CLOSURE PLAN

CCR 257.102(b)

Landfill Area

Welsh Power Plant
Pittsburg, Texas

October, 2016
Revision 2, August 2025

Prepared for : Southwest Electric Power Company – Welsh Plant

Pittsburg, Texas

Prepared by: American Electric Power Service Corporation

1 Riverside Plaza

Columbus, OH 43215

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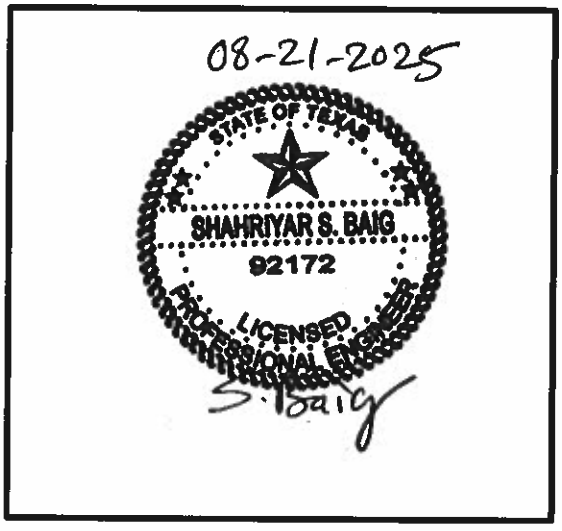
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CLOSURE PLAN
CCR 257.102(b)
WELSH POWER PLANT
LANDFILL AREA

PREPARED BY _____ DATE 08-21-2025
Shah S. Baig, P.E.

REVIEWED BY Pryce Warren DATE 08/22/25
Pryce Warren

APPROVED BY _____ DATE 08-29-2025
Dan W. Pizzino, P.E.
Director – AEP Civil Engineering



I certify to the best of my knowledge, information, and belief that the information contained in this closure plan meets the requirements of 40 CFR § 257.102

I certify to the best of my knowledge, information and belief that design of the final cover system as described in this closure plan meets the requirements of 40 CFR § 257.102.

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1.0 OBJECTIVE

This report was prepared by AEP- Geotechnical Engineering to fulfill requirements of CCR 257.102(b) for Closure Plans of Existing CCR Units.

2.0 DESCRIPTION OF THE CCR UNIT

The AEP J. Robert Welsh Plant is located in southern Titus County, approximately 8 miles northeast of Pittsburg, Texas, and approximately two miles northwest of Cason, Texas. It is owned and operated by Southwest Electric Power Company (SWEPCO). The facility operates a landfill for the disposal of CCR materials.

The Welsh Landfill is a Class 2, Industrial Solid Waste Facility per the Texas Commission on Environmental Quality, Industrial Solid Waste Management Technical Guideline No. 3.

3.0 DESCRIPTION OF CLOSURE PLAN 257.102(b)(1)(i)

[A narrative description of how the CCR unit will be closed in accordance with this section]

The Welsh Landfill Area will be closed by closure in place. The closure will consist of re-grading the existing onsite materials and the installation of an impermeable cap with vegetative cover. The existing surface will be graded to achieve a gently sloping surface to promote surface water runoff.

The regraded surface will be covered with an engineered closure turf material. The engineered closure turf will be compliant with both the CCR Rule and TCEQ guidelines and will consist of the following:

- 1-foot of intermediate soil cover
- 50 mil LLDPE micro spike geomembrane
- Engineered turf material
- 2-inches of sand ballast infill material

4.0 CLOSURE IN PLACE 257.102 (b)(1)(iii)

[If closure of the CCR unit will be accomplished by leaving the CCR in place, a description of the final cover system, designed in accordance with paragraph(d) of this section, and the methods and procedures to be used to install the final cover. The closure plan must also discuss how the final cover system will achieve the performance standards specified in paragraph (d) of this section.]

The final engineered turf cap system will consist of 1- foot of intermediate soil cover over the final graded CCR material with a 50 mil LLDPE Micro-Spike geomembrane cover. Over the geomembrane will be installed Engineered Turf Material that will be covered with 2-inches of sand ballast infill material. The final cover slopes will be a minimum of 2% and will convey water to a TPDES permitted outfall.

4.1 CLOSURE PERFORMANCE STANDARDS 257.102 (d)(1)

4.1.1 SECTION 257.102(d)(1)(i)

[Control, minimize or eliminate, 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.]

The final cover system will cover the CCR material and will have a permeability that is less than or equal to the permeability of the natural subsoils and is no greater than 1 x 10^{-5} cm/sec. The runon and runoff control plan for the landfill is included in Attachment 1.

4.1.2 SECTION 257.102(d)(1)(ii)

[Preclude the probability of future impoundment of water, sediment, or slurry.]

The final surface areas will be graded to a minimum slope 2% to prevent the ponding of surface runoff. Drainage features will be designed to have positive drainage.

4.1.3 SECTION 257.102(d)(1)(iii)

[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.]

The final cover system will be gently graded with a minimum of 2% slope. The final configuration of the impoundment will meet the stability requirements to prevent the sloughing or movement of the final cover system during the closure and post-closure care period.

4.1.4 SECTION 257.102(d)(1)(iv)

[Minimize the need for further maintenance of the CCR unit.]

The landfill facility will be covered with artificial turf material to prevent erosion. Maintenance of the final cover system will include replenishing the sand ballast infill as needed.

4.1.5 SECTION 257.102(d)(1)(v)

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

The CCR unit will be closed in a timeframe consistent with recognized and generally accepted good engineering practices. As the fill reaches the approved final grades, periodic closure activities may occur.

4.2 DRAINING AND STABILIZING OF THE SURFACE IMPOUNDMENT 257.102(d)(2)

This section is not applicable to a landfill.

4.3 FINAL COVER SYSTEM 257.102 (d)(3)

[If a CCR unit is closed by leaving CCR in place, the owner or operator must install a final cover system that is designed to minimize infiltration and erosion , and at a minimum, meets the requirements of paragraph (d)(3)(i) of this section, or the requirements of the alternative final cover system specified in paragraph (d)(3)(ii) of this section.

The final cover system must be designed and constructed to meet the criteria in paragraphs (d)(3)(i)(A) through (D) of this section. The design of the final cover system must be included in the written closure plan.]

The final cover system will consist 1-foot of intermediate soil cover over the final graded CCR material with a 50 Mil LLDPE Micro-Spike geomembrane cover. Over the geomembrane will be installed Engineered Turf Material that will be covered with 2-inches of sand ballast infill material. The final cover slopes will be a minimum of 2% and will convey water to a TPDES permitted outfall.

The final cover slopes will be a minimum of 2% and will convey water to a TPDES permitted outfall. The final cover slope will also be a minimum of 2% to accommodate settling and subsidence.

The Hydrologic Evaluation of Landfill Performance (HELP) model calculations (Attachment 1) included the following item; (i) 3-foot clay + 1.5-foot vegetative cover system and (ii) the design drawing illustrate landfill finished grades to be highest in the middle (ridge line). These items are revised as follows; (i) final cover system is a closure turf described above, and (ii) final grade of the landfill is sloped from east end of the landfill to the northwest corner. The HELP calculations are still valid with these changes and do not significantly impact the stormwater, contact water, or non-contact water management. All the other data included in the runoff and runoff plan (Attachment 1) are valid.

4.4 SLOPE STABILITY ANALYSIS, SETTLEMENT, AND COVER SYSTEM DESIGN 40 CFR257.102(b) & (d) & TAC §352.231(e)

Slope stability, settlement, and closure turf cover system engineering analysis and design was completed for the entire landfill facility. This engineering design report is provided in Attachment 2.

4.5 CONSTRUCTION QUALITY ASSURANCE AND QUALITY CONTROL SPECIFICATIONS 40 CFR257.102(b) & (d) & TAC §352.231(e)

Engineering specifications were used for the QAQC testing for the construction of various components of the landfill. All the specifications are included in Attachment 3. A tabulated list of specifications is provided below.

Specification #	Description
CE-004	Specification for Excavation
CE-005	Specification for Foundation Preparation
CE-006	Specification for Fill
CE-006A	Earthwork (Backfill) Testing
CE-007	Specification for Erosion and Sediment Control

5.0 ESTIMATE OF MAXIMUM CCR VOLUME 257.102 (b)(1)(iv)

[An estimate of the maximum inventory of CCR ever on-site over the active life of the CCR unit.]

The estimated maximum CCR volume on-site is 2,740,000 Cubic Yards for the Landfill Area.

6.0 ESTIMATE OF LARGEST AREA OF CCR REQUIRING COVER 257.102 (b)(1)(v)

[An estimate of the largest area of CCR unit ever requiring a final cover

The largest area of the CCR unit requiring a final cover is 40 acres for the Landfill Area.

7.0 CLOSURE SCHEDULE 257.102(b)(1)(vi)

[A schedule for completing all activities necessary to satisfy the closure criteria in the section, including an estimate of the year in which all closure activities for the CCR unit will be completed. The schedule should provide sufficient information to describe the sequential steps that will be taken to close the CCR 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 the CCR surface impoundment closure, or installation of the final cover system, and the estimated timeframes to complete each step or phase of the CCR unit closure.

At this time, the facility will be closed once it reaches final grades with the amount of CCR disposed in the landfill. The Welsh Plant will cease coal-fired generation in 2028. Closure of the other CCR units at the power plant must be completed before the landfill initiates final closure. Once final closure of the landfill commences, the work will be completed within six months as per the 40 CFR 257.102.

Schedule Activities

Activity	Description	Date/Year
1	Closure of all the CCR units	2028
2	Dispose of all the landfill waste and final grading	2029
3	Installation of stormwater control structures	2029
4	Initiate final closure	June 2030
5	Installation of final cover system	December 2030

ATTACHMENT 1

Runon and Runoff Control System Plan

SOUTHWESTERN ELECTRIC POWER COMPANY

WELSH POWER PLANT
ASH LANDFILL

Run-on and Run-off Control System Plan Update & Reissue

September 17, 2021 (Revision 1)

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WELSH POWER PLANT - ASH LANDFILL
Run-on and Run-off Control System Plan

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1.0 Introduction

The Welsh Power Plant has a deed recorded ash landfill (Phase 1 Landfill) that currently receives ash materials from two 528 MW coal fired boilers. The plant annually produces fly ash, bottom ash and economizer ash. Typically, bottom and economizer ash are sluiced to the Primary Ash Pond, which has been periodically dredged and temporarily stored in the Bottom Ash Storage Pond.

Welsh Units 1 and 3 were retrofitted in 2016 to capture mercury in order to comply with EPA Mercury and Air Toxics Standard (MATS) emissions regulations. Activated Carbon Injection (ACI) captures the mercury and is mixed with fly ash to form an ACI byproduct, which is captured in a Pulse Jet Fabric Filter (PJFF).

The Ash Landfill has traditionally been operated in two sections, with a portion of the landfill being primarily composed of dredged bottom ash, economizer ash, and fly ash material sluiced to the ash landfill between approximately 1986 and 2000. The western portion of the Ash Landfill is used to reclaim ash materials for beneficial reuse. Ash sales to the construction industry have helped to extend the Ash Landfill life. A contract ash marketer utilizes the western two-thirds of the Ash Landfill as a temporary storage and processing area for fly ash. The ash marketer is contracted to sell all marketable ash material for beneficial reuse in order to extend the life of the Ash Landfill.

Modifications to the Ash Landfill cap, cover and dewatering systems were incorporated into a landfill site development plan and implemented in 2016 through 2019 (two separate contract efforts). These modifications were submitted to the Texas Commission on Environmental Quality (TCEQ) Industrial Solid Waste Permits Section and each were acknowledged by same. The modifications included provisions for a minimum 3-foot thickness compacted clay cap and a minimum 1.5-foot thickness erosion/vegetative cover, in accordance with TCEQ Technical Guideline No. 3. A project was also conducted in 2017, adding the Low Water Crossing.

30 TAC 352.811 (and by reference 40 CFR 257.81) requires the owner or operator of an existing or new landfill or any lateral expansion of a landfill used for Coal Combustion Residuals (CCR) must comply with the following:

- Design, construct, operate, and maintain:
    - A run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm.
    - A run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour, 25-year storm.
- Run-off from the active portion of the CCR unit must be handled in accordance with the associated surface water requirements.

- Prepare initial and periodic run-on and run-off control system plans for the CCR unit according to the following timeframes:
    - For existing CCR landfills, the owner or operator of the CCR unit must have prepared the initial run-on and run-off control system plan no later than October 17, 2016.
    - The owner or operator of the CCR unit must prepare periodic run-on and run-off control system plans every five (5) years thereafter.
- Obtain a certification from a qualified professional engineer stating that the initial and periodic run-on and run-off control system plans meet the requirements of this section.
- Comply with the recordkeeping requirements specified in 30 TAC 352.1301, the notification requirements specified in 30 TAC 352.1311, and the Publicly Accessible Website requirements specified in 30 TAC 352.1321.

This Run-on and Run-off Control System Plan presents the regulatory-required materials as noted above for the Welsh Ash Landfill. Though design of permanent run-on and run-off control measures were prepared for the Welsh Ash Landfill in the previously submitted/approved Design Modification, this Run-on and Run-off Control System Plan addresses a combination of both interim and permanent systems which are hereafter described.

As the Welsh Ash Landfill is subsequently filled and completed, periodic updates to this Run-on and Run-off Control System Plan may be required.

2.0 Run-on Control Systems

Run-on Controls are provided and accomplished for the interim condition of the Welsh Ash Landfill by a combination of perimeter grading conditions and interim/permanent perimeter drainage systems. The design and function of these systems are as follows:

2.1 Perimeter Grading Conditions

As shown in Figure 1 – Fly Ash Storage Area Phase I (WEPX-88), the Welsh Ash Landfill was constructed with a screen dike on the entire west, north and east sides with drainage culverts located on the north and the southeast areas. A berm of minimal length was constructed on the eastern side of the south boundary. The net effect of this original construction is a perimeter grading condition that is an average of fifteen feet above the surrounding area. As a result of this perimeter grading condition and the hydraulic and hydrological conditions demonstrated in perimeter drainage systems hereafter, a run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm has been in place from the outset.

2.2 Interim & Permanent Perimeter Drainage Systems

As shown in Figure 2 – Current TCEQ NOR Site Development Plan, the future condition of the Welsh Ash Landfill provides for a perimeter drainage system consisting of varying depth perimeter drainage systems (ditches). These perimeter drainage systems are designed as both a run-on and run-off control system to prevent flow onto or away from the active portion of the landfill during the peak discharge from a 24-hour, 25-year storm (Design Event).

In the interim condition, as shown in Figure 3 – Composite Existing Conditions (Merged Field & LiDAR Topography) and the associated Figure 4 – Existing & Proposed Conditions - Drainage Area Map, interim/permanent perimeter drainage systems have been provided. Currently the Run-on and Run-off Control System includes permanent components of the perimeter drainage systems along a portion of the east and northeast sides of the Welsh Ash Landfill. All other perimeter drainage systems are interim. These perimeter ditches are designed to likewise prevent flow onto the active portion of the landfill during the peak discharge from the Design Event.

2.3 Summary of Design Requirements & Justifications

Both Table 1 – Drainage Area Summaries and Table 2 – Q25 Run-on and Run-off Analysis Justifications (and supporting design calculations), as contained in Appendix 2, provide a summary of hydraulic and hydrologic capacity of the interim run-on/run-off control system. These analyses demonstrate that, in all instances, the currently implemented (and maintained) drainage system functions to control run-on for the peak discharge from a 24-hour, 25-year storm.

3.0 Run-off Control Systems

Run-off Controls are provided and accomplished for the interim condition of the Welsh Ash Landfill by a combination of perimeter grading conditions and interim/permanent perimeter drainage systems. The design, operation and maintenance of these perimeter drainage systems provide for conveyance of all 24-hour, 25-year storm run-off from within the Welsh Landfill to the Primary Bottom Ash Pond, a management unit designed to accommodate these flows and other process discharges from the Welsh Power Plant. The design and function of these systems are as summarized follows:

3.1 Perimeter Grading Conditions

As previously noted, the original construction resulted in a perimeter grading condition that is an average of fifteen feet above the surrounding area. As a result of this perimeter grading condition and the hydraulic and hydrological conditions demonstrated in perimeter drainage systems hereafter, an uncontrolled run-off control system is in place to prevent flow away from the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm.

3.2 Interim Top Slope Diversion Berms and Swales

Due to proximity to interim perimeter drainage systems, Drainage Areas CDA 01, CDA 02, CDA 03, CDA 04, and CDA 05 currently require drainage swales in conjunction with berms, dikes or other top slope diversions to ensure contact runoff is managed within the landfill. As shown in Figure 3 – Composite Existing Conditions (Merged Field & LiDAR Topography) and the associated Figure 4 – Existing & Proposed Conditions - Drainage Area Map, these drainage features are configured with the purpose of preventing run-off from the adjacent perimeter drainage areas during a 24-hour, 25-year storm event.

3.3 Permanent Side Slope Terraces and Letdowns

Currently the Run-on and Run-off Control System includes earthen side slope terraces and letdowns along a portion of the east and northeast sides of the Welsh Ash Landfill. The future side slopes of the landfill will extend at a 3H:1V slope to a height of approximately 75-feet above the flowline of the permanent perimeter drainage systems (ditch). These systems or similar will be extended as the landfill continues to fill.

In accordance with Figure 2 – Current TCEQ NOR Site Development Plan and associated design, these terraces and letdowns are designed and implemented as run-off control systems to accommodate runoff from a 24-hour, 25-year storm (Design Event), when needed.

3.4 Interim and Permanent Perimeter Drainage Systems

As shown in Figure 2 – Current TCEQ NOR Site Development Plan, the future condition of the Welsh Ash Landfill provides for a perimeter drainage system consisting of varying depth perimeter drainage systems (ditches). These perimeter ditches are designed as both a run-on and run-off control system to prevent flow onto or away from the active portion of the landfill during the peak discharge from a 24-hour, 25-year storm (Design Event).

In the interim condition, as shown in Figure 3 – Composite Existing Conditions (Merged Field & LiDAR Topography) and the associated Figure 4 – Existing & Proposed Conditions - Drainage Area Map, some of these perimeter drainage systems (ditches) have been provided. Currently the Run-on and Run-off Control System includes permanent components of the perimeter drainage systems along a portion of the north and east sides of the Welsh Ash Landfill. All other perimeter drainage systems are interim. These perimeter ditches are designed to likewise prevent flow onto the active portion of the landfill during the peak discharge from the Design Event.

3.5 Interim and Permanent Culvert Systems

3.5.1 Interim. Driveway crossings are implemented around the perimeter drainage system on an as-needed basis. These crossings are considered interim; however, are sized for run-on and run-off control for the Design Event.

3.5.2 Permanent Culvert Systems, designed to control run-on and run-off equal to or greater than the 24-hour, 25-year design storm event and conveying same to the Primary Bottom Ash Pond, are currently in place as follows:

- Two HDPE culverts, one 30-inches in diameter and one 36-inches in diameter, in the perimeter ditch at the northeast corner of the Welsh Ash Landfill;
- Two 30-inch diameter HDPE culverts in the perimeter ditch at the northwest corner of the Welsh Ash Landfill; and
- A series of three 30-inch diameter HDPE culverts collecting and discharging stormwater runoff from within the landfill at the original “Culvert Number 2” (shown as 2a, 2b, and 2c) location (future landfill leachate collection sump).

3.6 Permanent Low Water Crossing System

The run-on and run-off designs provide for run-off to be routed south via a low water crossing. This low water crossing is comprised of a textured reinforced concrete trapezoidal broadcrest section, 10-feet wide by 2.76’ deep with 12H:1V side slopes and a -1.1% slope along the flowline. The crossing is sized and configured for in excess of the 24-hour, 25-year storm event for future landfill sideslope, terraces and letdowns.

At present, this low water crossing is blocked by perimeter berms to ensure that contact stormwater is routed to the Culvert Number 2 (shown as 2a, 2b, & 2c) location for discharge.

3.7 Summary of Design Requirements and Justifications

Both Table 1 – Drainage Area Summaries and Table 2 – Q25 Run-on and Run-off Analysis Justifications (and supporting design calculations), as contained in Appendix 2, provide a summary of hydraulic and hydrologic capacity of the interim run-on/run-off control system. These analyses demonstrate that, in all instances, the currently implemented (and maintained) drainage system function to control run-off for the peak discharge from a 24-hour, 25-year storm.

4.0 Summary of Requirements, Justifications and Conclusions

As previously stated,30 TAC 352.811 (and by reference Federal Regulation Title 40, Part 257.81) requires the owner or operator of an existing or new landfill or any lateral expansion of a landfill used for Coal Combustion Residuals (CCR) to comply with design, construction, operation, maintenance, certification and recordkeeping requirements that are summarized as follows:

- Design, construct, operate, and maintain:
    - A run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm.
    - A run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour, 25-year storm.
- Run-off from the active portion of the CCR unit must be handled in accordance with the surface water requirements under 30 TAC 352.2.
- Prepare initial and periodic run-on and run-off control system plans for the CCR unit according to the following timeframes:
    - For existing CCR landfills, the owner or operator of the CCR unit must have prepared the initial run-on and run-off control system plan no later than October 17, 2016.
    - The owner or operator of the CCR unit must prepare periodic run-on and run-off control system plans every five (5) years thereafter.
- Obtain a certification from a qualified professional engineer stating that the initial and periodic run-on and run-off control system plans meet the requirements of this section.
- Comply with the recordkeeping requirements specified in 30 TAC 352.1310, the notification requirements specified in 30 TAC 352.1311, and the Publicly Accessible Website requirements specified in 30 TAC 352.1321.

Both Table 1 – Drainage Area Summaries and Table 2 – Q25 Run-on and Run-off Analysis Justifications (and supporting design calculations), as contained in Appendix 2, provide a summary of hydraulic and hydrologic capacity of the interim run-on/run-off control system. These analyses demonstrate that, in all instances, the currently implemented (and maintained) drainage system functions to control both run-off and run-on for the peak discharge from a 24-hour, 25-year storm.

5.0 Plan Review and Changes in Welsh Ash Landfill Configuration

Landfill Owner and/or Operator will review and evaluate this Plan every five (5) years from initial plan preparation and when there are changes in the facility design, construction, operation, or maintenance that materially affect the facility's potential for run-on and run-off control. Amendments to the Plan made to address changes of this nature are referred to as technical or major amendments and must be certified by a Professional Engineer. Non-technical amendments can be performed by the Facility Owner and/or Operator. Non-technical amendments include the following:

Technical and administrative amendments to the Plan will be documented on the Plan Review Log. Owner/Operator will make the necessary revisions to the Plan as soon as possible, but no later than six months after the change occurs. The Plan must be implemented as soon as possible following a technical amendment, but no later than six months from the date of the amendment. The Designated Person is responsible for initiating and coordinating revisions to the Spill Prevention, Control, and Countermeasure (SPCC) Plan.

Scheduled reviews and Plan amendments will be recorded in the Plan Review Log provided in Appendix 3. The log will be completed even if no amendment is made to the Plan as a result of the review.

6.0 Professional Engineer Certification

The original plan and all reviews and amended plans must obtain certification from a qualified professional engineer stating that the initial and periodic run-on and run-off control system plans meet the requirements of TAC 352.811 (and by reference 40 CFR 257.81). This certification in no way relieves the owner or operator of the facility of his/her duty to fully implement this Plan. The Professional Engineer Certification page is provided in Appendix 4.

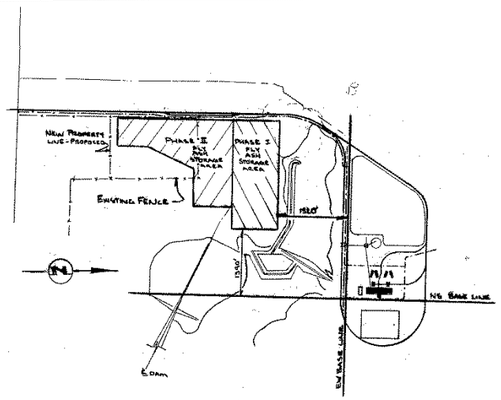
Appendix 1: Figures

Figure 1 – Fly Ash Storage Area Phase I (WEPX-88)

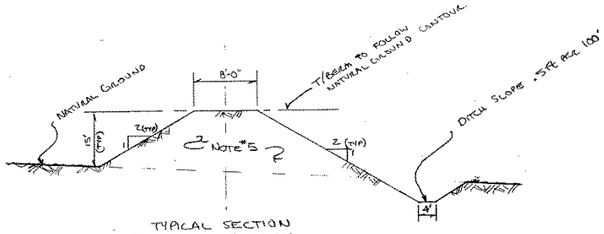
Figure 2 – Current TCEQ NOR Site Development Plan

Figure 3 – Composite Existing Conditions (Merged Field & LiDAR Topography)

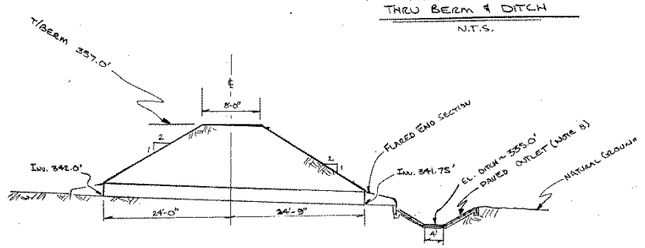
Figure 4 – Existing & Proposed Conditions - Drainage Area Map



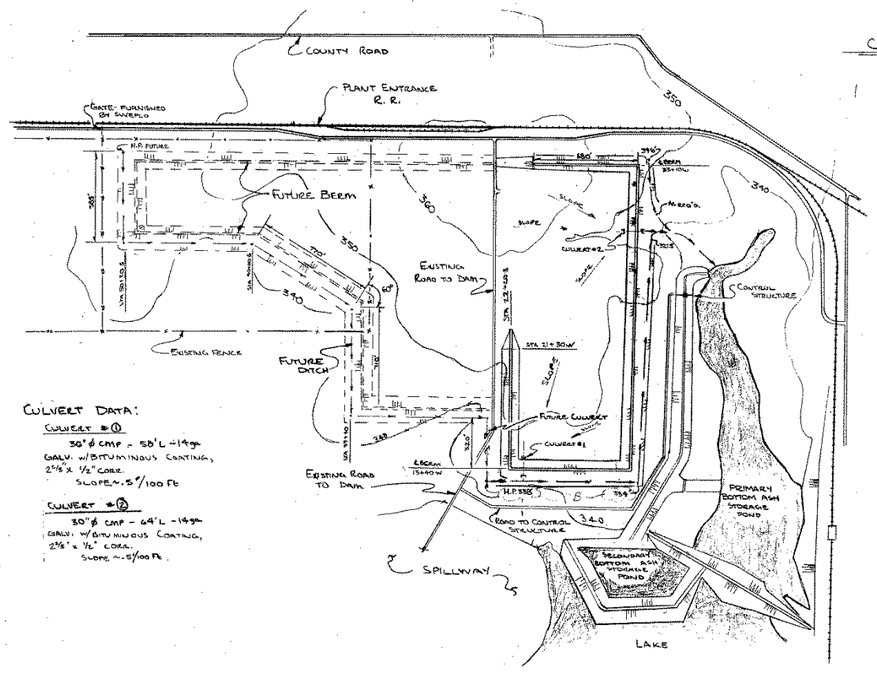
PLAN



TYPICAL SECTION
THRU BERM & DITCH
N.T.S.



SECTION THRU
CULVERT # 1
N.T.S.

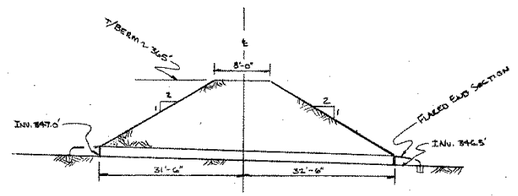


CULVERT DATA:

CULVERT #①
30" ϕ CMP - 58'L - 14ga
GALV. w/BITUMINOUS COATING,
2⅔" x ½" CORR.
SLOPE ~.5'/100 Ft

CULVERT #②
30" ϕ CMP - 64'L - 14ga
GALV. w/BITUMINOUS COATING,
2⅔" x ½" CORR.
SLOPE ~.5'/100 Ft.

ENLARGED PLAN
1" = 400'



SECTION THRU
CULVERT # 2
N.T.S.

NOTES:

1) PHASE I FLY ASH STORAGE AREA CONSTRUCTION WILL INCLUDE CONSTRUCTION OF BERM AND DRAINAGE DITCH AS SHOWN ON THIS DRAWING. NO WORK WILL BE DONE AT THIS TIME ON PHASE II.
2) ENTIRE AREA UNDER BERM SHALL BE STRIPPED, GRUBBED AND ALL UNSUITABLE MATERIAL ENCOUNTERED SHALL BE WASTED IN SECIFIED AREAS.
3) ALL TOPSOIL SHALL BE STOCKPILED AS DIRECTED BY FIELD ENGINEERS.
4) EMBANKMENT SHALL BE CONSTRUCTED FROM SUITABLE MATERIAL EXCAVATED FROM DITCH CONSTRUCTION AND FROM WITHIN STORAGE AREA.
5) EMBANKMENT SHALL BE 90% MODIFIED PROCTOR COMPACTION IN ACCORDANCE W/ S&L STD. 1714.
6) ALL SLOPES SHALL BE TOPSOILED AND SEEDED UPON COMPLETION OF WORK.
7) CULVERTS SHALL BE FURNISHED AND INSTALLED BY EARTHWORK CONTRACTOR. BEDDING AND BACKFILLING SHALL BE IN ACCORDANCE WITH MANUFACTURERS SPECS.
8) OUTLET OF CULVERT #1 SHALL HAVE CONCRETE SLOPE PROTECTION OF 4" SLAB W/6" x 6" #6 MESH. BANKS OF DITCH SHALL BE PAVED FOR 10FT EITHER SIDE OF CULVERT #1.

EXHIBIT A

REV.	DATE	BY	SUBJECT
B	1/8/77	AM	CHAN. EXTENSION, ADD CULVERT #2, REVISE CONTOURS PER ENGINEER.
A	9/1/76	AM	REVISE DITCH WIDTH TO 4'
	8/6/76	AM	FOR CONSTRUCTION

WELSH POWER PLANT - UNIT 1
FLY ASH STORAGE AREA
PHASE I

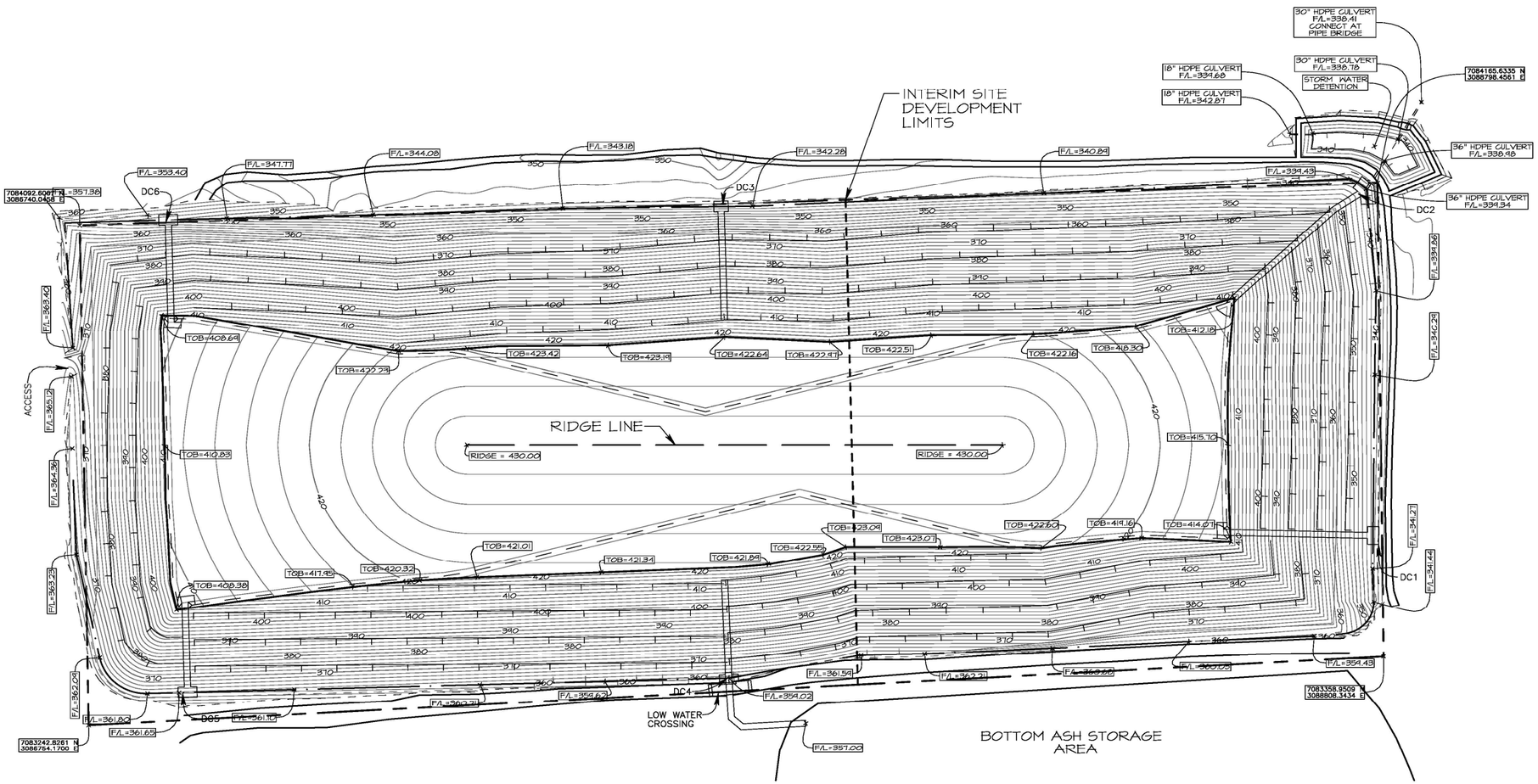
SOUTHWESTERN ELECTRIC POWER CO.
POWER CONSTRUCTION DEPARTMENT
DIVISION

APPROVED ENGR. IN CHARGE
APPROVED DIV. SUPT.
APPROVED CHIEF ENGR.

SHEET
DRWN. BY MELSON
TRAC. BY
DATE: 12-8-76
SCALE: As Noted
WORK ORDER
DRWG NO. WEPX-88

FILE

Figure 1- Fly Ash Storage Area Phase I (WEPX-88)



STATE OF TEXAS
ROBERT H. MURRAY
59111
REGISTERED PROFESSIONAL ENGINEER

THE SEAL APPEARING ON THIS DOCUMENT WAS AUTHORIZED BY ROBERT H. MURRAY, P.E. NO. 59111 ON MARCH 2, 2016

ISSUED FOR REGISTRATION PURPOSES ONLY

MTG engineers & surveyors
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TEXARKANA, TEXAS 75501
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DATE	NO.	DESCRIPTION	APPD.

