP		1			31651	07/12/19 14:10	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		1			31713	07/15/19 12:26	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		10			31713	07/15/19 13:39	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		2			31713	07/15/19 17:42	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc.
Project/Site: Martin Lake A1 Area LF SEP + Totals

Job ID: 140-15492-1

Client Sample ID: BMW-31 (14-15)

Lab Sample ID: 140-15492-3
Date Collected: 05/31/19 11:15
Matrix: Solid
Date Received: 06/05/19 09:20
Percent Solids: 84.2

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Prep	7470A			5.0 mL	50.0 mL	30859	06/16/19 08:00	DKW	TAL KNX
Total/NA	Analysis	7470A		1			30868	06/16/19 14:24	DKW	TAL KNX
	Instrument ID: HG									

Client Sample ID: BMW-32 (25-26)

Lab Sample ID: 140-15492-4
Date Collected: 05/29/19 15:45
Matrix: Solid
Date Received: 06/05/19 09:20

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			31744	07/16/19 17:31	CLJ	TAL KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			30602	06/06/19 14:52	BKD	TAL KNX
	Instrument ID: W3									

Client Sample ID: BMW-32 (25-26)

Lab Sample ID: 140-15492-4
Date Collected: 05/29/19 15:45
Matrix: Solid
Date Received: 06/05/19 09:20
Percent Solids: 84.2

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.529 g	50 mL	31128	06/26/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31553	07/10/19 12:49	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31713	07/15/19 15:18	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		10			31713	07/15/19 16:35	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		2			31713	07/15/19 19:19	KNC	TAL KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5.000 g	25 mL	31148	06/26/19 09:47	KNC	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	31252	06/29/19 08:00	KNC	TAL KNX
Step 1	Analysis	6010B SEP		4			31604	07/11/19 13:40	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5.000 g	25 mL	31253	06/29/19 08:00	KNC	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	31256	06/30/19 08:00	KNC	TAL KNX
Step 2	Analysis	6010B SEP		3			31604	07/11/19 15:09	KNC	TAL KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5.000 g	25 mL	31257	06/30/19 08:00	KNC	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	31338	07/02/19 08:00	KNC	TAL KNX
Step 3	Analysis	6010B SEP		1			31604	07/11/19 16:58	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc. | Job ID: 140-15492-1

Project/Site: Martin Lake A1 Area LF SEP + Totals

Client Sample ID: BMW-32 (25-26) | Lab Sample ID: 140-15492-4

Date Collected: 05/29/19 15:45 | **Matrix: Solid**

Date Received: 06/05/19 09:20 | **Percent Solids: 84.2**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 4	SEP	Metal Hydroxide			5.000 g	25 mL	31341	07/02/19 09:00	KNC	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	31360	07/03/19 08:00	KNC	TAL KNX
Step 4	Analysis	6010B SEP		1			31604	07/11/19 18:25	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5.000 g	75 mL	31436	07/08/19 07:00	KNC	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	31500	07/10/19 08:00	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			31651	07/12/19 12:47	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5.000 g	250 mL	31502	07/10/19 08:00	KNC	TAL KNX
Step 6	Analysis	6010B SEP		1			31651	07/12/19 14:15	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		1			31713	07/15/19 12:32	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		10			31713	07/15/19 13:44	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		2			31713	07/15/19 17:47	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Prep	7470A			5.0 mL	50.0 mL	30859	06/16/19 08:00	DKW	TAL KNX
Total/NA	Analysis	7470A		1			30868	06/16/19 14:27	DKW	TAL KNX
	Instrument ID: HG									

Client Sample ID: BMW-33 (38-39) | Lab Sample ID: 140-15492-5

Date Collected: 05/30/19 11:35 | **Matrix: Solid**

Date Received: 06/05/19 09:20

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Sum of Steps 1-7	Analysis	6010B SEP		1			31744	07/16/19 17:31	CLJ	TAL KNX
	Instrument ID: NOEQUIP									
Total/NA	Analysis	Moisture		1			30602	06/06/19 14:52	BKD	TAL KNX
	Instrument ID: W3									

Client Sample ID: BMW-33 (38-39) | Lab Sample ID: 140-15492-5

Date Collected: 05/30/19 11:35 | **Matrix: Solid**

Date Received: 06/05/19 09:20 | **Percent Solids: 77.5**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.527 g	50 mL	31128	06/26/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31553	07/10/19 12:54	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31713	07/15/19 15:23	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc.
Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Client Sample ID: BMW-33 (38-39)
Lab Sample ID: 140-15492-5

Date Collected: 05/30/19 11:35
Matrix: Solid
Date Received: 06/05/19 09:20
Percent Solids: 77.5

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		10			31713	07/15/19 16:40	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		5			31713	07/15/19 19:24	KNC	TAL KNX
	Instrument ID: DUO									
Step 1	SEP	Exchangeable			5.000 g	25 mL	31148	06/26/19 09:47	KNC	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	31252	06/29/19 08:00	KNC	TAL KNX
Step 1	Analysis	6010B SEP		4			31604	07/11/19 13:45	KNC	TAL KNX
	Instrument ID: DUO									
Step 2	SEP	Carbonate			5.000 g	25 mL	31253	06/29/19 08:00	KNC	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	31256	06/30/19 08:00	KNC	TAL KNX
Step 2	Analysis	6010B SEP		3			31604	07/11/19 15:14	KNC	TAL KNX
	Instrument ID: DUO									
Step 3	SEP	Non-Crystalline			5.000 g	25 mL	31257	06/30/19 08:00	KNC	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	31338	07/02/19 08:00	KNC	TAL KNX
Step 3	Analysis	6010B SEP		1			31604	07/11/19 17:03	KNC	TAL KNX
	Instrument ID: DUO									
Step 4	SEP	Metal Hydroxide			5.000 g	25 mL	31341	07/02/19 09:00	KNC	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	31360	07/03/19 08:00	KNC	TAL KNX
Step 4	Analysis	6010B SEP		1			31604	07/11/19 18:45	KNC	TAL KNX
	Instrument ID: DUO									
Step 5	SEP	Organic-Bound			5.000 g	75 mL	31436	07/08/19 07:00	KNC	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	31500	07/10/19 08:00	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			31651	07/12/19 12:53	KNC	TAL KNX
	Instrument ID: DUO									
Step 6	SEP	Acid/Sulfide			5.000 g	250 mL	31502	07/10/19 08:00	KNC	TAL KNX
Step 6	Analysis	6010B SEP		1			31651	07/12/19 14:21	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		1			31713	07/15/19 12:37	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		10			31713	07/15/19 14:04	KNC	TAL KNX
	Instrument ID: DUO									
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		2			31713	07/15/19 17:52	KNC	TAL KNX
	Instrument ID: DUO									
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Prep	7470A			5.0 mL	50.0 mL	30859	06/16/19 08:00	DKW	TAL KNX
Total/NA	Analysis	7470A		1			30868	06/16/19 14:29	DKW	TAL KNX
	Instrument ID: HG									

Lab Chronicle

Client: Golder Associates Inc.
Project/Site: Martin Lake A1 Area LF SEP + Totals

Job ID: 140-15492-1

Client Sample ID: Method Blank

Lab Sample ID: MB 140-30683/13-A
Date Collected: N/A
Date Received: N/A
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31713	07/15/19 11:13	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank

Lab Sample ID: MB 140-30683/13-B
Date Collected: N/A
Date Received: N/A
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Prep	7470A			5.0 mL	50.0 mL	30859	06/16/19 08:00	DKW	TAL KNX
Total/NA	Analysis	7470A		1			30868	06/16/19 13:56	DKW	TAL KNX
	Instrument ID: HG									

Client Sample ID: Method Blank

Lab Sample ID: MB 140-31128/14-A
Date Collected: N/A
Date Received: N/A
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.500 g	50 mL	31128	06/26/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31553	07/10/19 11:42	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank

Lab Sample ID: MB 140-31148/13-B ^4
Date Collected: N/A
Date Received: N/A
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 1	SEP	Exchangeable			5.000 g	25 mL	31148	06/26/19 09:47	KNC	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	31252	06/29/19 08:00	KNC	TAL KNX
Step 1	Analysis	6010B SEP		4			31604	07/11/19 12:33	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank

Lab Sample ID: MB 140-31253/13-B ^3
Date Collected: N/A
Date Received: N/A
Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 2	SEP	Carbonate			5.000 g	25 mL	31253	06/29/19 08:00	KNC	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	31256	06/30/19 08:00	KNC	TAL KNX
Step 2	Analysis	6010B SEP		3			31604	07/11/19 14:06	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Method Blank
Lab Sample ID: MB 140-31257/13-B
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 3	SEP	Non-Crystalline			5.000 g	25 mL	31257	06/30/19 08:00	KNC	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	31338	07/02/19 08:00	KNC	TAL KNX
Step 3	Analysis	6010B SEP		1			31604	07/11/19 15:50	KNC	TAL KNX
	Instrument ID:	DUO								

Client Sample ID: Method Blank
Lab Sample ID: MB 140-31341/13-B
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 4	SEP	Metal Hydroxide			5.000 g	25 mL	31341	07/02/19 09:00	KNC	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	31360	07/03/19 08:00	KNC	TAL KNX
Step 4	Analysis	6010B SEP		1			31604	07/11/19 17:24	KNC	TAL KNX
	Instrument ID:	DUO								

Client Sample ID: Method Blank
Lab Sample ID: MB 140-31436/13-B ^5
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 5	SEP	Organic-Bound			5.000 g	75 mL	31436	07/08/19 07:00	KNC	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	31500	07/10/19 08:00	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			31651	07/12/19 11:39	KNC	TAL KNX
	Instrument ID:	DUO								

Client Sample ID: Method Blank
Lab Sample ID: MB 140-31502/13-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 6	SEP	Acid/Sulfide			5.000 g	250 mL	31502	07/10/19 08:00	KNC	TAL KNX
Step 6	Analysis	6010B SEP		1			31651	07/12/19 13:14	KNC	TAL KNX
	Instrument ID:	DUO								

Client Sample ID: Method Blank
Lab Sample ID: MB 140-31615/13-A
Date Collected: N/A
Matrix: Solid
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		1			31713	07/15/19 10:58	KNC	TAL KNX
	Instrument ID:	DUO								