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SITE DEVELOPMENT PLAN - FINAL

SWEPCO WELSH POWER PLANT DESIGN MODIFICATIONS TO FLY ASH STORAGE AREA

UNIT:	DRAWING NUMBER: 1-30202 REV:
SCALE:	
DR:	AS GRAPHED
CH:	
SUP:	
ENG:	
DATE:	

AEP AMERICAN ELECTRIC POWER

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

X:\2015 Projects\157003 AEP Ash Landfill Project\05 Engineering Design\Design\157003_EOTA.pro
Tue Sep 6, 2016 2:18PM

Figure 2 - Current TCEQ NOR Site Development Plan

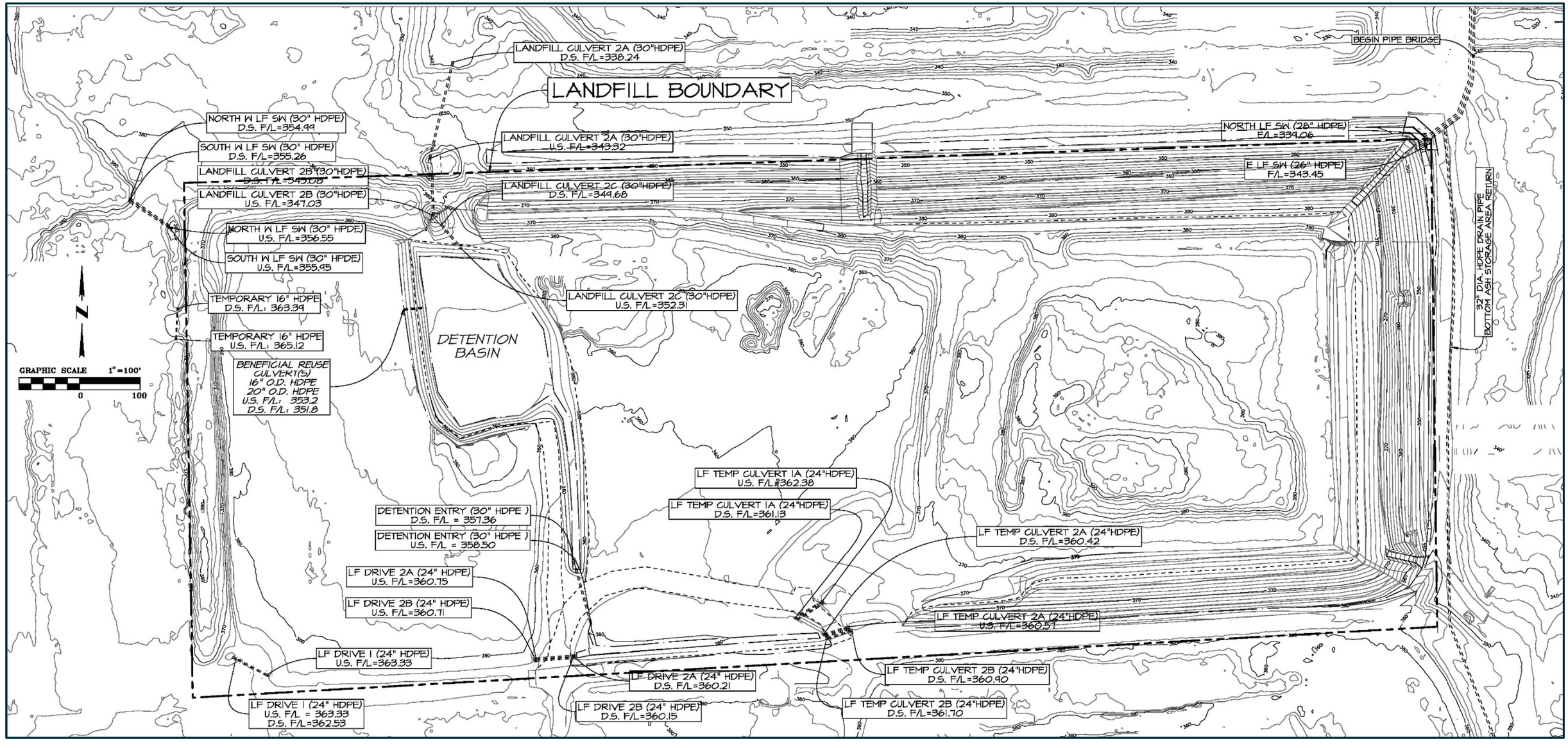


Figure 3 - Composite Existing Conditions (Merged Field & LiDAR Topography)

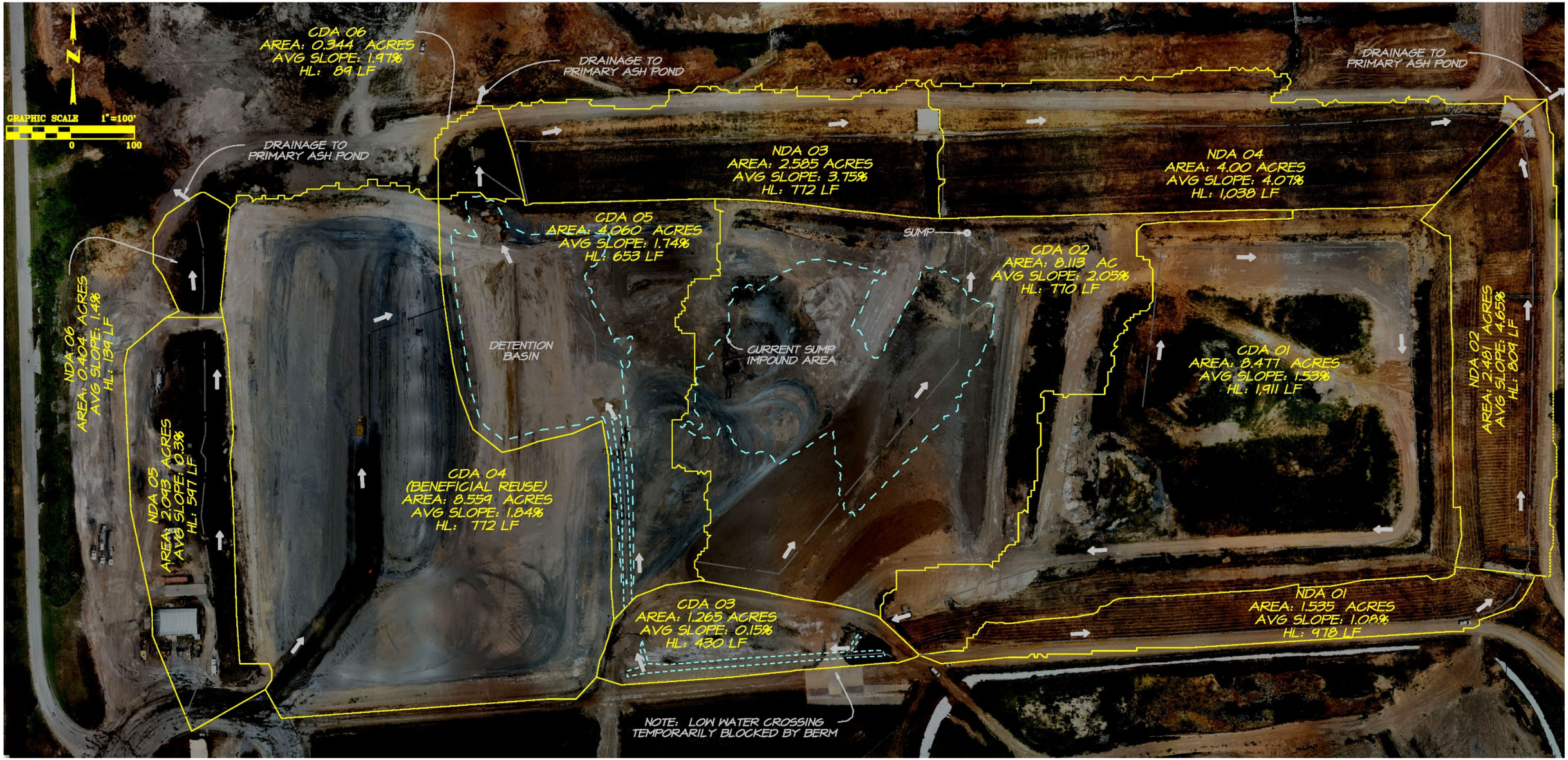


Figure 4 – Existing & Proposed Conditions - Drainage Area Map

Appendix 2: Tables

Table 1 – Drainage Area Summaries

Table 2 – Q25 Run-on and Run-off Analysis Justifications

DRAINAGE AREA SUMMARIES

DRAINAGE AREA ID	DISCHARGE STATUS	DRAINAGE AREA LOCATION	AREA (ACRES)	SLOPE (%)	HYDRAULIC LENGTH (FEET)	RATIONAL C FACTOR	CALCULATED TC (MIN)	USED TC (MIN)
CDA 01	CONTACT	LANDFILL INTERIOR	8.477	1.53%	1911	0.40	13.00	13.00
CDA 02 *	CONTACT	LANDFILL INTERIOR	8.113	2.05%	770	0.50	5.85	10.00
CDA 03	CONTACT	LANDFILL INTERIOR	1.265	0.15%	430	0.50	10.74	11.00
CDA 04	CONTACT	LANDFILL INTERIOR	8.559	1.84%	772	0.50	6.08	10.00
CDA 05 **	CONTACT	LANDFILL INTERIOR	4.060	1.74%	653	0.50	5.76	10.00
CDA 06	CONTACT	LANDFILL INTERIOR	0.344	1.97%	89	0.75	1.12	10.00
NDA 01	NON-CONTACT	LANDFILL PERIMETER DITCH	1.535	1.08%	978	0.50	8.95	10.00
NDA 02	NON-CONTACT	LANDFILL PERIMETER DITCH	2.481	4.65%	809	0.50	4.41	10.00
NDA 03	NON-CONTACT	LANDFILL PERIMETER DITCH	2.585	3.75%	772	0.50	4.32	10.00
NDA 04	NON-CONTACT	LANDFILL PERIMETER DITCH	4.000	4.07%	1038	0.50	5.62	10.00
NDA 05	NON-CONTACT	LANDFILL PERIMETER DITCH	2.093	0.30%	597	0.40	10.02	10.00
NDA 06	NON-CONTACT	LANDFILL PERIMETER DITCH	0.404	1.40%	139	0.40	1.80	10.00

** Q25 DISCHARGE IS BY LEACHATE COLLECTION SUMP PUMP AT 30 GPM (0.08027 CFS)*

*** DISCHARGE FROM CDA 05 IS VIA A TEMPORARY STORMWATER DETENTION BASIN WITH A 30-INCH DIAMETER HDPE OUTLET CULVERT*

Table 1 – Drainage Area Summaries

Q-25 RUN-ON/RUN-OFF ANALYSIS JUSTIFICATIONS

ANALYSIS ID	JUSTIFICATION ANALYSIS DRAINAGE AREAS INCLUDED	DRAINAGE STATUS	ANALYSIS TYPE	ANALYSIS AREA (ACRES)	ANALYSIS SLOPE (%)	BASIN SLOPE (%)	HYDRAULIC LENGTH (FEET)	ANALYSIS C FACTOR	ANALYSIS TC (MIN)	REQUIRED Q25 CAPACITY (CFS)	ANALYSIS JUSTIFICATION CONFIGURATION	AVAILABLE DEPTH (FT)	ANALYSIS DEPTH (FT)
INTERNAL CONTACT DRAINAGE AREAS													
I-01	CDA 01	CONTACT	TWO 24" HDPE CULVERTS	8.477	0.86%	1.53%	1911	0.40	13.00	27.09	TWO 52-FT LONG X 24" DIA HDPE CULVERTS	4.90	4.19
I-02	CDA 02 (LEACHATE COLLECTION AREA)	CONTACT	DRAINAGE CAPTURED & REMOVED BY SUMP PUMP	8.113	2.05%	2.05%	770	0.50	10.00	36.27	AREA RETAINS Q-25 RUNOFF VIA DETENTION PEAK Q = 0.07 CFS	2.38	1.93
I-03	CDA 01 & CDA 03	CONTACT	TRAPEZOIDAL CHANNEL, 3:1 SIDES	9.742	0.15%	1.35%	2341	0.41	23.74	23.32	0.15% 10-FT CHANNEL, 3:1 Sides, 1.5-FT DEEP	1.50	0.54
	CDA 01 & CDA 03	CONTACT	TWO 60'X24" HDPE CULVERTS	9.742	2.33%	1.35%	2341	0.41	23.74	23.32	70-FT LONG X 30" DIA HDPE CULVERT	8.80	2.51
I-04	CDA 04	CONTACT	TWO 32'X16" HDPE CULVERTS	8.559	4.37%	1.84%	772	0.50	10.00	38.26	TWO 32-FT LONG X 16" DIA HDPE CULVERTS *	6.22	6.92
I-05	DETENTION - AREAS CDA 1, 3, 4 & 5	CONTACT	DETENTION BASIN T0 SERIES OF HDPE PIPES	22.361	4.35%	1.26%	2994	0.57	20.00	82.21	SERIES - TWO 30" HDPE CULVERTS - PEAK Q = 34.74 CFS	8.00	3.29
I-06	DETENTION I-05 DISCHARGE	CONTACT	32'X32" HDPE CULVERT	22.705	0.40%	1.26%	3083	0.57	N/A	34.74	USE I-05 DETENTION PEAK DISCHARGE	8.00	3.27
PERIMETER NON-CONTACT DRAINAGE AREAS													
P-01	NDA 01	NON-CONTACT	V-DITCH, 3:1 SIDES	1.535	0.30%	1.97%	978	0.50	10.00	6.9	0.3% V-DITCH, 3:1 SIDES, 1.78-FEET DEPTH	1.80	1.13
P-02	NDA 01 & NDA 02	NON-CONTACT	5' CHANNEL, 3:1 SIDES	4.016	0.30%	3.29%	1787	0.50	10.00	17.97	0.3% - V-DITCH, 3:1 SIDES, 4-FEET DEPTH	4.00	1.63
P-03	NDA 03	NON-CONTACT	20' CHANNEL, 3:1 SIDES	2.585	0.30%	10.05%	772	0.50	10.00	11.56	0.3% - 20' CHANNEL, 3:1 SIDES, 7.5-FEET DEPTH	7.70	0.39
P-04	NDA 03 & NDA 04	NON-CONTACT	15' CHANNEL, 3:1 SIDES	6.585	0.30%	3.94%	1810	0.50	10.00	29.46	0.3% - 15' CHANNEL, 3:1 SIDES, 6.5-FEET DEPTH	6.50	0.80
P-02 & P04	DETENTION - AREAS NDA 01, 02,03 & 04	NON-CONTACT	426'X26" HDPE, U.S. 343.45, D.S. 335.48	10.601	1.87%	3.69%	1810	0.5	10.00	47.38	426'X26' HDPE @ 1.887% (COMBINED MAX Q = 38.49 CFS)	4.05	N/A
		NON-CONTACT	587'X28" HDPE, U.S. 339.06, D.S. 333.87		0.88%						587X28' HDPE @ 0.88%	8.44	2.42
P-05	NDA 05	NON-CONTACT	.3% V-DITCH, 3:1 L & 4:1R SIDES	2.093	3.46%	0.30%	597	0.4	10.00	7.49	.3% V-DITCH, 3:1 L & 4:1R SIDES	4.60	1.10
			50'X16" TEMP HDPE, U.S.365.12, D.S. 363.39								50'X16" TEMP HDPE @ 3.46%	6.72	1.92
P-06	NDA 05 & NDA 06	NON-CONTACT	.3% V-DITCH, 3:1 L & 3:1R SIDES	2.497	1.19%	1.19%	736	0.40	10.00	8.94	.3% V-DITCH, 3:1 L & 3:1R SIDES	1.92	1.73
			TWO 84'X30" HDPE, U.S.356.55, D.S. 355.26	2.497	1.54%	1.19%	736	0.40	10.00	8.94	TWO 84'X30" HDPE, U.S.356.55, D.S. 355.26	8.20	0.99

* ANALYSIS RUN FOR 15-INCH CULVERT OPTION AND AREA IS CONTAINED AND MERELY RUNS OVER THE TOP OF ROCK DETENTION BERM

Table 2 - Q25 Run-on and Run-off Analysis Justifications

ANALYSIS JUSTIFICATION CALCULATIONS
INTERNAL CONTACT DRAINAGE AREAS

Note: "Contact Drainage Areas" refers to storm water runoff from these areas having come in contact with CCR materials.

ANALYSIS JUSTIFICATION - SECTION I-01

PROJECT: Welsh Run-On & Run-Off Protection Plan\2021 DA Map with H&H Calcs.pro

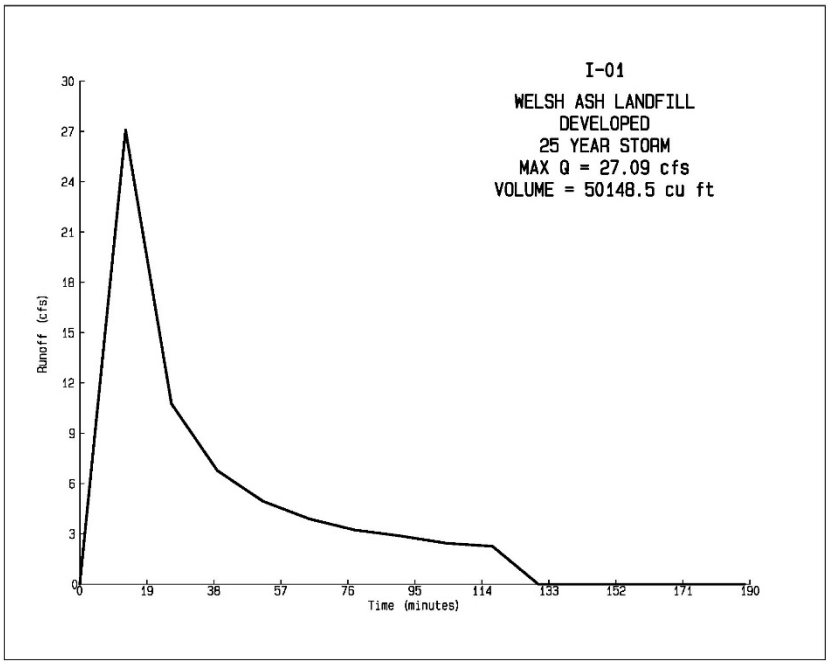
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HYDROLOGIC REPORT

DEVELOPED UNIVERSAL RATIONAL HYDROGRAPH
Q(PEAK) = C*I*A

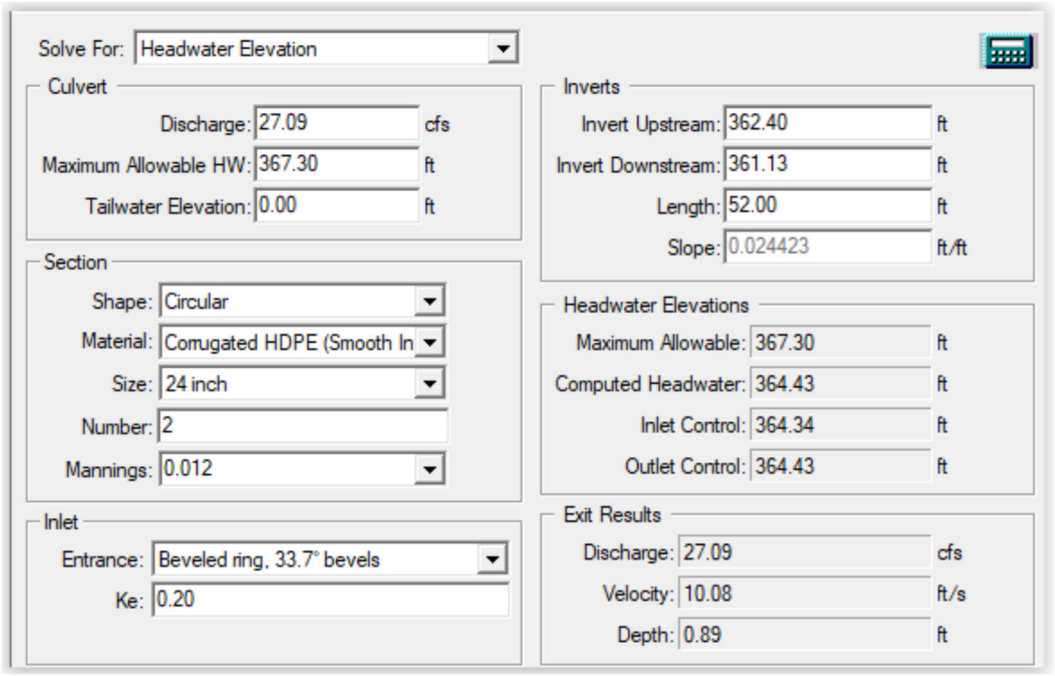
25 YEAR STORM FREQUENCY
BASIN IDENTIFIER SECTION I-01 (CDA 01)
DISCHARGES INTO WELSH ASH LANDFILL
BASIN AREA = 8.48 ACRES
RUNOFF COEFF. = 0.40
RAINFALL INT. = 7.99 IN/HR
TIME OF CONC. = 13.00 MINUTES

TIME (MIN)	RUNOFF (CFS)
0.0	0.0
6.5	13.5
13.0	27.1
19.5	18.9
26.0	10.8
32.5	8.8
39.0	6.8
45.5	5.9
52.0	4.9
58.5	4.4
65.0	3.9
71.5	3.6
78.0	3.2
84.5	3.1
91.0	2.9
97.5	2.7
104.0	2.4
110.5	2.4
117.0	2.3
123.5	1.1
130.0	0.0
136.5	0.0
143.0	0.0
149.5	0.0
156.0	0.0
162.5	0.0
169.0	0.0
175.5	0.0
182.0	0.0
188.5	0.0



PEAK FLOW = 27.09 CFS
TIME TO PEAK = 13.00 MIN
TOTAL VOLUME = 50148.54 CU FT

I-01 CULVERTS: TWO 52’ X 24" DIA HDPE CULVERTS, 4.9’ MAX HW DEPTH
4.19’ CALCULATED HW DEPTH - MEETS Q-25 REQUIREMENT*



* Bentley CulvertMaster – Culvert Analysis

ANALYSIS JUSTIFICATION - SECTION I-02

PROJECT: Welsh Run-On & Run-Off Protection Plan\2021 DA Map with H&H Calcs.pro

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HYDROLOGIC REPORT

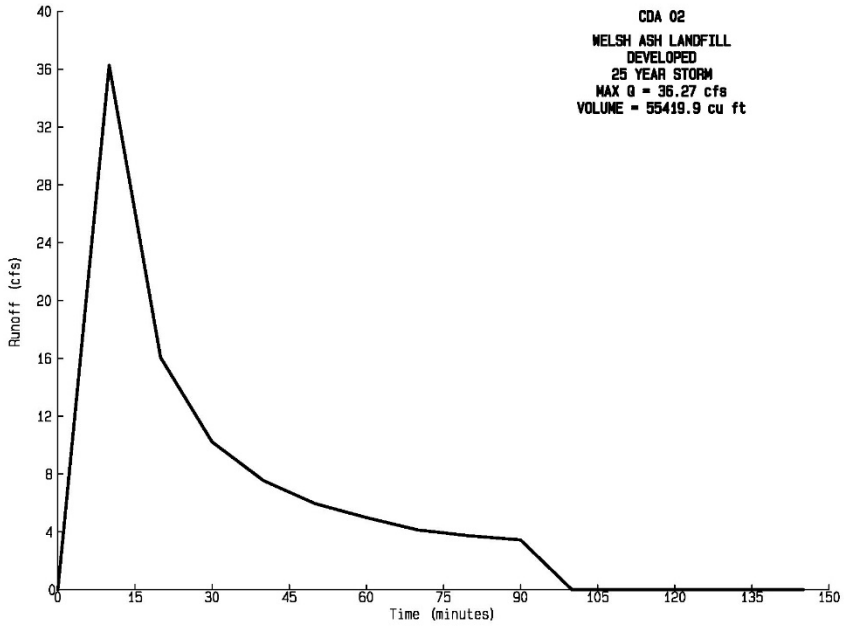
DEVELOPED UNIVERSAL RATIONAL HYDROGRAPH
Q(PEAK) = C*I*A
25 YEAR STORM FREQUENCY

BASIN IDENTIFIER CDA 02
DISCHARGES INTO WELSH ASH LANDFILL

BASIN AREA = 8.11 ACRES
RUNOFF COEFF. = 0.50
RAINFALL INT. = 8.94 IN/HR
TIME OF CONC. = 10.00 MINUTES

TIME (MIN)	RUNOFF (CFS)
0.0	0.0
5.0	18.1
10.0	36.3
15.0	26.2
20.0	16.1
25.0	13.1
30.0	10.2
35.0	8.9
40.0	7.5
45.0	6.8
50.0	6.0
55.0	5.5
60.0	5.0
65.0	4.6
70.0	4.1
75.0	3.9
80.0	3.7
85.0	3.6
90.0	3.4
95.0	1.7
100.0	0.0
105.0	0.0
110.0	0.0
115.0	0.0
120.0	0.0
125.0	0.0
130.0	0.0
135.0	0.0
140.0	0.0
145.0	0.0

PEAK FLOW = 36.27 CFS
TIME TO PEAK = 10.00 MIN
TOTAL VOLUME = 55419.90 CU FT



NOTE: Section I-02 is essentially a leachate collection cell which drains to the north side of the landfill where water is collected in a sump and pumped to the Primary Ash Pond return system. As a result, Section I-02 does not discharge to the stormwater run-on & run-off system and is treated as a detention pond with no Q25 impact to landfill drainage systems.

ANALYSIS JUSTIFICATION - SECTION I-02 (CONT)

PROJECT: Welsh Run-On & Run-Off Protection Plan\2021 DA Map with H&H Calcs.pro

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HYDROLOGIC REPORT - STAGE, STORAGE, AND DISCHARGE

Pumped Detention Area - CDA 02

1=USER DEFINED

1)	356.620	Q	0.00
	Through		
7)	359.500	Q	0.07

ELEV	STORAGE (CU.FT.)	OUTFLOW (CFS)	2S/T+O (CFS)
356.62	0.0	0.0	0.0
356.67	0.0	0.0	0.0
356.72	0.0	0.0	0.0
356.76	0.0	0.0	0.0
356.81	0.0	0.0	0.0
356.86	0.0	0.0	0.0
356.91	0.0	0.1	0.1
356.95	0.0	0.1	0.1
357.00	0.0	0.1	0.1
357.06	68.5	0.1	0.5
357.13	137.0	0.1	1.0
357.19	205.5	0.1	1.4
357.25	274.1	0.1	1.9
357.31	342.6	0.1	2.4
357.38	411.1	0.1	2.8
357.44	479.6	0.1	3.3
357.50	548.1	0.1	3.7
357.56	915.3	0.1	6.2
357.63	1282.5	0.1	8.6
357.69	1649.7	0.1	11.1
357.75	2016.9	0.1	13.5
357.81	2384.1	0.1	16.0
357.88	2751.3	0.1	18.4
357.94	3118.5	0.1	20.9
358.00	3485.7	0.1	23.3
358.06	4524.5	0.1	30.2
358.13	5563.4	0.1	37.2
358.19	6602.2	0.1	44.1
358.25	7641.0	0.1	51.0
358.31	8679.8	0.1	57.9
358.38	9718.7	0.1	64.9
358.44	10757.5	0.1	71.8
358.50	11796.3	0.1	78.7
358.56	13968.8	0.1	93.2
358.63	16141.3	0.1	107.7
358.69	18313.8	0.1	122.2
358.75	20486.3	0.1	136.6
358.81	22658.7	0.1	151.1
358.88	24831.2	0.1	165.6
358.94	27003.7	0.1	180.1
359.00	29176.2	0.1	194.6

ANALYSIS JUSTIFICATION - SECTION I-02 (CONT)

PROJECT: Welsh Run-On & Run-Off Protection Plan\2021 DA Map with H&H Calcs.pro

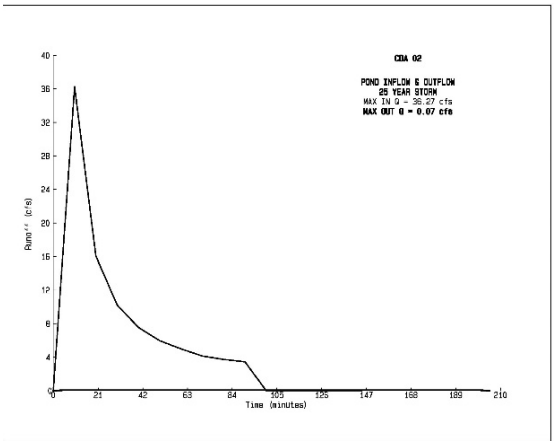
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SECTION I-02 HYDROGRAPH ROUTING (Discharges via Forcemain to Primary Ash Pond)
PUMPED DETENTION AREA: CDA 02

T	I1	I2	2S1/T	O1	2S2/T+O2	O2	2S2/T
25 YEAR STORM FREQUENCY							
5.00	0.0	18.1	0.0	0.0	18.1	0.1	18.1
10.00	18.1	36.3	18.1	0.1	72.4	0.1	72.3
15.00	36.3	26.2	72.3	0.1	134.7	0.1	134.6
20.00	26.2	16.1	134.6	0.1	176.8	0.1	176.7
25.00	16.1	13.1	176.7	0.1	205.9	0.1	205.8
30.00	13.1	10.2	205.8	0.1	229.1	0.1	229.0
35.00	10.2	8.9	229.0	0.1	248.1	0.1	248.0
40.00	8.9	7.5	248.0	0.1	264.4	0.1	264.3
45.00	7.5	6.8	264.3	0.1	278.5	0.1	278.5
50.00	6.8	6.0	278.5	0.1	291.1	0.1	291.0
55.00	6.0	5.5	291.0	0.1	302.4	0.1	302.3
60.00	5.5	5.0	302.3	0.1	312.7	0.1	312.7
65.00	5.0	4.6	312.7	0.1	322.2	0.1	322.1
70.00	4.6	4.1	322.1	0.1	330.7	0.1	330.7
75.00	4.1	3.9	330.7	0.1	338.7	0.1	338.6
80.00	3.9	3.7	338.6	0.1	346.2	0.1	346.1
85.00	3.7	3.6	346.1	0.1	353.4	0.1	353.3
90.00	3.6	3.4	353.3	0.1	360.3	0.1	360.2
95.00	3.4	1.7	360.2	0.1	365.3	0.1	365.3
100.00	1.7	0.0	365.3	0.1	366.9	0.1	366.9
105.00	0.0	0.0	366.9	0.1	366.8	0.1	366.7
110.00	0.0	0.0	366.7	0.1	366.7	0.1	366.6
115.00	0.0	0.0	366.6	0.1	366.5	0.1	366.5
120.00	0.0	0.0	366.5	0.1	366.4	0.1	366.3
125.00	0.0	0.0	366.3	0.1	366.2	0.1	366.2
130.00	0.0	0.0	366.2	0.1	366.1	0.1	366.0
135.00	0.0	0.0	366.0	0.1	366.0	0.1	365.9
140.00	0.0	0.0	365.9	0.1	365.8	0.1	365.8
145.00	0.0	0.0	365.8	0.1	365.7	0.1	365.6
150.00	0.0	0.0	365.6	0.1	365.6	0.1	365.5
155.00	0.0	0.0	365.5	0.1	365.4	0.1	365.4
160.00	0.0	0.0	365.4	0.1	365.3	0.1	365.2
165.00	0.0	0.0	365.2	0.1	365.2	0.1	365.1
170.00	0.0	0.0	365.1	0.1	365.0	0.1	365.0
175.00	0.0	0.0	365.0	0.1	364.9	0.1	364.8
180.00	0.0	0.0	364.8	0.1	364.8	0.1	364.7
185.00	0.0	0.0	364.7	0.1	364.6	0.1	364.6
190.00	0.0	0.0	364.6	0.1	364.5	0.1	364.4
195.00	0.0	0.0	364.4	0.1	364.4	0.1	364.3
200.00	0.0	0.0	364.3	0.1	364.2	0.1	364.2

TIME TO PEAK = 0.08 HOURS
MAXIMUM OUTFLOW = 0.07 CFS
MAXIMUM STORAGE = 55028 CU FT
MAXIMUM ELEVATION = 65.41 FT
INFLOW VOLUME = 55420 CU FT
OUTFLOW VOLUME = 804 CU FT

MEETS Q25 REQUIREMENT (empties over time)



ANALYSIS JUSTIFICATION - SECTION I-03

PROJECT: Welsh Run-On & Run-Off Protection Plan\2021 DA Map with H&H Calcs.pro

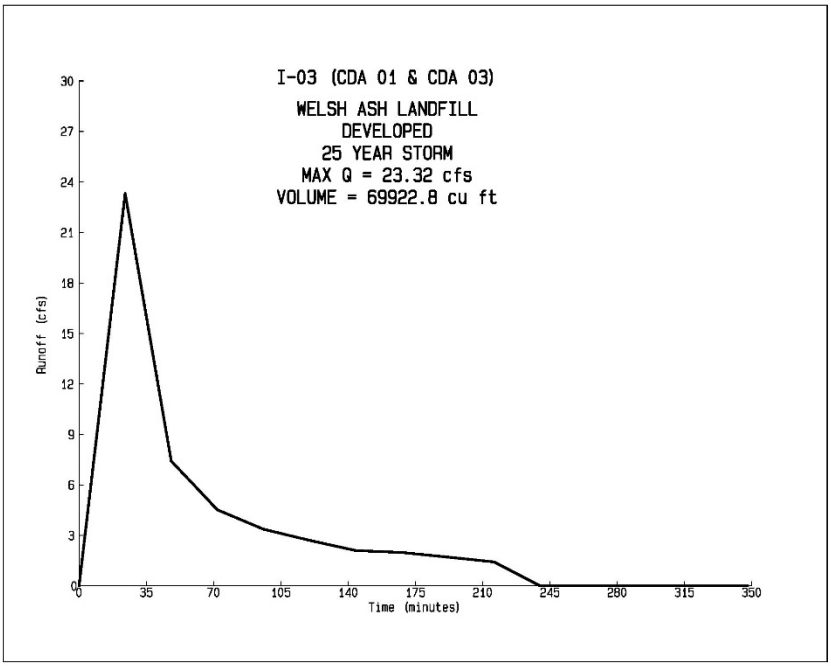
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DEVELOPED UNIVERSAL RATIONAL HYDROGRAPH
Q(PEAK) = C*I*A
25 YEAR STORM FREQUENCY

BASIN IDENTIFIER I-03 (CDA 01 & CDA 03)

DISCHARGES INTO WELSH ASH LANDFILL
BASIN AREA = 9.74 ACRES
RUNOFF COEFF. = 0.41
RAINFALL INT. = 5.84 IN/HR
TIME OF CONC. = 24.00 MINUTES

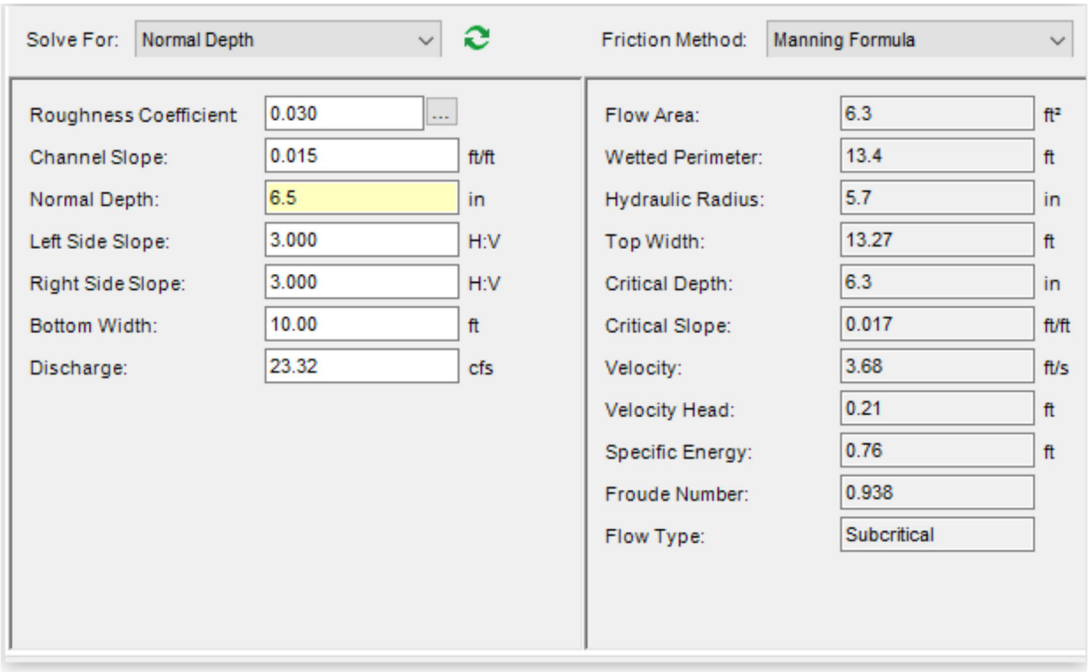
TIME (MIN)	RUNOFF (CFS)
0.0	0.0
12.0	11.7
24.0	23.3
36.0	15.4
48.0	7.4
60.0	6.0
72.0	4.5
84.0	3.9
96.0	3.4
108.0	3.0
120.0	2.7
132.0	2.4
144.0	2.1
156.0	2.0
168.0	2.0
180.0	1.8
192.0	1.7
204.0	1.6
216.0	1.4
228.0	0.7
240.0	0.0
252.0	0.0
264.0	0.0
276.0	0.0
288.0	0.0
300.0	0.0
312.0	0.0
324.0	0.0
336.0	0.0
348.0	0.0



PEAK FLOW = 23.32 CFS
TIME TO PEAK = 24.00 MIN
TOTAL VOLUME = 69922.80 CU FT

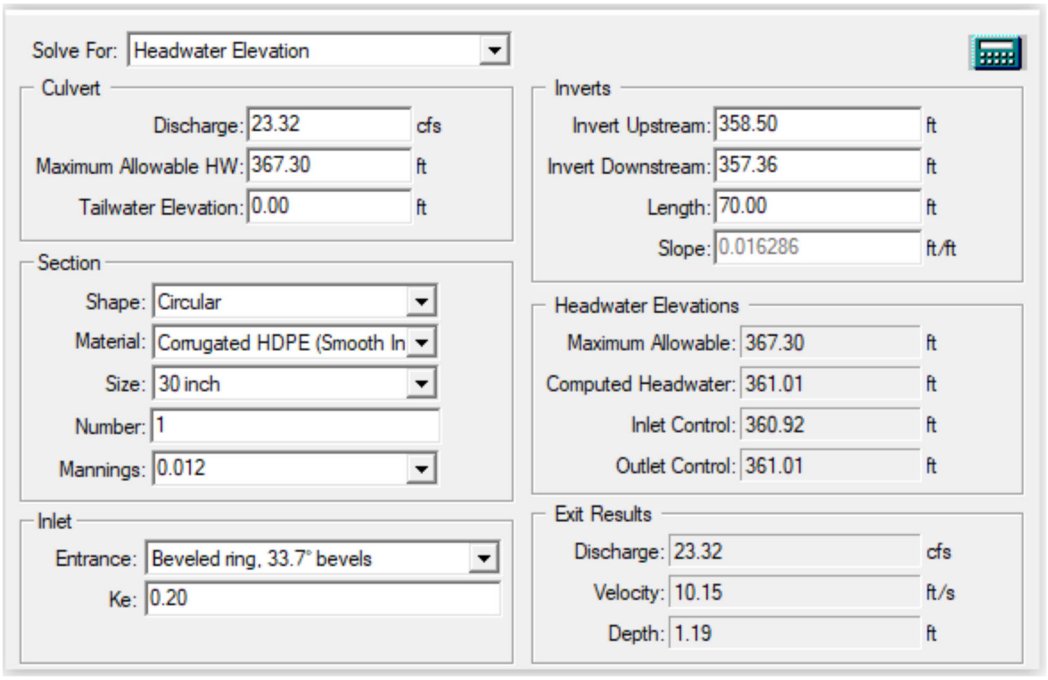
ANALYSIS JUSTIFICATION - SECTION I-03 (CONT)

I-03 CHANNEL: 0.15% V-DITCH, 10-FT TRAPEZOIDAL, 3:1 SIDES, 1.5-FT MIN. DEPTH
MANNING N VALUE: 0.03 (GRASSED – CONSERVATIVE)
0.55'CALCULATED DEPTH, MEETS Q-25 REQUIREMENT*