Lab Chronicle

Client: Golder Associates Inc. Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Client Sample ID: Lab Control Sample Lab Sample ID: LCS 140-30683/14-A
Date Collected: N/A **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31713	07/15/19 11:19	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Lab Sample ID: LCS 140-30683/14-B
Date Collected: N/A **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Prep	7470A			5.0 mL	50.0 mL	30859	06/16/19 08:00	DKW	TAL KNX
Total/NA	Analysis	7470A		1			30868	06/16/19 13:59	DKW	TAL KNX
	Instrument ID: HG									

Client Sample ID: Lab Control Sample Lab Sample ID: LCS 140-31128/15-A
Date Collected: N/A **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3050B			0.500 g	50 mL	31128	06/26/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31553	07/10/19 11:47	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Lab Sample ID: LCS 140-31148/14-B ^5
Date Collected: N/A **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 1	SEP	Exchangeable			5.000 g	25 mL	31148	06/26/19 09:47	KNC	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	31252	06/29/19 08:00	KNC	TAL KNX
Step 1	Analysis	6010B SEP		5			31604	07/11/19 12:38	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Lab Sample ID: LCS 140-31253/14-B ^5
Date Collected: N/A **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 2	SEP	Carbonate			5.000 g	25 mL	31253	06/29/19 08:00	KNC	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	31256	06/30/19 08:00	KNC	TAL KNX
Step 2	Analysis	6010B SEP		5			31604	07/11/19 14:11	KNC	TAL KNX
	Instrument ID: DUO									

Lab Chronicle

Client: Golder Associates Inc. Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Client Sample ID: Lab Control Sample — Lab Sample ID: LCS 140-31257/14-B

Date Collected: N/A — **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 3	SEP	Non-Crystalline			5.000 g	25 mL	31257	06/30/19 08:00	KNC	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	31338	07/02/19 08:00	KNC	TAL KNX
Step 3	Analysis	6010B SEP		1			31604	07/11/19 15:56	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample — Lab Sample ID: LCS 140-31341/14-B

Date Collected: N/A — **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 4	SEP	Metal Hydroxide			5.000 g	25 mL	31341	07/02/19 09:00	KNC	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	31360	07/03/19 08:00	KNC	TAL KNX
Step 4	Analysis	6010B SEP		1			31604	07/11/19 17:29	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample — Lab Sample ID: LCS 140-31436/14-B ^5

Date Collected: N/A — **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 5	SEP	Organic-Bound			5.000 g	75 mL	31436	07/08/19 07:00	KNC	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	31500	07/10/19 08:00	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			31651	07/12/19 11:44	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample — Lab Sample ID: LCS 140-31502/14-A

Date Collected: N/A — **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 6	SEP	Acid/Sulfide			5.000 g	250 mL	31502	07/10/19 08:00	KNC	TAL KNX
Step 6	Analysis	6010B SEP		1			31651	07/12/19 13:19	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample — Lab Sample ID: LCS 140-31615/14-A

Date Collected: N/A — **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		1			31713	07/15/19 11:03	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup — Lab Sample ID: LCSD 140-30683/15-A

Date Collected: N/A — **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Analysis	6010B		1			31713	07/15/19 11:24	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup — Lab Sample ID: LCSD 140-30683/15-B

Date Collected: N/A — **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	Total			1.000 g	50 mL	30683	06/11/19 08:00	KNC	TAL KNX
Total/NA	Prep	7470A			5.0 mL	50.0 mL	30859	06/16/19 08:00	DKW	TAL KNX
Total/NA	Analysis	7470A		1			30868	06/16/19 14:02	DKW	TAL KNX
	Instrument ID: HG									

Client Sample ID: Lab Control Sample Dup — Lab Sample ID: LCSD 140-31148/15-B ^5

Date Collected: N/A — **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 1	SEP	Exchangeable			5.000 g	25 mL	31148	06/26/19 09:47	KNC	TAL KNX
Step 1	Prep	3010A			5 mL	50 mL	31252	06/29/19 08:00	KNC	TAL KNX
Step 1	Analysis	6010B SEP		5			31604	07/11/19 12:43	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup — Lab Sample ID: LCSD 140-31253/15-B ^5

Date Collected: N/A — **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 2	SEP	Carbonate			5.000 g	25 mL	31253	06/29/19 08:00	KNC	TAL KNX
Step 2	Prep	3010A			5 mL	50 mL	31256	06/30/19 08:00	KNC	TAL KNX
Step 2	Analysis	6010B SEP		5			31604	07/11/19 14:16	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup — Lab Sample ID: LCSD 140-31257/15-B

Date Collected: N/A — **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 3	SEP	Non-Crystalline			5.000 g	25 mL	31257	06/30/19 08:00	KNC	TAL KNX
Step 3	Prep	3010A			5 mL	50 mL	31338	07/02/19 08:00	KNC	TAL KNX
Step 3	Analysis	6010B SEP		1			31604	07/11/19 16:01	KNC	TAL KNX
	Instrument ID: DUO									

Client: Golder Associates Inc. Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Client Sample ID: Lab Control Sample Dup — Lab Sample ID: LCSD 140-31341/15-B
Date Collected: N/A — **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 4	SEP	Metal Hydroxide			5.000 g	25 mL	31341	07/02/19 09:00	KNC	TAL KNX
Step 4	Prep	3010A			5 mL	50 mL	31360	07/03/19 08:00	KNC	TAL KNX
Step 4	Analysis	6010B SEP		1			31604	07/11/19 17:44	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup — Lab Sample ID: LCSD 140-31436/15-B ^5
Date Collected: N/A — **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 5	SEP	Organic-Bound			5.000 g	75 mL	31436	07/08/19 07:00	KNC	TAL KNX
Step 5	Prep	3010A			5 mL	50 mL	31500	07/10/19 08:00	KNC	TAL KNX
Step 5	Analysis	6010B SEP		5			31651	07/12/19 11:49	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup — Lab Sample ID: LCSD 140-31502/15-A
Date Collected: N/A — **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 6	SEP	Acid/Sulfide			5.000 g	250 mL	31502	07/10/19 08:00	KNC	TAL KNX
Step 6	Analysis	6010B SEP		1			31651	07/12/19 13:24	KNC	TAL KNX
	Instrument ID: DUO									

Client Sample ID: Lab Control Sample Dup — Lab Sample ID: LCSD 140-31615/15-A
Date Collected: N/A — **Matrix: Solid**
Date Received: N/A

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Step 7	Prep	Residual			1.000 g	50 mL	31615	07/12/19 09:08	KNC	TAL KNX
Step 7	Analysis	6010B SEP		1			31713	07/15/19 11:08	KNC	TAL KNX
	Instrument ID: DUO									

Laboratory References:
TAL KNX = Eurofins TestAmerica, Knoxville, 5815 Middlebrook Pike, Knoxville, TN 37921, TEL (865)291-3000

Method Summary

Client: Golder Associates Inc.
Project/Site: Martin Lake A1 Area LF SEP + Totals

Job ID: 140-15492-1

Method	Method Description	Protocol	Laboratory
6010B	Metals (ICP)	SW846	TAL KNX
6010B	SEP Metals (ICP) - Total	SW846	TAL KNX
6010B SEP	SEP Metals (ICP)	SW846	TAL KNX
7470A	SEP Mercury (CVAA) - Total	SW846	TAL KNX
Moisture	Percent Moisture	EPA	TAL KNX
3010A	Preparation, Total Metals	SW846	TAL KNX
3050B	Preparation, Metals	SW846	TAL KNX
7470A	Preparation, Mercury	SW846	TAL KNX
Acid/Sulfide	Sequential Extraction Procedure, Acid/Sulfide Fraction	TAL-KNOX	TAL KNX
Carbonate	Sequential Extraction Procedure, Carbonate Fraction	TAL-KNOX	TAL KNX
Exchangeable	Sequential Extraction Procedure, Exchangeable Fraction	TAL-KNOX	TAL KNX
Metal Hydroxide	Sequential Extraction Procedure, Metal Hydroxide Fraction	TAL-KNOX	TAL KNX
Non-Crystalline	Sequential Extraction Procedure, Non-crystalline Materials	TAL-KNOX	TAL KNX
Organic-Bound	Sequential Extraction Procedure, Organic Bound Fraction	TAL-KNOX	TAL KNX
Residual	Sequential Extraction Procedure, Residual Fraction	TAL-KNOX	TAL KNX
Total	Preparation, Total Material	TAL-KNOX	TAL KNX

Protocol References:

EPA = US Environmental Protection Agency

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

TAL-KNOX = TestAmerica Laboratories, Knoxville, Facility Standard Operating Procedure.

Laboratory References:

TAL KNX = Eurofins TestAmerica, Knoxville, 5815 Middlebrook Pike, Knoxville, TN 37921, TEL (865)291-3000

Sample Summary

Client: Golder Associates Inc.
Job ID: 140-15492-1
Project/Site: Martin Lake A1 Area LF SEP + Totals

Lab Sample ID	Client Sample ID	Matrix	Collected	Received	Asset ID
140-15492-1	BMW-29 (30-31)	Solid	05/31/19 16:45	06/05/19 09:20	
140-15492-2	BMW-30 (40-41)	Solid	05/30/19 15:55	06/05/19 09:20	
140-15492-3	BMW-31 (14-15)	Solid	05/31/19 11:15	06/05/19 09:20	
140-15492-4	BMW-32 (25-26)	Solid	05/29/19 15:45	06/05/19 09:20	
140-15492-5	BMW-33 (38-39)	Solid	05/30/19 11:35	06/05/19 09:20	

Eurofins TestAmerica, Knoxville
5815 Middlebrook Pike
Knoxville, TN 37921
Phone (865) 291-3000 Fax (865) 584-4315

Chain of Custody Record

eurofins | Environment Testing TestAmerica

Client Information	Sampler: S. Ruiz / K. worley	Lab PM: Walker Wasmund, Terry	Carrier Tracking No(s):	COC No: 140-6682-2228.1
Client Contact: Will Vienne	Phone: 281-750-2734	E-Mail: terry.wasmund@testamericainc.com		Page: Page 1 of 1
Company: Golder Associates Inc.				Job #:
Address: 2201 Double Creek Dr Suite 4004	Due Date Requested:			
City: Round Rock	TAT Requested (days): Standard			
State, Zip: TX, 78664				
Phone: 512-671-3434(Tel)	PO #: 19122434-D			
Email: William_Vienne@golder.com	WO #: 19122434-D			
Project Name: Martin Lake A1 Area LF SEP + Totals	Project #: 14005267			
Site:	SSOW#:			