* Bentley FlowMaster V8i – Trapezoidal Channel Analysis

I-03 CULVERT: 70' X 30" DIA HDPE CULVERT, 8.8' MAX HW DEPTH
2.51' CALCULATED HW DEPTH - MEETS Q-25 REQUIREMENT*



* Bentley CulvertMaster – Culvert Analysis

ANALYSIS JUSTIFICATION - SECTION I-05

PROJECT: Welsh Run-On & Run-Off Protection Plan\2021 DA Map with H&H Calcs.pro

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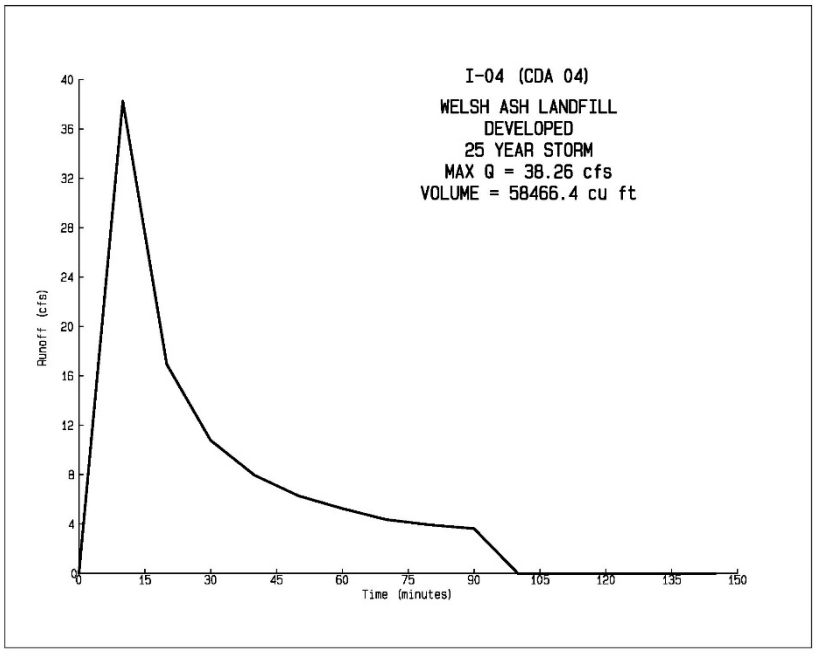
HYDROLOGIC REPORT

DEVELOPED UNIVERSAL RATIONAL HYDROGRAPH
Q(PEAK) = C*I*A
25 YEAR STORM FREQUENCY

BASIN IDENTIFIER I-04 (CDA 04) - BENEFICIAL REUSE AREA

DISCHARGES INTO WELSH ASH LANDFILL
BASIN AREA = 8.56 ACRES
RUNOFF COEFF. = 0.50
RAINFALL INT. = 8.94 IN/HR
TIME OF CONC. = 10.00 MINUTES

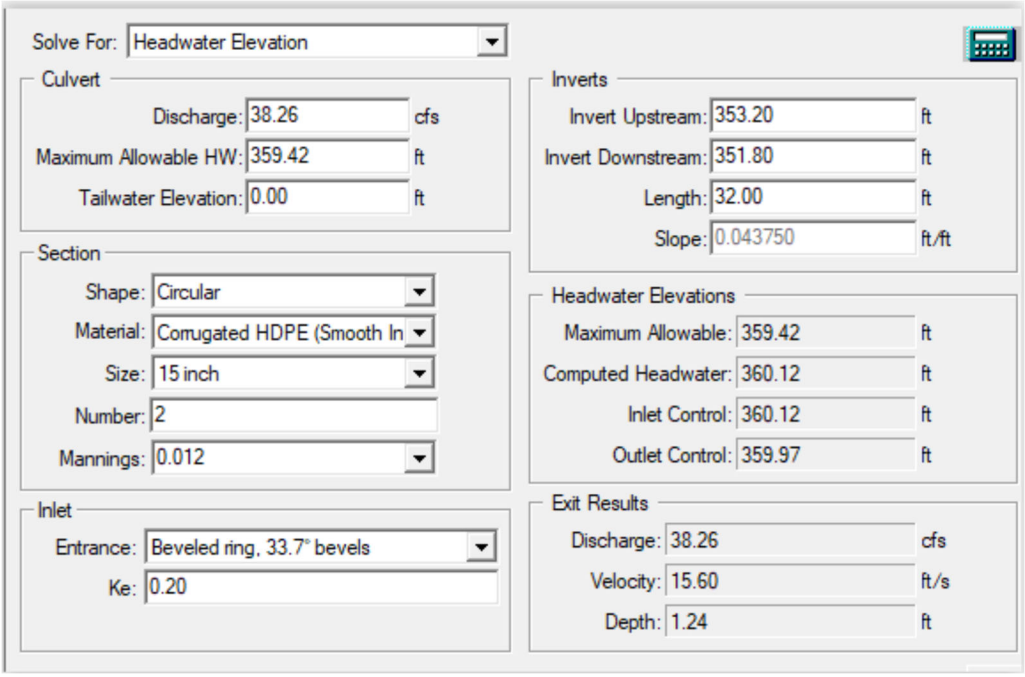
TIME (MIN)	RUNOFF (CFS)
0.0	0.0
5.0	19.1
10.0	38.3
15.0	27.6
20.0	16.9
25.0	13.9
30.0	10.8
35.0	9.4
40.0	8.0
45.0	7.1
50.0	6.3
55.0	5.8
60.0	5.3
65.0	4.8
70.0	4.4
75.0	4.2
80.0	3.9
85.0	3.8
90.0	3.6
95.0	1.8
100.0	0.0
105.0	0.0
110.0	0.0
115.0	0.0
120.0	0.0
125.0	0.0
130.0	0.0
135.0	0.0
140.0	0.0
145.0	0.0



PEAK FLOW = 38.26 CFS
TIME TO PEAK = 10.00 MIN
TOTAL VOLUME = 58466.40 CU FT

ANALYSIS JUSTIFICATION - SECTION I-04 (CONT)

I-03 TEMPORARY CULVERTS: TWO 32'X16" HDPE CULVERTS, 6.22' MAX HW DEPTH
6.92' HW DEPTH (FOR 15" DIA CULVERTS) EXCEEDS (0.7') TOP OF ROCK BERM OF THE DETENTION BASIN; HOWEVER, FLOWS ARE CONTAINED MEETS Q-25 REQUIREMENT*



* Bentley CulvertMaster – Culvert Analysis - (Calculated W/ 15" Dia Culverts)

ANALYSIS JUSTIFICATION - SECTION I-05
SERIES OF TWO 30-IN DIA HDPE CULVERTS – DETENTION OUTLET

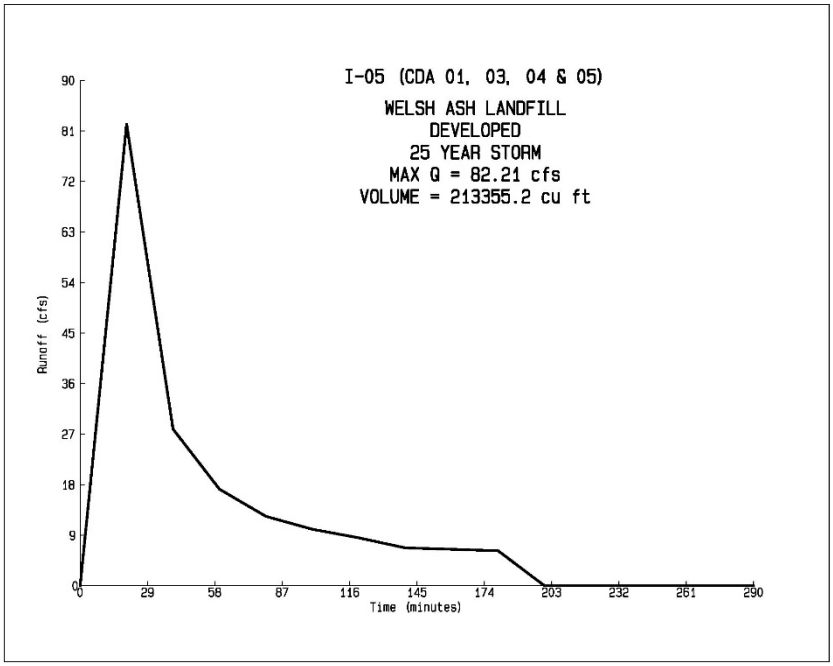
PROJECT: Welsh Run-On & Run-Off Protection Plan\2021 DA Map with H&H Calcs.pro

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HYDROLOGIC REPORT

DEVELOPED UNIVERSAL RATIONAL HYDROGRAPH
Q(PEAK) = C*I*A
25 YEAR STORM FREQUENCY
BASIN IDENTIFIER I-05 (DETENTION FOR CDA 01, 03, 04 & 05)
DISCHARGES INTO WELSH ASH LANDFILL
BASIN AREA = 22.36 ACRES
RUNOFF COEFF. = 0.57
RAINFALL INT. = 6.45 IN/HR
TIME OF CONC. = 20.00 MINUTES

TIME (MIN)	RUNOFF (CFS)
0.0	0.0
10.0	41.1
20.0	82.2
30.0	55.1
40.0	27.9
50.0	22.6
60.0	17.2
70.0	14.8
80.0	12.4
90.0	11.2
100.0	10.1
110.0	9.3
120.0	8.5
130.0	7.6
140.0	6.8
150.0	6.6
160.0	6.5
170.0	6.4
180.0	6.2
190.0	3.1
200.0	0.0
210.0	0.0
220.0	0.0
230.0	0.0
240.0	0.0
250.0	0.0
260.0	0.0
270.0	0.0
280.0	0.0
290.0	0.0



PEAK FLOW = 82.21 CFS
TIME TO PEAK = 20.00 MIN
TOTAL VOLUME = 213355.20 CU FT

ANALYSIS JUSTIFICATION - SECTION I-05 (CONT)
SERIES OF 30-IN DIA HDPE – DETENTION OUTLET

PROJECT: Welsh Run-On & Run-Off Protection Plan\2021 DA Map with H&H Calcs.pro

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HYDROLOGIC REPORT - STAGE, STORAGE, AND DISCHARGE

POND: I-05 (DETENTION FOR CDA 01, 03, 04 & 05)

1=USER DEFINED *

1)	350.500	Q	0.00	10)	353.450	Q	30.00
2)	351.150	Q	2.00	11)	353.990	Q	38.00
3)	351.440	Q	4.00	12)	354.470	Q	44.00
4)	351.660	Q	6.00	13)	355.040	Q	50.00
5)	351.860	Q	8.00	14)	355.910	Q	58.00
6)	352.040	Q	10.00	15)	356.650	Q	64.00
7)	352.500	Q	16.00	16)	357.180	Q	68.00
8)	352.920	Q	22.00	17)	358.040	Q	74.00
9)	353.060	Q	24.00	18)	358.970	Q	80.00

ELEV	STORAGE (CU.FT.)	OUTFLOW (CFS)	2S/T+O (CFS)
350.50	0.0	0.0	0.0
350.75	12.8	0.8	0.8
351.00	25.6	1.5	1.6
351.25	615.8	2.7	4.7
351.50	1205.9	4.5	8.6
351.75	3435.9	6.9	18.4
352.00	5665.9	9.6	28.4
352.25	10391.0	12.7	47.4
352.50	15116.1	16.0	66.4
352.75	22732.0	19.6	95.3
353.00	30347.8	23.1	124.3
353.25	40426.1	26.9	161.7
353.50	50504.3	30.7	199.1
353.75	62132.0	34.4	241.6
354.00	73759.7	38.1	284.0
354.25	86213.7	41.2	328.6
354.50	98667.6	44.3	373.2
354.75	111596.0	46.9	418.9
355.00	124524.3	49.6	464.7
355.25	137942.5	51.9	511.7
355.50	151360.8	54.2	558.8
355.75	165355.4	56.5	607.7
356.00	179350.0	58.7	656.6
356.35	200039.7	61.6	728.4
356.70	220729.4	64.4	800.1
356.75	223797.2	64.8	810.7
356.80	226865.0	65.1	821.3
356.90	233083.1	65.9	842.8
357.00	239301.2	66.6	864.3
357.05	242453.6	67.0	875.2
357.10	245605.9	67.4	886.1
357.15	248789.3	67.8	897.1
357.20	251972.8	68.1	908.0
357.35	261714.3	69.2	941.6
357.50	271455.7	70.2	975.1
357.75	288481.5	72.0	1033.6
358.00	305507.4	73.7	1092.1
357.25	255220.0	68.5	919.2
356.50	208906.7	62.8	759.1
356.75	223797.2	64.8	810.7
357.00	239301.2	66.6	864.3
357.25	255220.0	68.5	919.2
357.50	271455.7	70.2	975.1
357.75	288481.5	72.0	1033.6
358.00	305507.4	73.7	1092.1
358.25	419039.7	75.4	1472.2
358.50	436919.1	77.0	1533.4

Discharge (cfs)	HW Elev. (ft)
0.00	350.50
2.00	351.15
4.00	351.44
6.00	351.66
8.00	351.86
10.00	352.04
12.00	352.20
14.00	352.35
16.00	352.50
18.00	352.65
20.00	352.78
22.00	352.92
24.00	353.06
26.00	353.19
28.00	353.32
30.00	353.45
32.00	353.59
34.00	353.72
36.00	353.85
38.00	353.99
40.00	354.13
42.00	354.30
44.00	354.47
46.00	354.65
48.00	354.84
50.00	355.04
52.00	355.24
54.00	355.46
56.00	355.68
58.00	355.91
60.00	356.15
62.00	356.39
64.00	356.65
66.00	356.91
68.00	357.18
70.00	357.46
72.00	357.74
74.00	358.04
76.00	358.34
78.00	358.65
80.00	358.97
82.00	359.30
84.00	359.63
85.00	359.80

* Discharge Rating Curve by Bentley CulvertMaster – Culvert Analysis

ANALYSIS JUSTIFICATION - SECTION I-05 (CONT)
SERIES OF 30-IN DIA HDPE – DETENTION OUTLET
MEETS Q-25 REQUIREMENT

PROJECT: Welsh Run-On & Run-Off Protection Plan\2021 DA Map with H&H Calcs.pro

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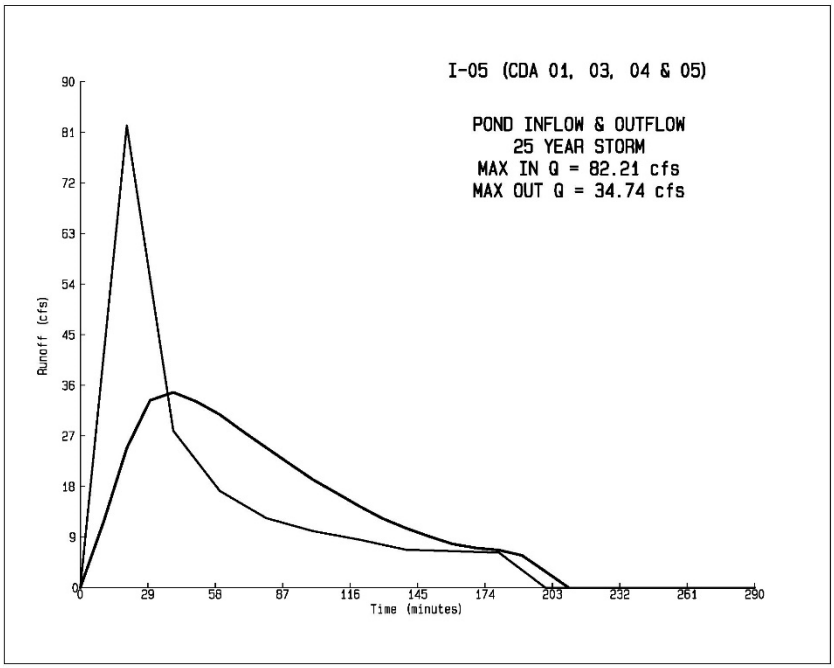
HYDROLOGIC REPORT

POND OUTFLOW HYDROGRAPH

POND IDENTIFIER I-05 (DETENTION FOR CDA 01, 03, 04 & 05)

25 YEAR STORM FREQUENCY

TIME (MIN)	RUNOFF (CFS)
0.0	0.0
10.0	11.7
20.0	24.8
30.0	33.3
40.0	34.7
50.0	33.1
60.0	30.8
70.0	27.8
80.0	24.9
90.0	22.0
100.0	19.2
110.0	16.9
120.0	14.5
130.0	12.3
140.0	10.6
150.0	9.1
160.0	7.8
170.0	7.1
180.0	6.7
190.0	5.7
200.0	2.9
210.0	0.0



PEAK FLOW = 34.74 CFS

TIME TO PEAK = 40.00 MIN

TOTAL VOLUME = 213542.40 CU FT

ANALYSIS JUSTIFICATION - SECTION I-05 (CONT)

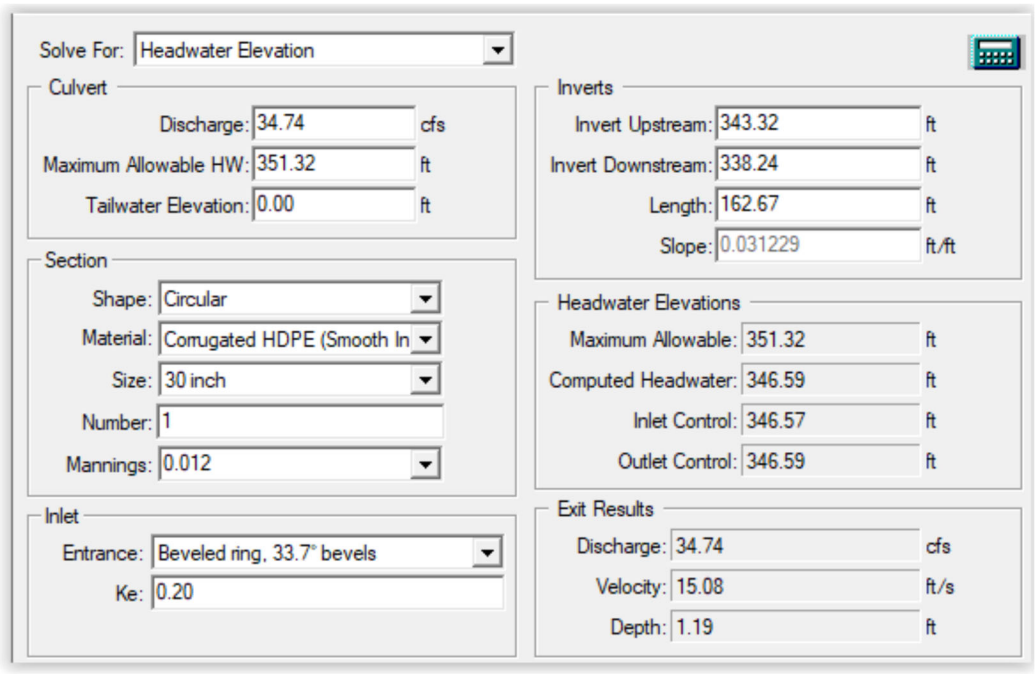
I-05 CULVERT: 32’ X 30" DIA HDPE CULVERT, 8.8’ MAX HW DEPTH

3.27’ CALCULATED HW DEPTH - MEETS Q-25 REQUIREMENT*

USE I-05 DETENTION DISCHARGE HYDROGRAPH

25 YEAR STORM FREQUENCY

TIME (MIN)	RUNOFF (CFS)
0.0	0.0
10.0	11.7
20.0	24.8
30.0	33.3
40.0	34.7
50.0	33.1
60.0	30.8
70.0	27.8
80.0	24.9
90.0	22.0
100.0	19.2
110.0	16.9
120.0	14.5
130.0	12.3
140.0	10.6
150.0	9.1
160.0	7.8
170.0	7.1
180.0	6.7
190.0	5.7
200.0	2.9
210.0	0.0



PEAK FLOW = 34.74 CFS
TIME TO PEAK = 40.00 MIN
TOTAL VOLUME = 213542.40 CU FT

ANALYSIS JUSTIFICATION CALCULATIONS
PERIMETER NON-CONTACT DRAINAGE AREAS

Note: "Perimeter Non-Contact Drainage Areas" refers to storm water runoff from these areas having not come in contact with CCR materials.

ANALYSIS JUSTIFICATION - SECTION P-01 DITCH

0.3% V-DITCH, 3:1 SIDES, 1.8-FT MIN. HW DEPTH

MANNING N VALUE: 0.03 (GRASSED – CONSERVATIVE)

HYDROLOGIC REPORT

DEVELOPED UNIVERSAL RATIONAL HYDROGRAPH
Q(PEAK) = C*I*A
25 YEAR STORM FREQUENCY
BASIN IDENTIFIER P-01
DISCHARGES INTO WELSH ASH LANDFILL
BASIN AREA = 1.53 ACRES
RUNOFF COEFF. = 0.50
RAINFALL INT. = 8.94 IN/HR
TIME OF CONC. = 10.00 MINUTES

TIME (MIN)	RUNOFF (CFS)
0.0	0.0
5.0	3.4
10.0	6.9
15.0	5.0
20.0	3.0
25.0	2.5
30.0	1.9
35.0	1.7
40.0	1.4
45.0	1.3
50.0	1.1
55.0	1.0
60.0	0.9
65.0	0.9
70.0	0.8
75.0	0.7
80.0	0.7
85.0	0.7
90.0	0.7
95.0	0.3
100.0	0.0
105.0	0.0
110.0	0.0
115.0	0.0
120.0	0.0
125.0	0.0
130.0	0.0
135.0	0.0
140.0	0.0
145.0	0.0

PEAK FLOW = 6.86 CFS
TIME TO PEAK = 10.00 MIN
TOTAL VOLUME = 10485.00 CU FT

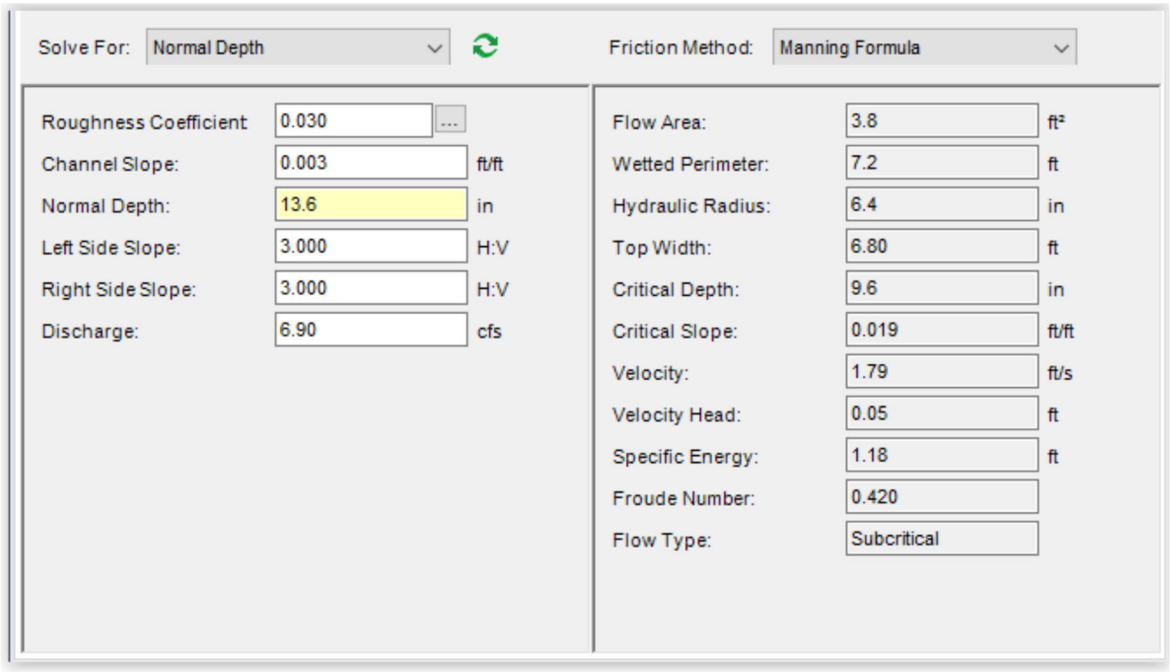
ANALYSIS JUSTIFICATION - SECTION P-01 DITCH (CONT)

0.3% V-DITCH, 3:1 SIDES, 1.5-FEET MIN. DEPTH AVAIL.

MANNING N VALUE: 0.03 (GRASSED – CONSERVATIVE)

1.13' CALCULATED HW DEPTH, MEETS Q-25 REQUIREMENT*

*



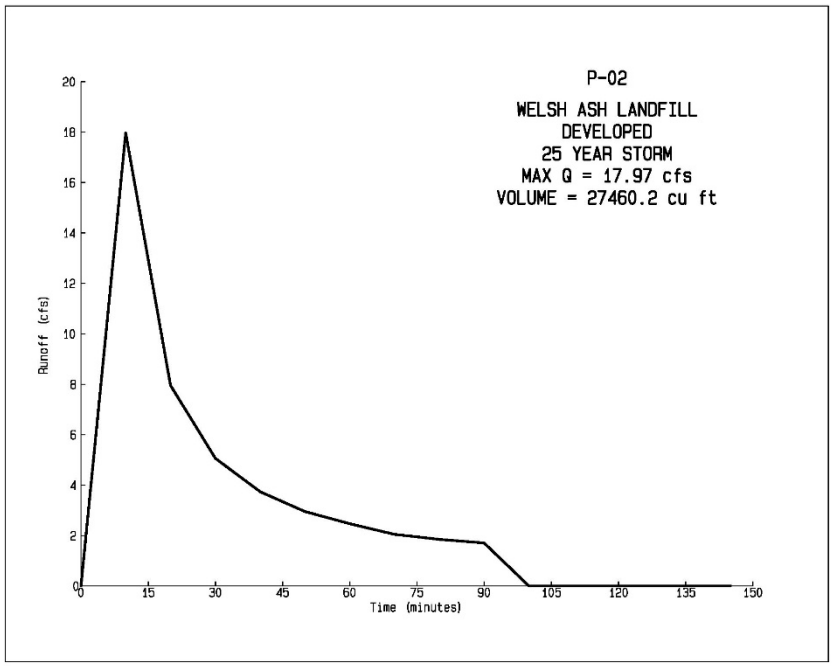
Bentley FlowMaster V8i – Triangular Channel Analysis

ANALYSIS JUSTIFICATION - SECTION P-02

0.3% V-DITCH, 3:1 SIDES, 4.0' MIN. DEPTH

MANNING N VALUE: 0.03 (GRASSED – CONSERVATIVE)

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PROJECT:  Welsh Run-On & Run-Off Protection Plan\2021 DA Map with H&H Calcs.pro
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HYDROLOGIC REPORT
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DEVELOPED UNIVERSAL RATIONAL HYDROGRAPH
Q(PEAK) = C*I*A
25 YEAR STORM FREQUENCY
BASIN IDENTIFIER   P-02 (NDA 01 & NDA 02)
DISCHARGES INTO    WELSH ASH LANDFILL
BASIN AREA     =      4.02  ACRES
RUNOFF COEFF. =       0.50
RAINFALL INT. =       8.94  IN/HR
TIME OF CONC. =      10.00  MINUTES
      TIME      RUNOFF
     (MIN)       (CFS)
    -------   ------------
       0.0         0.0
       5.0         9.0
      10.0        18.0
      15.0        13.0
      20.0         8.0
      25.0         6.5
      30.0         5.1
      35.0         4.4
      40.0         3.7
      45.0         3.3
      50.0         3.0
      55.0         2.7
      60.0         2.5
      65.0         2.3
      70.0         2.0
      75.0         2.0
      80.0         1.8
      85.0         1.8
      90.0         1.7
      95.0         0.9
     100.0         0.0
     105.0         0.0
     110.0         0.0
     115.0         0.0
     120.0         0.0
     125.0         0.0
     130.0         0.0
     135.0         0.0
     140.0         0.0
     145.0         0.0
    PEAK FLOW =        17.97  CFS
  TIME TO PEAK =       10.00  MIN
  TOTAL VOLUME =    27460.20  CU FT
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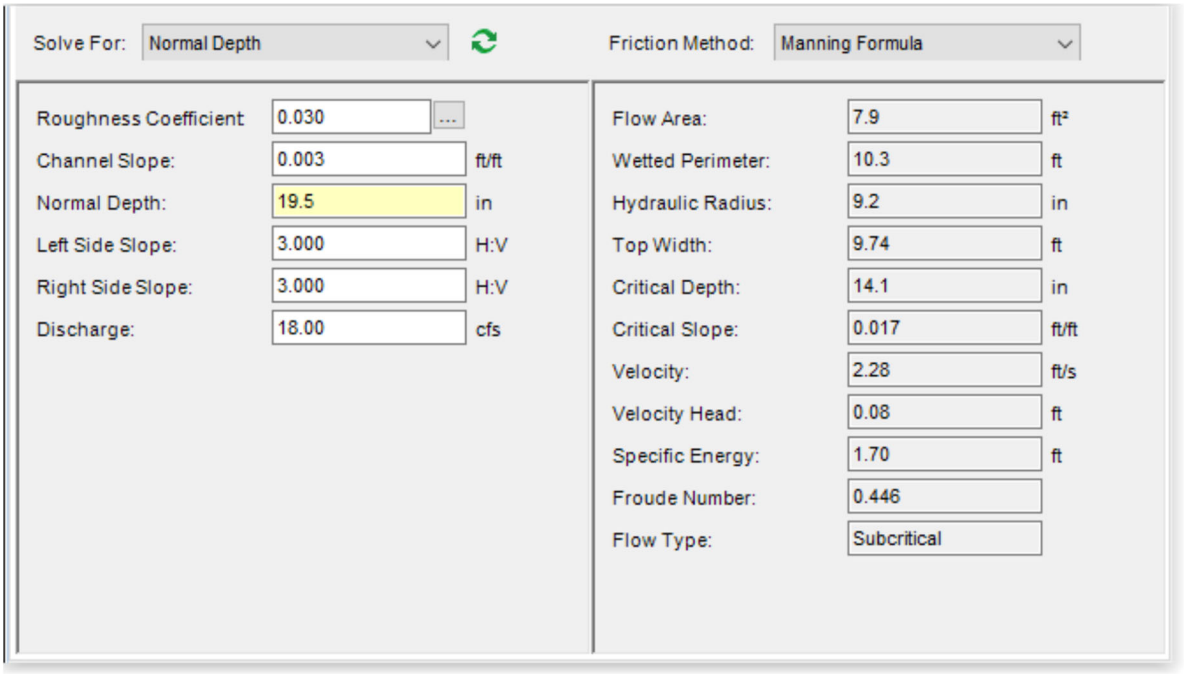


ANALYSIS JUSTIFICATION - SECTION P-02 (CONT)

1.1%,11.8L/12.6R:1, 10' CHANNEL, AVAIL. 4.0' MIN. HW DEPTH

MANNING N VALUE: 0.02 (ROUGHENED CONCRETE)

1.63' CALCULATED HW DEPTH -- MEETS Q-25 REQUIREMENT*



* Bentley FlowMaster V8i – Triangular Channel Analysis

ANALYSIS JUSTIFICATION - SECTION P-03

20-FT WIDE, 0.3% CHANNEL, 3:1 SIDES, 7.7-FT MIN. DEPTH

MANNING N VALUE: 0.03 (GRASSED – CONSERVATIVE)

PROJECT: Welsh Run-On & Run-Off Protection Plan\2021 DA Map with H&H Calcs.pro

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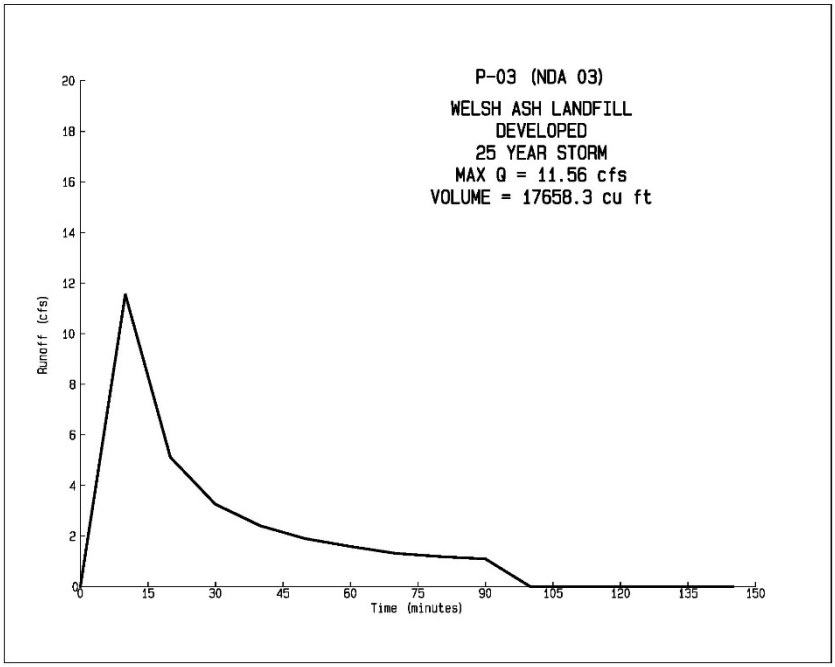
HYDROLOGIC REPORT

DEVELOPED UNIVERSAL RATIONAL HYDROGRAPH
Q(PEAK) = C*I*A
25 YEAR STORM FREQUENCY

BASIN IDENTIFIER P-03 (NDA 03)
DISCHARGES INTO WELSH ASH LANDFILL
BASIN AREA = 2.59 ACRES
RUNOFF COEFF. = 0.50
RAINFALL INT. = 8.94 IN/HR
TIME OF CONC. = 10.00 MINUTES

TIME (MIN)	RUNOFF (CFS)
0.0	0.0
5.0	5.8
10.0	11.6
15.0	8.3
20.0	5.1
25.0	4.2
30.0	3.3
35.0	2.8
40.0	2.4
45.0	2.2
50.0	1.9
55.0	1.7
60.0	1.6
65.0	1.5
70.0	1.3
75.0	1.3
80.0	1.2
85.0	1.1
90.0	1.1
95.0	0.5
100.0	0.0
105.0	0.0
110.0	0.0
115.0	0.0
120.0	0.0
125.0	0.0
130.0	0.0
135.0	0.0
140.0	0.0
145.0	0.0

PEAK FLOW = 11.56 CFS
TIME TO PEAK = 10.00 MIN
TOTAL VOLUME = 17658.30 CU FT

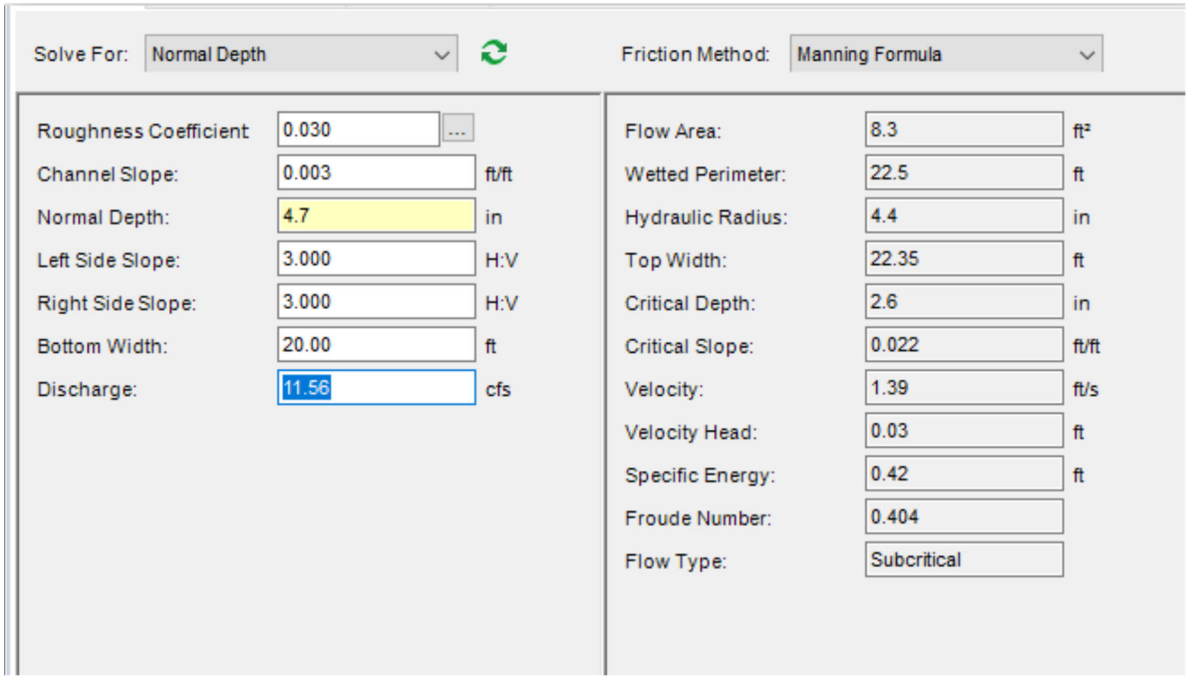


ANALYSIS JUSTIFICATION - SECTION P-03 (CONT)

20-FT WIDE, 0.3% CHANNEL, 3:1 SIDES, 7.7' MIN. HW DEPTH

MANNING N VALUE: 0.03 (GRASSED – CONSERVATIVE)

0.39' CALCULATED HW DEPTH, MEETS Q-25 REQUIREMENT*



* Bentley FlowMaster V8i – Triangular Channel Analysis

ANALYSIS JUSTIFICATION - SECTION P-04

15-FT WIDE, 0.3% CHANNEL, 3:1 SIDES, 6.5-FT MIN. DEPTH

MANNING N VALUE: 0.03 (GRASSED – CONSERVATIVE)

PROJECT: Welsh Run-On & Run-Off Protection Plan\2021 DA Map with H&H Calcs.pro

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HYDROLOGIC REPORT

DEVELOPED UNIVERSAL RATIONAL HYDROGRAPH
Q(PEAK) = C*I*A
25 YEAR STORM FREQUENCY

BASIN IDENTIFIER P-04 (NDA 03 & NDA 04)

DISCHARGES INTO WELSH ASH LANDFILL
BASIN AREA = 6.59 ACRES
RUNOFF COEFF. = 0.50
RAINFALL INT. = 8.94 IN/HR
TIME OF CONC. = 10.00 MINUTES

TIME (MIN)	RUNOFF (CFS)
0.0	0.0
5.0	14.7
10.0	29.5
15.0	21.3
20.0	13.0
25.0	10.7
30.0	8.3
35.0	7.2
40.0	6.1
45.0	5.5
50.0	4.8
55.0	4.4
60.0	4.1
65.0	3.7
70.0	3.4
75.0	3.2
80.0	3.0
85.0	2.9
90.0	2.8
95.0	1.4
100.0	0.0
105.0	0.0
110.0	0.0
115.0	0.0
120.0	0.0
125.0	0.0
130.0	0.0
135.0	0.0
140.0	0.0
145.0	0.0

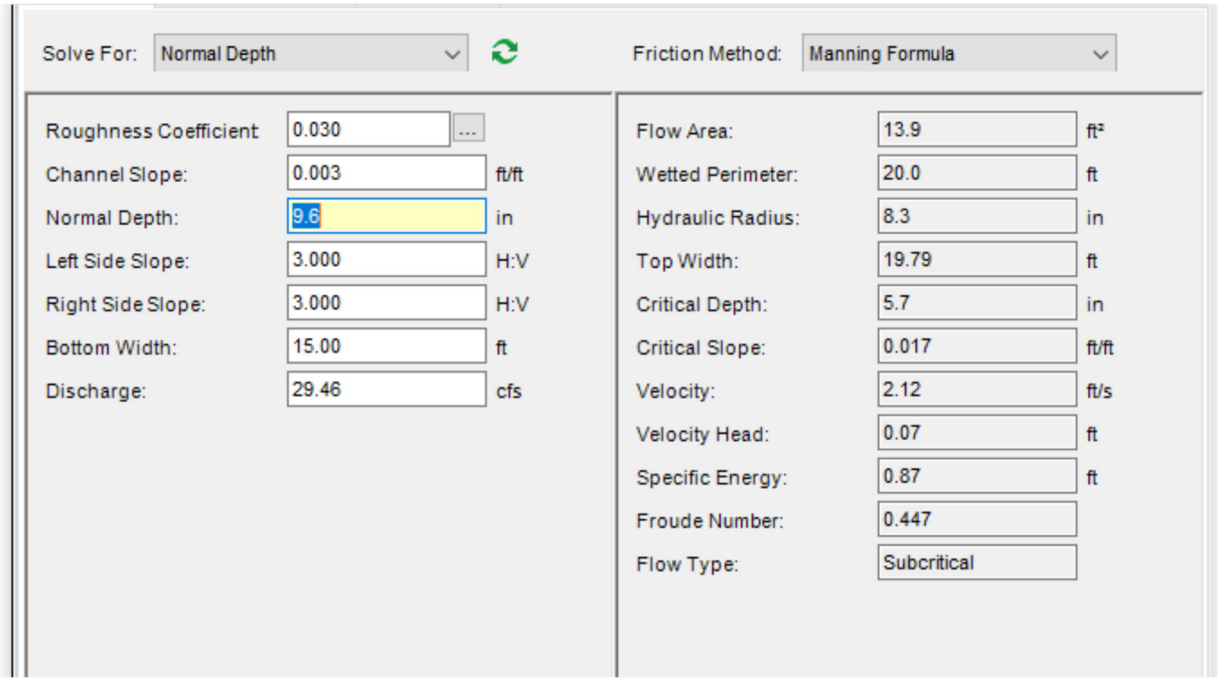
PEAK FLOW = 29.46 CFS
TIME TO PEAK = 10.00 MIN
TOTAL VOLUME = 45016.20 CU FT

ANALYSIS JUSTIFICATION - SECTION P-04 (CONT)

15-FT WIDE, 0.3% CHANNEL, 3:1 SIDES, 6.5-FT MIN. HW DEPTH

MANNING N VALUE: 0.03 (GRASSED – CONSERVATIVE)

0.80' CALCULATED HW DEPTH, MEETS Q-25 REQUIREMENT*



* Bentley FlowMaster V8i – Triangular Channel Analysis

ANALYSIS JUSTIFICATION - SECTION P-02 & P-04

P-04 & 02 CULVERTS: 28" & 26" DIA HDPE CULVERTS
SOLVE AS DETENTION

PROJECT: Welsh Run-On & Run-Off Protection Plan\2021 DA Map with H&H Calcs.pro

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HYDROLOGIC REPORT

DEVELOPED UNIVERSAL RATIONAL HYDROGRAPH
Q(PEAK) = C*I*A
25 YEAR STORM FREQUENCY

BASIN IDENTIFIER P-04 & P-02 COMBINED AT CULVERT - CHANNEL DETENTION

DISCHARGES INTO WELSH ASH LANDFILL
BASIN AREA = 10.60 ACRES
RUNOFF COEFF. = 0.50
RAINFALL INT. = 8.94 IN/HR
TIME OF CONC. = 10.00 MINUTES

TIME (MIN)	RUNOFF (CFS)
0.0	0.0
5.0	23.7
10.0	47.4
15.0	34.2
20.0	21.0
25.0	17.2
30.0	13.4
35.0	11.6
40.0	9.9
45.0	8.8
50.0	7.8
55.0	7.2
60.0	6.5
65.0	6.0
70.0	5.4
75.0	5.1
80.0	4.9
85.0	4.7
90.0	4.5
95.0	2.3
100.0	0.0
105.0	0.0
110.0	0.0
115.0	0.0
120.0	0.0
125.0	0.0
130.0	0.0
135.0	0.0
140.0	0.0
145.0	0.0

PEAK FLOW = 47.38 CFS
TIME TO PEAK = 10.00 MIN
TOTAL VOLUME = 72408.60 CU FT

ANALYSIS JUSTIFICATION - SECTION P-02 & P-04

P-04 & 02 CULVERTS: 28" & 26" DIA HDPE CULVERTS

2.42' CALCULATED HW DEPTH AT 28" CULVERT - MEETS Q-25 REQUIREMENT*

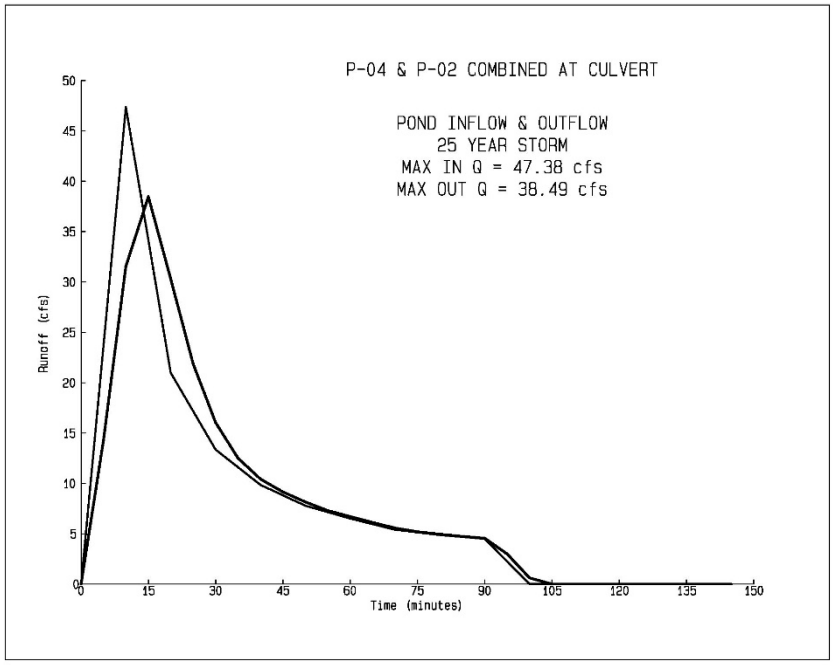
PROJECT: Welsh Run-On & Run-Off Protection Plan\2021 DA Map with H&H Calcs.pro

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HYDROGRAPH RESERVOIR ROUTING
POND: P-04 & P-02 COMBINED AT CULVERT

T	I1	I2	2S1/T	O1	2S2/T+O2	O2	2S2/T
25 YEAR STORM FREQUENCY							
5.00	0.0	23.7	0.0	0.0	23.7	14.3	9.4
10.00	23.7	47.4	9.4	14.3	66.2	31.6	34.6
15.00	47.4	34.2	34.6	31.6	84.6	38.5	46.1
20.00	34.2	21.0	46.1	38.5	62.8	30.3	32.5
25.00	21.0	17.2	32.5	30.3	40.3	21.9	18.5
30.00	17.2	13.4	18.5	21.9	27.2	16.0	11.1
35.00	13.4	11.6	11.1	16.0	20.0	12.5	7.5
40.00	11.6	9.9	7.5	12.5	16.5	10.4	6.1
45.00	9.9	8.8	6.1	10.4	14.3	9.2	5.2
50.00	8.8	7.8	5.2	9.2	12.6	8.2	4.5
55.00	7.8	7.2	4.5	8.2	11.2	7.3	3.9
60.00	7.2	6.5	3.9	7.3	10.3	6.7	3.6
65.00	6.5	6.0	3.6	6.7	9.4	6.1	3.2
70.00	6.0	5.4	3.2	6.1	8.5	5.6	2.9
75.00	5.4	5.1	2.9	5.6	7.9	5.2	2.7
80.00	5.1	4.9	2.7	5.2	7.5	5.0	2.5
85.00	4.9	4.7	2.5	5.0	7.1	4.7	2.4
90.00	4.7	4.5	2.4	4.7	6.9	4.6	2.3
95.00	4.5	2.3	2.3	4.6	4.5	3.0	1.5

TIME TO PEAK = 0.25 HOURS
MAXIMUM OUTFLOW = 38.49 CFS
MAXIMUM STORAGE = 6920 CU FT
MAXIMUM ELEVATION = 341.48 FT
INFLOW VOLUME = 72409 CU FT
OUTFLOW VOLUME = 72482 CU FT


P-04 & P-02 COMBINED AT CULVERT
POND INFLOW & OUTFLOW
25 YEAR STORM
MAX IN Q = 47.38 cfs
MAX OUT Q = 38.49 cfs
Runoff (cfs)
Time (minutes)
0
5
10
15
20
25
30
35
40
45
50
0
15
30
45
60
75
90
105
120
135
150

ANALYSIS JUSTIFICATION - SECTION P-05
0.3% V-DITCH, 3:1 SIDES & 50'X16" DIA HDPE,
MANNING N VALUE: 0.03 (GRASSED – CONSERVATIVE)
50'X16" DIA HDPE CULVERT, 8.8' MAX HW DEPTH

PROJECT: Welsh Run-On & Run-Off Protection Plan\2021 DA Map with H&H Calcs.pro

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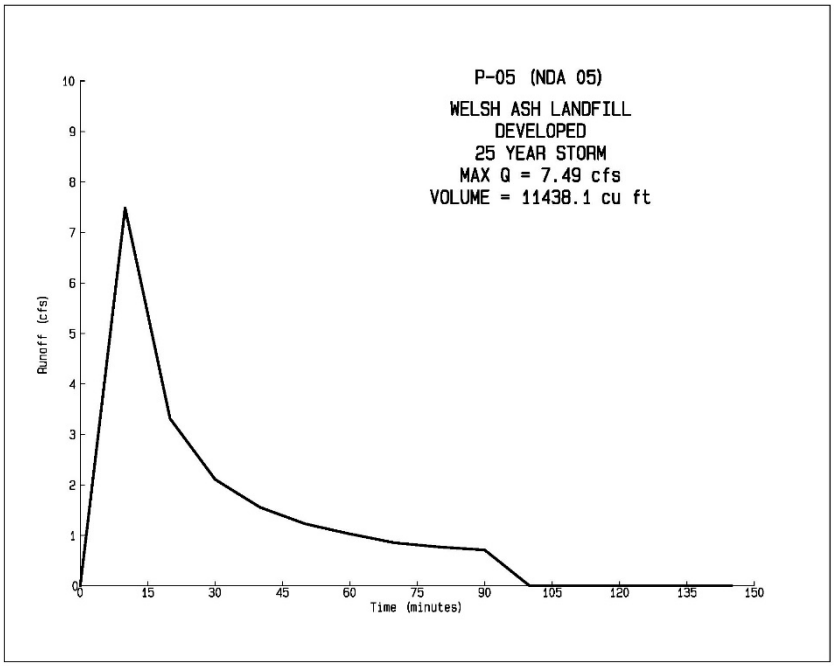
HYDROLOGIC REPORT

DEVELOPED UNIVERSAL RATIONAL HYDROGRAPH
Q(PEAK) = C*I*A
25 YEAR STORM FREQUENCY

BASIN IDENTIFIER P-05 (NDA 05)

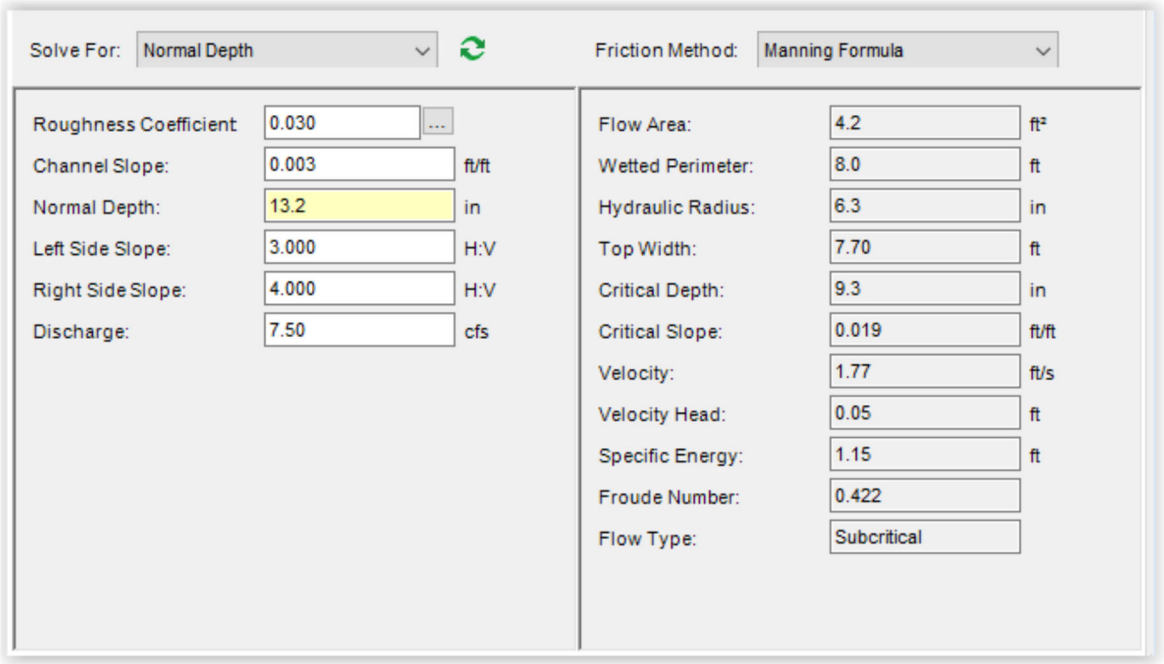
DISCHARGES INTO WELSH ASH LANDFILL
BASIN AREA = 2.09 ACRES
RUNOFF COEFF. = 0.40
RAINFALL INT. = 8.94 IN/HR
TIME OF CONC. = 10.00 MINUTES

TIME (MIN)	RUNOFF (CFS)
0.0	0.0
5.0	3.7
10.0	7.5
15.0	5.4
20.0	3.3
25.0	2.7
30.0	2.1
35.0	1.8
40.0	1.6
45.0	1.4
50.0	1.2
55.0	1.1
60.0	1.0
65.0	0.9
70.0	0.9
75.0	0.8
80.0	0.8
85.0	0.7
90.0	0.7
95.0	0.4
100.0	0.0
105.0	0.0
110.0	0.0
115.0	0.0
120.0	0.0
125.0	0.0
130.0	0.0
135.0	0.0
140.0	0.0
145.0	0.0



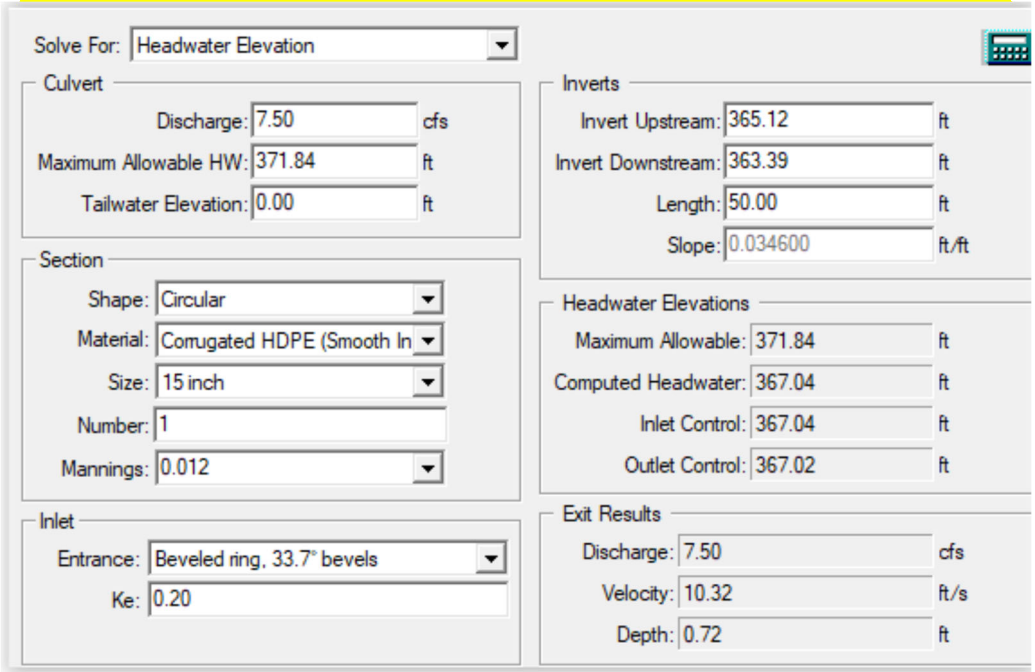
PEAK FLOW = 7.49 CFS
TIME TO PEAK = 10.00 MIN
TOTAL VOLUME = 11438.10 CU FT

ANALYSIS JUSTIFICATION - SECTION P-05
0.3% V-DITCH, 3:1L X 4:1R SIDES, 6.72' MIN. HW DEPTH
MANNING N VALUE: 0.03 (GRASSED – CONSERVATIVE)
1.10' CALCULATED HW DEPTH -- MEETS Q-25 REQUIREMENT*



* Bentley FlowMaster V8i – Trapezoidal Channel Analysis

ANALYSIS JUSTIFICATION - SECTION P-05
50'X16" DIA HDPE, 6.72 MIN. HW DEPTH
1.92-FT CALCULATED HW DEPTH – MEETS Q-25 REQUIREMENT



* Bentley CulvertMaster – Culvert Analysis (Used 15" DIA HDPE, Conservative)

ANALYSIS JUSTIFICATION - SECTION P-06
0.3% V-DITCH, 3:1 SIDES & TWO 30-IN DIA HDPE
MANNING N VALUE: 0.03 (GRASSED – CONSERVATIVE)

PROJECT: Welsh Run-On & Run-Off Protection Plan\2021 DA Map with H&H Calcs.pro

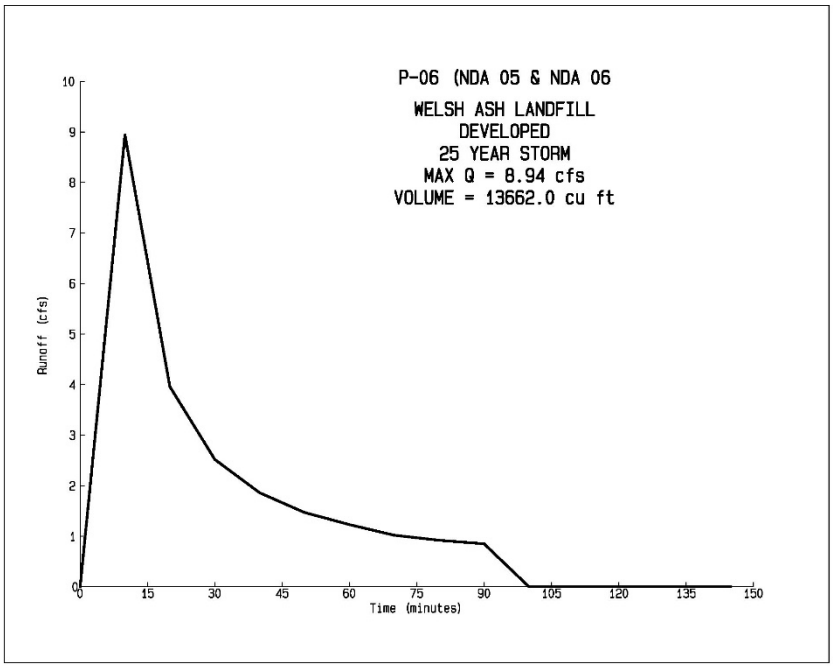
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HYDROLOGIC REPORT

DEVELOPED UNIVERSAL RATIONAL HYDROGRAPH
Q(PEAK) = C*I*A
25 YEAR STORM FREQUENCY

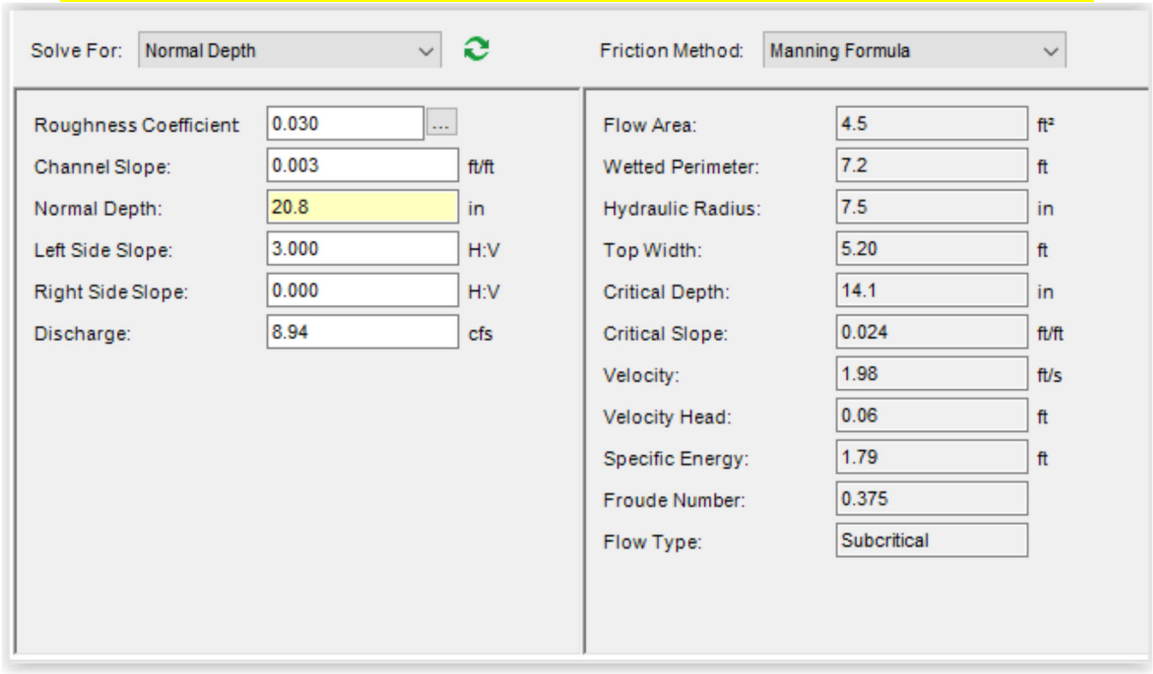
BASIN IDENTIFIER P-06 (NDA 05 & NDA 06
DISCHARGES INTO WELSH ASH LANDFILL
BASIN AREA = 2.50 ACRES
RUNOFF COEFF. = 0.40
RAINFALL INT. = 8.94 IN/HR
TIME OF CONC. = 10.00 MINUTES

TIME (MIN)	RUNOFF (CFS)
0.0	0.0
5.0	4.5
10.0	8.9
15.0	6.5
20.0	4.0
25.0	3.2
30.0	2.5
35.0	2.2
40.0	1.9
45.0	1.7
50.0	1.5
55.0	1.4
60.0	1.2
65.0	1.1
70.0	1.0
75.0	1.0
80.0	0.9
85.0	0.9
90.0	0.8
95.0	0.4
100.0	0.0
105.0	0.0
110.0	0.0
115.0	0.0
120.0	0.0
125.0	0.0
130.0	0.0
135.0	0.0
140.0	0.0
145.0	0.0



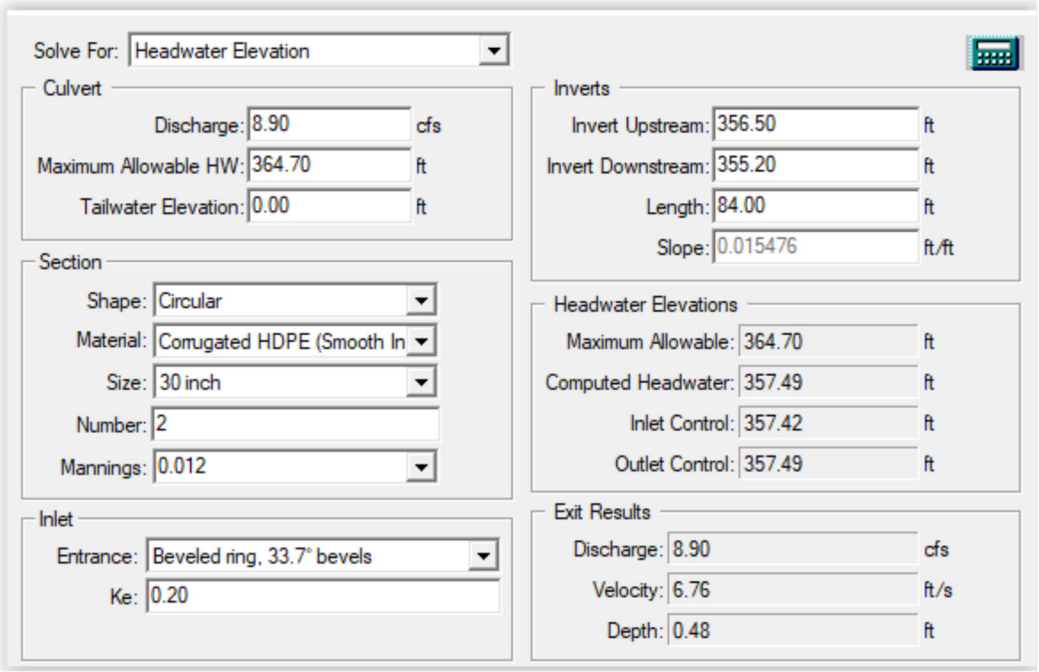
PEAK FLOW = 8.94 CFS
TIME TO PEAK = 10.00 MIN
TOTAL VOLUME = 13662.00 CU FT

ANALYSIS JUSTIFICATION - SECTION P-06 (CONT)
0.3% V-DITCH, 3:1 SIDES & MIN 1.92' HW DEPTH
MANNING N VALUE: 0.03 (GRASSED – CONSERVATIVE)
1.73-FEET CALCULATED HW DEPTH – MEETS Q-25 REQUIREMENT



* Bentley FlowMaster V8i – Triangular Channel Analysis

ANALYSIS JUSTIFICATION - SECTION P-06 (CONT)
TWO 84'X30" DIA HDPE, 8.2 MIN. HW DEPTH
0.99' CALCULATED HW DEPTH – MEETS Q-25 REQUIREMENT



* Bentley CulvertMaster – Culvert Analysis

Appendix 3: Plan Review Log

Plan Review and Changes in Facility Configuration

Scheduled reviews and Plan amendments shall be recorded in the Plan Review Log below. This log must be completed even if no amendment is made to the Plan as a result of the review.

By	Date	Amendment Description	P.E. Certification Required?	P.E. Name	Licensing State Registration No.
RHM	9/13/2021	Complete Reissue *	Yes	Robert H. Murray	Texas 59111

** Significant drainage modifications resulted in major differences require a complete reissue of the Plan*

Revision 1: Appendix 4 updated with the engineer's signature and date

Appendix 4: Professional Engineer Certification

Professional Engineer Certification Page

The undersigned licensed Professional Engineer (P.E.) attests that this Run-on and Run-off Control Plan has been prepared, reviewed, and/or revised in accordance with good engineering practice, including consideration of applicable industry standards and the requirements of 40 CFR 257. This certification in no way relieves the Owner or Operator of the facility of his/her duty to fully implement this Plan.

Engineer: _____
Robert H. Murray, P.E.



Registration Number: 59111

State: Texas

Date: September 17, 2021

MTG Engineers & Surveyors TBPE FIRM No. 354
P.E. certification is required for the Original Plan and Plan Reviews and Amendments.

RECORD OF PLAN REVISIONS

Revision Number	Date	Revision Description
1	May 6, 2022	(i) the content of the plan has not been revised, (ii) the originally posted document inadvertently did not include the completed PE certification, and (iii) the revised version contains the completed certification from Sept 17, 2021

ATTACHMENT 2A

Phase 1 Landfill (Slope stability, Settlement, Final Cover System, and Veneer Design Report)

Coal Combustion Residuals (CCR) Landfill: Final Closure Stability and Settlement Assessment

J. Robert Welsh Power Plant
Pittsburg, Texas

Auckland Project No. 2023-007
October 26, 2023

Prepared For:

SWEPCO – AEP Welsh Power Plant
1187 County Road 4865
Pittsburg, Texas 75686

Prepared By:

Auckland Consulting, LLC
Jacksonville, Texas
(903) 483-1568

TBPE Firm Registration No. F-16721
Expires 2/28/2024

Auckland Consulting LLC

October 26, 2023

Mr. Greg Carter, P.E.
SWEPCO – AEP Welsh Power Plant
1187 County Road 4865
Pittsburg, Texas 75686
Email: gcarter@aep.com

RE: CCR Landfill: Final Closure Stability and Settlement Assessment
J. Robert Welsh Power Plant
Pittsburg, Texas
Auckland Project No. 2023-007

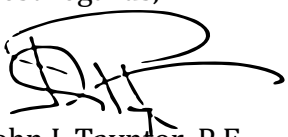
Dear Mr. Carter:

Auckland Consulting, LLC (Auckland) has completed the following stability and settlement assessment for the above referenced facility. Services were performed in accordance with the authorized scope of work.

The purpose of this evaluation was to review available subsurface data and provide information pertaining to the stability and settlement data for anticipated site development. The information provided in this report is based on available information and laboratory analysis of collected materials at the site.

We appreciate the opportunity to provide consultation services for the referenced project. If you have any questions regarding the information presented in this report please do not hesitate to contact us.

Best regards,



John J. Tayntor, P.E.
Auckland Consulting LLC
TBPE Registration No. F-16721, Expires 2/28/2024



10/26/2023

Enclosures

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Appendix

1.0 Introduction and Landfill Expansion Information

1.1 Introduction

The following report provides the findings of the recently completed slope stability and settlement analyses of the proposed vertical expansion and Final Closure of the existing CCR landfill located at the J. Robert Welsh Power Station (Welsh) near Pittsburg, Texas.

In addition, the following report includes the slope stability analysis of the proposed South Stability Dike and provides general embankment construction recommendations. This report should not be used by the contractor or earthwork contractors in lieu of project specifications or approved plans provided by the project engineer.

1.2 Referenced Information and Data

The historical subsurface and design data utilized in this assessment was provided by the client and included evaluations completed by MTG Engineers and Surveyors (MTG) titled *Welsh Ash Landfill – Closure Grading Plan, Optimized 3H:1V Side Slope* Version provided April 2023; *Project Drawings for the 2021 Welsh Power Plant BASP Closure-By-Removal and Landfill Modifications, Engineer's Project No. 217001,* dated October 2021; *Welsh Power Plant 2016-2017 Ash Landfill Cap and Cover Project, Soil Cap and Cover Evaluation Report* dated October 27, 2017; *Welsh Power Plant 2018-2019 Ash Landfill Cap and Cover Project (Phase 2) Soil Cap and Cover Evaluation Report* dated September 19, 2019; and *Welsh Power Plant Welsh Ash Landfill Soil Borrow Investigation and Plan* dated January 29, 2018. In addition, subsurface data and laboratory information provided in ETTL Engineers and Consultants, Inc. report titled *Phase 1 Landfill Seepage Evaluation and Final Stability of Vertical Expansion, Geotechnical Investigation – Final Report, ETTL Job No. G4207-14* dated April 16, 2015 was also be utilized in our assessment. Auckland was not involved in the original evaluation discussed in these referenced reports; however, has made a cursory review of the presented data, and it appears applicable for this assessment.

Proposed elevation data and geometry used in our updated analyses and models are based on information provided recently (April 2023) by MTG and included in the Appendix. Furthermore, references to current and estimated leachate elevations in the waste material were derived from recent piezometers (abandoned during 2022) and HELP Model estimations.

No additional field or subsurface investigations were completed in direct support of this evaluation. However, laboratory testing of bulk CCR material (ash) from the Bottom Ash Storage Pond (BASP), West Dredge Receiving Area (WDRA) and onsite borrow area were conducted. The material strength parameters used for the stability and settlement models include data from both referenced documents and recent laboratory data.

Additional Subsurface Investigation. The following evaluation includes closure of western portions of the landfill not previously evaluated. For the purposes of this assessment, underlying foundation soils are assumed to be uniform and like those encountered in the central and eastern extents of the existing landfill. However, the client should verify subsurface conditions are similar to those modeled herein.

1.3 Design and Model Criteria

Landfill Expansion and Final Closure. The vertical expansion and final closure area includes the entire footprint of the existing landfill and covers an area of approximately 38 acres (including existing material). The final closure will accommodate the disposal of material excavated from the Bottom Ash Storage Pond (BASP) or Winston Pond, and Primary Ash Pond. Presently, most of the disposed ash material is located in the eastern portion of the landfill, while the western portions of the landfill are currently utilized for fly-ash processing efforts and offsite sales.

It is our understanding that waste placement will be completed in multiple fills or lifts consisting of stable material with integrated water control terraces, stability dikes or berms. Finished maximum side slopes are anticipated to be 3:1 (horizontal to vertical) and maximum waste depth of approximately 46 feet, at a maximum elevation of 406 feet, MSL. The landfill final cap and cover will consist of a synthetic membrane (ClosureTurf or similar) with underlying intermediate soils. It is our understanding that stability dikes were used in the construction of the northern and eastern faces of the landfill; however, no specific design and construction information was available and therefore these features were not included in our evaluation.

The critical slope sections or areas of potential soil sensitivity (slope stability analysis) based on existing and landfill geometry are identified as the North Section and East Section. These critical sections are depicted on Figure A-1 provided in the Appendix of this report.

The surcharge load used for settlement analyses is based on the loads created by the above-mentioned fill phasing and a compacted ash unit weight of approximately 100 pounds per cubic foot (pcf). The actual build out and placement of ash material will likely differ than that provided by Figure B-1; however, design geometry has been simplified for modeling purposes. The settlement analysis considers potential immediate (or elastic) and long-term consolidation of foundation soils. Compression of placed compacted and landfilled ash materials for this assessment is assumed to be negligible. Tolerances for maximum and differential settlement are not currently known for planned liner and leachate collection systems.

South Stability Dike. Preliminary design schematics indicate that the South Stability Dike will generally extend the existing south slope of the landfill to the west. The stability dike will be a continuation of the existing stability embankment with an anticipated maximum height of 15 feet, crest width of approximately 10 feet and inside and outside side slopes of 2:1 and 3:1 (H:V), respectively.

Borrow material for the stability dike is assumed to consist of onsite lean or fat clay (CL/CH) material identified as Sample No. 2 in the referenced reports. No additional subsurface investigation or laboratory testing were performed.

2.0 Laboratory Testing

2.1 Laboratory Testing Program

As previously stated, laboratory testing was conducted on collected samples of ash material to evaluate the physical and engineering properties. Laboratory test results may be found on individual test reports included in the Appendix. Laboratory tests were performed in general accordance with ASTM procedures cited in the table below.

Laboratory Test	Test Designation
Moisture Density Compaction Test	ASTM D698
One-Dimensional Consolidation of Soils	ASTM D 2435
Consolidated – Undrained Triaxial Compression	ASTM D4767
Unconsolidated Undrained (UU) Triaxial Compression	ASTM D 2850

Laboratory Test (Interface Shear)	Test Designation
Large Scale Direct Shear Test	ASTM D 3080
Shear Strength of Soil-Geosynthetic Interface (by Direct Shear)	ASTM D 5321
Multi-Layered Interface Friction Test	ASTM D3080/5321 Modified

Interface Shear Laboratory Testing. In accordance with approved guidance by AEP, prior to prescribed testing, sample (borrow and CCR material) specimens were remolded to 95 percent (95%) of maximum density at optimum moisture content (OMC) as determined by the standard Proctor compaction test (ASTM D 698). Intermediate cover borrow soil consisting of silty sand (SM) material will be excavated from an onsite borrow location.

Interface testing for this project consisted of one (1) Large Scale Direct Shear Tests (ASTM D3080 Modified), one (1) Shear Strength of Soil-Geosynthetic Interface Tests (ASTM D5321) and one (1) Multi-Layer Interface Friction Tests (ASTM D3080/5321 Modified). Interface testing was completed at the normal stresses of 200, 400 and 600 psf applied at a constant rate with a consolidation or seat time of 24-hour prior to shearing. Each test section was sheared at an approximate rate of 0.04 inches per minute (IPM). All laboratory test results are included in the Appendix.

3.0 Site Conditions

3.1 General

Interpretation of soil and groundwater conditions for the project site is based on the information obtained from referenced documents and reports. The information from these referenced reports have been utilized for the basis of the evaluations detailed herein, unless otherwise noted. Subsurface conditions may vary at areas not evaluated. If significant variations are encountered in areas not explored by the soil borings, then additional field activities and re-evaluation of the recommendations herein will be necessary.