Analysis Requested

140-15492 Chain of Custody

Preservation Codes:
A - HCL, B - NaOH, C - Zn Acetate, D - Nitric Acid, E - NaHSO4, F - MeOH, G - Amchlor, H - Ascorbic Acid, I - Ice, J - DI Water, K - EDTA, L - EDA
M - Hexane, N - None, O - AsNaO2, P - Na2O4S, Q - Na2SO3, R - Na2S2O3, S - H2SO4, T - TSP Dodecahydrate, U - Acetone, V - MCAA, W - pH 4-5, Z - other (specify)
Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	6010B_SEP - SEP Metals (12 Metals)	6010B - Total B, Cr, Pb	Total Number of containers	Special Instructions/Note:
			Preservation Code:				N	I		
Bmw-29 (30-31)	5/31/19	1645	C	S	N		X	X		On Ice
Bmw-30 (40-41)	5/30/19	1555	C	S	N		X	X		" "
Bmw-31 (14-15)	5/31/19	1115	C	S	N		X	X		" "
Bmw-32 (25-26)	5/29/19	1545	C	S	N		X	X		" "
Bmw-33 (38-39)	5/30/19	1135	C	S	N		X	X		" "

RT: 1.4°C CT: 1.4°C, 1 cooler
Fedex SO, trk# 7876 7321 5641
Custody seal intact
KL 6/5/A

Possible Hazard Identification
☒ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☒ Disposal By Lab ☐ Archive For ____ Months

Deliverable Requested: I, II, III, IV, Other (specify)
Special Instructions/QC Requirements:

Empty Kit Relinquished by:	Date:	Time:	Method of Shipment:

Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
[signature]	06/04/19 1245	Golder	[signature]	6/5/19 0920	TA Knox

Custody Seals Intact: Δ Yes Δ No	Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks:

Ver: 01/16/2019

TESTAMERICA KNOXVILLE SAMPLE RECEIPT/CONDITION UPON RECEIPT ANOMALY CHECKLIST

Log In Number: Loc: 140 **15492**

Review Items	Yes	No	NA	If No, what was the problem?	Comments/Actions Taken
1. Are the shipping containers intact?	✓			☐ Containers, Broken	
2. Were ambient air containers received intact?			✓	☐ Checked in lab	
3. The coolers/containers custody seal if present, is it intact?	✓			☐ Yes ☐ NA	
4. Is the cooler temperature within limits? (> freezing temp. of water to 6 °C, VOST: 10°C) Thermometer ID : SC68 Correction factor: +0.0	✓			☐ Cooler Out of Temp, Client Contacted, Proceed/Cancel ☐ Cooler Out of Temp, Same Day Receipt	
5. Were all of the sample containers received intact?	✓			☐ Containers, Broken	
6. Were samples received in appropriate containers?	✓			☐ Containers, Improper; Client Contacted; Proceed/Cancel	
7. Do sample container labels match COC? (IDs, Dates, Times)	✓			☐ COC & Samples Do Not Match ☐ COC Incorrect/Incomplete ☐ COC Not Received	
8. Were all of the samples listed on the COC received?	✓			☐ Sample Received, Not on COC ☐ Sample on COC, Not Received	
9. Is the date/time of sample collection noted?	✓			☐ COC; No Date/Time; Client Contacted	**Labeling Verified by: Date:**
10. Was the sampler identified on the COC?	✓			☐ Sampler Not Listed on COC	
11. Is the client and project name/# identified?	✓			☐ COC Incorrect/Incomplete	**pH test strip lot number:**
12. Are tests/parameters listed for each sample?	✓			☐ COC No tests on COC	
13. Is the matrix of the samples noted?	✓			☐ COC Incorrect/Incomplete	
14. Was COC relinquished? (Signed/Dated/Timed)	✓			☐ COC Incorrect/Incomplete	
15. Were samples received within holding time?	✓			☐ Holding Time - Receipt	
16. Were samples received with correct chemical preservative (excluding Encore)?			✓	☐ pH Adjusted, pH Included (See box 16A) ☐ Incorrect Preservative	
17. Were VOA samples received without headspace?			✓	☐ Headspace (VOA only)	
18. Did you check for residual chlorine, if necessary? (e.g. 1613B, 1668) Chlorine test strip lot number:			✓	☐ Residual Chlorine	
19. For 1613B water samples is pH<9?			✓	☐ If no, notify lab to adjust	
20. For rad samples was sample activity info. Provided?			✓	☐ Project missing info	

	Box 16A: pH Preservation	Box 18A: Residual Chlorine
Preservative:		
Lot Number:		
Exp Date:		
Analyst:		
Date:		
Time:		

Project #: 14005267 PM Instructions:

Sample Receiving Associate: Ken Z[illegible] Date: 6/5/19

QA026R31.doc, 112618

APPENDIX C

GROUNDWATER SAMPLING RECORDS

APPENDIX G-Revision 1 December 15, 2022

GOLDER

RECORD OF WATER LEVEL READINGS

Project Name: LUMINANT- MLSES-A1　　Location: TATUM TX　　Project No.: 19122262-D

Borehole No.	Date	Time	Measuring Device / Serial No.	Measurement Point (M.P)	Water Level Below M.P.	Correction To Survey Mark	Survey Mark Elevation	Water Level Elevation	By	Comments
BMW-24	5-15-19	0701	SOLINST	TOC	9.83				JTB	
BMW-23	5-15-19	0751		TOC	9.98					
BMW-22	5-15-19	0838		TOC	4.47					
BMW-21	5-15-19	0923		TOC	4.23					
BMW-27	5-15-19	1019		TOC	2.79					
BMW-26	5-15-19	1106		TOC	1.62					
BMW-11AR	5-15-19	1159		TOC	31.87					
BMW-19	5-15-19	1250		TOC	12.49					
BMW-18	5-15-19	~~[illegible]~~1336		TOC	21.97					
BMW-28	5-15-19	1424		TOC	18.22					
BMW-20	5-15-19	1523		TOC	7.16					

Sheet 1 of 1

GROUNDWATER SAMPLING RECORD

Project Number: 19122262-D Project Name: LUMINANT-MCSES-A1 Date: 5-15-19

Sample Number: BMW-20	Starting Water Level (ft. BMP): 7.16
Sampling Location (well ID, etc.): BMW-20	Casing Stickup (ft.): -
Sampled by: JTB	Starting Water Level (ft. BGL): 7.16
Measuring Point (MP) of Well: TOC/PVC	Total Depth (ft. BGL): -
Screened Interval (ft. BGL): -	Casing Diameter (in ID): 2.0
Filter Pack Interval (ft. BGL): -	Casing Volume (gal.): —

QUALITY ASSURANCE

METHODS (describe):

Cleaning Equipment: alconox & DI rinse

Purging: peristaltic/bladder Sampling: Same

Disposal of Discharged Water: on site

INSTRUMENTS (Indicate make, model, i.d.)

Water Level:	KECK	Thermometer:	HORIBA
pH Meter:	HORIBA	Field Calibration:	7-4
Conductivity Meter:	HORIBA	Field Calibration:	1413
Filter / Filter Size:	—	Other:	

SAMPLING MEASUREMENTS

1526 Time	Cum. Vol (gal. or L)	Purge Rate (gal. or L/m)	Temp. (oC)	pH	Spec. Cond. (mmhos/cm)	D.O.	Redox (mV)	Turbidity & Color	Water Depth (ft BMP)
1536	—	.2	22.7	6.71	1660	0.47	-52	4.8	7.39
1541			22.9	6.72	1640	0.39	-51	5.6	7.41
1546			22.9	6.71	1640	0.38	-51	5.8	7.42

Water Level (ft. BMP) at End of Purge: 7.42 Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Time	Volume	Composition (G, P)	No.	Filtration (Y / N)	Preservation	Remarks (quality control sample, other)
1600	250mL	P	1	N	—	GEN CHEM
	500mL	P	1	N	HNO_3	METALS
	1L	P	2	N	HNO_3	—
	40mL	G	3	N	—	—

Comments:

Pastor, Behling & Wheeler, LLC
2201 Double Creek Dr., Suite 4004
Round Rock, TX 78664
(512) 671-3434 Fax (512) 671-3446

GROUNDWATER SAMPLING RECORD	PAGE 1 of 1

Project Number: 19122262-D Project Name: LUMINANT-MCSES-A1 Date: 5-15-19

Sample Number:	BMW-28	Starting Water Level (ft. BMP):	18.22
Sampling Location (well ID, etc.):	BMW-28	Casing Stickup (ft.):	—
Sampled by:	JTB	Starting Water Level (ft. BGL):	18.22
Measuring Point (MP) of Well:	TOC/PVC	Total Depth (ft. BGL):	—
Screened Interval (ft. BGL):	—	Casing Diameter (in ID):	2.0
Filter Pack Interval (ft. BGL):	—	Casing Volume (gal.):	—

QUALITY ASSURANCE

METHODS (describe):

Cleaning Equipment: alconox & DI rinse

Purging: peristaltic / bladder Sampling: same

Disposal of Discharged Water: on site

INSTRUMENTS (Indicate make, model, I.d.)

Water Level:	KECK	Thermometer:	HORIBA
pH Meter:	HORIBA	Field Calibration:	7-4
Conductivity Meter:	HORIBA	Field Calibration:	1413
Filter / Filter Size:	—	Other:	

SAMPLING MEASUREMENTS

Time	Cum. Vol (gal. or L)	Purge Rate (gal. or L/m)	Temp. (oC)	pH	Spec. Cond. (mmhos/cm)	D.O.	Redox (mV)	Turbidity & Color	Water Depth (ft BMP)
1427									
1437	—	.2	23.2	6.79	1720	0.41	-41	6.9	18.41
1442		↓	23.1	6.77	1740	0.26	-44	5.7	18.42
1447		↓	23.2	6.77	1740	0.25	-43	5.9	18.41

Water Level (ft. BMP) at End of Purge: 18.41 Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Time	Volume	Composition (G, P)	No.	Filtration (Y / N)	Preservation	Remarks (quality control sample, other)
1500	250mL	P	1	N	—	GEN CHEM
↓	500mL	P	1	N	HNO3	METALS
↓	1L	P	2	N	HNO3	—
↓	40mL	G	3	N	—	—

Comments:

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GROUNDWATER SAMPLING RECORD

PAGE 1 of 1

Project Number: 19122262-D Project Name: LUMINANT-MCSES - A1 Date: 5-15-19

Sample Number:	BMW-18	Starting Water Level (ft. BMP):	21.97
Sampling Location (well ID, etc.):	BMW-18	Casing Stickup (ft.):	-
Sampled by:	JTB	Starting Water Level (ft. BGL):	21.97
Measuring Point (MP) of Well:	TOC/PVC	Total Depth (ft. BGL):	-
Screened Interval (ft. BGL):	-	Casing Diameter (in ID):	2.0
Filter Pack Interval (ft. BGL):	-	Casing Volume (gal.):	-

QUALITY ASSURANCE

METHODS (describe):

Cleaning Equipment: alconox & DI rinse

Purging: peristaltic / bladder Sampling: same

Disposal of Discharged Water: on site

INSTRUMENTS (Indicate make, model, I.d.)