3.2 Subsurface Soil Stratigraphy

Generalized subsurface stratigraphy and soil profiles are based on subsurface information provided by ETTL in their report titled *Phase 1 Landfill Seepage Evaluation and Final Stability of Vertical Expansion, Geotechnical Investigation – Final Report, ETTL Job No. G4207-14* dated April 16, 2015 (referenced sections included in the Appendix). These profiles indicate that soils underlying the landfill generally consist of soft to medium stiff lean and fat clay (CL/CH) overlying very dense silty sand (SM) and sandy silt (ML), underlain by hard fat clay (CH).

Evaluated landfilled ash varies in thickness from generally 25 to 33 feet with varying strength and material properties. Referenced borehole logs located in the Appendix of this report provide additional information pertaining to subsurface soil properties, soil engineering properties, and relative stratigraphy and should be reviewed for more detail.

3.3 Groundwater Referenced Data

Groundwater levels below the landfill were not monitored as part of this evaluation. However, based on recent measurements of up- and down gradient monitoring wells provided in the *Annual Groundwater Monitoring Report, Landfill CCR Management Unit* dated January 2022, we have assumed a groundwater elevation of 335 feet, MSL for this evaluation.

Groundwater levels may fluctuate with climatic and season variations, land-use or drainage pattern changes and should be verified before construction. The installation of piezometers to evaluate long-term groundwater conditions, and subsequent monitoring, was not included in the scope of services.

4.0 Slope Stability Analyses

4.1 General

Model sections and material strength parameters used for stability analyses of the completed landfill are based on findings of the referenced previous studies completed at the Welsh Power Plant. Soil parameters are presented on the respective stability model analysis graphic. Probable failure planes were analyzed using the analytical slope stability software, SLIDE by Rocscience, Inc. Methods of evaluation used in SLIDE are considered limited equilibrium methods of analysis, where each individual shear plane is evaluated to determine the resulting shear stress at the point of failure. For the purposes of this evaluation the Bishop Method of analysis, which analyzes circular failure planes through the slope, was utilized.

The profiles utilized in the stability analyses generally depict the North and East Sections and South Stability Dike upon completion of disposal activities with a maximum section waste height ranging between 26 and 46 feet, respectively. These sections were selected because they represent the deepest areas of potential waste placement and subsurface soil sensitivity to loading. Block or wedge failure analyses were also conducted along the interface of the in-situ clay liner and disposed ash. This interface represents a probable slip surface for an assumed homogenous mass block failure of disposed material. For the results included herein, active support (resisting forces) is assumed to decrease the driving force and assumes no movement has taken place.

Strength parameters of existing soils were determined either by referenced laboratory analyses, available field penetration testing of past evaluations or empirical correlations with soil index properties. Selected soil parameters are presented on the respective stability analyses and following tables.

Summary of Total Stress Soil Parameters North and East Sections			
Material Type	**Unit Weight (pcf)**	**Cohesion (psf)**	**Angle of Internal Friction (degrees)**
New Ash	100	0	20
Existing Ash	100	0	25
Lean/Fat Clay (CL/CH)	125	250	18
Silty Sand/Sandy Silt (SM/ML)	125	0	29
Fat Clay (CH)	125	400	14
NOTE: Properties based on Unconsolidated-Undrained (UU) Triaxial Testing, assumption of undrained material conditions and field results.			

Summary of Effective Stress Soil Parameters North and East Sections			
Material Type	**Unit Weight (pcf)**	**Cohesion (psf)**	**Angle of Internal Friction (degrees)**
New Ash	100	0	32
Existing Ash	100	0	29
Lean/Fat Clay (CL/CH)	125	150	27
Silty Sand/Sandy Silt (SM/ML)	125	0	34
Fat Clay (CH)	125	300	22
NOTE: Properties based on Consolidated-Undrained Triaxial Compression Testing, and field results.			

Summary of Total Stress Soil Parameters South Stability Dike			
Material Type	**Unit Weight (pcf)**	**Cohesion (psf)**	**Angle of Internal Friction (degrees)**
Ash Fill	100	0	20
Embankment Fill	125	200	15
Lean Clay (CL) – Native	125	250	18
Fat Clay (CH) – Native	125	400	14
Sandy Silt (ML)	125	0	29
NOTE: Properties based on Unconsolidated-Undrained (UU) Triaxial Testing, assumption of undrained material conditions and field results.			

Summary of Effective Stress Soil Parameters South Stability Dike			
Material Type	**Unit Weight (pcf)**	**Cohesion (psf)**	**Angle of Internal Friction (degrees)**
Ash Fill	100	0	32
Embankment Fill	125	100	25
Lean Clay (CL) – Native	125	150	27
Fat Clay (CH) – Native	125	300	22
Sandy Silt (ML)	125	0	34
NOTE: Properties based on Consolidated-Undrained Triaxial Compression Testing, and field results			

4.2 Probabilistic-Sensitivity Evaluation

To evaluate the effect of leachate elevation variability on the structural stability of the landfill, each slope stability analysis includes a normalized mean statistical analysis. Finite element analysis (FEA) was utilized to evaluate the factors of safety between the probable minimum ($W_{(min)}$) and maximum ($W_{(max)}$) leachate elevations in the landfill. Leachate elevations utilized in the stability models are based on data from the landfill piezometers and estimations generated by the Hydrologic Evaluation of Landfill Performance (HELP) models. A normalized mean leachate elevation (denoted as $W_{(mean)}$) was established

between both the maximum and minimum leachate elevations. The analysis consisted of evaluating stability and corresponding safety factors in 50 equal increments between the maximum and minimum elevations.

The mean leachate elevation for the North and East Sections utilized in our analyses are 349 feet, MSL and 354 feet, MSL, respectively. The determination of the modeled failure plane and corresponding factor of safety in the North and East Sections are based on the mean elevation ($W_{(mean)}$).

4.3 Seismic Loading – End of Construction

For the evaluation of End of Construction with seismic loading conditions, the peak ground acceleration for this location was obtained from the USGS Earthquake Hazards Program website (http://earthquake.usgs.gov/hazards), ASCE 7 Hazard Tool using the ASCE/SEI 7-16 guidance and referenced material in the Appendix. Based on the ASCE/SEI 7-16 guidance, the anticipated site-specific ground acceleration (PGA) is 0.058g (acceleration at rock sites) for a two (2) percent probability of exceedance in 50 years. Correcting for stiff soil sites (Site Classification D and Site Coefficient, F_{PGA} = 1.6) yields an estimated maximum geometric mean peak ground acceleration (PGA_M) of 0.093g (e.g., PGA_M = [F_{PGA}][PGA] = [1.6][0.058g] = 0.093g). The seismic coefficient (k) used for pseudo static analysis is the same as the PGA_M for the site.

4.4 Slope Stability Results

The following table presents the factors of safety determined by the slope stability model for the End of Construction with referenced maximum assumed disposal height. Simulations were performed using both total (including seismic loading) and effective stresses. Model graphical outputs are provided in the Appendix of this report.

The minimum factor of safety (FS) against mass movements is based on information from the Texas Commission on Environmental Quality (TCEQ) for Class 2 Industrial Nonhazardous Landfill facilities.

Summary of Stability Analyses – East Section		
Evaluated Condition	**Factor of Safety[1]**	
	Actual	**Minimum**
End of Construction – Effective Stress	2.0	1.3
End of Construction – Total Stress	1.4	1.3
End of Construction – Seismic Loading	1.4	1.0
End of Construction – Block/Wedge	1.6	1.3

NOTE: 1. Minimum factors of safety based on guidance provided by the Texas Commission on Environmental Quality (TCEQ).

Summary of Stability Analyses – North Section		
Evaluated Condition	**Factor of Safety[1]**	
	Actual	**Minimum**
End of Construction – Effective Stress	2.0	1.3
End of Construction – Total Stress	1.7	1.3
End of Construction – Seismic Loading	1.2	1.0
End of Construction – Block/Wedge	1.7	1.3

NOTE: 1. Minimum factors of safety based on guidance provided by the Texas Commission on Environmental Quality (TCEQ).

Summary of Stability Analyses – South Stability Dike		
Evaluated Condition	**Factor of Safety[1]**	
	Actual	**Minimum**
End of Construction – Effective Stress	2.0	1.3
End of Construction – Total Stress	1.6	1.3
End of Construction – Seismic Loading	1.2	1.0
End of Construction – Block/Wedge	2.0	1.3

NOTE: 1. Minimum factors of safety based on guidance provided by the Texas Commission on Environmental Quality (TCEQ).

Based on the findings of these analyses, the evaluated sections and embankment appear to be stable under modeled conditions and mean leachate elevations.

4.5 Final Cover Veneer Stability Analyses

4.5.1 Final Cover Section

Based on information provided by the client, it is our understanding the final cap and cover will consist of a synthetic turf (50-mil Super Gripnet [SGN] LLDPE liner and ClosureTurf [with sand infill]) secured using an anchor trench. At the time this stability evaluation was completed, the final cap and cover design section will consist of placed fly-ash/sludge, an intermediate soil layer (approximate thickness of 18 inches) and capped with 50-mil SGN and ClosureTurf (top most layer). The liner manufacturer provided samples of the proposed synthetic turf material and LLDPE to the laboratory for testing. No exposed veneer soils are proposed.

For the purposes of this evaluation, it was assumed that the final cover system will have slope angles of 3H:1V and 16H:1V, with approximate slope lengths of approximately 80 feet and 250 feet and vertical heights of approximately 25 and 16 feet, respectively.

4.5.2 Veneer Stability Analyses.

The Limit Equilibrium (LE) Finite Slope method used in this analysis closely follows the methods outlined by Koerner and Soong (*Analysis and Design of Veneer Cover Soils*, Koerner and Soong, 2005). The LE analysis is performed using force equilibrium to balance the driving forces due to gravity pulling on the intermediate soils and the resistance to sliding due to friction between the underlying subsurface (CCR ash). In addition, resistance to sliding is also due in part to the toe support (passive wedge) located at the base of the sliding mass (a free body diagram is provided with attached calculations in the attachments). Residual or large displacement shear strength (via linear regression from normal stresses 200 and 400 psf data points) as determined by laboratory testing was utilized, representing a conservative approach to evaluating the long-term stability of intermediate cover soils.

In addition, probable wedge and rotational failure planes were analyzed using the analytical slope stability software, SLIDE by Rocscience, Inc. Evaluation of rotational failures were generally focused or restricted (as practical) to area in the CCR ash approximately five (5) feet below the surface by using a defined search or focus line. Methods of evaluation used in SLIDE are considered limited equilibrium methods of analysis, where each individual shear plane is evaluated to determine resulting shear stress at the point of failure. For the purpose of this evaluation, Spencer's Method satisfies both force and moment equilibrium and is considered more rigorous than other methods, such as the Bishop and Janbu Methods.

For the analyses presented in this document, the following general conditions and factors of safety were used.

Summary of Veneer Stability Analyses – Factors of Safety	
Evaluated Conditions	**Factor of Safety**
Static Condition (Residual Strength)	1.5
Static Condition (Residual Strength) – Parallel Seepage (Full Depth)	1.1
Seismic Conditions (Residual Strength)	1.0
Effective Stress, Block Wedge & Rotational Failure (Drained Conditions)	1.5
Total Stress, Block-Wedge & Rotational Failure (Undrained conditions)	1.5
Seismic Loading, Block-Wedge & Rotational Failure (Undrained Conditions)	1.0

The critical interface analyzed represent preferential pathways for mass sliding and are typically evaluated between adjacent geosynthetic materials or between geosynthetic and soil materials. However, for this evaluation the interface between disposed CCR ash and intermediate cover soils were evaluated. The critical interfaces analyzed and subsequently presented herein was the interface between the intermediate cover (borrow soil) and CCR ash.

4.5.3 Veneer Stability Analyses Results

The analysis of veneer soils and CCR ash interface performed consists of calculating factors of safety against translational and rotational failure based on interface shear testing and laboratory test results. The results of these analyses are summarized below (associated calculations and graphical outputs are provided in the attachments).

Summary of Veneer Stability Analysis		
Evaluated Condition and Analysis	**Intermediate Cover – CCR Ash (FS)**	**Minimum Factor of Safety (FS)**
Static Conditions[1]	2.9	1.5
Static Conditions (Parallel Seepage)[1,2]	<1.0	1.1
Seismic Conditions[1]	1.9	1.0
Effective Stress, Block-Wedge	2.9	1.5
Total Stress, Block-Wedge	2.2	1.5
Seismic Loading, Block-Wedge	1.8	1.0
Effective Stress, Rotational Failure	2.3	1.5
Total Stress, Rotational Failure	1.7	1.5
Seismic Loading, Rotational Failure	1.3	1.0

NOTE: 1. Static Conditions (including parallel seepage and seismic) based on finite slope analysis as presented by Koerner (2005), Designing with Geosynthetics, 5th Edition. The Factor of Safety associated with proposed 3:1 side slope provided here, results of 16:1 side slope provided in the Appendix.
2. Assumed development or build-up of parallel-to-slope phreatic surface per request of AEP
3. Minimum Factor of Safety referenced from *Analysis and Design of Veneer Cover Soils (Koerner and Soong, 2005)*
4. Factors of Safety from Spencer's Method.

Based on the findings of the above analyses, the proposed intermediate soil veneer underlying the synthetic turf should generally be stable for most of the conditions evaluated. In accordance with AEP's request, intermediate soils were evaluated under Static Conditions (Parallel Seepage) assuming the development or build-up of a parallel-to-slope phreatic surface in the veneer soils. Based on these modeled saturated conditions, as expected, the intermediate soil veneer becomes unstable, likely resulting in a seepage induced translational failure of veneer soils. It is not expected the veneer soils for this project would become fully saturated resulting in a phreatic surface due to a tear, welding or similar defect in the geosynthetic cover material. Regardless, to prevent any damage to the veneer or liner system, installation activities should be monitored and tested under a construction inspection and quality control program to insure proper placement and welding practices.

5.0 Settlement Analysis

5.1 General

Settlement analyses included the evaluation of soil profiles and information presented in referenced data. Settlement analyses were performed using Settle3D software developed by Rocscience. Settle3D is a 3-dimensional program for the analysis of vertical settlement and consolidation under surface loads. Settle3D calculates three-dimensional stresses due to surface loads; however, settlement (or displacement) and pore pressures are computed in one-dimension assuming only vertical displacements can occur. Further, for the purposes of this evaluation the Boussinesq Stress Computation Method of analysis was utilized. The Boussinesq method uses the theory of soil elasticity to calculate the vertical stress under a point load in a homogeneous, semi-infinite half space.

Review of available laboratory data compiled for this evaluation generally correlate with those data collected previously. Estimated groundwater levels were adjusted in the model to incorporate recent field observations and annual reports, as referenced herein.

5.2 Landfill Foundation Soils

The modeled profiles provided herein focus primarily on foundation soils that will consolidate under load. Consolidation properties of modeled soils are based on historical and recent laboratory analyses and empirical correlations with field penetration test results, as provided in the reference documents. Soil parameters used in the evaluating potential estimated settlement are presented on each respective model output. Results of referenced consolidation testing are provided in the Appendix. Soil parameters used in evaluating potential estimated settlement is provided in the following table.

Summary of Consolidation Parameters: Foundation Soils

Material Type	Unit Weight (pcf)	C_C[1]	C_R[1]	OCR	e_0
Lean/Fat Clay (CL/CH)	120	0.120	0.007	15	0.637
Fat Clay – Upper (CH_1)	120	0.178	0.018	6.5	0.706
Fat Clay – Lower (CH_2)	120	0.178	0.018	3.9	0.706

NOTE: 1. Compression and recompression indices obtained from 1-D Consolidation laboratory tests and referenced data.

As stated previously, the foundation soils in the western extent of the landfill have not been evaluated. For the purposes of this evaluation, we have assumed (until additional data is available) that material properties of underlying soils are uniform.

5.3 Settlement Analysis Results

For the purposes of modeling, the waste placement occurs as Stage 1 and Stage 2 loading conditions. These loading conditions appear consistent with existing waste placement, design parameters and progression of waste disposal. These conditions included the current placement of waste material in the landfill (Stage 1) with an existing waste height ranging from approximately 20 to 36 feet (EL. 344 to 360 feet, MSL), and the proposed vertical expansion (Stage 2) with a maximum depth of 26 feet (EL. 380 to 406 feet, MSL) and total waste height of approximately 60 feet. As previously noted, slopes were assumed to be a maximum of 3:1 (horizontal to vertical). The unit weight of the waste was assumed to be 100 pounds per cubic foot (pcf) throughout the entire depth. Model study areas and corresponding load conditions are provided on Figure B-1 in the Appendix.

The estimated settlement values for each of the installation stages and corresponding waste fill height are included in the following table:

Estimated Settlement Summary – Foundation Soils
Phase 1 Vertical Expansion

Disposal Stage	Total Settlement [1] (inches)
Stage 1	2.2
Stage 2	3.1

NOTE: 1. Settlement values do not include consolidation of disposed ash material.

Plots depicting each of the various stages and queries as derived by Settle3D and model data or information are presented in the Appendix of this report.

5.4 Installation of Settlement Plates - Optional

The installation of settlement plates at various locations throughout the disposal area should be considered to monitor and document actual settlement as ash disposal elevation increases. Collected data from settlement plates would provide actual settlement data points, allowing the correlation and comparison to the estimated modeled settlement values provided above. In the event observed settlement values (as obtained from

settlement plates) exceed those estimates provided herein, the height and extent of the landfill might require additional review or modification to prevent structural failure.

6.0 South Stability Dike Construction Recommendations

6.1 General

The following provides general construction guidance for the South Stability Dike and may include conditions not encountered at this particular site. Design schematics and engineering design should be viewed for additional information.

6.2 Onsite Borrow Soils

At the time this report was prepared, various onsite borrow areas were being evaluated for suitability for this project. Prior to use in embankment construction, borrow soils should be laboratory tested (including for dispersive characteristics) to meet the minimum shear strength (total and effective stress) design criteria (cohesion [c] and internal friction angle [phi, Φ]) utilized in the stability assessment provided herein. Advanced laboratory testing, engineering review and additional model analysis may be required prior to use of selected borrow material(s) and should be anticipated prior to construction.

6.3 Subgrade Preparation

Prior to construction of the slope foundation and embankment foundation, topsoil, organics, pooled water and loose (or saturated) soils should be removed. After removal of vegetation and topsoil, the exposed embankment subgrade should be proofrolled to confirm stability. Proofrolling should be performed with a fully loaded tandem axle dump truck or similar equipment with a minimum gross weight of 20 tons (recommended). Proofrolling should consist of several overlapping passes. If proofrolling is not feasible due to spatial constraints, then areas should be hand probed and verified firm and stable by a qualified soil technician. Any identified loose or yielding areas should be excavated to firm soil and replaced with properly placed select fill or approved fill material. Dependent on subgrade conditions during construction, the use of a bridge lift may be necessary.

Subgrade soils should be stable before placement of fill material. Subgrade stability should be verified by proofroll inspection. Subsequent to proofrolling and immediately prior to placement of select fill, the exposed subgrade should be scarified and compacted to a minimum 95% Standard Proctor (ASTM D 698) of the maximum dry density ranging from one percent below (-1%) of optimum moisture content to three percent above (+3%) Standard Proctor and the excavation backfilled with properly placed (moisture and density controlled) approved fill material to finished grade elevation.

During placement of soils for the embankment modifications, the existing embankment should be benched with successive lifts to allow uniformity and continuity between the

existing embankment and placed soil. Bench widths made into the existing embankment should range between 1½ to two (2) feet per lift. Prior to placement, organics and topsoil should be removed from the existing embankment.

6.4 Approved Fill Criteria

Core Material. Material used as core material should consist of clayey sand (SC), sandy lean clay (CL) or sandy fat clay (CH) material with a liquid limit between 20 and 50 and plasticity index between 15 and 40. Core material should have a minimum 40% passing the No. 200 sieve. All fill should be free of organics (or debris), have a maximum particle size of three (3) inches and relatively consistent material properties throughout.

Fill material should be placed in thin, loose lifts not exceeding eight (8) inches, and moisture content between optimum and three percentage points above (+3%) the optimum moisture content and compacted to a minimum 95% of the maximum density as determined by Standard Proctor test (ASTM D 698). Water should be added uniformly and mixed thoroughly into the soil by disking or scarifying.

Cover Material. Salvaged topsoil or similar soils should be utilized along the side slopes of the completed embankment to promote vegetative growth and reduce erosion. Topsoil should not be used in the core construction of the embankment. Soils used for vegetative cover may require augmentation with fertilizer and lime to establish and promote growth.

6.5 Construction Inspection and Quality Control

During construction activities, continued laboratory testing of borrow material is crucial to the project. Soils that do not meet the minimum criteria provided herein or per design plans should not be used for embankment construction. Prior to commencement of construction activities, borrow sources should be identified, laboratory tested and approved to minimize delay (and rework) and placement of soils.

The following are minimum recommended field-testing criteria:

- One (1) field moisture density test for every 2,000 cubic yards of compacted fill (at least one [1] test per lift);
- One (1) field moisture density test for every 200 cubic yards of compacted fill in trenches or around structures (at least one [1] test per lift);
- Conduct ongoing and periodic classification testing of borrow material to include Atterberg Limits, Percentage of Fines and Crumb Tests;
- Maintain a maximum loose lift thickness of eight (8) inches during embankment compaction; and
- Each lift should be tested (and documented) and inspected prior to placement of subsequent lifts.

Fill placement should be monitored by an experienced field engineer or engineering technician. Additional testing may be required if observations of material placement warrant.

Engineering design and details should be reviewed for additional testing criteria during construction activities.

6.6 Dewatering

Based on the proposed modifications and available subsurface information, dewatering of the site is not expected. However, if conditions dictate, the site may be dewatered using well points or cut off trenches (with a minimum depth of three [3] to four [4] feet) to drawdown and maintain groundwater levels below the excavation bottom (as required). Deeper sumps or trenches may be required to adequately drawdown groundwater. Collected water in sumps or trenches should be conveyed offsite and discharged in accordance with applicable requirements or permits.

7.0 Additional Construction Considerations

7.1 Site Drainage

Positive drainage should be maintained around the site, preventing water to pond and otherwise saturate subgrade soils. Ponded water or saturation of subgrade soils adjacent to the embankment or constructed elements may encumber construction activities and may require reworking of previously placed embankment materials.

7.2 OSHA Soil Classification

Soils previously disturbed by construction or similar activities should be considered to be OSHA Classification – Type C soils. In accordance with OSHA guidelines the following soil classifications are provided for soils encountered at the site during our evaluation.

- Lean Clay (CL) Type B Soil

7.3 Construction Material Testing & Inspections

Recommendations provided herein are made assuming proper civil design of foundations and civil site work, as well the use of satisfactory construction materials and installation practices. It is recommended that client contract construction inspection and material testing services from a licensed and accredited laboratory who has an established history of working in the immediate vicinity of the site and is accustom to matters of local soil behavior and construction practices including but not limited to mass grading, compaction of fine and coarse grained soils and trenching. Onsite representation of the laboratory

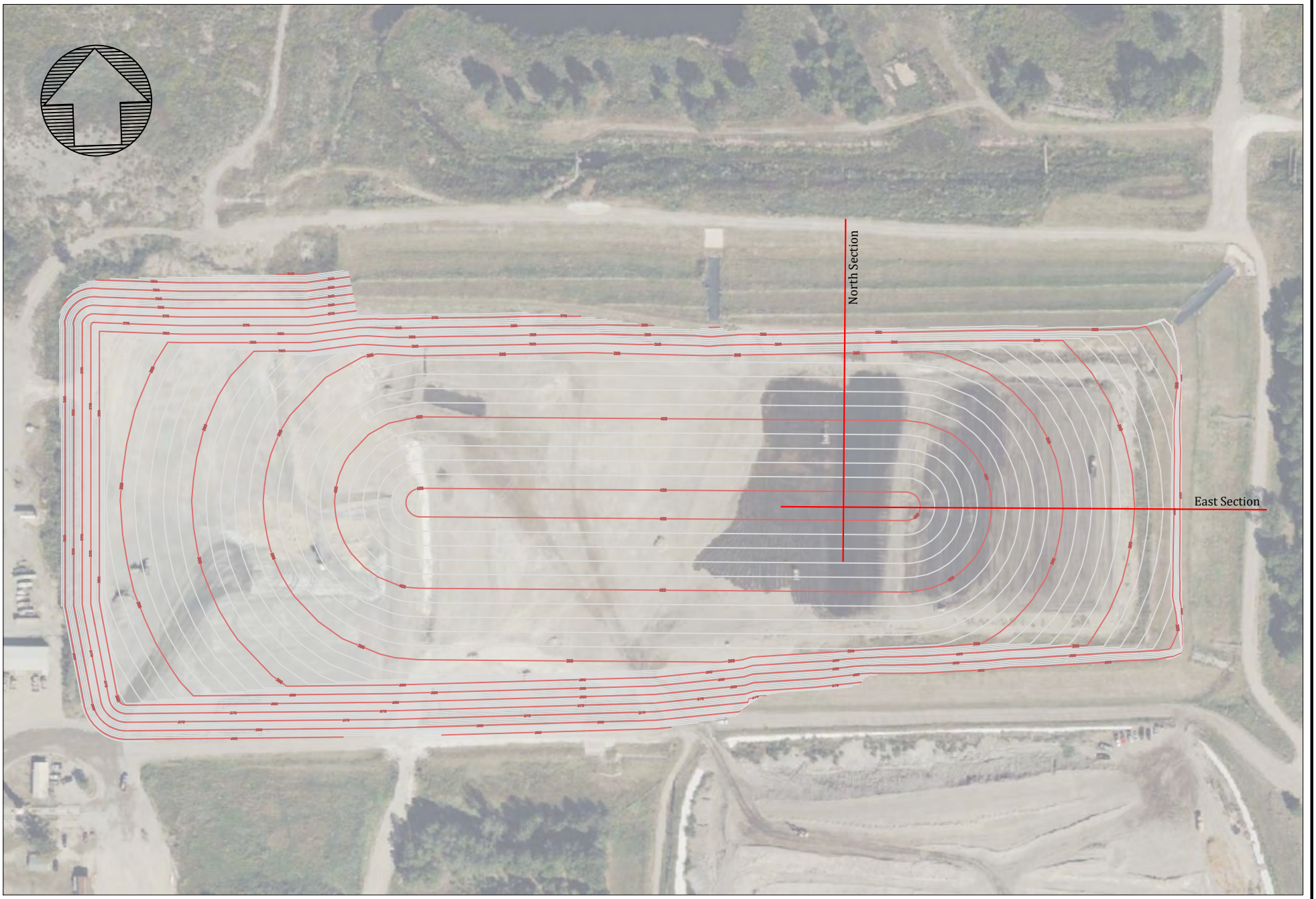
should have a working knowledge of the on-going construction and testing requirements as evident by ICC, NICET or Department of Transportation certifications, or subsequent education in Civil Engineering or Construction Science.

8.0 Report Limitations

This report has been prepared for the exclusive use of our client for the specific application to the project discussed and has been prepared in accordance with the generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. The analyses contained in the report are based on the data obtained from the soil borings performed within the project site and previous geotechnical data cited herein. This report does not reflect variations that may occur between borings or across the site. Soil borings do not necessarily reflect strata variations that may exist at other locations within the project site. This report does not reflect the potential variations that may occur in subsurface conditions and waste material across the site.

Appendix

Figure A-1
Boring Logs
Slope Stability Analyses
Figure B-1
Settlement Analyses
Veneer Stability Analyses
Interface Friction Laboratory Data
Referenced Data



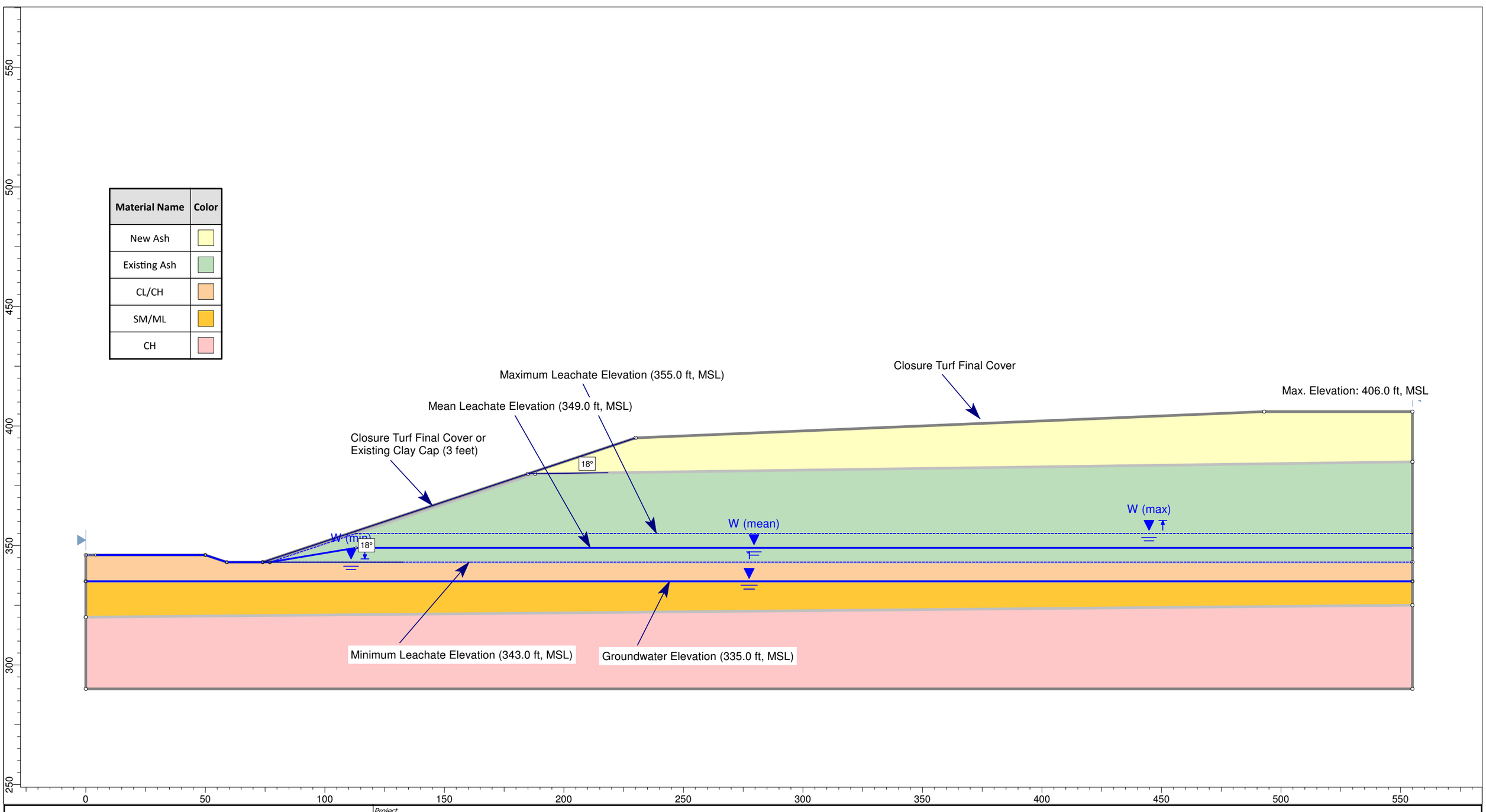
Auckland Consulting, LLC
PO Box 8155
Jacksonville, Texas 75766
TBPE Firm Registration No. F-16721

FIGURE A-1: Slope Stability Model Sections
Welsh Power Plant - CCR Landfill Final Closure
Pittsburg, Texas

No.	Revision	Date

Project No.:	2023-007
Date:	06/29/2023
Drawn by:	JJT
Scale:	NTS

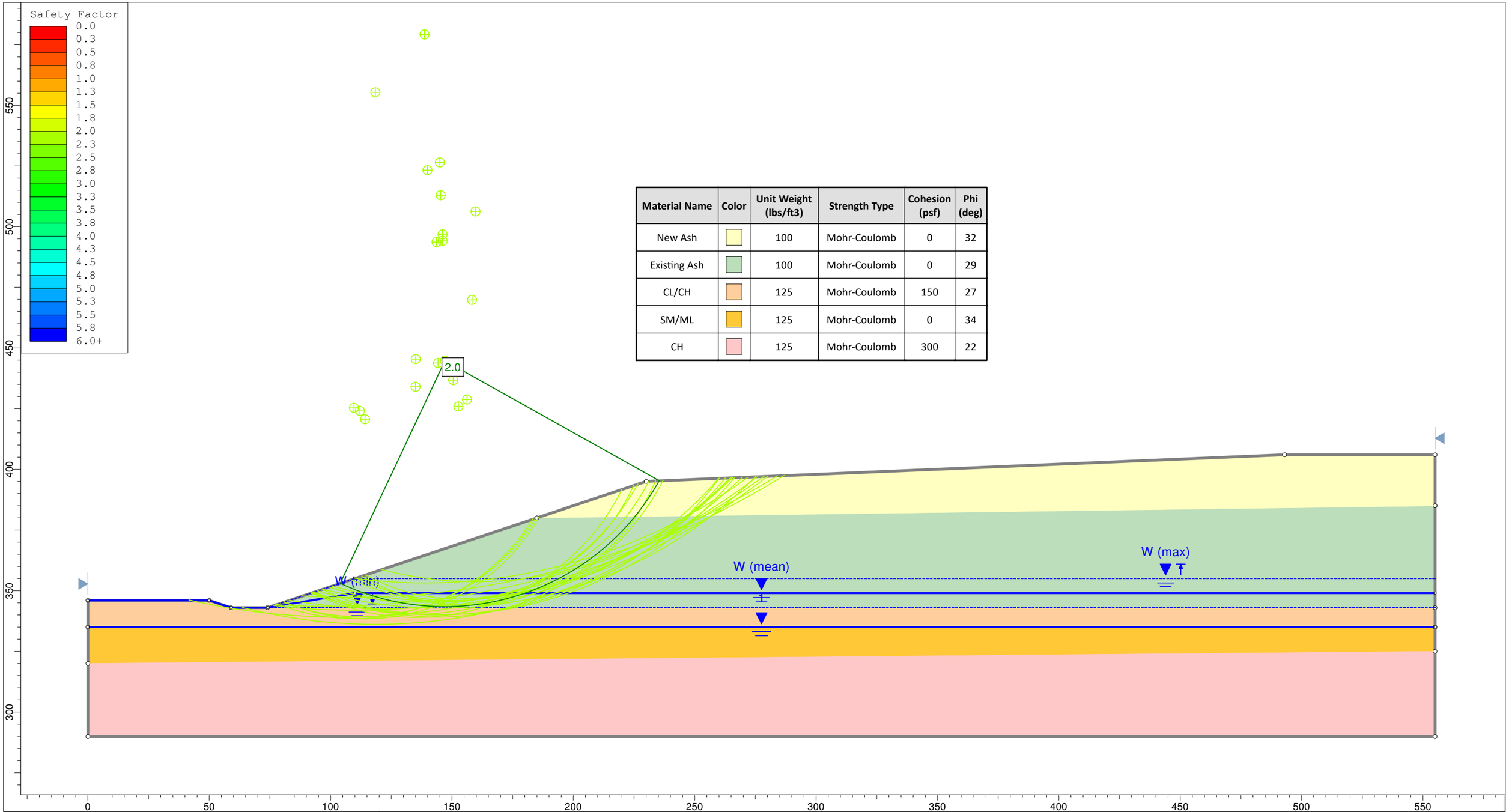
Material Name	Color
New Ash	
Existing Ash	
CL/CH	
SM/ML	
CH	



Auckland Consulting LLC

Project	Welsh Power Plant: CCR Landfill Final Closure				
Analysis Description	North Section: Model Geometry (Section C-C')				
Drawn By	J. Tayntor	Scale	1:450	Company	Auckland Consulting, LLC
Date	07/11/2023			File Name	LF-North Slope_0723.slim

SLIDE 6.039

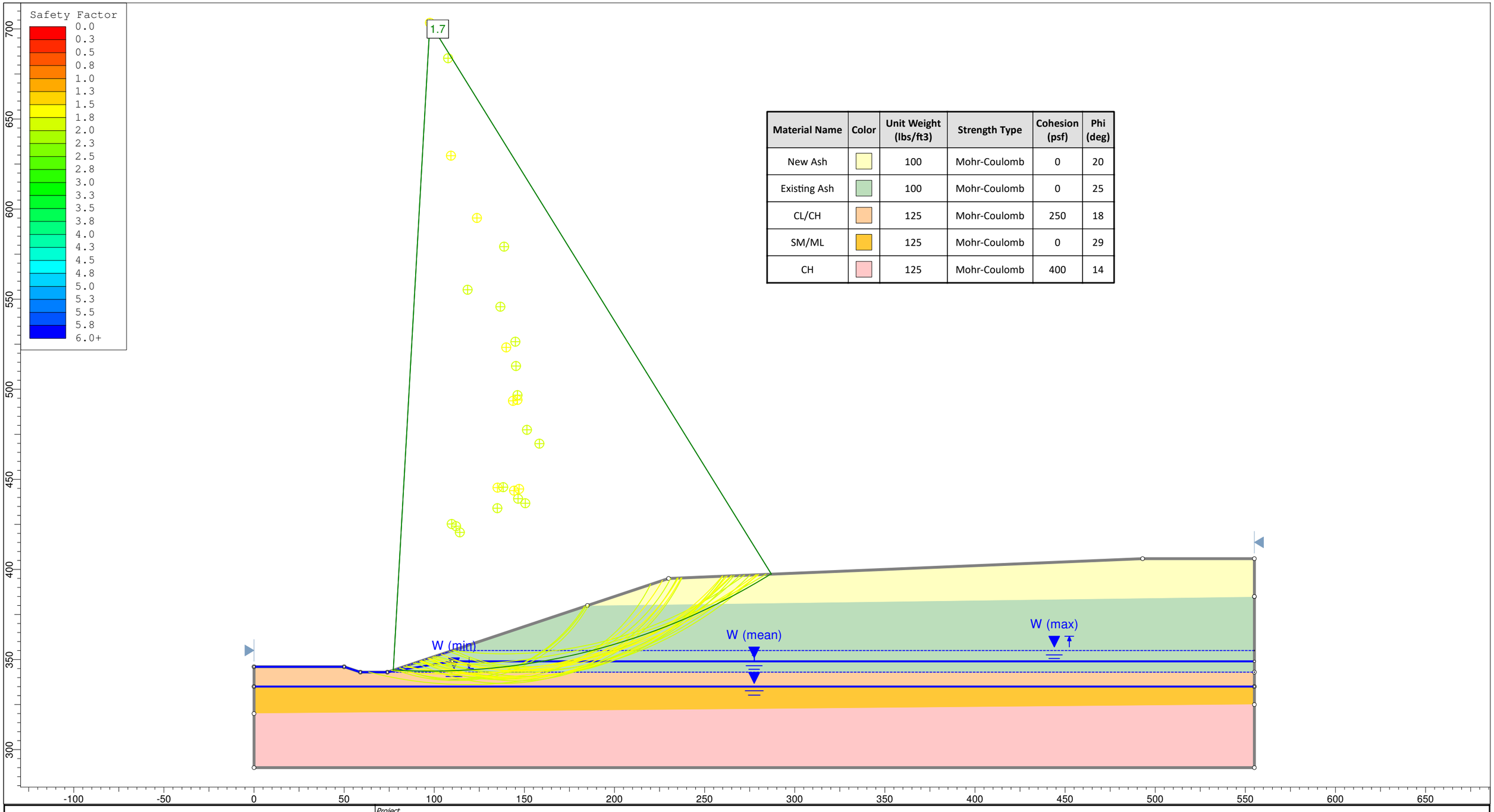


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	0	32
Existing Ash		100	Mohr-Coulomb	0	29
CL/CH		125	Mohr-Coulomb	150	27
SM/ML		125	Mohr-Coulomb	0	34
CH		125	Mohr-Coulomb	300	22