Water Level:	KECK	Thermometer:	HORIBA
pH Meter	HORIBA	Field Calibration:	7-4
Conductivity Meter:	HORIBA	Field Calibration:	1413
Filter / Filter Size:	-	Other:	

SAMPLING MEASUREMENTS

Time 1338	Cum. Vol (gal. or L)	Purge Rate (gal. or L/m)	Temp (oC)	pH	Spec. Cond. (mmhos/cm)	D.O.	Redox (mV)	Turbidity & Color	Water Depth (ft BMP)
1348	-	.2	23.4	6.68	1870	0.61	-29	6.7	22.17
1352		↓	23.5	6.64	1910	0.49	-31	7.1	22.16
1358		↓	23.4	6.65	1920	0.49	-32	7.2	22.16

Water Level (ft. BMP) at End of Purge: 22.16 Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Time	Volume	Composition (G, P)	No.	Filtration (Y / N)	Preservation	Remarks (quality control sample, other)
1410	250mL	P	1	N	-	GEN CHEM
↓	500mL	P	1	N	HNO3	METALS
↓	1L	P	2	N	HNO3	-
↓	40mL	G	3	N	-	-

Comments:

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GROUNDWATER SAMPLING RECORD

PAGE 1 of 1

Project Number: 19122262-D Project Name: LUMINANT-MCSES - A1 Date: 5-15-19

Sample Number:	BMW-19	Starting Water Level (ft. BMP):	12.49
Sampling Location (well ID, etc.):	BMW-19	Casing Stickup (ft.):	-
Sampled by:	JTB	Starting Water Level (ft. BGL):	12.49
Measuring Point (MP) of Well:	TOC/PVC	Total Depth (ft. BGL):	-
Screened Interval (ft. BGL):	-	Casing Diameter (in ID):	2.0
Filter Pack Interval (ft. BGL):	-	Casing Volume (gal.):	-

QUALITY ASSURANCE

METHODS (describe):

Cleaning Equipment: alconox & DI rinse

Purging: peristaltic / bladder Sampling: Same

Disposal of Discharged Water: on site

INSTRUMENTS (Indicate make, model, I.d.)

Water Level:	KECK	Thermometer:	HORIBA
pH Meter:	HORIBA	Field Calibration:	7-4
Conductivity Meter:	HORIBA	Field Calibration:	1413
Filter / Filter Size:	-	Other:	

SAMPLING MEASUREMENTS

Time 1242	Cum. Vol. (gal. or L)	Purge Rate (gal. or L/m)	Temp. (oC)	pH	Spec. Cond. (mmhos/cm)	D.O	Redox (mV)	Turbidity & Color	Water Depth (ft BMP)
1302	-	.2	22.9	6.86	1830	1.16	-13	9.6	12.71
1308			23.0	6.89	1860	1.09	-14	4.6	12.70
1315			23.0	6.88	1870	1.10	-14	5.2	12.70

Water Level (ft. BMP) at End of Purge: 12.70 Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Time	Volume	Composition (G, P)	No.	Filtration (Y / N)	Preservation	Remarks (quality control sample, other)
1325	250mL	P	1	N	-	GEN CHEM
	500mL	P	1	N	HNO_3	METALS
	1L	P	2	N	HNO_3	-
	40mL	G	3	N	-	-

Comments:

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GROUNDWATER SAMPLING RECORD

Project Number: 19122262-D Project Name: LUMINANT-MCSES-A1 Date: 5-15-19

Sample Number:	BMW-11AR	Starting Water Level (ft. BMP):	31.87
Sampling Location (well ID, etc.):	BMW-11AR	Casing Stickup (ft.):	–
Sampled by:	JTB	Starting Water Level (ft. BGL):	31.87
Measuring Point (MP) of Well:	TOC/PVC	Total Depth (ft. BGL):	–
Screened Interval (ft. BGL):	–	Casing Diameter (in ID):	2.0
Filter Pack Interval (ft. BGL):	–	Casing Volume (gal.):	–

QUALITY ASSURANCE

METHODS (describe):

Cleaning Equipment: alconox & DI rinse

Purging: peristaltic / bladder Sampling: Same

Disposal of Discharged Water: on site

INSTRUMENTS (Indicate make, model, I.d.)

Water Level:	KECK	Thermometer:	HORIBA
pH Meter:	HORIBA	Field Calibration:	7-4
Conductivity Meter:	HORIBA	Field Calibration:	1413
Filter / Filter Size:	–	Other:	

SAMPLING MEASUREMENTS

1202 Time	Cum. Vol (gal. or L)	Purge Rate (gal. or L/m)	Temp. (oC)	pH	Spec. Cond. (mmhos/cm)	D.O.	Redox (mV)	Turbidity & Color	Water Depth (ft BMP)
1211	–	.2	22.7	6.83	1570	0.38	-17	4.8	32.09
1216		↓	22.9	6.84	1590	0.33	-21	3.8	32.11
1223		↓	22.9	6.84	1590	0.34	-22	4.4	32.12

Water Level (ft. BMP) at End of Purge: 32.12 Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Time	Volume	Composition (G, P)	No.	Filtration (Y / N)	Preservation	Remarks (quality control sample, other)
1235	250mL	P	1	N	–	GEN CHEM
↓	500mL	P	1	N	HNO_3	METALS
↓	1L	P	2	N	HNO_3	–
↓	40mL	G	3	N	–	–

Comments:

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GROUNDWATER SAMPLING RECORD

PAGE 1 of 1

Project Number: 19122262-D Project Name: LUMINANT-MCSES-A1 Date: 5-15-19

Sample Number: BMW-26	Starting Water Level (ft. BMP): 1.62
Sampling Location (well ID, etc.): BMW-26	Casing Stickup (ft.): –
Sampled by: JTB	Starting Water Level (ft. BGL): 1.62
Measuring Point (MP) of Well: TOC/PVC	Total Depth (ft. BGL): ~
Screened Interval (ft. BGL): –	Casing Diameter (in ID): 2.0
Filter Pack Interval (ft. BGL): –	Casing Volume (gal.): –

QUALITY ASSURANCE

METHODS (describe):

Cleaning Equipment: alconox & DI rinse

Purging: peristaltic/bladder Sampling: Same

Disposal of Discharged Water: on site

INSTRUMENTS (Indicate make, model, I.d.)

Water Level: KECK Thermometer: HORIBA

pH Meter: HORIBA Field Calibration: 7-4

Conductivity Meter: HORIBA Field Calibration: 1413

Filter / Filter Size: – Other:

SAMPLING MEASUREMENTS

Time	Cum. Vol. (gal. or L)	Purge Rate (gal. or L/m)	Temp. (oC)	pH	Spec. Cond. (mmhos/cm)	D.O	Redox (mV)	Turbidity & Color	Water Depth (ft BMP)
1109									
1119	–	.2	23.9	6.91	1320	0.71	-47	8.6	1.81
1123		↓	24.1	6.90	1360	0.49	-44	6.7	1.82
1129		↓	24.2	6.90	1370	0.51	-46	6.9	1.81

Water Level (ft. BMP) at End of Purge: 1.81 Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Bottles Collected				Filtration		Remarks
Time	Volume	Composition (G, P)	No.	(Y / N)	Preservation	(quality control sample, other)
1140	250mL	P	1	N	–	GEN CHEM
↓	500mL	P	1	N	HNO_3	METALS
↓	1L	P	2	N	HNO_3	–
↓	40mL	G	3	N	–	–

Comments:

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GROUNDWATER SAMPLING RECORD

PAGE 1 of 1

Project Number: 19122262-D Project Name: LUMINANT-MCSES - A1 Date: 5-15-19

Sample Number:	BMW-27	Starting Water Level (ft. BMP):	2.79
Sampling Location (well ID, etc.):	BMW-27	Casing Stickup (ft.):	–
Sampled by:	JTB	Starting Water Level (ft. BGL):	2.79
Measuring Point (MP) of Well:	TOC/PVC	Total Depth (ft. BGL):	–
Screened Interval (ft. BGL):	–	Casing Diameter (in ID):	2.0
Filter Pack Interval (ft. BGL):	–	Casing Volume (gal.):	–

QUALITY ASSURANCE

METHODS (describe):

Cleaning Equipment: alconox & DI rinse

Purging: peristaltic / bladder Sampling: Same

Disposal of Discharged Water: on site

INSTRUMENTS (Indicate make, model, I.d.)

Water Level: KECK Thermometer: HORIBA

pH Meter: HORIBA Field Calibration: 7-4

Conductivity Meter: HORIBA Field Calibration: 1413

Filter / Filter Size: – Other:

SAMPLING MEASUREMENTS

1022 Time	Cum. Vol (gal. or L)	Purge Rate (gal. or L/m)	Temp. (oC)	pH	Spec. Cond. (mmhos/cm)	D.O.	Redox (mV)	Turbidity & Color	Water Depth (ft BMP)
1032	–	.2	23.4	6.71	1970	0.60	-27	13	3.11
1037		↓	23.3	6.72	1940	0.46	-28	9.1	3.12
1043		↓	23.3	6.72	1950	0.44	-28	7.8	3.12

Water Level (ft. BMP) at End of Purge: 3.12 Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Time	Bottles Collected: Volume	Composition (G, P)	No.	Filtration (Y / N)	Preservation	Remarks (quality control sample, other)
1055	250mL	P	1	N	–	GEN CHEM
↓	500mL	P	1	N	HNO3	METALS
↓	1L	P	2	N	HNO3	–
↓	40mL	G	3	N	–	–

Comments:

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GROUNDWATER SAMPLING RECORD

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Project Number: 19122262-D Project Name: LUMINANT-MCSES-A1 Date: 5-15-19

Sample Number:	BMW-21	Starting Water Level (ft. BMP):	4.23
Sampling Location (well ID, etc.):	BMW-21	Casing Stickup (ft.):	–
Sampled by:	JTB	Starting Water Level (ft. BGL):	4.23
Measuring Point (MP) of Well:	TOC/PVC	Total Depth (ft. BGL):	–
Screened Interval (ft. BGL):	–	Casing Diameter (in ID):	2.0
Filter Pack Interval (ft. BGL):	–	Casing Volume (gal.):	–

QUALITY ASSURANCE

METHODS (describe):

Cleaning Equipment: alconox & DI rinse

Purging: peristaltic / bladder Sampling: same

Disposal of Discharged Water: on site

INSTRUMENTS (Indicate make, model, I.d.)

Water Level:	KECK	Thermometer:	HORIBA
pH Meter:	HORIBA	Field Calibration:	7-4
Conductivity Meter:	HORIBA	Field Calibration:	1413
Filter / Filter Size:	–	Other:	

SAMPLING MEASUREMENTS

Time 0926	Cum. Vol (gal. or L)	Purge Rate (gal. or L/m)	Temp. (oC)	pH	Spec. Cond. (mmhos/cm)	D.O.	Redox (mV)	Turbidity & Color	Water Depth (ft BMP)
0936	–	.2	22.9	6.89	1810	0.91	-6	5.7	4.41
0942		↓	22.7	6.91	1840	0.77	-11	5.1	4.43
0947		↓	22.7	6.92	1850	0.78	-12	6.8	4.43

Water Level (ft. BMP) at End of Purge: 4.43 Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Time	Volume	Composition (G, P)	No.	Filtration (Y / N)	Preservation	Remarks (quality control sample, other)
0955	250mL	P	1	N	–	GEN CHEM
↓	500mL	P	1	N	HNO3	METALS
↓	1L	P	2	N	HNO3	–
↓	40mL	G	3	N	–	–

Comments:

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GROUNDWATER SAMPLING RECORD

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Project Number: 19122262-D Project Name: LUMINANT-MCSES-A1 Date: 5-15-19

Sample Number: BMW-22	Starting Water Level (ft. BMP): 4.47
Sampling Location (well ID, etc.): BMW-22	Casing Stickup (ft.): -
Sampled by: JTB	Starting Water Level (ft. BGL): 4.47
Measuring Point (MP) of Well: TOC/PVC	Total Depth (ft. BGL): -
Screened Interval (ft. BGL): -	Casing Diameter (in ID): 2.0
Filter Pack Interval (ft. BGL): -	Casing Volume (gal.): -

QUALITY ASSURANCE

METHODS (describe):

Cleaning Equipment: alconox & DI rinse

Purging: peristaltic / bladder Sampling: Same

Disposal of Discharged Water: on site

INSTRUMENTS (Indicate make, model, I.d.)

Water Level: KECK	Thermometer: HORIBA
pH Meter: HORIBA	Field Calibration: 7-4
Conductivity Meter: HORIBA	Field Calibration: 1413
Filter / Filter Size: -	Other:

SAMPLING MEASUREMENTS

Time	Cum. Vol (gal. or L)	Purge Rate (gal. or L/m)	Temp (oC)	pH	Spec. Cond. (mmhos/cm)	D.O.	Redox (mV)	Turbidity & Color	Water Depth (ft BMP)
0842									
0852	—	.2	23.1	6.64	1790	1.26	-39	13	4.61
0858			23.2	6.67	1810	0.92	-41	10	4.64
0902			23.1	6.68	1810	0.91	-42	10	4.63

Water Level (ft. BMP) at End of Purge: 4.63 Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Time	Volume	Composition (G, P)	No.	Filtration (Y / N)	Preservation	Remarks (quality control sample, other)
0915	250mL	P	1	N	—	GEN CHEM
	500mL	P	1	N	HNO_3	METALS
	1L	P	2	N	HNO_3	—
	40mL	G	3	N	—	—

Comments:

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GROUNDWATER SAMPLING RECORD

PAGE 1 of 1

Project Number: 19122262-D Project Name: LUMINANT-MCSES-A1 Date: 5-15-19

Sample Number:	BMW-23	Starting Water Level (ft. BMP):	9.98
Sampling Location (well ID, etc.):	BMW-23	Casing Stickup (ft.):	—
Sampled by:	JTB	Starting Water Level (ft. BGL):	9.98
Measuring Point (MP) of Well:	TOC/PVC	Total Depth (ft. BGL):	—
Screened Interval (ft. BGL):	—	Casing Diameter (In ID):	2.0
Filter Pack Interval (ft. BGL):	—	Casing Volume (gal.):	—

QUALITY ASSURANCE

METHODS (describe):

Cleaning Equipment: alconox & DI rinse

Purging: peristaltic / bladder Sampling: Same

Disposal of Discharged Water: on site

INSTRUMENTS (Indicate make, model, I.d.)

Water Level:	KECK	Thermometer:	HORIBA
pH Meter	HORIBA	Field Calibration:	7-4
Conductivity Meter:	HORIBA	Field Calibration:	1413
Filter / Filter Size:	—	Other:	

SAMPLING MEASUREMENTS

Time	Cum. Vol. (gal. or L)	Purge Rate (gal. or L/m)	Temp. (oC)	pH	Spec. Cond. (mmhos/cm)	D.O	Redox (mV)	Turbidity & Color	Water Depth (ft BMP)
0753									
0802	—	.2	22.7	6.82	1960	0.79	-27	11	10.27
0808		↓	23.1	6.84	1940	0.52	-26	7.6	10.28
0814			23.2	6.84	1940	0.53	-26	8.2	10.28

Water Level (ft. BMP) at End of Purge: Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Time	Bottles Collected: Volume	Composition (G, P)	No.	Filtration (Y / N)	Preservation	Remarks (quality control sample, other)
0825	250mL	P	1	N	—	GEN CHEM
↓	500mL	P	1	N	HNO_3	METALS
	1L	P	2	N	HNO_3	—
	40mL	G	3	N	—	—

Comments:

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GROUNDWATER SAMPLING RECORD

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Project Number: 19122262-D Project Name: LUMINANT-MCSES-A1 Date: 5-15-19

Sample Number:	BMW-24	Starting Water Level (ft. BMP):	9.83
Sampling Location (well ID, etc.):	BMW-24	Casing Stickup (ft.):	–
Sampled by:	JTB	Starting Water Level (ft. BGL):	9.83
Measuring Point (MP) of Well:	TOC/PVC	Total Depth (ft. BGL):	–
Screened Interval (ft. BGL):	–	Casing Diameter (in ID):	2.0
Filter Pack Interval (ft. BGL):	–	Casing Volume (gal.):	–

QUALITY ASSURANCE

METHODS (describe):

Cleaning Equipment: alconox & DI rinse

Purging: peristaltic/bladder Sampling: same

Disposal of Discharged Water: on site

INSTRUMENTS (Indicate make, model, I.d.)

Water Level:	KECK	Thermometer:	HORIBA
pH Meter	HORIBA	Field Calibration:	7-4
Conductivity Meter:	HORIBA	Field Calibration:	1413
Filter / Filter Size:	–	Other:	

SAMPLING MEASUREMENTS

Time 0709	Cum. Vol. (gal. or L)	Purge Rate (gal. or L/m)	Temp. (oC)	pH	Spec. Cond. (mmhos/cm)	D.O.	Redox (mV)	Turbidity & Color	Water Depth (ft BMP)
0713	–	.2	21.7	6.74	2320	0.61	-17	6.6	10.16
0718		↓	22.1	6.77	2210	0.60	-16	7.8	10.17
0723		↓	22.2	6.78	2210	0.60	-16	7.7	10.17

Water Level (ft. BMP) at End of Purge: 10.17 Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Bottles Collected				Filtration	Preservation	Remarks
Time	Volume	Composition (G, P)	No.	(Y / N)		(quality control sample, other)
0735	250mL	P	1	N	–	GEN CHEM
↓	500mL	P	1	N	HNO_3	METALS
↓	1L	P	2	N	HNO_3	–
↓	40mL	G	3	N	–	–

Comments:

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Groundwater Sample Collection

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GOLDER

Project/Phase	19122434-D	Equipment Decon	☑ Dedicated equipment		Depth to Water	9.50	ft. BMP
Site Location	A-1		☐ Decon between locations		Casing Stickup		ft.
Date	6-13-19	Reference Point	☑ Top of casing		Depth to Water		ft. BGL
MW ID	BMW-25	Location	☐ Other		Total MW Depth		ft. BGL
Sample ID	BMW-25	Water Quality			MW Diameter	2	inches
Pump	☑ Waterra ☐ Submersible	Meter Model	Horiba U-50		MW Volume		gallons
	☑ Peristaltic ☐ Bladder	Unit Number			Pump Intake Depth		ft. BGL

Standard volume capacity of monitoring wells: Schedule 40 PVC (1-inch OD, 0.04 gallons/foot; 2-inch OD, 0.16 gallons/foot; 4-inch OD, 0.65 gallons/foot)

Time	Purge Rate (L/min)	Cumulative Purge Volume (L)	Depth to Water (ft)	Temp (°C) ☐ NM	pH ☐ NM	Conductivity (µS/m or mS/cm) ☐ not measured	Dissolved Oxygen (mg/L) ☐ not measured	Redox Potential (mV) ☐ not measured	Turbidity (NTU) ☐ NM
0900	0.1	1.0		21.96	6.74	3.56	10.93	330	10.6
0910		2.0		21.42	6.96	3.62	9.38	316	10.9
0915		2.5		20.21	7.00	2.48	9.27	317	14.2
0920		3.0		21.36	7.01	2.21	9.19	312	16.[illegible]
0925		3.5		21.42	7.02	2.13	9.19	309	8.4
0930		4.0		21.93	7.01	2.16	9.21	30[illegible]	7.0

Purging was completed based on: ☐ stabilization of water quality parameters ☐ removal of three well volumes ☐ removal of at least one half well volume (low yield well)

Bottles Collected				Filtration	Preserved	Notes and Observations
Time	Volume	Composition (G / P)	No.	(10µm / 45µm)	(type)	(quality control sample, other)
0930				☐ filtered ☑ unfiltered		
0				☐ filtered ☑ unfiltered		

Notes: record time at which purging is started. For low flow sampling, recommended stabilization criteria: temp ± 0.5°C; pH ± 0.1 units; conductivity ± 3%; DO ± 1 mg/L; ORP ± 10 mV; for at least three successive measurements that are made every 3-5 minutes with <1 foot of stable draw down.

Unless otherwise noted, groundwater sample collection was completed in accordance with the applicable requirements of Golder's Quality Assurance Program and Standard Operating Procedure ☐ 9 Conventional Groundwater Sample Collection ☐ 10 Low Flow Groundwater Sample Collection.