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Final Closure		
Analysis Description	North Section: End of Construction (Effective Stresses)		
Drawn By J. Tayntor	*Scale* 1:450	*Company*	Auckland Consulting, LLC
Date 07/12/2022		*File Name*	LF-North Slope_EOC (Effective Stress)_0723.slim

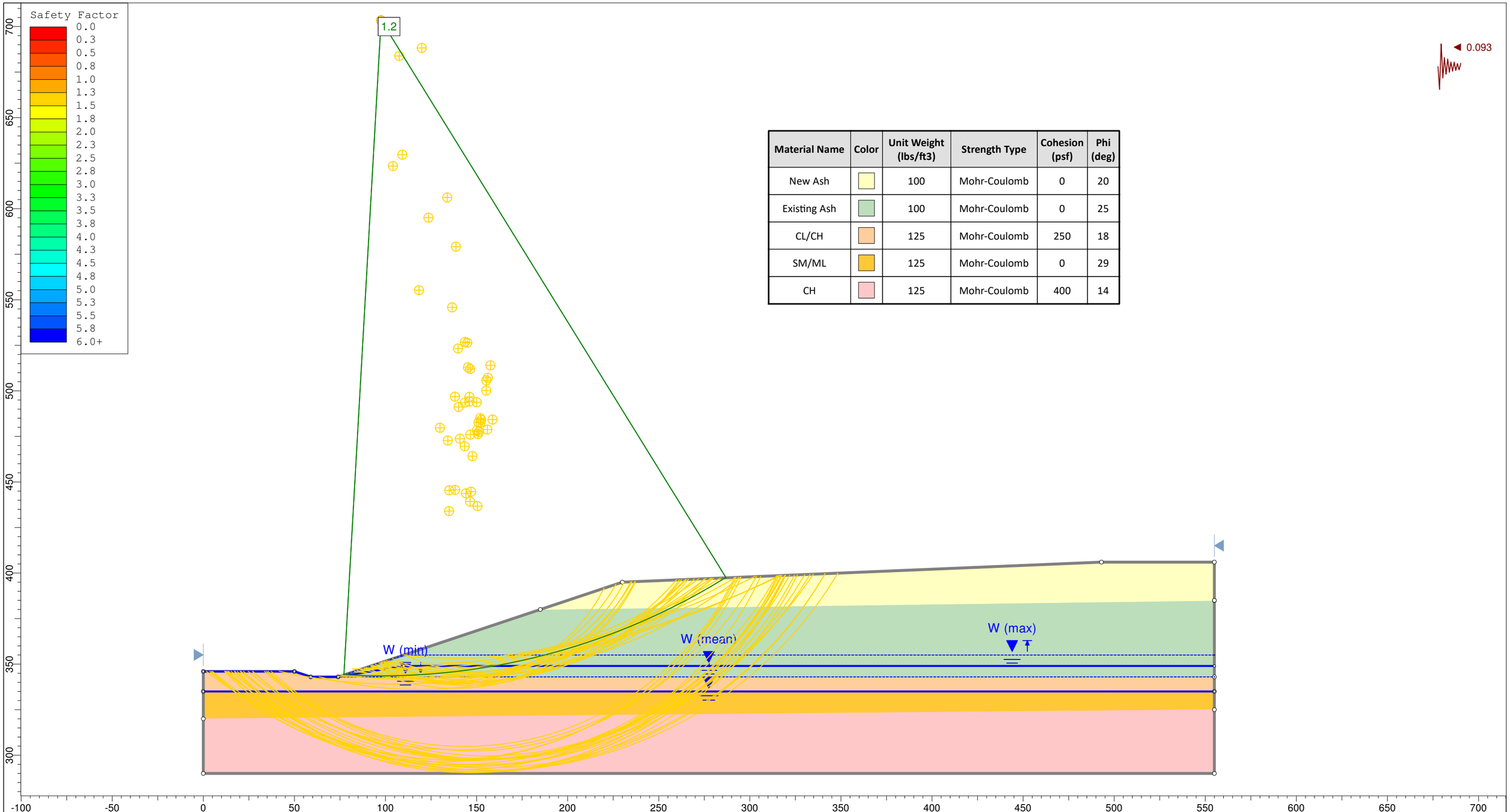


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	0	20
Existing Ash		100	Mohr-Coulomb	0	25
CL/CH		125	Mohr-Coulomb	250	18
SM/ML		125	Mohr-Coulomb	0	29
CH		125	Mohr-Coulomb	400	14

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Final Closure			
Analysis Description	North Section: End of Construction (Total Stresses)			
Drawn By	J. Tayntor	*Scale*	1:600	*Company* Auckland Consulting, LLC
Date	07/12/2022			*File Name* LF-North Slope_EOC (Total Stress)_0723.slim

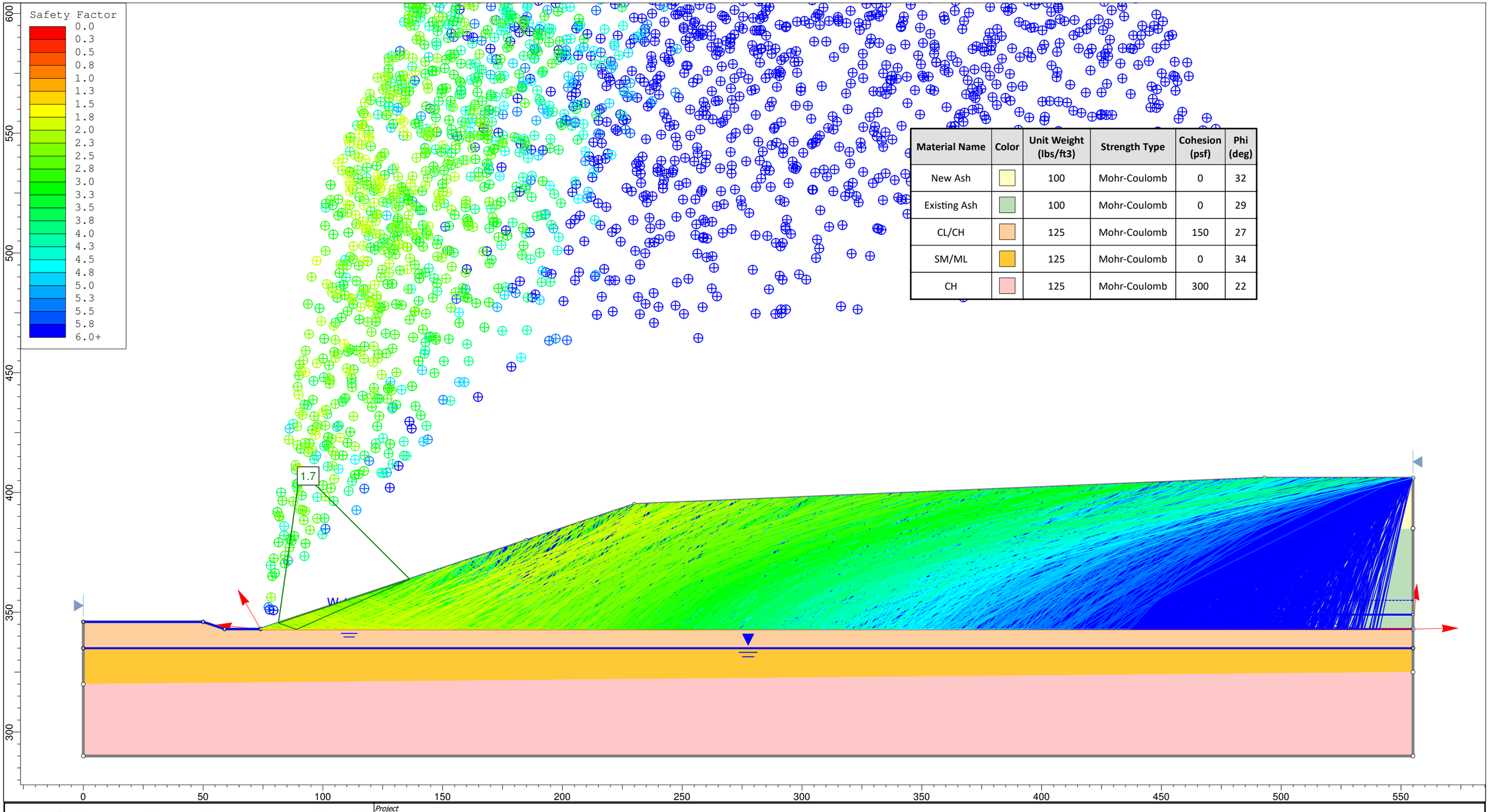


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	0	20
Existing Ash		100	Mohr-Coulomb	0	25
CL/CH		125	Mohr-Coulomb	250	18
SM/ML		125	Mohr-Coulomb	0	29
CH		125	Mohr-Coulomb	400	14

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Final Closure		
Analysis Description	North Section: End of Construction (Seismic Loading Conditions, Total Stresses)		
Drawn By J. Tayntor	*Scale* 1:600	*Company*	Auckland Consulting, LLC
Date 07/11/2023		*File Name*	LF-North Slope_EOC_Seismic Loading (Total Stress)_0723.slim



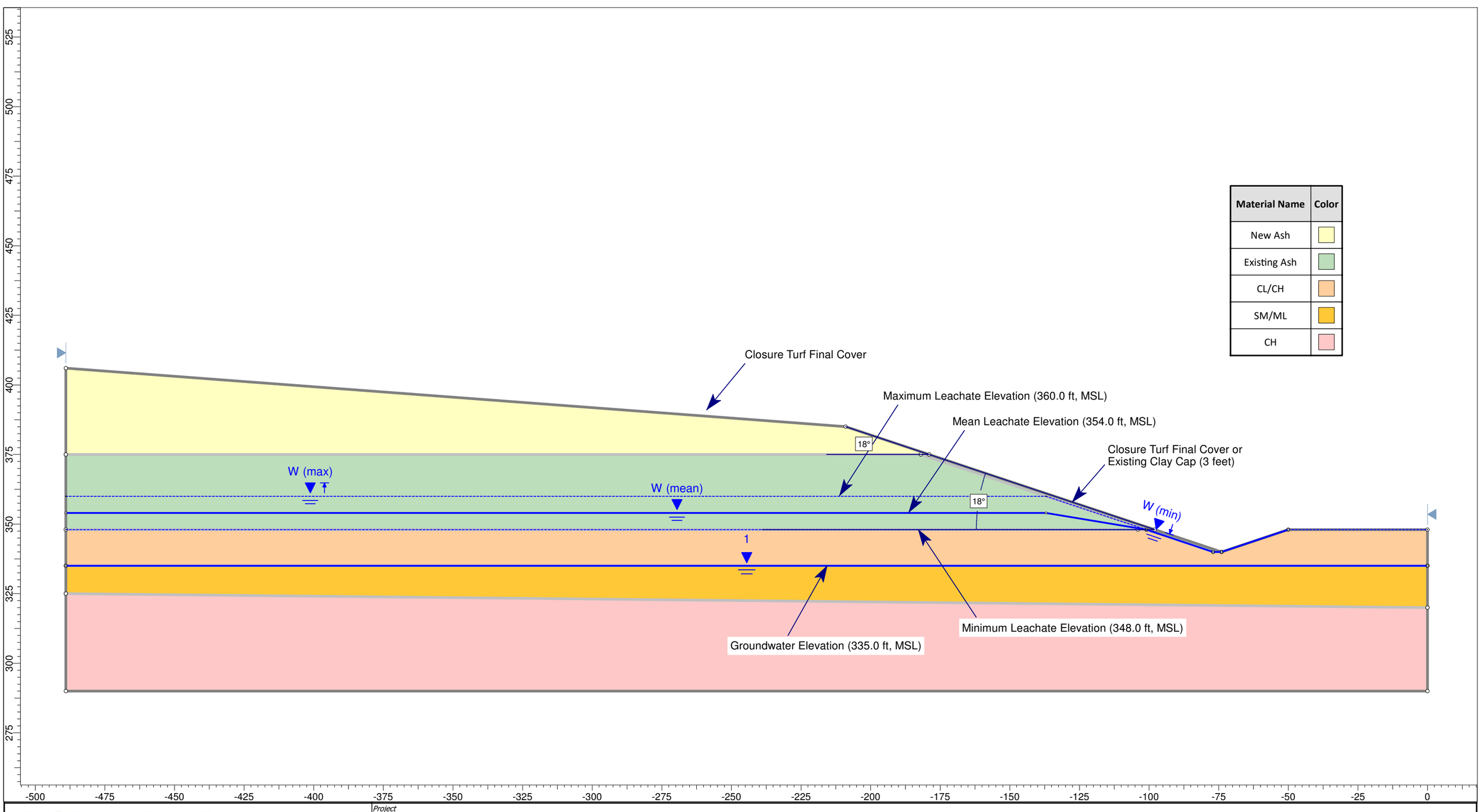
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	0	32
Existing Ash		100	Mohr-Coulomb	0	29
CL/CH		125	Mohr-Coulomb	150	27
SM/ML		125	Mohr-Coulomb	0	34
CH		125	Mohr-Coulomb	300	22

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Final Closure				
Analysis Description	North Section: End of Construction (Block Wedge Failure, Effective Stresses)				
Drawn By	J. Tayntor	*Scale*	1:450	*Company*	Auckland Consulting, LLC
Date	07/11/2023			*File Name*	LF-North Slope_EOC (Block Wedge Failure Effective Stress)_0723.slim

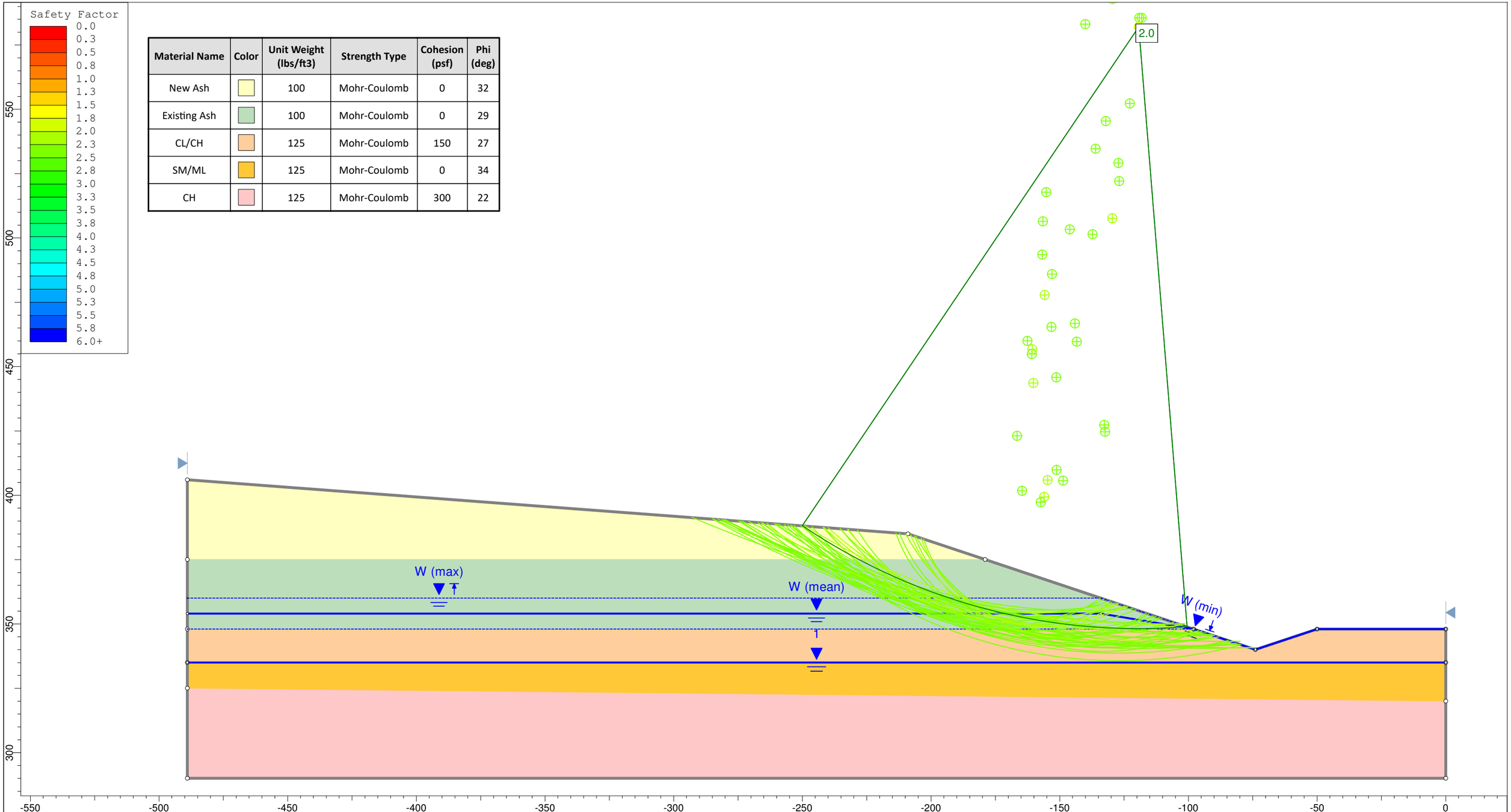
Material Name	Color
New Ash	
Existing Ash	
CL/CH	
SM/ML	
CH	



Auckland Consulting LLC

Project	Welsh Power Plant: CCR Landfill Final Closure				
Analysis Description	East Section: Model Geometry (Section A-A')				
Drawn By	J. Tayntor	Scale	1:385	Company	Auckland Consulting, LLC
Date	07/14/2023			File Name	LF-East Slope_0723.slim

SLIDE 6.039



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	0	32
Existing Ash		100	Mohr-Coulomb	0	29
CL/CH		125	Mohr-Coulomb	150	27
SM/ML		125	Mohr-Coulomb	0	34
CH		125	Mohr-Coulomb	300	22

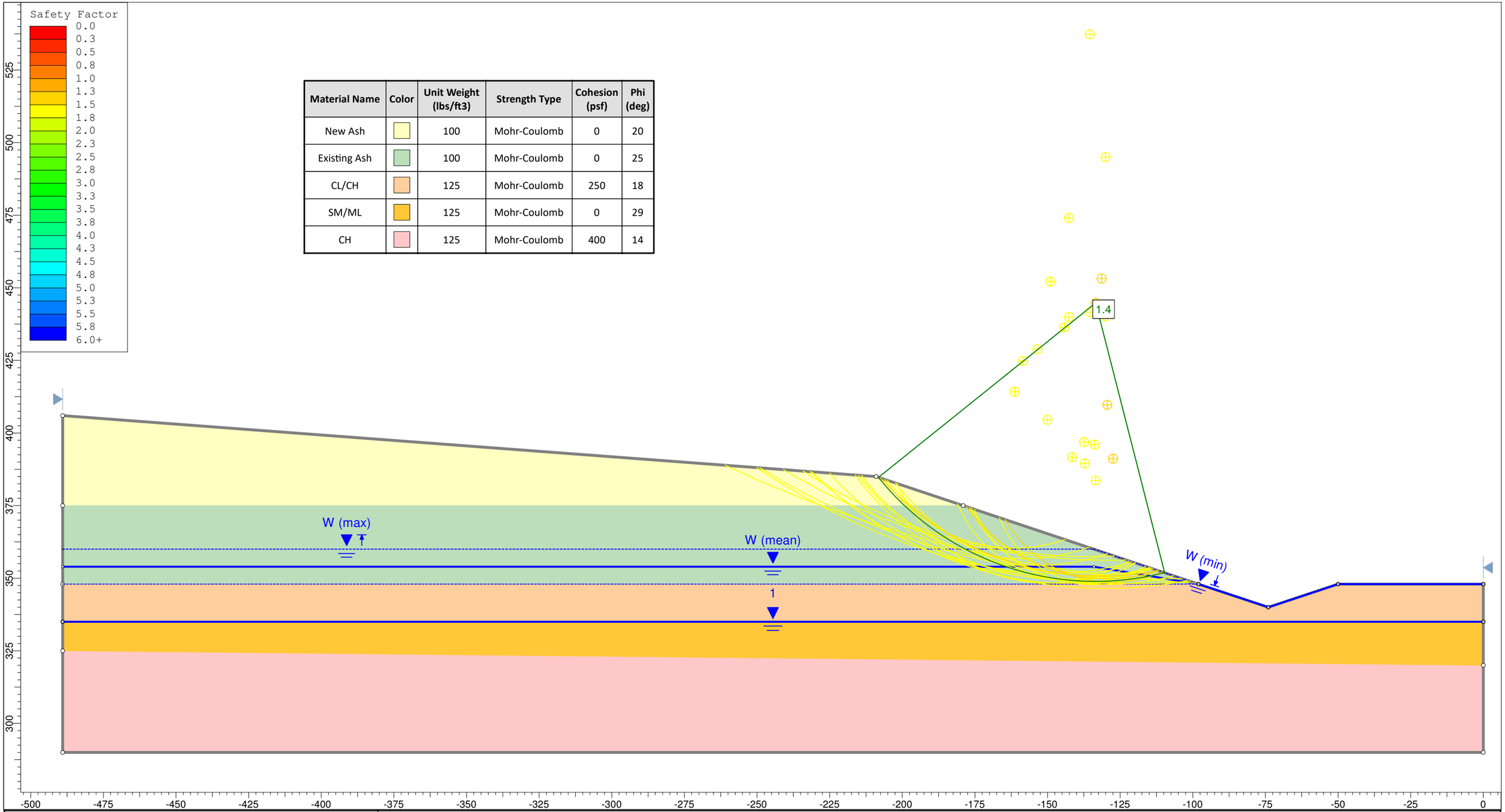
Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Final Closure		
Analysis Description	East Section: End of Construction (Effective Stresses)		
Drawn By J. Tayntor	*Scale* 1:425	*Company*	Auckland Consulting, LLC
Date 07/14/2023		*File Name*	LF-East Slope EOC (Effective Stress)_072022.slim

Safety Factor
0.0
0.3
0.5
0.8
1.0
1.3
1.5
1.8
2.0
2.3
2.5
2.8
3.0
3.3
3.5
3.8
4.0
4.3
4.5
4.8
5.0
5.3
5.5
5.8
6.0+

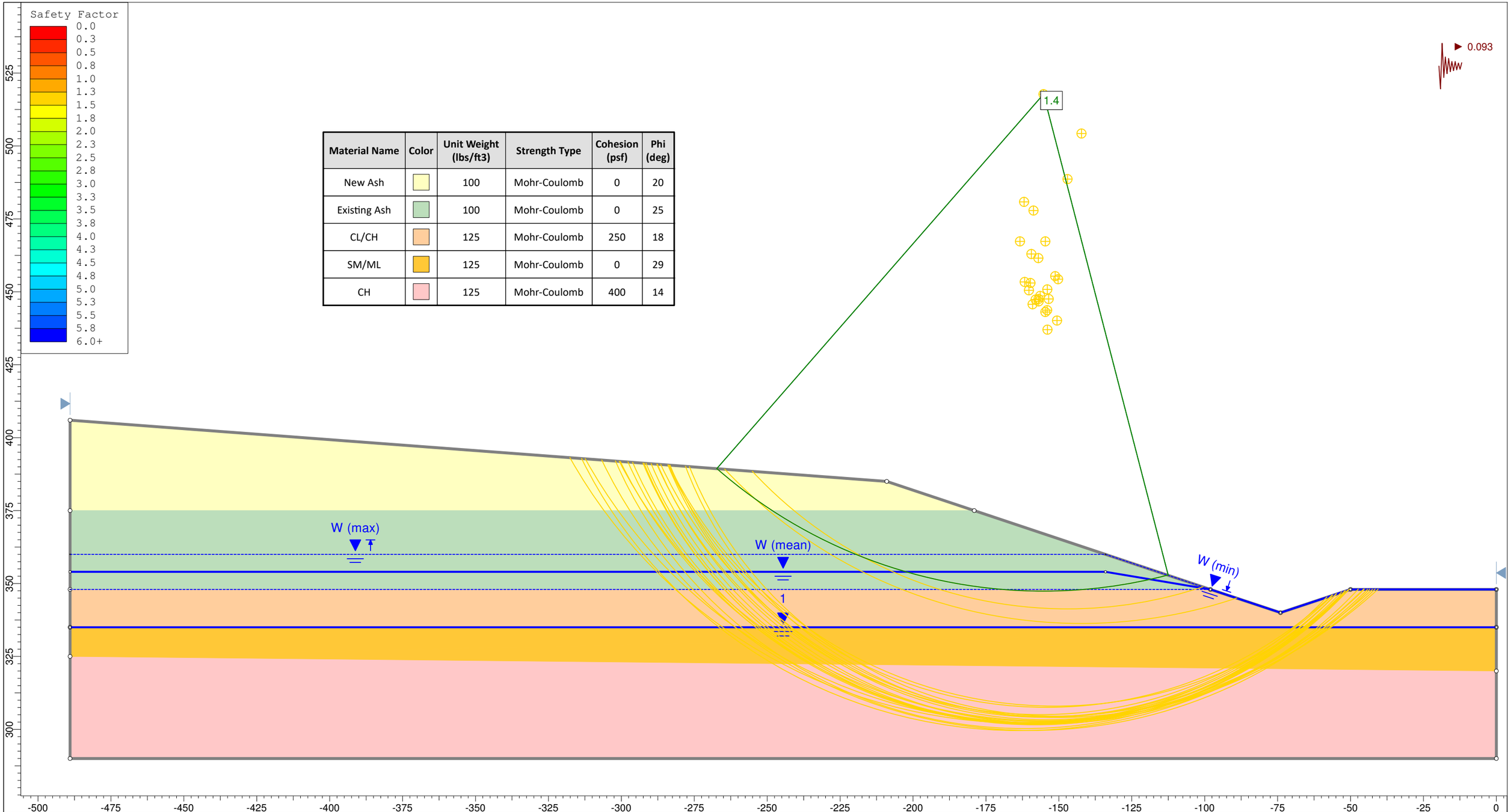
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	0	20
Existing Ash		100	Mohr-Coulomb	0	25
CL/CH		125	Mohr-Coulomb	250	18
SM/ML		125	Mohr-Coulomb	0	29
CH		125	Mohr-Coulomb	400	14



Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Final Closure		
Analysis Description	East Section: End of Construction (Total Stresses)		
Drawn By	J. Tayntor	*Scale* 1:375	*Company* Auckland Consulting, LLC
Date	07/14/2023		*File Name* LF-East Slope EOC (Total Stress)_0723.slim

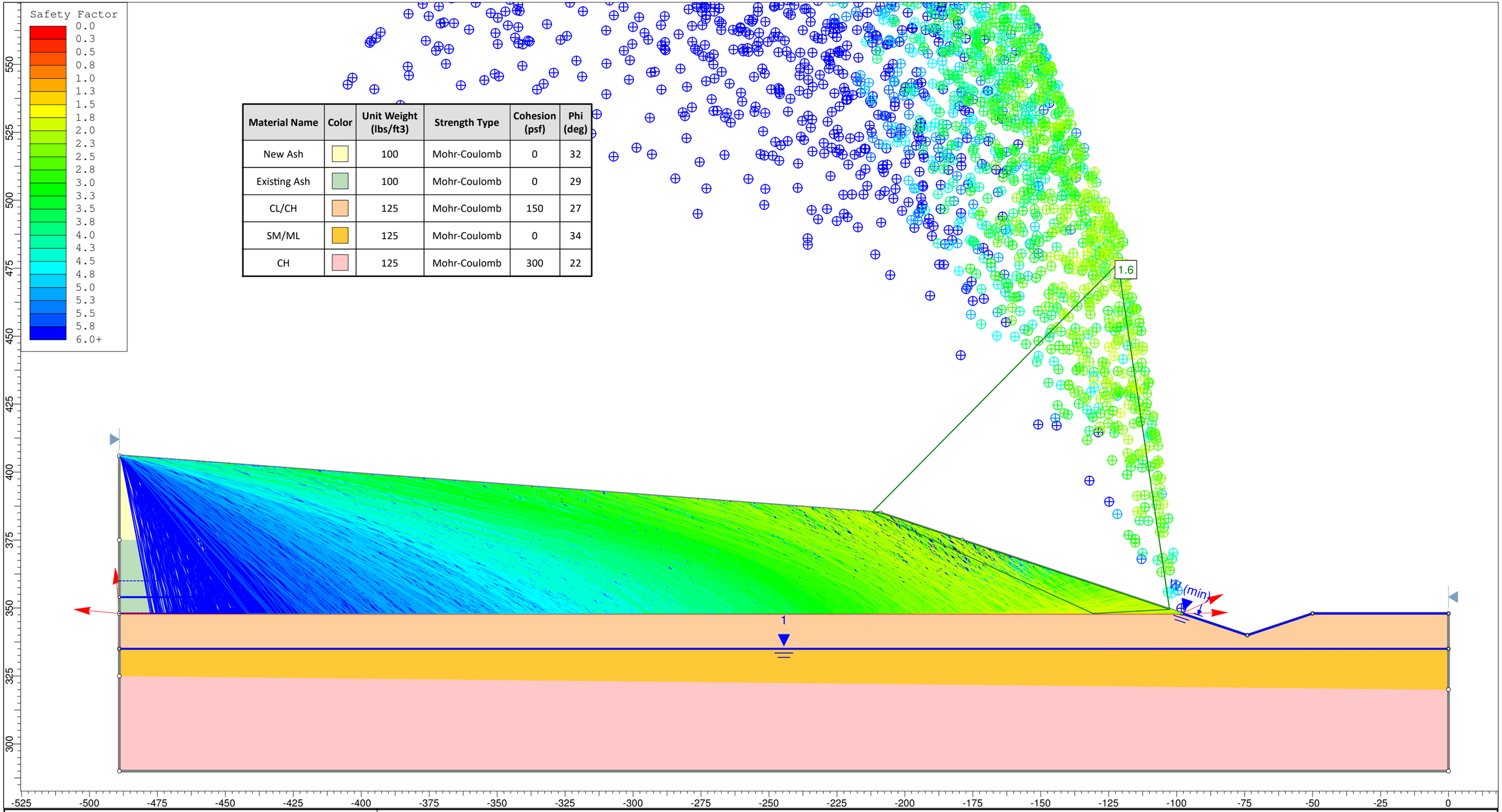


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	0	20
Existing Ash		100	Mohr-Coulomb	0	25
CL/CH		125	Mohr-Coulomb	250	18
SM/ML		125	Mohr-Coulomb	0	29
CH		125	Mohr-Coulomb	400	14

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill - Phase 1 Expansion		
Analysis Description	East Section: End of Construction (Seismic Loading Conditions, Total Stresses)		
Drawn By J. Tayntor	*Scale* 1:375	*Company*	Auckland Consulting, LLC
Date 07/12/2022		*File Name*	LF-East Slope EOC_Seismic Loading (Total Stress)_0723.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	0	32
Existing Ash		100	Mohr-Coulomb	0	29
CL/CH		125	Mohr-Coulomb	150	27
SM/ML		125	Mohr-Coulomb	0	34
CH		125	Mohr-Coulomb	300	22

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Final Closure			
Analysis Description	East Section: End of Construction (Block Wedge Failure, Effective Stresses)			
Drawn By	J. Tayntor	*Scale*	1:400	*Company* Auckland Consulting, LLC
Date	07/17/2023			*File Name* LF-East Slope EOC (Block Wedge Failure - Effective Stress)_0723.slim

Material Name	Color
Ash Fill	
CL-Native	
CH-Native	
ML	
Embankment Fill	

Closure Turf Final Cover

Maximum Leachate Elevation (371.0 ft, MSL)

Mean Leachate Elevation (367.0 ft, MSL)

Stability Dike/Embankment

Service Road

W (max)

W (mean)

W (min)

Minimum Leachate Elevation (363.0 ft, MSL)

1

Groundwater Elevation (333.0 ft, MSL)

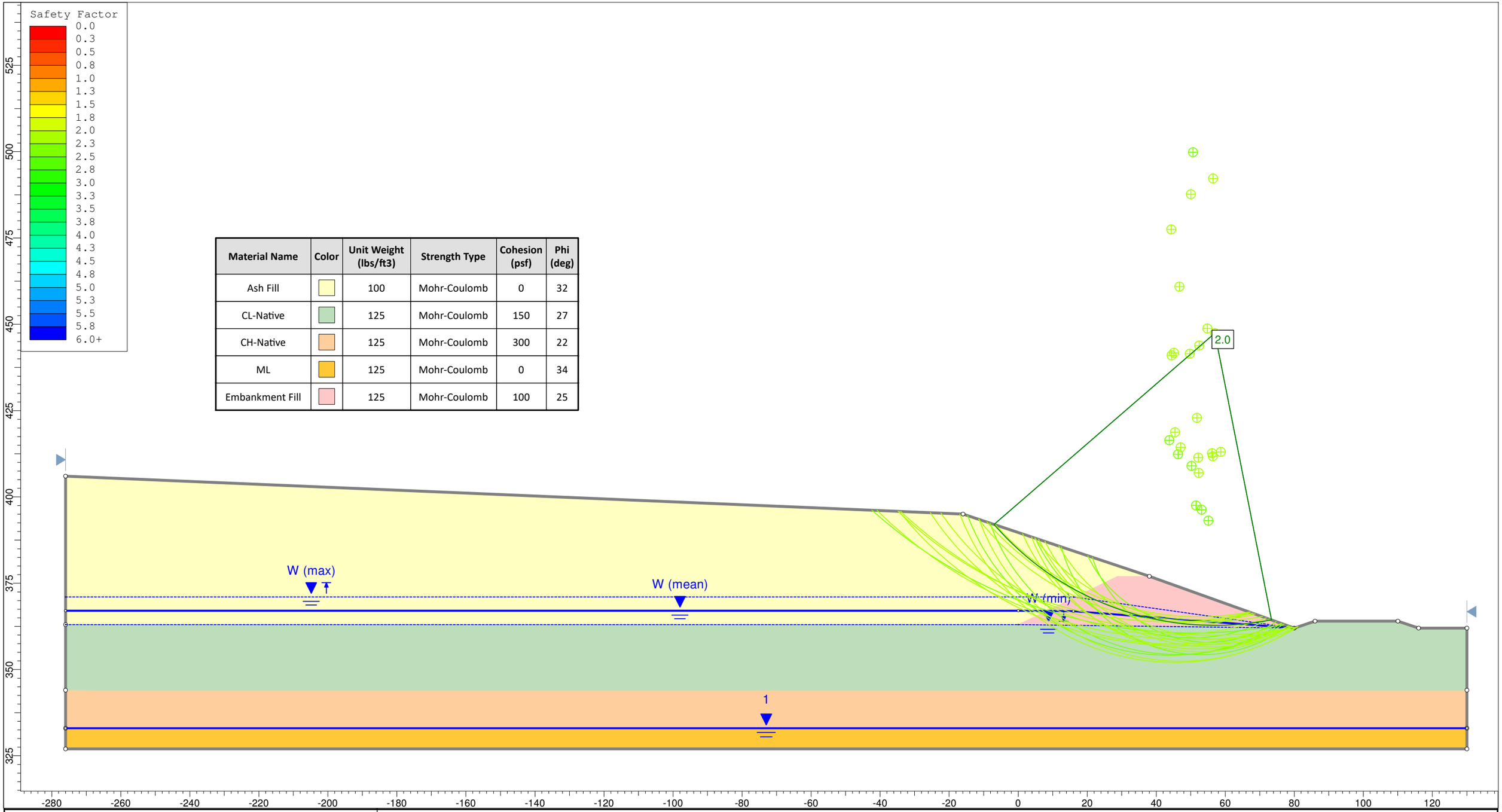
500 475 450 425 400 375 350 325 300

-280 -260 -240 -220 -200 -180 -160 -140 -120 -100 -80 -60 -40 -20 0 20 40 60 80 100 120

Auckland Consulting LLC

SLIDE 6.039

Project	Welsh Power Plant: CCR Landfill Final Closure		
Analysis Description	South Stability Dike/Embankment: Model Geometry (Section B-B')		
Drawn By: J. Tayntor	Scale: 1:310	Company: Auckland Consulting, LLC	
Date: 07/11/2023		File Name: FL-South Stability Dike_0723.slim	