Field Team Leader Alex Bozzetto (name) [signature] (signature)

GOLDER

Groundwater Sample Collection

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Project/Phase	19122434-D	Equipment Decon	☐ Dedicated equipment	Depth to Water	29.80	ft. BMP
Site Location	A-1		☐ Decon between locations	Casing Stickup		ft.
Date	6-13-19	Reference Point	☒ Top of casing	Depth to Water		ft. BGL
MW ID	BMW-29	Location	☐ Other ______	Total MW Depth		ft. BGL
Sample ID	BMW-29	Water Quality	Bladder Pump	MW Diameter	2	inches
Pump	☒ Waterra ☐ Submersible	Meter Model	Horiba U-50	MW Volume		gallons
	☐ Peristaltic ☐ Bladder	Unit Number		Pump Intake Depth		ft. BGL

Standard volume capacity of monitoring wells: Schedule 40 PVC (1-inch OD, 0.04 gallons/foot; 2-inch OD, 0.16 gallons/foot; 4-inch OD, 0.65 gallons/foot)

Time	Purge Rate (L/min)	Cumulative Purge Volume (L)	Depth to Water (ft)	Temp (°C) ☐ NM	pH ☐ NM	Conductivity (µS/m or mS/cm) ☐ not measured	Dissolved Oxygen (mg/L) ☐ not measured	Redox Potential (mV) ☐ not measured	Turbidity (NTU) ☐ NM
1000	0.1	1.0		22.94	6.36	1.98	10.36	246	131.2
1010		2.0		23.36	6.41	2.02	10.41	256	84.0
1015		2.5		24.04	7.30	2.01	10.74	274	62.8
1020		3.0		24.13	7.10	2.00	9.96	281	71.9
1025		3.5		24.24	7.11	2.00	9.34	295	62.1
1030		4.0		24.19	7.19	2.00	9.24	299	92.4

Purging was completed based on: ☐ stabilization of water quality parameters ☐ removal of three well volumes ☐ removal of at least one half well volume (low yield well)

Bottles Collected				Filtration	Preserved	Notes and Observations
Time	Volume	Composition (G / P)	No.	(10µm / 45µm)	(type)	(quality control sample, other)
1030				☐ filtered ☐ unfiltered		
				☐ filtered ☐ unfiltered		

Notes: record time at which purging is started. For low flow sampling, recommended stabilization criteria: temp ± 0.5°C; pH ± 0.1 units; conductivity ± 3%; DO ± 1 mg/L; ORP ± 10 mV; for at least three successive measurements that are made every 3-5 minutes with <1 foot of stable draw down.

Unless otherwise noted, groundwater sample collection was completed in accordance with the applicable requirements of Golder's Quality Assurance Program and Standard Operating Procedure ☐ 9 Conventional Groundwater Sample Collection ☐ 10 Low Flow Groundwater Sample Collection.

Field Team Leader Alex Barletta (name) — [signature] (signature)

Groundwater Sample Collection

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GOLDER

Project/Phase	19122434-D	**Equipment Decon**	☐ Dedicated equipment	**Depth to Water**	31.54	ft. BMP
Site Location	A-1		☐ Decon between locations	**Casing Stickup**		ft.
Date	6-13-19	**Reference Point Location**	☒ Top of casing	**Depth to Water**		ft. BGL
MW ID	BMW-30		☐ Other ______	**Total MW Depth**		ft. BGL
Sample ID	BMW-30	**Water Quality Meter Model**	Bladder Pump	**MW Diameter**	2	inches
Pump	☒ Waterra ☐ Submersible ☐ Peristaltic ☒ Bladder	**Unit Number**	HORIBA U50	**MW Volume**		gallons
				Pump Intake Depth		ft. BGL

Standard volume capacity of monitoring wells: Schedule 40 PVC (1-inch OD, 0.04 gallons/foot; 2-inch OD, 0.16 gallons/foot; 4-inch OD, 0.65 gallons/foot)

Time	Purge Rate (L/min)	Cumulative Purge Volume (L)	Depth to Water (ft)	Temp (°C) ☐ NM	pH ☐ NM	Conductivity (µS/m or mS/cm) ☐ not measured	Dissolved Oxygen (mg/L) ☐ not measured	Redox Potential (mV) ☐ not measured	Turbidity (NTU) ☐ NM
1220	0.1	1.0		24.26	6.94	1.01	9.36	146	101
1230		2.0		24.52	6.92	0.92	8.41	202	97
1235		2.5		24.76	7.08	1.30	6.24	219	88
1240		3.0		24.69	7.09	1.21	7.69	258	100
1245		3.5		24.52	7.09	1.13	7.38	292	90
1250		4.0		24.61	7.09	1.15	7.94	303	82

Purging was completed based on: ☒ stabilization of water quality parameters ☐ removal of three well volumes ☐ removal of at least one half well volume (low yield well)

Bottles Collected				Filtration (10µm / 45µm)	Preserved (type)	Notes and Observations (quality control sample, other)
Time	Volume	Composition (G / P)	No.			
1250				☐ filtered ☒ unfiltered		
				☐ filtered ☒ unfiltered		

Notes: record time at which purging is started. For low flow sampling, recommended stabilization criteria: temp ± 0.5°C; pH ± 0.1 units; conductivity ± 3%; DO ± 1 mg/L; ORP ± 10 mV; for at least three successive measurements that are made every 3-5 minutes with <1 foot of stable draw down.

Unless otherwise noted, groundwater sample collection was completed in accordance with the applicable requirements of Golder's Quality Assurance Program and Standard Operating Procedure ☐ 9 Conventional Groundwater Sample Collection ☐ 10 Low Flow Groundwater Sample Collection.

Field Team Leader Alex Bozzetto (name) Alex Bozzetto (signature)

Groundwater Sample Collection

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GOLDER

Project/Phase	19122434-D	**Equipment Decon**	☒ Dedicated equipment		**Depth to Water**	9.26	ft. BMP
Site Location	A-1		☐ Decon between locations		**Casing Stickup**		ft.
Date	6-13-19	**Reference Point**	☒ Top of casing		**Depth to Water**		ft. BGL
MW ID	BMW-31	**Location**	☐ Other		**Total MW Depth**		ft. BGL
Sample ID	BMW-31	**Water Quality**			**MW Diameter**		inches
Pump	☒ Waterra ☐ Submersible	**Meter Model**	Horiba		**MW Volume**		gallons
	☒ Peristaltic ☐ Bladder	**Unit Number**			**Pump Intake Depth**		ft. BGL

Standard volume capacity of monitoring wells: Schedule 40 PVC (1-inch OD, 0.04 gallons/foot; 2-inch OD, 0.16 gallons/foot; 4-inch OD, 0.65 gallons/foot)

Time	Purge Rate (L/min)	Cumulative Purge Volume (L)	Depth to Water (ft)	Temp (°C) ☐ NM	pH ☐ NM	Conductivity (µS/m or mS/cm) ☐ not measured	Dissolved Oxygen (mg/L) ☐ not measured	Redox Potential (mV) ☐ not measured	Turbidity (NTU) ☐ NM
1400	0.1	1.0		24.90	6.90	2.16	8.36	209	126
1410		2.0		23.26	7.01	2.01	9.31	213	131
1415		2.5		24.01	7.04	2.06	9.24	224	145
1420		3.0		24.21	7.66	1.97	9.30	235	111
1425		3.5		24.16	7.01	1.82	9.21	250	130
1430		4.0		24.12	7.01	1.80	9.14	254	124

Purging was completed based on: ☒ stabilization of water quality parameters ☐ removal of three well volumes ☐ removal of at least one half well volume (low yield well)

Bottles Collected				Filtration (10µm / 45µm)	Preserved (type)	Notes and Observations (quality control sample, other)
Time	Volume	Composition (G / P)	No.			
1430				☐ filtered ☒ unfiltered		
1C				☐ filtered ☒ unfiltered		

Notes: record time at which purging is started. For low flow sampling, recommended stabilization criteria: temp ± 0.5°C; pH ± 0.1 units; conductivity ± 3%; DO ± 1 mg/L; ORP ± 10 mV; for at least three successive measurements that are made every 3-5 minutes with <1 foot of stable draw down.

Unless otherwise noted, groundwater sample collection was completed in accordance with the applicable requirements of Golder's Quality Assurance Program and Standard Operating Procedure ☐ 9 Conventional Groundwater Sample Collection ☐ 10 Low Flow Groundwater Sample Collection.

Field Team Leader Alex Bozzetto (name) [signature] (signature)

Groundwater Sample Collection

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GOLDER

Project/Phase	19122484-D	Equipment Decon	☒ Dedicated equipment ☐ Decon between locations	Depth to Water	12.53	ft. BMP
Site Location	A-1			Casing Stickup	3.00	ft.
Date	6-13-19	Reference Point	☒ Top of casing	Depth to Water	9.53	ft. BGL
MW ID	BMW-~~34~~ 32	Location	☐ Other	Total MW Depth	40.00	ft. BGL
Sample ID	BMW-~~34~~ 32	Water Quality		MW Diameter	2	inches
Pump	☒ Waterra ☐ Submersible	Meter Model	Horiba U 50	MW Volume	14	gallons
	☒ Peristaltic ☐ Bladder	Unit Number		Pump Intake Depth	30.00	ft. BGL

Standard volume capacity of monitoring wells: Schedule 40 PVC (1-inch OD, 0.04 gallons/foot; 2-inch OD, 0.16 gallons/foot; 4-inch OD, 0.65 gallons/foot)

Time	Purge Rate (L/min)	Cumulative Purge Volume (L)	Depth to Water (ft)	Temp (°C) ☐ NM	pH ☐ NM	Conductivity (µS/m or mS/cm) ☐ not measured	Dissolved Oxygen (mg/L) ☐ not measured	Redox Potential (mV) ☐ not measured	Turbidity (NTU) ☐ NM
0700	0.1	1.0		20.53	6.59	2.32	9.98	167	15.0
0710		2.0		21.45	6.48	2.27	9.35	142	13.5
0715		2.5		20.09	6.52	2.26	9.05	134	13.8
0720		3.0		20.12	6.54	2.26	9.03	124	13.0
0725		3.5		20.01	6.56	2.26	9.01	116	14.2
0730		4.0		20.46	6.56	2.27	9.00	114	12.1

Purging was completed based on: ☒ stabilization of water quality parameters ☐ removal of three well volumes ☐ removal of at least one half well volume (low yield well)

Bottles Collected				Filtration	Preserved	Notes and Observations
Time	Volume	Composition (G / P)	No.	(10µm / 45µm)	(type)	(quality control sample, other)
0730				☐ filtered ☐ unfiltered		
0730				☐ filtered ☐ unfiltered		

Notes: record time at which purging is started. For low flow sampling, recommended stabilization criteria: temp ± 0.5°C; pH ± 0.1 units; conductivity ± 3%; DO ± 1 mg/L; ORP ± 10 mV; for at least three successive measurements that are made every 3-5 minutes with <1 foot of stable draw down.

Unless otherwise noted, groundwater sample collection was completed in accordance with the applicable requirements of Golder's Quality Assurance Program and Standard Operating Procedure ☐ 9 Conventional Groundwater Sample Collection ☐ 10 Low Flow Groundwater Sample Collection.

Field Team Leader Alex Bozzato (name) [signature] (signature)

Groundwater Sample Collection

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GOLDER

Project/Phase	19122434-D	Equipment Decon	☐ Dedicated equipment	Depth to Water	26.01	ft. BMP
Site Location	A-1		☐ Decon between locations	Casing Stickup	2.85	ft.
Date	6-13-19	Reference Point	☑ Top of casing	Depth to Water		ft. BGL
MW ID	BMW-33	Location	☐ Other ______	Total MW Depth	48.00	ft. BGL
Sample ID	BMW-33	Water Quality		MW Diameter	2	inches
Pump	☐ Waterra ☐ Submersible	Meter Model	Horiba U 50	MW Volume		gallons
	☑ Peristaltic ☐ Bladder	Unit Number		Pump Intake Depth		ft. BGL

Standard volume capacity of monitoring wells: Schedule 40 PVC (1-inch OD, 0.04 gallons/foot; 2-inch OD, 0.16 gallons/foot; 4-inch OD, 0.65 gallons/foot)

Time	Purge Rate (L/min)	Cumulative Purge Volume (L)	Depth to Water (ft)	Temp (°C) ☐ NM	pH ☐ NM	Conductivity (µS/m or mS/cm) ☐ not measured	Dissolved Oxygen (mg/L) ☐ not measured	Redox Potential (mV) ☐ not measured	Turbidity (NTU) ☐ NM
0745	0.1	1.0		23.79	7.02	1.48	0.42	240	7.1
0755		2.0		23.32	6.91	1.49	0.52	228	1.6
0800		2.5		23.63	6.82	1.47	0.51	227	2.2
0805		3.0		23.41	6.80	1.36	0.36	226	2.1
0810		3.5		23.64	6.80	1.40	0.21	226	1.9
0815		4.0		23.31	6.75	1.42	0.17	221	1.7

Purging was completed based on: ☐ stabilization of water quality parameters ☐ removal of three well volumes ☐ removal of at least one half well volume (low yield well)

Bottles Collected: Time	Volume	Composition (G / P)	No.	Filtration (10µm / 45µm)	Preserved (type)	Notes and Observations (quality control sample, other)
0815				☐ filtered ☑ unfiltered		
0815				☐ filtered ☑ unfiltered		

Notes: record time at which purging is started. For low flow sampling, recommended stabilization criteria: temp ± 0.5°C; pH ± 0.1 units; conductivity ± 3%; DO ± 1 mg/L; ORP ± 10 mV; for at least three successive measurements that are made every 3-5 minutes with <1 foot of stable draw down.

Unless otherwise noted, groundwater sample collection was completed in accordance with the applicable requirements of Golder's Quality Assurance Program and Standard Operating Procedure ☐ 9 Conventional Groundwater Sample Collection ☐ 10 Low Flow Groundwater Sample Collection.

Field Team Leader Alex Bozzelo (name) Alex Bozzelo (signature)

Groundwater Sample Collection

Page ___ of ___

GOLDER

Project/Phase	19122434-D	Equipment Decon	☒ Dedicated equipment ☐ Decon between locations	Depth to Water	9.49	ft. BMP
Site Location	A-1			Casing Stickup		ft.
Date	6-13-19	Reference Point Location	☒ Top of casing ☐ Other ___	Depth to Water		ft. BGL
MW ID	MW PDP 2019-1			Total MW Depth		ft. BGL
Sample ID	MW-PDP 2019-1	Water Quality Meter Model	Horiba U-50	MW Diameter		inches
Pump	☒ Waterra ☐ Submersible ☒ Peristaltic ☐ Bladder			MW Volume		gallons
		Unit Number		Pump Intake Depth		ft. BGL

Standard volume capacity of monitoring wells: Schedule 40 PVC (1-inch OD, 0.04 gallons/foot; 2-inch OD, 0.16 gallons/foot; 4-inch OD, 0.65 gallons/foot)

Time	Purge Rate (L/min)	Cumulative Purge Volume (L)	Depth to Water (ft)	Temp (°C) ☐ NM	pH ☐ NM	Conductivity (µS/m or mS/cm) ☐ not measured	Dissolved Oxygen (mg/L) ☐ not measured	Redox Potential (mV) ☐ not measured	Turbidity (NTU) ☐ NM
1530	0.1	1.0		22.14	6.84	2.01	12.42	92	214
1540		2.0		22.04	7.36	1.36	12.36	109	105
1545		2.5		22.12	7.41	1.42	11.92	142	90
1550		3.0		22.16	7.02	1.01	10.34	139	69
1600		3.5		22.36	7.09	102	10.19	174	13
1605		4.0		22.41	7.10	1.00	10.61	202	15

Purging was completed based on: ☐ stabilization of water quality parameters ☐ removal of three well volumes ☐ removal of at least one half well volume (low yield well)

Bottles Collected: Time	Volume	Composition (G / P)	No.	Filtration (10µm / 45µm)	Preserved (type)	Notes and Observations (quality control sample, other)
1605				☐ filtered ☒ unfiltered		
				☐ filtered ☒ unfiltered		

Notes: record time at which purging is started. For low flow sampling, recommended stabilization criteria: temp ± 0.5°C; pH ± 0.1 units; conductivity ± 3%; DO ± 1 mg/L; ORP ± 10 mV; for at least three successive measurements that are made every 3-5 minutes with <1 foot of stable draw down.

Unless otherwise noted, groundwater sample collection was completed in accordance with the applicable requirements of Golder's Quality Assurance Program and Standard Operating Procedure ☐ 9 Conventional Groundwater Sample Collection ☐ 10 Low Flow Groundwater Sample Collection.

Field Team Leader Alex Bozzato (name) [signature] (signature)

GROUNDWATER SAMPLING RECORD

Project Number: 19122262-D	Project Name: UMINANT-ALCOA LANDFILL	Date: 7-9-19
Sampling Location (well ID, etc.): AIV-18-OB-95	Starting Water Level (ft. BMP): 23.12	
Sample Number: AIV-18-OB-95	Casing Stickup (ft.):	
Sampled by: JTB	WL (ft. BMP):	(ft. BGL):
Measuring Point (MP) of Well: TOC - Steel or PVC	TD (ft. BMP):	(ft. BGL):
Screened Interval (ft. BGL): —	Ft. water:	Casing Dia. (In ID):
Filter Pack Interval (ft. BGL): —	1X Casing Vol (gal.):	3X (gal):

QUALITY ASSURANCE

Gallons/Foot: 2": 0.16 4": 0.65 5.25": 1.12 6": 1.47 6.25": 1.59

METHODS (describe): Low Flow - Dedicated Tubing/Equipment

Cleaning Equipment: DI/Alconox Rinse

Purge: Peristaltic Pump / SS Pump / Bailer Sampling: Peristaltic Pump / SS Pump / Bailer

Disposal of Discharged Water:

INSTRUMENTS (Indicate make, model, I.d.)

Water Level: SOLINST Other:

Multi Meter: HORIBA

Field Calibration: AUTO CAL

Filter / Filter Size:

SAMPLING MEASUREMENTS

Begin Purge:

1109 Time	DTW (ft BTOC)	Cum. Vol. (gal. or L)	Purge Rate (gal. or L/m)	Temp. (oC)	DO (mg/L)	Spec. Cond. (µs/cm)	pH	ORP (mV)	Turbidity (NTU)	Color & Sediment
1118	23.31	—	.1	20.6	0.62	1920	6.71	-23	5.7	neutral
1124	23.34		↓	20.7	0.51	1930	6.68	-26	6.7	↓
1129	23.35		↓	20.7	0.52	1930	6.67	-26	6.2	↓

WL (ft. BMP) at End of Purge: Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Time		Bottles Collected Volume	Composition (G, P)	No.	Filtration (Y / N)	Preservation (type)	Remarks (quality control sample, other)
1135		500mL	P	1	N		
1135		250mL	P	1	N		

Comments:

GOLDER
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Round Rock, Texas 78664
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GROUNDWATER SAMPLING RECORD

PAGE 1 of 1

Project Number: 19122262-D Project Name: LUMINANT- AI AREA LANDFILL Date: 7-9-19

Sampling Location (well ID, etc.): BMW-25	Starting Water Level (ft. BMP): 9.34
Sample Number: BMW-25	Casing Stickup (ft.):
Sampled by: JTB	WL (ft. BMP): (ft. BGL):
Measuring Point (MP) of Well: TOC - Steel or PVC	TD (ft. BMP): (ft. BGL):
Screened Interval (ft. BGL): —	Ft. water: Casing Dia. (In ID):
Filter Pack Interval (ft. BGL): —	1X Casing Vol (gal.): 3X (gal):

QUALITY ASSURANCE

Gallons/Foot: 2": 0.16 4": 0.65 5.25": 1.12 6": 1.47 6.25": 1.59

METHODS (describe): Low Flow - Dedicated Tubing/Equipment

Cleaning Equipment: DI/Alconox Rinse

Purge: Peristaltic Pump / SS Pump / Bailer Sampling: Peristaltic Pump / SS Pump / Bailer

Disposal of Discharged Water:

INSTRUMENTS (Indicate make, model, I.d.)

Water Level: SOLINST Other:

Multi Meter: HORIBA

Field Calibration: AUTO CAL

Filter / Filter Size:

SAMPLING MEASUREMENTS

Begin Purge:

1229 Time	DTW (ft BTOC)	Cum. Vol. (gal. or L)	Purge Rate (gal. or L/m)	Temp. (oC)	DO (mg/L)	Spec. Cond. (µs/cm)	pH	ORP (mV)	Turbidity (NTU)	Color & Sediment
1238	9.62	—	.1	21.7	1.42	2030	6.82	27	7.4	neutral
1244	9.64		↓	21.5	1.17	2020	6.83	32	6.4	↓
1251	9.64			21.5	1.18	2030	6.82	29	7.1	

WL (ft. BMP) at End of Purge: Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Time		Bottles Collected Volume	Composition (G, P)	No.	Filtration (Y / N)	Preservation (type)	Remarks (quality control sample, other)
1255		500mL	P	1	N		
1255		250mL	P	1	N		

Comments:

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GROUNDWATER SAMPLING RECORD

PAGE 1 of 1

Project Number: 19122262 -D Project Name: LUMINANT- A1 AREA LANDFILL Date: 7-9-19

Sampling Location (well ID, etc.): BMW-29

Starting Water Level (ft. BMP): 29.62

Sample Number: BMW-29

Casing Stickup (ft.):

Sampled by: JTB

WL (ft. BMP): (ft. BGL):

Measuring Point (MP) of Well: TOC - Steel or PVC

TD (ft. BMP): (ft. BGL):

Screened Interval (ft. BGL): —

Ft. water: Casing Dia. (In ID):

Filter Pack Interval (ft. BGL): —

1X Casing Vol (gal.): 3X (gal):

QUALITY ASSURANCE

Gallons/Foot: 2": 0.16 4": 0.65 5.25": 1.12 6": 1.47 6.25": 1.59

METHODS (describe): Low Flow - Dedicated Tubing/Equipment

Cleaning Equipment: DI/Alconox Rinse

Purge: Peristaltic Pump / SS Pump / Bailer Bladder pump Sampling: Peristaltic Pump / SS Pump / Bailer bladder pump

Disposal of Discharged Water:

INSTRUMENTS (Indicate make, model, I.d.)

Water Level: SOLINST

Other:

Multi Meter: HORIBA

Field Calibration: AUTOCAL

Filter / Filter Size:

SAMPLING MEASUREMENTS

Begin Purge: 0919

Time	DTW (ft BTOC)	Cum. Vol. (gal. or L)	Purge Rate (gal. or L/m)	Temp. (oC)	DO (mg/L)	Spec. Cond. (µs/cm)	pH	ORP (mV)	Turbidity (NTU)	Color & Sediment
0928	29.91	—	.1	22.6	2.16	1930	6.86	-17	16	neutral
0936	29.93			22.7	1.76	1960	6.84	-13	7.3	
0940	29.92			22.7	1.77	1960	6.83	-13	7.4	

WL (ft. BMP) at End of Purge:

Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Time		Bottles Collected: Volume	Composition (G, P)	No.	Filtration (Y / N)	Preservation (type)	Remarks (quality control sample, other)
0945		500mL	P	1	N		
0945		250mL	P	1	N		

Comments:

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GROUNDWATER SAMPLING RECORD

PAGE 1 of 1

Project Number: 19122262-D	Project Name: LUMINANT - A1 AREA LANDFILL	Date: 7-9-19	
Sampling Location (well ID, etc.): BMW-32		Starting Water Level (ft. BMP):	12.39
Sample Number: BMW-32		Casing Stickup (ft.):	
Sampled by: JTB		WL (ft. BMP):	(ft. BGL):
Measuring Point (MP) of Well: TOC - Steel or PVC		TD (ft. BMP):	(ft. BGL):
Screened Interval (ft. BGL): —		Ft. water:	Casing Dia. (In ID):
Filter Pack Interval (ft. BGL): —		1X Casing Vol (gal.):	3X (gal):

QUALITY ASSURANCE

Gallons/Foot: 2": 0.16 4": 0.65 5.25": 1.12 6": 1.47 6.25": 1.59

METHODS (describe): Low Flow - Dedicated Tubing/Equipment

Cleaning Equipment: DI/Alconox Rinse

Purge: Peristaltic Pump / SS Pump / Bailer Sampling: Peristaltic Pump / SS Pump / Bailer

Disposal of Discharged Water:

INSTRUMENTS (Indicate make, model, I.d.)

Water Level: SOLINST Other:

Multi Meter: HORIBA

Field Calibration: AUTO CAL

Filter / Filter Size:

SAMPLING MEASUREMENTS

Begin Purge: 1346

Time	DTW (ft BTOC)	Cum. Vol. (gal. or L)	Purge Rate (gal. or L/m)	Temp. (oC)	DO (mg/L)	Spec. Cond. (µs/cm)	pH	ORP (mV)	Turbidity (NTU)	Color & Sediment
1356	12.61	—	.1	21.3	1.62	2160	6.67	-7	6.7	neutral
1402	12.62		↓	21.4	1.32	2130	6.61	-11	7.2	↓
1413	12.62			21.3	1.31	2130	6.62	-12	5.9	

WL (ft. BMP) at End of Purge: Sample Intake Depth (ft. BMP):

SAMPLE INVENTORY

Time		Bottles Collected: Volume	Composition (G, P)	No.	Filtration (Y / N)	Preservation (type)	Remarks (quality control sample, other)
1420		500mL	P	1	N		
1420		250mL	P	1	N		

Comments:

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APPENDIX F13 - SEMI-ANNUAL REMEDY SELECTION PROGRESS REPORTS (A-1 AREA LANDFILL – MARCH 4, 2020 AND SEPTEMBER 3, 2020)

March 4, 2020

SEMIANNUAL REMEDY SELECTION PROGRESS REPORT
MARTIN LAKE STEAM ELECTRIC STATION – A1 AREA LANDFILL

In accordance with Title 40 Code of Federal Regulations (C.F.R.) § 257.97(a), the owner or operator of a coal combustion residuals (CCR) unit must prepare a semiannual report describing the progress in selecting and designing a remedy for statistically significant levels (SSLs) of constituents listed in Appendix IV of 40 C.F.R. Part 257 over the groundwater protection standards established in accordance with 40 C.F.R. § 257.95(h).

This report is for the A1 Area Landfill (A1 LF) at the Martin Lake Steam Electric Station.

As stated in the notifications dated February 6, 2019 and October 7, 2019, an SSL for cobalt was identified at the A1 LF during assessment monitoring completed in accordance with 40 C.F.R. § 257.95.

In response to the SSL, an Assessment of Corrective Measures (ACM) report was completed for the A1 LF in September 2019 as required by 40 C.F.R. § 257.96. The ACM report evaluated closure in place with a low-permeability cap system for purposes of source control. Further evaluation of monitored natural attenuation, groundwater extraction and treatment or a vertical hydraulic barrier is ongoing for purposes of selecting a remedy under 40 C.F.R. § 257.97.

A public meeting was held on November 13, 2019 at the Henderson Chamber of Commerce in Henderson, Texas to discuss the results of the of the ACM in accordance with 40 C.F.R. § 257.96(e).

Areas of the A1 LF are closed in place with a low-permeability cap system as they reach design capacity. Selection of the groundwater remedy for the A1 LF is currently in the feasibility study phase.

Luminant

September 3, 2020

SEMI-ANNUAL REMEDY SELECTION PROGRESS REPORT
MARTIN LAKE STEAM ELECTRIC STATION – A1 AREA LANDFILL

In accordance with Title 40 Code of Federal Regulations (C.F.R.) § 257.97(a), the owner or operator of a coal combustion residuals (CCR) unit must prepare a semiannual report describing the progress in selecting and designing a remedy for statistically significant levels (SSLs) of constituents listed in Appendix IV of 40 C.F.R. Part 257 over the groundwater protection standards established in accordance with 40 C.F.R. § 257.95(h).

This report is for the A1 Area Landfill (A1 LF) at the Martin Lake Steam Electric Station.

As stated in the notification dated February 6, 2019, SSLs for arsenic, barium, cobalt, and lithium were identified at the A1 LF during 2018 assessment monitoring completed in accordance with 40 C.F.R. § 257.95. However, no SSLs for arsenic, barium or lithium were identified in subsequent semi-annual assessment monitoring events completed in 2019 and 2020. As stated in the notifications dated October 7, 2019 and February 7, 2020, an SSL for cobalt was identified at the A1 LF during 2019 assessment monitoring completed in accordance with 40 C.F.R. § 257.95.

In response to the SSL, an Assessment of Corrective Measures (ACM) report was completed for the A1 LF in September 2019 as required by 40 C.F.R. § 257.96. The ACM report concluded that the source control remedy would be closure in place with a low-permeability cap system and the groundwater remedy would be monitored natural attenuation (MNA), groundwater extraction and treatment or a vertical hydraulic barrier.

A public meeting was held on November 13, 2019 at the Henderson Chamber of Commerce in Henderson, Texas to discuss the results of the of the ACM in accordance with 40 C.F.R. § 257.96(e).

Areas of the A1 LF are closed in place with a low-permeability cap system as they reach design capacity.

A feasibility study to evaluate MNA as a potential groundwater remedy for the A1 LF is currently being performed. Feasibility study activities completed since March 4, 2020 include collection of additional groundwater samples to supplement previous soil and groundwater data and development of site-specific geochemical and groundwater models in order to understand the natural attenuation mechanisms occurring at the A1 LF and evaluate the effectiveness of natural attenuation in meeting applicable groundwater protection standards.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

WASHINGTON, D.C. 20460

January 11, 2022

OFFICE OF
LAND AND EMERGENCY
MANAGEMENT

Ms. Cynthia Vodopivec
Luminant Generation Company LLC
Martin Lake Steam Electric Station
Environmental Services
6555 Sierra Drive
Irving, Texas 75039

Dear Ms. Vodopivec:

On November 25, 2020, the Environmental Protection Agency (EPA) received a demonstration from Martin Lake Steam Electric Station requesting authorization to continue using Ash Pond Area and Permanent Disposal Pond 5 until June 29, 2022, and July 1, 2023, respectively, pursuant to the alternative closure provision 40 C.F.R. § 257.103(f)(1). EPA reviewed your demonstration to determine whether it included the required information, analyses and documentation specified under 40 C.F.R. § 257.103(f)(1), and we have determined that your demonstration is complete.

This letter merely communicates EPA's determination that your submitted demonstration contains sufficient information for EPA to evaluate the merits of your demonstration. EPA has not made any decision on whether to approve your request. The demonstration will undergo further review to make such a determination. After this review, EPA will publish its proposed decision for public comment in a docket on www.regulations.gov. After consideration of the comments, EPA will issue its final decision on the demonstration.

As a consequence of your submission of a complete demonstration, the deadline for the Coal Combustion Residuals units covered by the demonstration to cease receipt of waste is tolled until EPA issues a final decision on the demonstration. 40 C.F.R. § 257.103(f)(3)(ii).

EPA will notify you when a proposed decision on the demonstration is issued. If you have any questions, please contact Kirsten Hillyer at Hillyer.Kirsten@epa.gov.

Sincerely,

Barry N. Breen
Acting Assistant Administrator