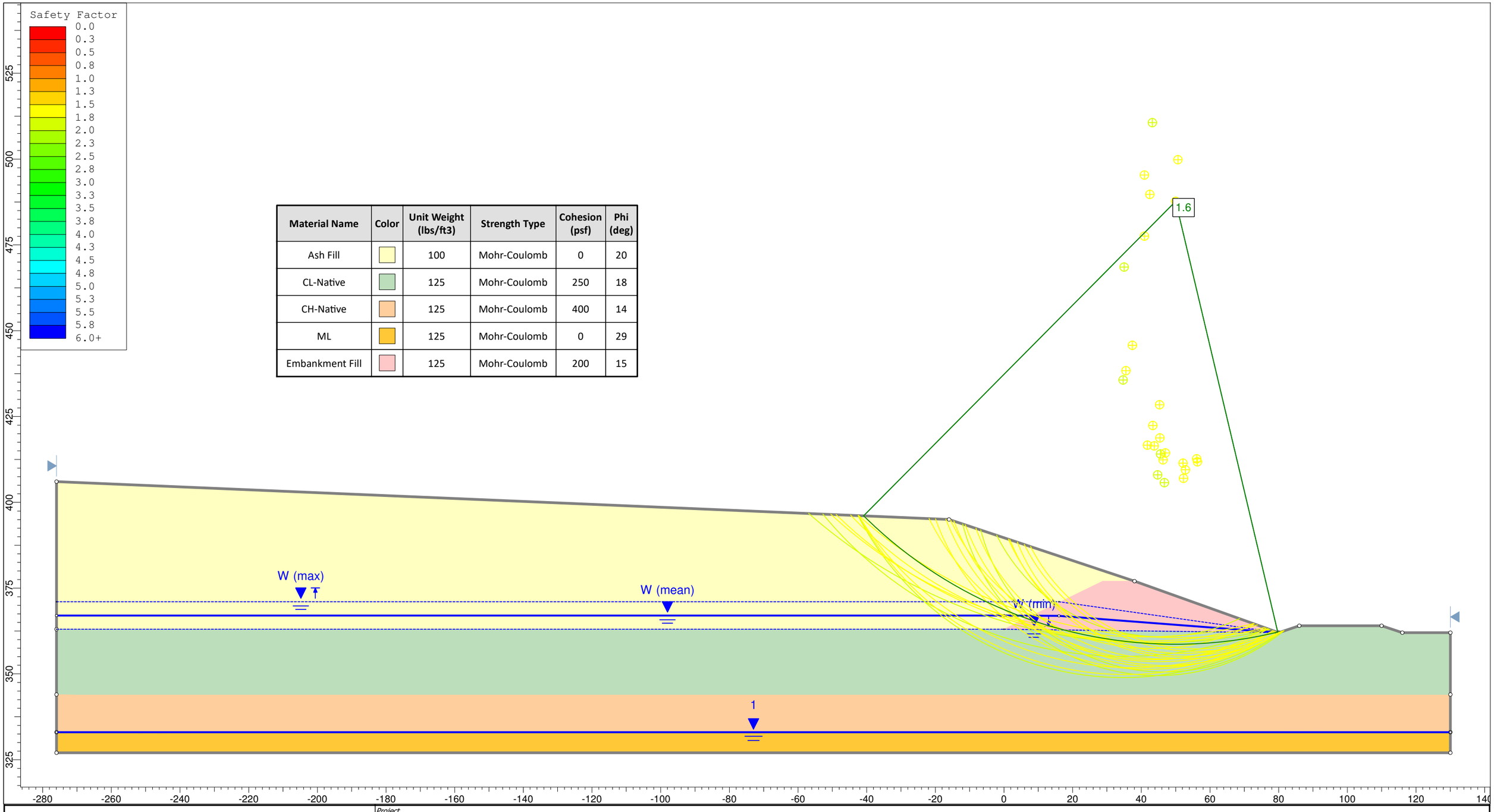


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Ash Fill		100	Mohr-Coulomb	0	32
CL-Native		125	Mohr-Coulomb	150	27
CH-Native		125	Mohr-Coulomb	300	22
ML		125	Mohr-Coulomb	0	34
Embankment Fill		125	Mohr-Coulomb	100	25

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Final Closure		
Analysis Description	South Stability Dike: End of Construction (Effective Stresses)		
Drawn By	J. Tayntor	*Scale* 1:315	*Company* Auckland Consulting, LLC
Date	07/11/2023		*File Name* LF-South Stability Dike EOC (Effective Stress)_07233.slim

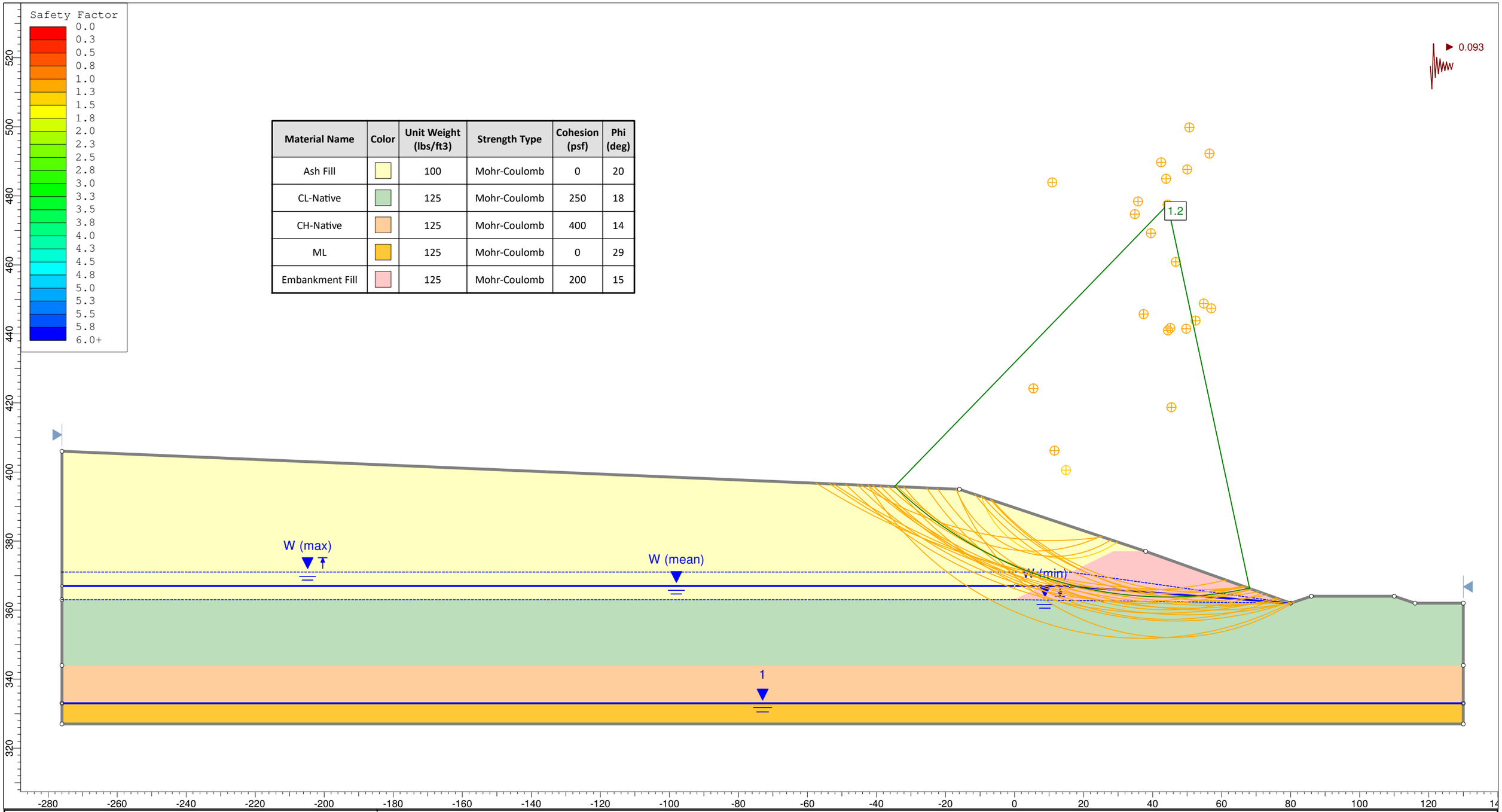


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Ash Fill		100	Mohr-Coulomb	0	20
CL-Native		125	Mohr-Coulomb	250	18
CH-Native		125	Mohr-Coulomb	400	14
ML		125	Mohr-Coulomb	0	29
Embankment Fill		125	Mohr-Coulomb	200	15

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Final Closure		
Analysis Description	South Stability Dike: End of Construction (Total Stresses)		
Drawn By J. Tayntor	*Scale* 1:315	*Company*	Auckland Consulting, LLC
Date 07/14/2023		*File Name*	LF-South Stability Dike EOC (Total Stress)_0723.slim

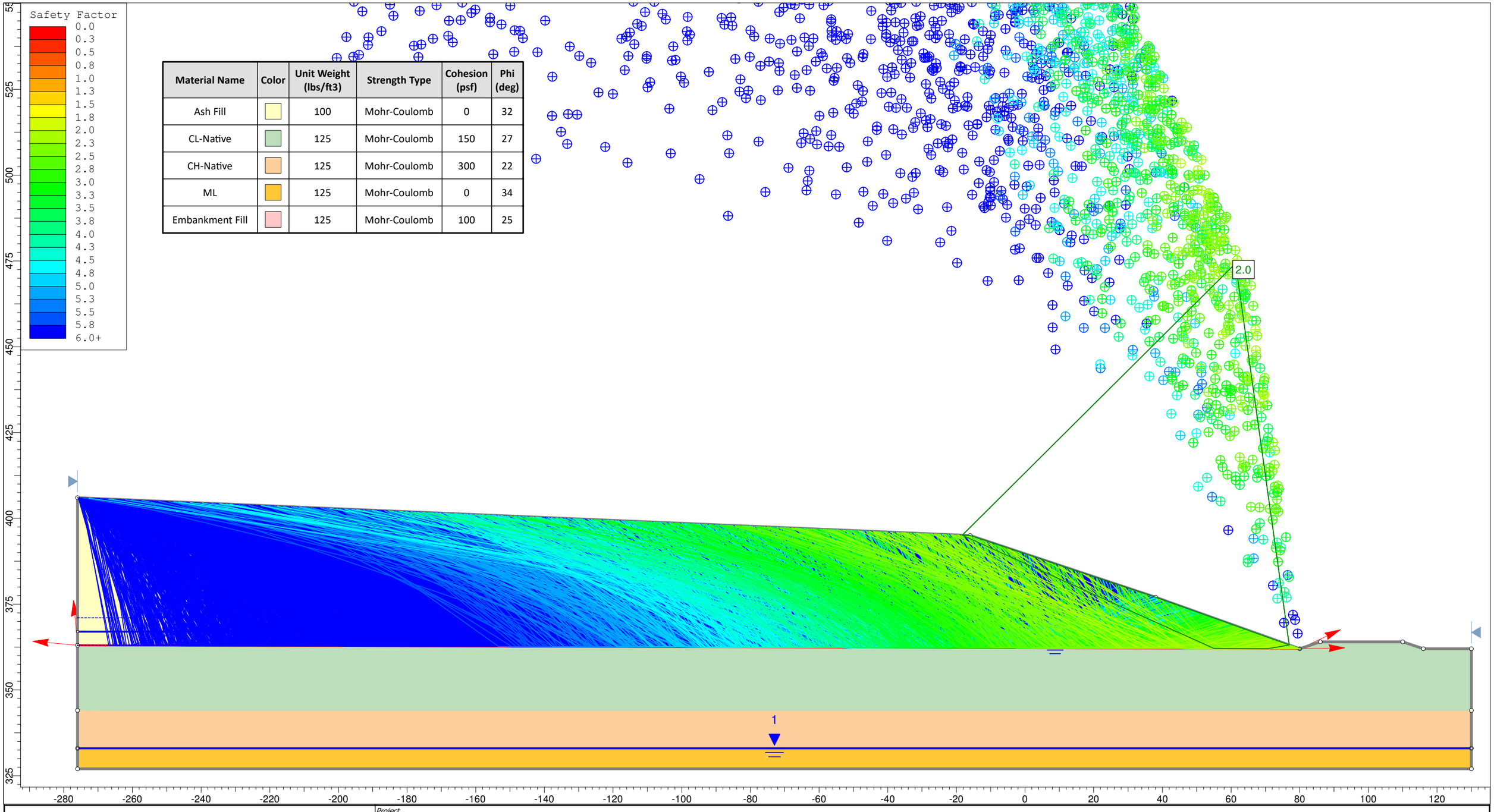


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Ash Fill		100	Mohr-Coulomb	0	20
CL-Native		125	Mohr-Coulomb	250	18
CH-Native		125	Mohr-Coulomb	400	14
ML		125	Mohr-Coulomb	0	29
Embankment Fill		125	Mohr-Coulomb	200	15

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Final Closure		
Analysis Description	South Stability Dike: End of Construction (Seismic Loading Conditions, Total Stresses)		
Drawn By: J. Tayntor	Scale: 1:315	Company: Auckland Consulting, LLC	
Date: 07/14/2023		File Name: LF-South Stability Dike EOC_Seismic Loading (Total Stress)_0723.slim	

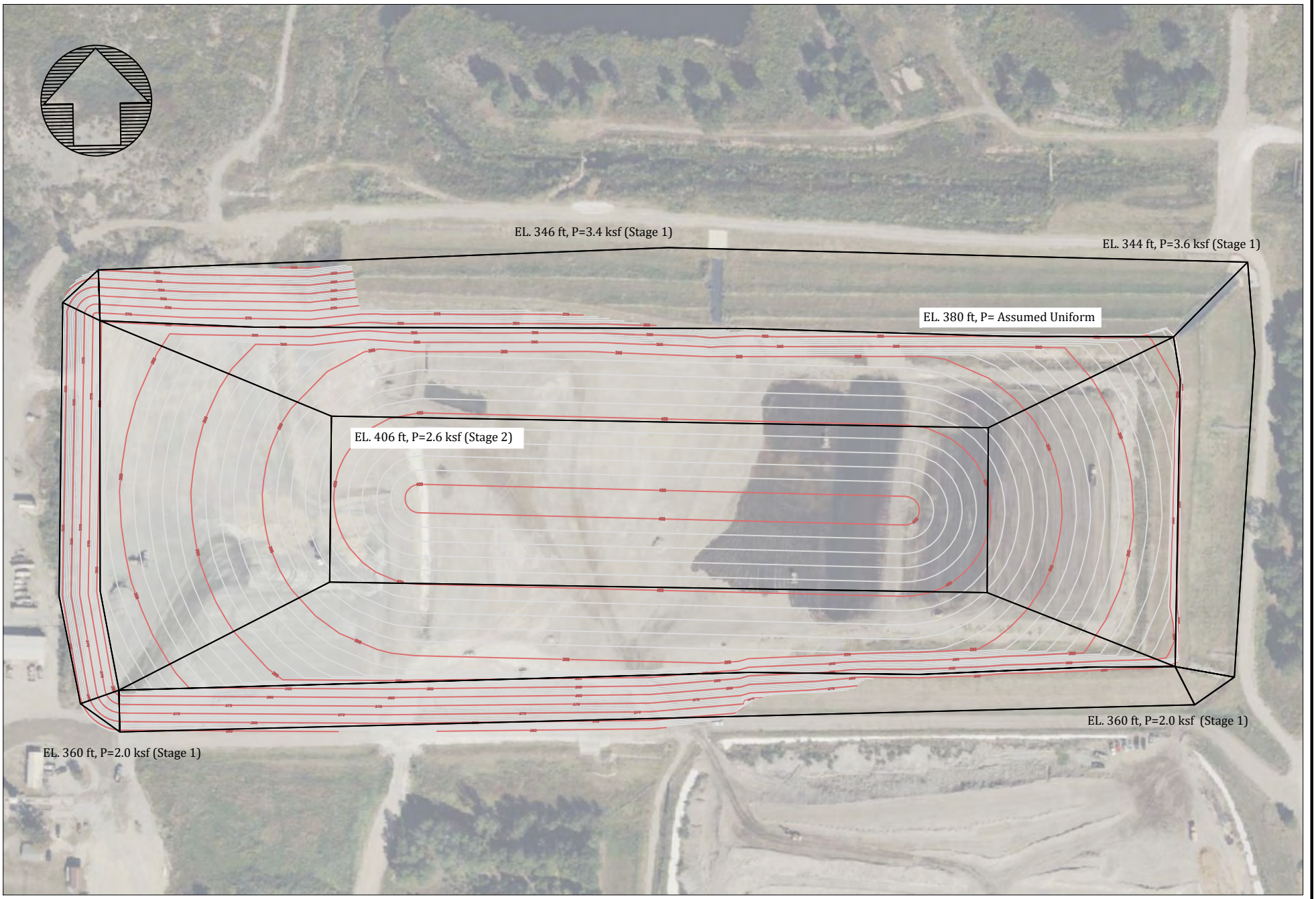


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Ash Fill		100	Mohr-Coulomb	0	32
CL-Native		125	Mohr-Coulomb	150	27
CH-Native		125	Mohr-Coulomb	300	22
ML		125	Mohr-Coulomb	0	34
Embankment Fill		125	Mohr-Coulomb	100	25

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Final Closure			
Analysis Description	South Stability Dike: End of Construction (Block Wedge Failure, Effective Stresses)			
Drawn By	J. Tayntor	*Scale*	1:315	*Company* Auckland Consulting, LLC
Date	07/14/2023			*File Name* LF-South Stability Dike EOC (Block Wedge Failure - Effective Stress)_0723.slim



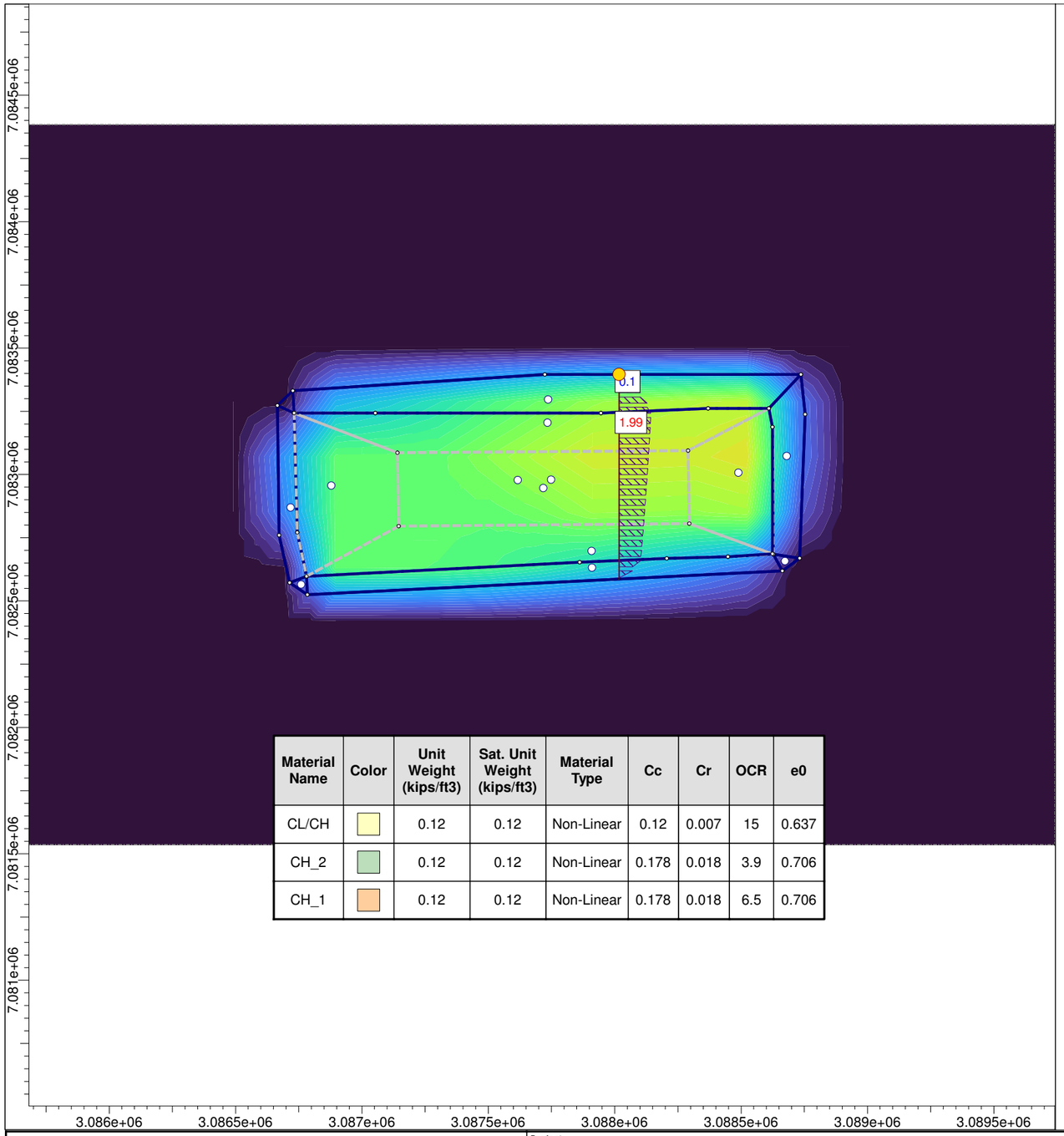
Auckland Consulting, LLC
PO Box 8155
Jacksonville, Texas 75766
TBPE Firm Registration No. F-16721

FIGURE A-2: Settle Model Areas
Welsh Power Plant - CCR Landfill Final Closure
Pittsburg, Texas

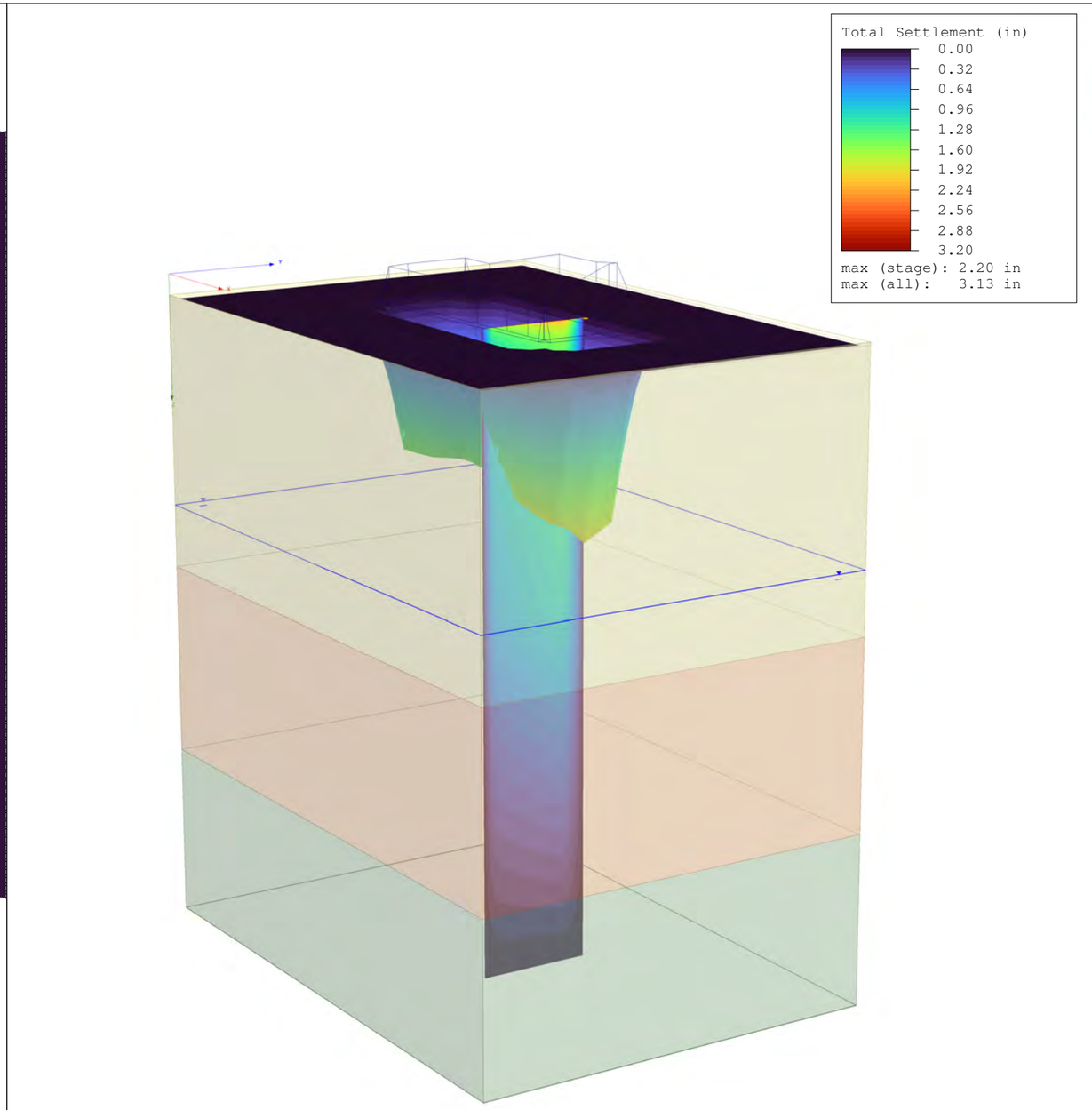
No.	Revision	Date

Project No.:	2023-007
Date:	06/20/2023
Drawn by:	JJT
Scale:	NTS

Sheet No.
1 of 1



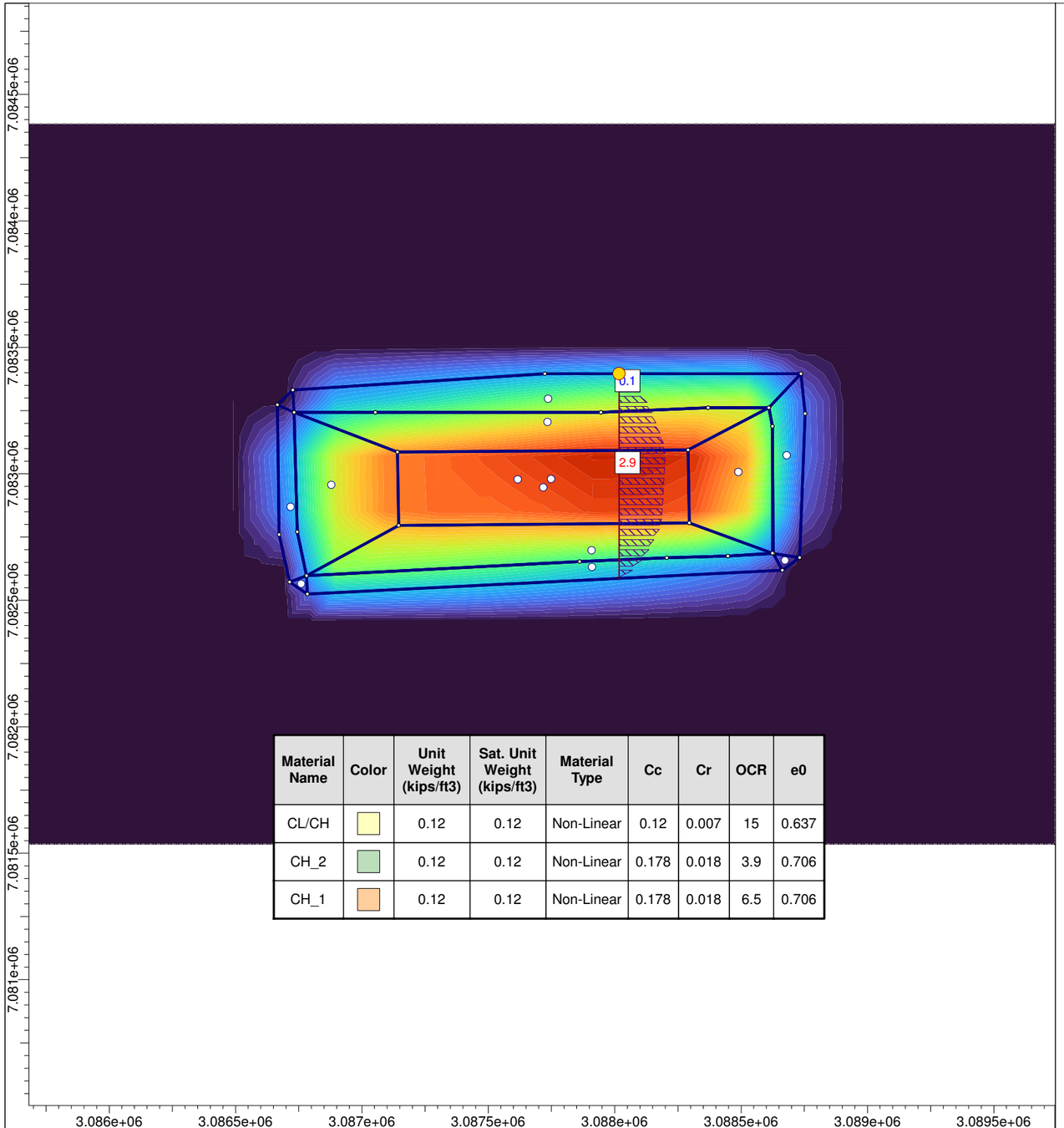
Material Name	Color	Unit Weight (kips/ft3)	Sat. Unit Weight (kips/ft3)	Material Type	Cc	Cr	OCR	e0
CL/CH		0.12	0.12	Non-Linear	0.12	0.007	15	0.637
CH_2		0.12	0.12	Non-Linear	0.178	0.018	3.9	0.706
CH_1		0.12	0.12	Non-Linear	0.178	0.018	6.5	0.706



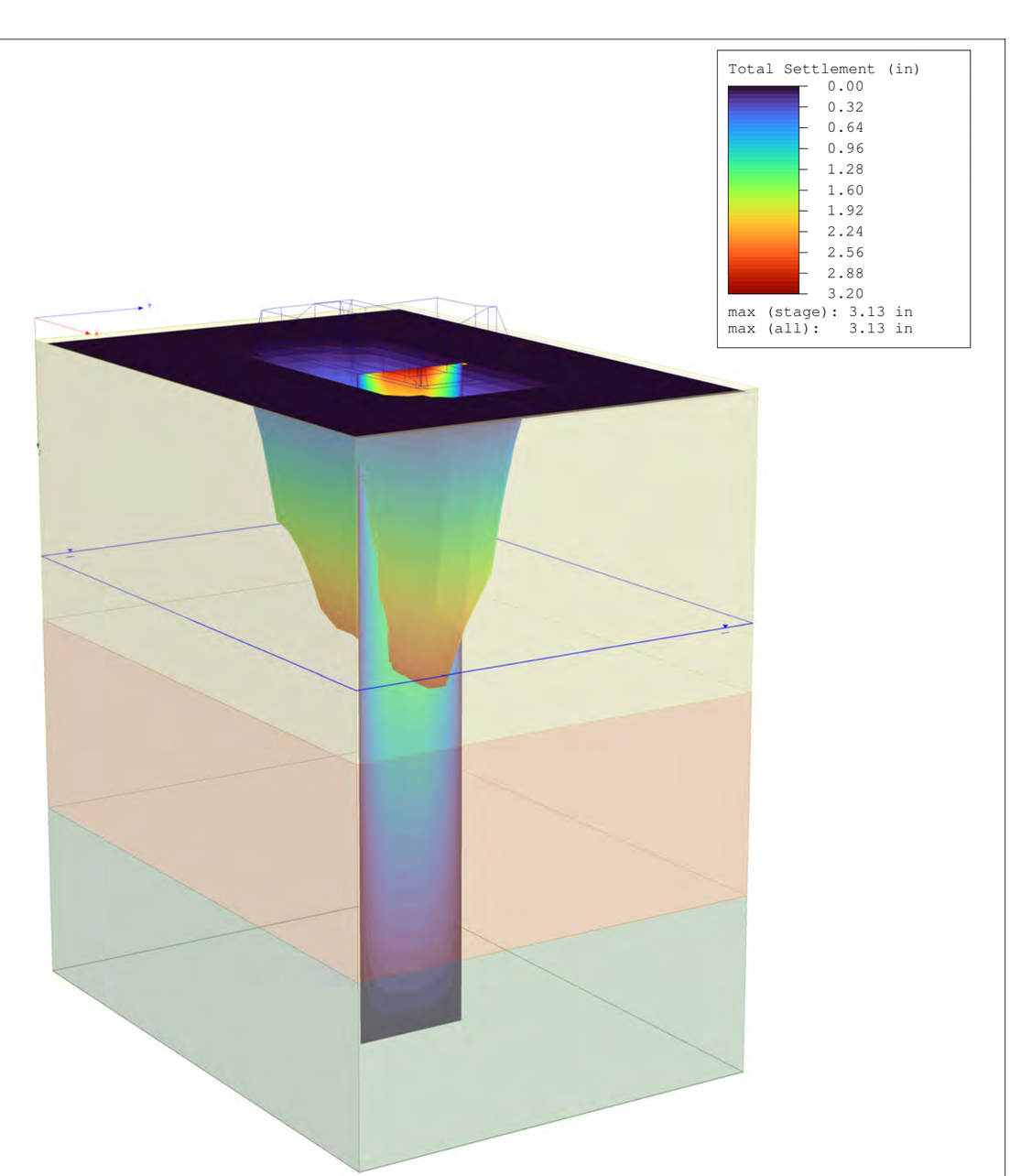
Auckland Consulting LLC

SETTLE3 5.020

Project	Welsh Power Plant: CCR Landfill - Final Closure		
Analysis Description	Settlement Analysis - Stage 1 (Foundation Soils)		
Drawn By	J. Tayntor	*Company*	Auckland Consulting, LLC
Date	6/20/2023, 3:08:32 PM	*File Name*	2023-007 Settle_LF_062023.s3z



Material Name	Color	Unit Weight (kips/ft3)	Sat. Unit Weight (kips/ft3)	Material Type	Cc	Cr	OCR	e0
CL/CH		0.12	0.12	Non-Linear	0.12	0.007	15	0.637
CH_2		0.12	0.12	Non-Linear	0.178	0.018	3.9	0.706
CH_1		0.12	0.12	Non-Linear	0.178	0.018	6.5	0.706



Auckland Consulting LLC

SETTLE3 5.020

Project	Welsh Power Plant: CCR Landfill - Final Closure		
Analysis Description	Settlement Analysis - Stage 2 (Foundation Soils)		
Drawn By	J. Tayntor	*Company*	Auckland Consulting, LLC
Date	6/20/2023, 3:08:32 PM	*File Name*	2023-007 Settle_LF_062023.s3z

CCR Landfill: Final Closure
Stability and Settlement Assessment
Welsh Power Plant
Auckland Project No. 2023-007

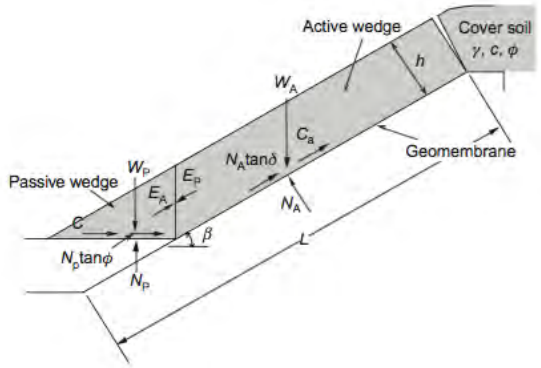
Final Cap Veneer Stability Analysis and Interface Friction Laboratory Data

Static Conditions - Cover Soil Forces (No Equipment Loading)

	FS	β	L	γ	h	Φ	c	δ	C	c_a	C_A	W_A	W_P	N_A	A	B	C
Interface	Safety Factor	Slope (degrees)	Length of Slope	Unit Weight of Cover Soil	Thickness of Cover Soil (feet)	Internal Friction Angle of Cover Soil (degrees)	Cohesion of Cover Soil (lb/ft2)	Interface Friction Angle (degrees)	Cohesive Force Along the Failure Plane, Passive Wedge (lb/ft2)	Adhesion between Cover Soil (active) and the Geomembrane (lb/ft^2)	Adhesive Force between Cover Soil and Geomembrane	Weight of Active Wedge (lb/ft)	Weight of Neutral Block (lb/ft)	Effective Force Normal to Failure Plane, Active Wedge	Resultant A	Resultant B	Resultant C
Intermediate (3:1)	**2.91**	18.40	80.00	115.00	1.500	31.70	0.00	27.50	0.00	69.00	5192.10	12,937.22	431.95	12,275.82	1,223.09	- 3,804.59	712.73
Intermediate (16:1)	**15.53**	3.52	250.00	115.00	1.500	31.70	0.00	27.50	0.00	69.00	15564.25	38,902.66	2,111.17	38,829.27	146.37	- 2,278.10	83.30

Where:

W_A	total weight of active wedge
W_P	total weight of passive wedge
N_A	effective force normal to the failure plane of the active wedge
N_p	effective force normal to the failure plane of the passive wedge
γ	unit weight of the cover soil
h	thickness of cover soil
L	length of slope measures along the geomembrane
β	soil slope angle beneath the geomembrane
Φ	friction angle of cover soil
δ	interface friction angle between cover soil and geomembrane (or cured CCR)
C_A	adhesive force between cover soil of the active wedge and the geomembrane
c_A	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
E_A	interwedge force acting on the active wedge from the passive wedge
E_P	interwedge force acting on the passive wedge from the active wedge
FS	factor of safety against cover soil sliding on the geomembrane



$$W_A = \gamma h^2 \left(\frac{L}{h} - \frac{1}{\sin\beta} - \frac{\tan\beta}{2}\right) \quad (3)$$

$$N_A = W_A \cos\beta \quad (4)$$

$$C_a = c_a \left(L - \frac{h}{\sin\beta}\right) \quad (5)$$

$$W_P = \frac{\gamma h^2}{\sin 2\beta} \quad (8)$$

$$N_p = W_P + E_P \sin\beta \quad (9)$$

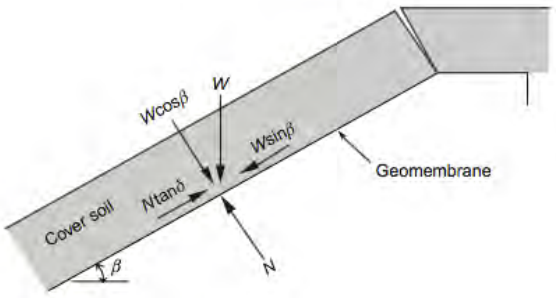
$$C = \frac{ch}{\sin\beta} \quad (10)$$

$$a = (W_A - N_A \cos\beta)\cos\beta$$

$$b = -[(W_A - N_A \cos\beta)\sin\beta\tan\phi + (N_A \tan\delta + C_a)\sin\beta\cos\beta + \sin\beta(C + W_P \tan\phi)] \quad (14)$$

$$c = (N_A \tan\delta + C_a)\sin^2\beta\tan\phi$$

$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a} \quad (15)$$



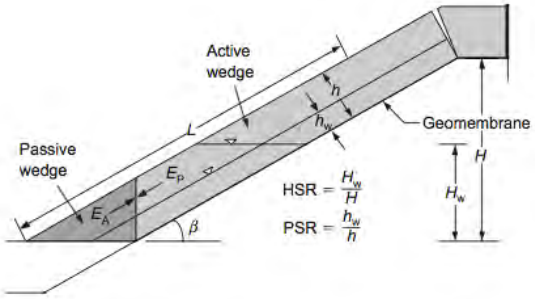
Parallel to Slope - Seepage Build-up

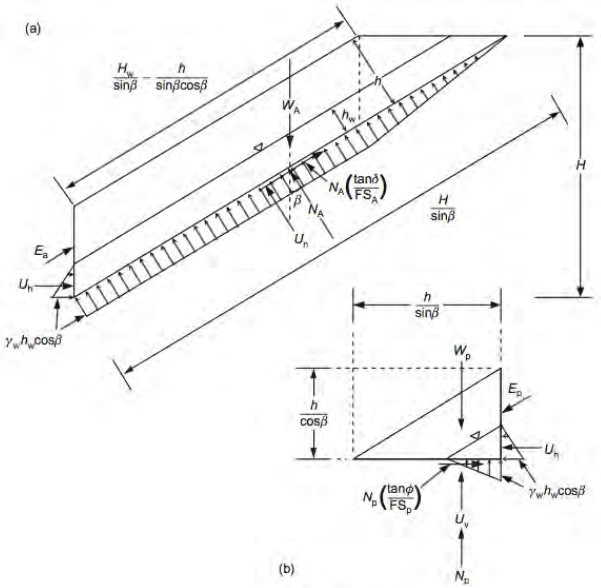
γ_{dry}	115 pcf
$\gamma_{sat'd}$	125 pcf
γ_w	62.4 pcf

	FS	β	L	h	h_w	H	δ	Φ	c	U_h	U_N	U_V	c_a	C_A	W_A	W_P	N_A	A	B	C
Interface	Safety Factor	Slope (degrees)	Length of Slope	Thickness of Cover Soil (feet)	Height of water with Cover Soil (ft)	Vertical Height of the Slope Measured from the Toe	Interface Friction Angle between Cover Soil and Geomembrane	Internal Friction Angle of Cover Soil (degrees)	Cohesion of Cover Soil (lb/ft2)	Resultant Pore Pressures on Interwedge Surface	Resultant Pore Pressures Perpendicular to Slope	Resultant Vertical Pore Pressures acting on Passive Wedge	Adhesion between Cover Soil (active) and the Geomembrane (lb/ft^2)	Adhesive Force between Cover Soil and Geomembrane	Weight of Active Wedge (lb/ft)	Weight of Neutral Block (lb/ft)	Effective Force Normal to Failure Plane, Active Wedge	Resultant A	Resultant B	Resultant C
Intermediate (3:1)	**0.73**	18.40	80.00	1.500	1.500	25.000	27.500	31.70	0.00	70.20	6811.90	211.03	69.00	5192.10	12,638.19	469.51	5,202.34	3,792.28	- 3,494.07	527.95
Intermediate (16:1)	**4.47**	3.52	250.00	1.500	1.500	16.000	27.500	31.70	0.00	70.20	23202.69	1141.22	69.00	15564.25	46,360.94	2,294.75	23,075.09	2,841.32	- 12,807.18	455.49

Where:

W_A	total weight of active wedge
W_P	total weight of passive wedge
N_A	effective force normal to the failure plane of the active wedge
γ_{dry}	dry unit weight of the cover soil
$\gamma_{sat'd}$	saturated unit weight of the cover soil
γ_w	unit weight of water
h	thickness of cover soil
h_w	height of water within cover soil
H	vertical height of the slope measured from the toe
L	length of slope measures along the geomembrane
β	soil slope angle beneath the geomembrane
Φ	friction angle of cover soil
δ	interface friction angle between cover soil and geomembrane (or cured CCR)
C_A	adhesive force between cover soil of the active wedge and the geomembrane
c_A	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
E_A	interwedge force acting on the active wedge from the passive wedge
E_P	interwedge force acting on the passive wedge from the active wedge
FS	factor of safety against cover soil sliding on the geomembrane
Uh	resultant of pore pressures acting on the interwedge surfaces
Un	resultant of pore pressures acting perpendicuar to the slope
Uv	resultant of the vertical pore pressures acting on the passive wedge





$$W_A = \frac{\gamma_{dry}(h - h_w)[2H\cos\beta - (h + h_w)]}{\sin 2\beta} + \frac{\gamma_{sat'd} h_w (2H\cos\beta - h_w)}{\sin 2\beta}$$

$$U_n = \frac{\gamma_w h_w \cos\beta (2H\cos\beta - h_w)}{\sin 2\beta}$$

$$U_h = \frac{\gamma_w h_w^2}{2}$$

$$W_P = \frac{\gamma_{dry}(h^2 - h_w^2) + \gamma_{sat'd} h_w^2}{\sin 2\beta}$$

$$W_P = \frac{\gamma_{sat'd} h^2}{\sin 2\beta}$$

$$U_V = U_h \cot\beta$$

$$\left.\begin{aligned} a &= W_A \sin\beta\cos\beta - U_h\cos^2\beta + U_h \\ b &= -W_A\sin^2\beta\tan\phi + U_h\sin\beta\cos\beta\tan\phi \\ &\quad - N_A\cos\beta\tan\delta - (W_P - U_V)\tan\phi \\ c &= N_A\sin\beta\tan\delta\tan\phi \end{aligned}\right\} \quad (31)$$

$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

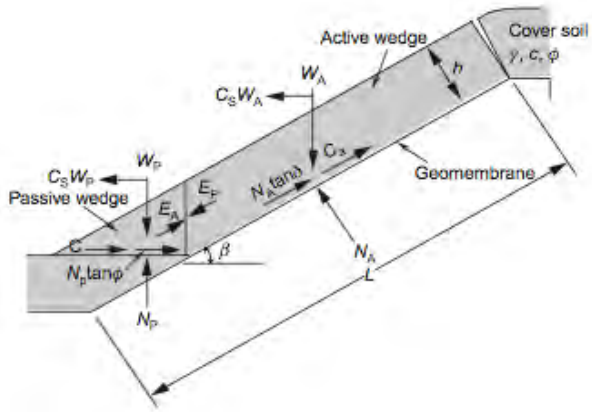
Seismic Forces

C_S 0.093 %g

	FS	β	L	γ	h	Φ	c	δ	C	c_a	C_A	W_A	W_P	N_A	A	B	C
Interface	Safety Factor	Slope (degrees)	Length of Slope	Unit Weight of Cover Soil	Thickness of Cover Soil (feet)	Internal Friction Angle of Cover Soil (degrees)	Cohesion of Cover Soil (lb/ft2)	Interface Friction Angle (degrees)	Cohesive Force Along the Failure Plane, Passive Wedge (lb/ft2)	Adhesion between Cover Soil (active) and the Geomembrane (lb/ft^2)	Adhesive Force between Cover Soil and Geomembrane	Weight of Active Wedge (lb/ft)	Weight of Neutral Block (lb/ft)	Effective Force Normal to Failure Plane, Active Wedge	Resultant A	Resultant B	Resultant C
Intermediate (3:1)	**1.86**	18.40	80.00	115.00	1.500	31.70	0.00	27.50	0.00	69.00	5192.10	13,796.67	431.95	13,091.33	5,877.66	- 12,119.56	2,221.09
Intermediate (16:1)	**5.34**	3.52	250.00	115.00	1.500	31.70	0.00	27.50	0.00	69.00	15564.25	43,108.68	2,111.17	43,027.35	7,329.42	- 39,373.39	1,436.82

Where:

W_A	total weight of active wedge
W_P	total weight of passive wedge
N_A	effective force normal to the failure plane of the active wedge
N_p	effective force normal to the failure plane of the passive wedge
γ	unit weight of the cover soil
h	thickness of cover soil
L	length of slope measures along the geomembrane
β	soil slope angle beneath the geomembrane
Φ	friction angle of cover soil
δ	interface friction angle between cover soil and geomembrane (or cured CCR)
C_A	adhesive force between cover soil of the active wedge and the geomembrane
c_A	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
E_A	interwedge force acting on the active wedge from the passive wedge
E_P	interwedge force acting on the passive wedge from the active wedge
FS	factor of safety against cover soil sliding on the geomembrane



$$W_A = \gamma h^2 \left(\frac{L}{h} - \frac{1}{\sin\beta} - \frac{\tan\beta}{2} \right) \quad (3)$$

$$N_A = W_A \cos\beta \quad (4)$$

$$C_a = c_a \left(L - \frac{h}{\sin\beta} \right) \quad (5)$$

$$W_P = \frac{\gamma h^2}{\sin 2\beta} \quad (8)$$

$$N_p = W_P + E_P \sin\beta \quad (9)$$

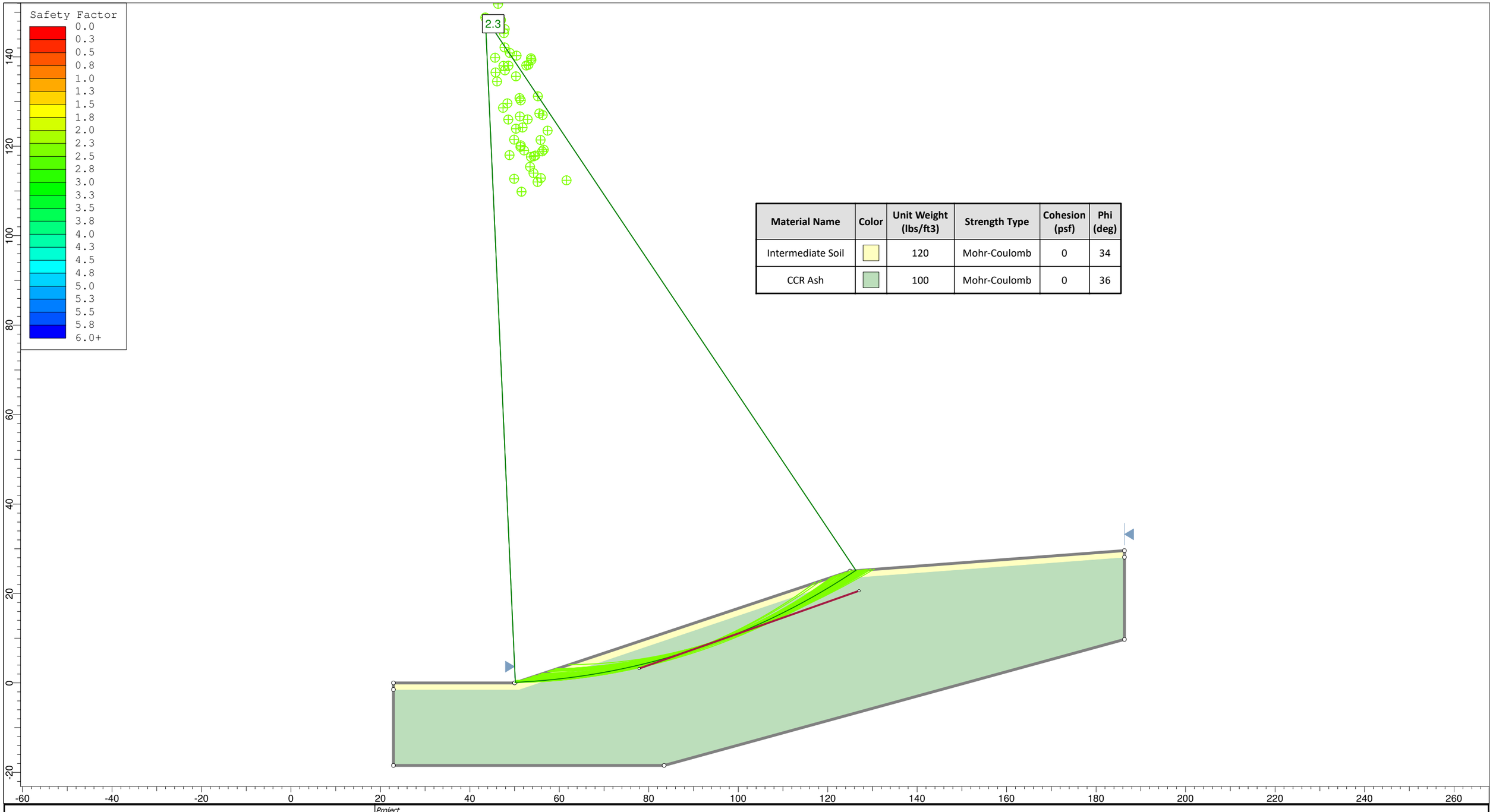
$$C = \frac{ch}{\sin\beta} \quad (10)$$

$$a = (W_A - N_A \cos\beta)\cos\beta$$

$$b = -[(W_A - N_A \cos\beta)\sin\beta \tan\phi + (N_A \tan\delta + C_a)\sin\beta\cos\beta + \sin\beta(C + W_P \tan\phi)] \quad (14)$$

$$c = (N_A \tan\delta + C_a)\sin^2\beta \tan\phi$$

$$FS = \frac{-b + \sqrt{b^2 - 4ac}}{2a} \quad (15)$$

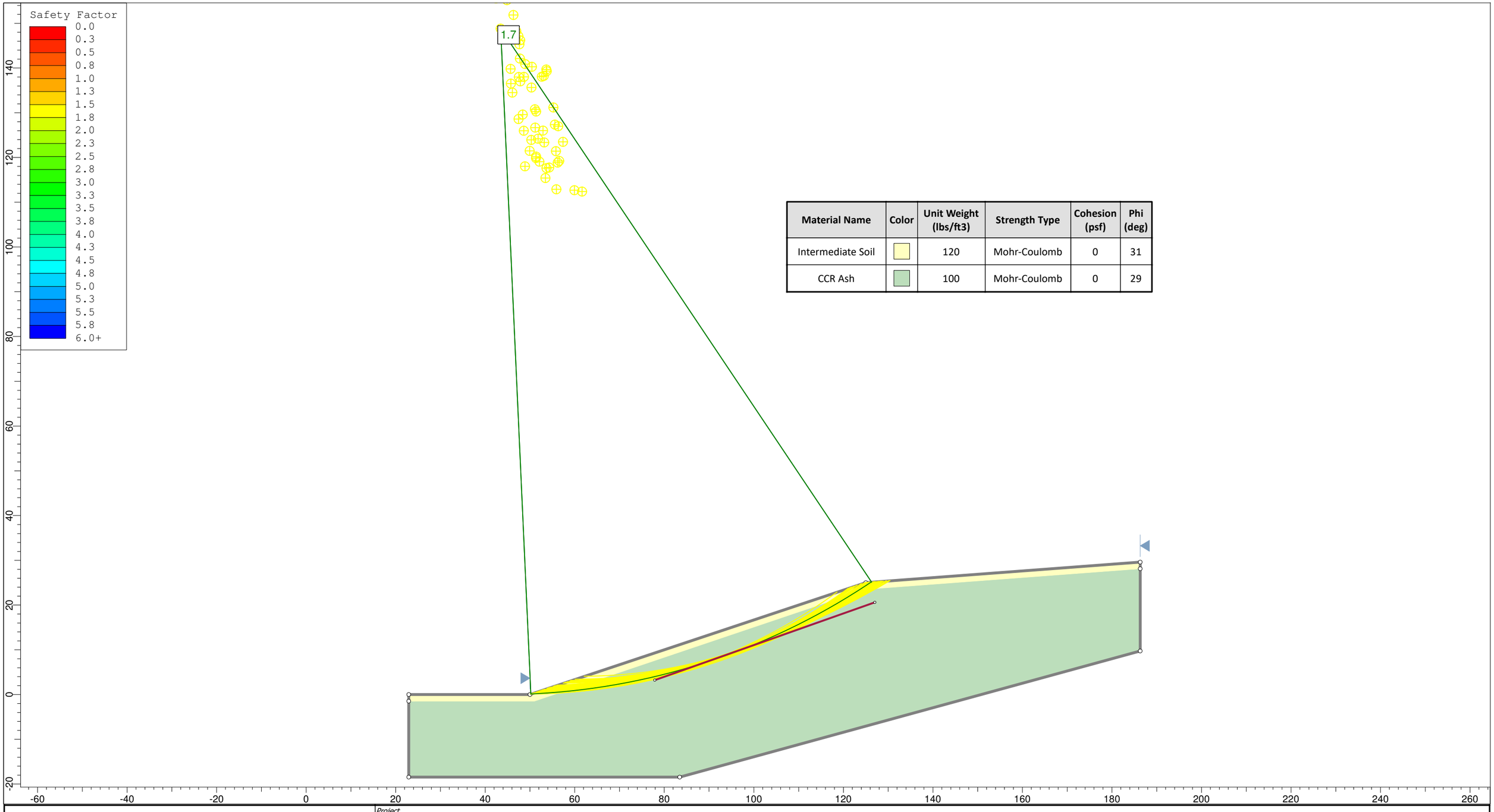


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Intermediate Soil		120	Mohr-Coulomb	0	34
CCR Ash		100	Mohr-Coulomb	0	36

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Final Closure			
Analysis Description	Intermediate Soil - CCR Ash Interface (Effective Stress, Rotational Failure)			
Drawn By	J. Tayntor, PE	*Scale*	1:242	*Company* Auckland Consulting, LLC
Date	8/14/2023, 4:36:41 PM			*File Name* WLF_Intermediate_effective _Rotational Failure.slim

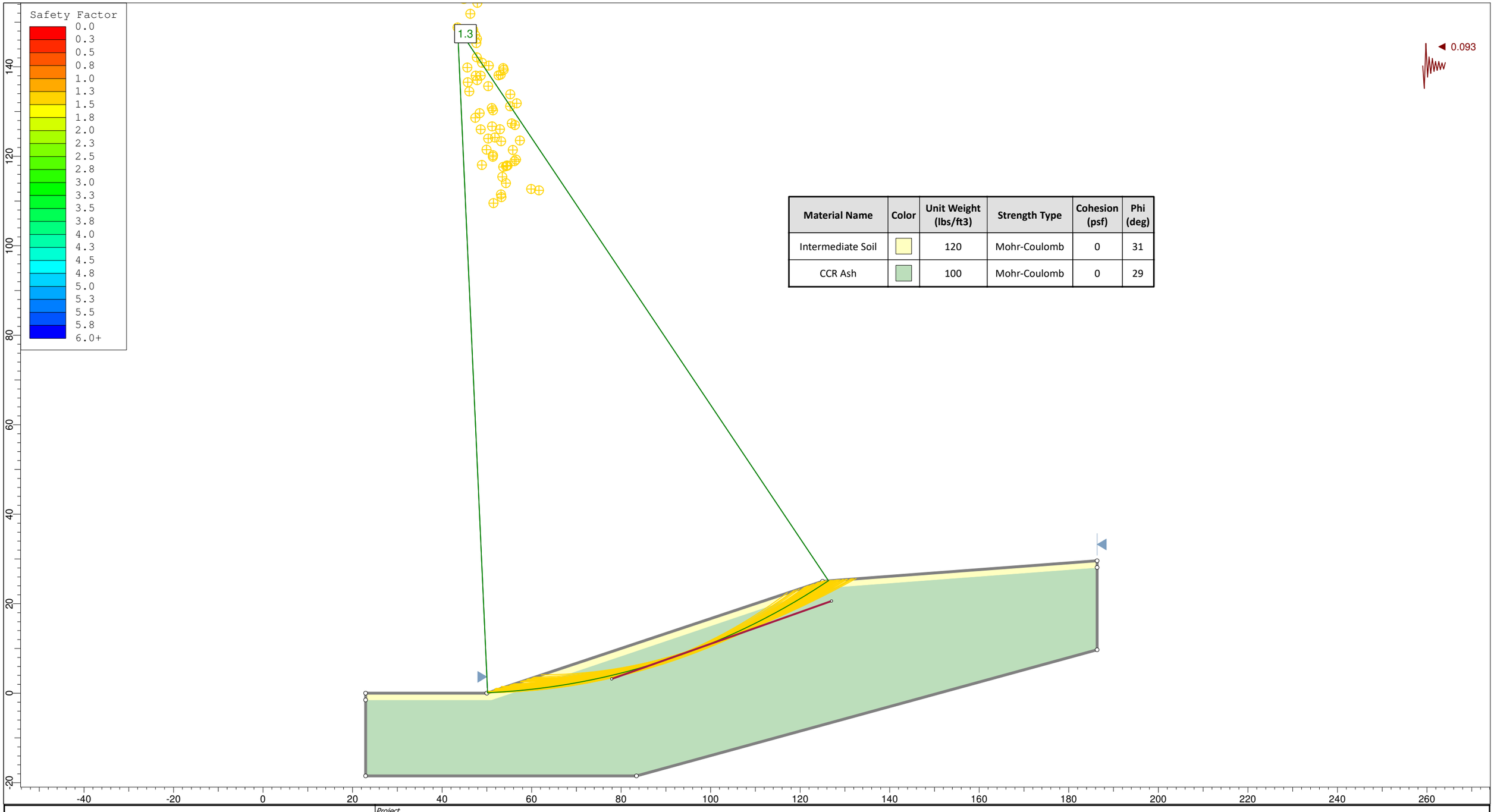


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Intermediate Soil		120	Mohr-Coulomb	0	31
CCR Ash		100	Mohr-Coulomb	0	29

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Final Closure			
Analysis Description	Intermediate Soil - CCR Ash Interface (Total Stress, Rotational Failure)			
Drawn By	J. Tayntor, PE	*Scale*	1:242	*Company* Auckland Consulting, LLC
Date	8/14/2023, 4:36:41 PM			*File Name* WLF_Intermediate_total _Rotational Failure.slim

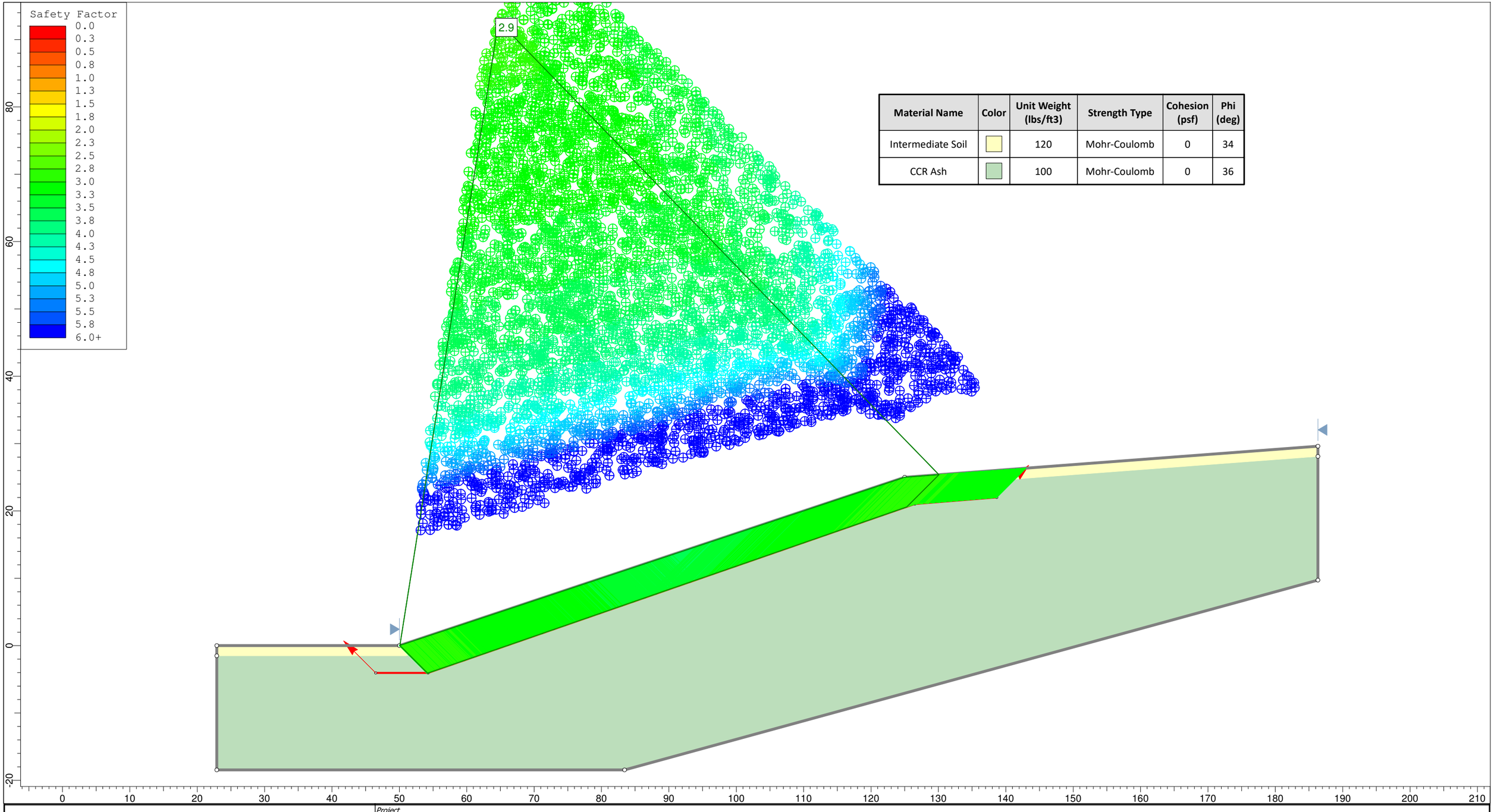


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Intermediate Soil		120	Mohr-Coulomb	0	31
CCR Ash		100	Mohr-Coulomb	0	29

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Final Closure			
Analysis Description	Intermediate Soil - CCR Ash Interface (Seismic Loading Condition, Rotational Failure)			
Drawn By	J. Tayntor, PE	*Scale*	1:242	*Company* Auckland Consulting, LLC
Date	8/14/2023, 4:36:41 PM			*File Name* WLF_Intermediate_total _Rotational Failure_Seismic.slim

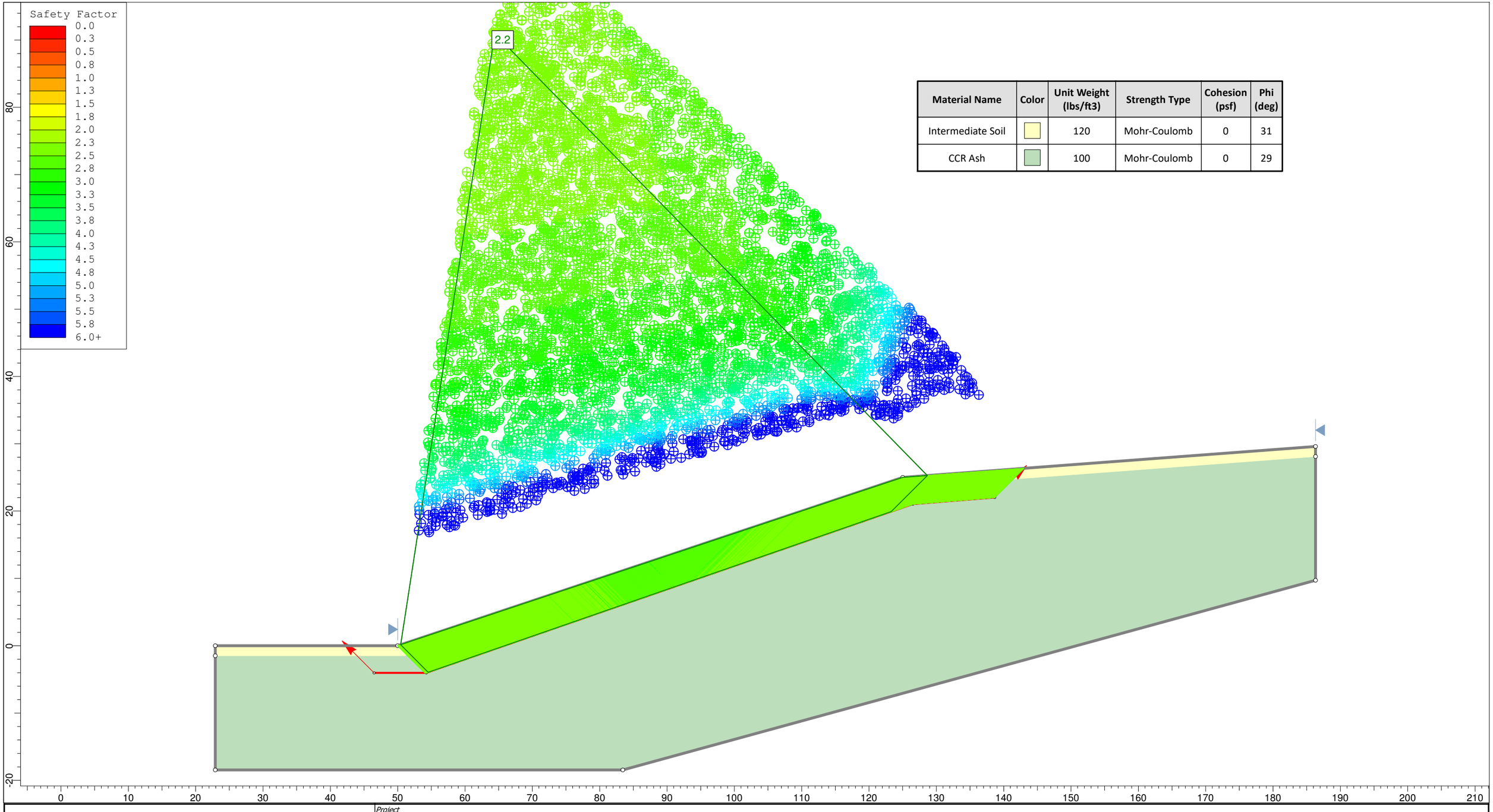


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Intermediate Soil		120	Mohr-Coulomb	0	34
CCR Ash		100	Mohr-Coulomb	0	36

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Final Closure			
Analysis Description	Intermediate Soil - CCR Ash Interface (Effective Stress, Block-Wedge Analysis)			
Drawn By	J. Tayntor, PE	*Scale* 1:161	*Company*	Auckland Consulting, LLC
Date	8/14/2023, 4:36:41 PM		*File Name*	WLF_Intermediate_Effective_Block Failure.slim

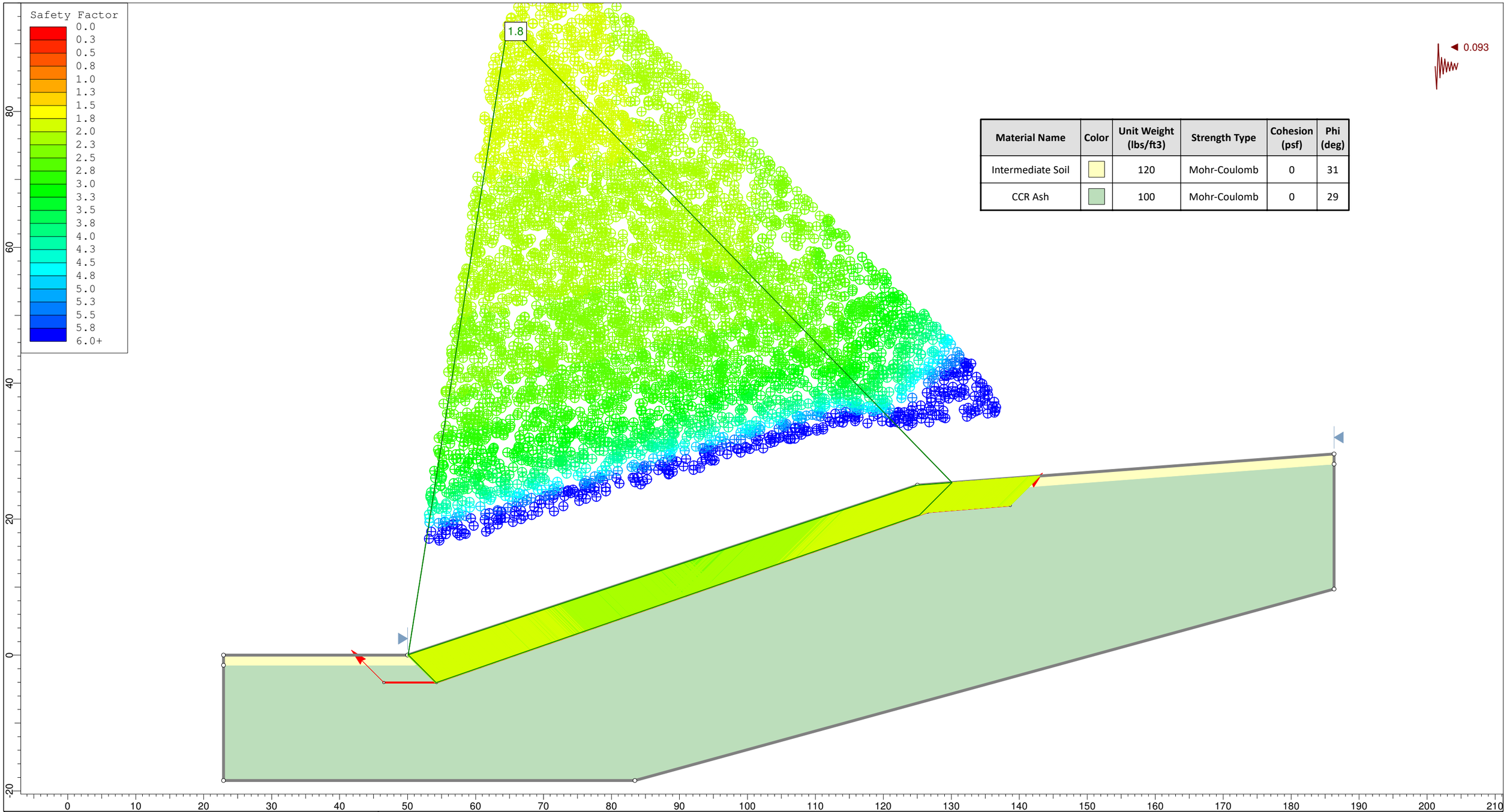


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Intermediate Soil		120	Mohr-Coulomb	0	31
CCR Ash		100	Mohr-Coulomb	0	29

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Final Closure			
Analysis Description	Intermediate Soil - CCR Ash Interface (Total Stress, Block-Wedge Analysis)			
Drawn By	J. Tayntor, PE	Scale	1:161	Company: Auckland Consulting, LLC
Date	8/14/2023, 4:36:41 PM			File Name: WLF_Intermediate_Total_Block Failure.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Intermediate Soil		120	Mohr-Coulomb	0	31
CCR Ash		100	Mohr-Coulomb	0	29

Auckland Consulting LLC

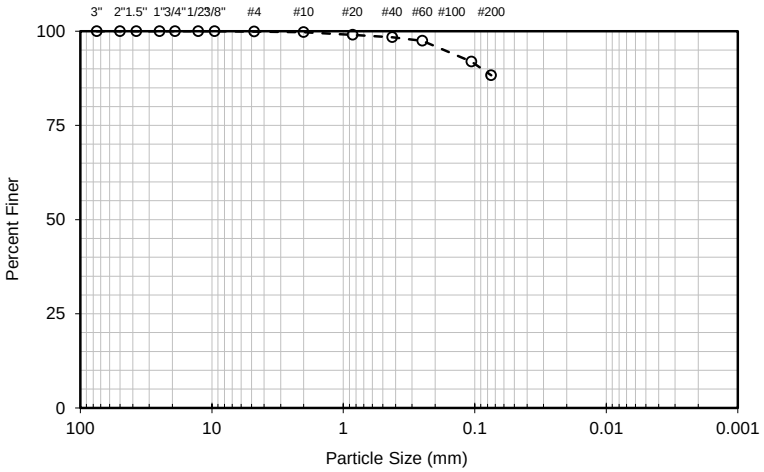
SLIDEINTERPRET 6.039

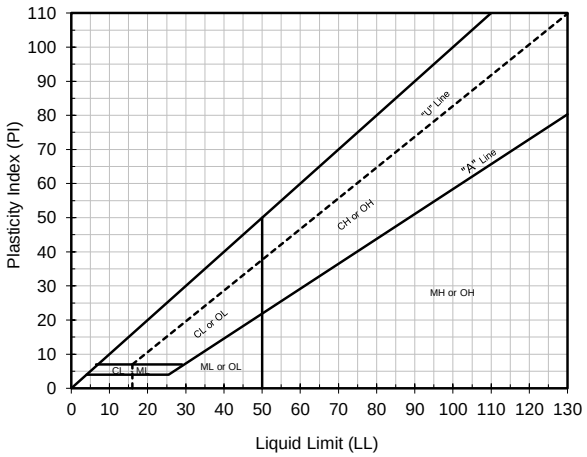
Project	Welsh Power Plant: CCR Landfill Final Closure		
Analysis Description	Intermediate Soil - CCR Ash Interface (Seismic Loading Conditions, Block-Wedge Analysis)		
Drawn By	J. Tayntor, PE	*Scale* 1:161	*Company* Auckland Consulting, LLC
Date	8/14/2023, 4:36:41 PM		*File Name* WLF_Intermediate_Seismic Loading_Block Failure.slim

Particle Size, Atterberg Limit, and USCS Analyses for Soils

Client: Auckland Consulting, L.L.C.
Project: 2022-007 AEP Welsh LF- Interface Testing
Sample ID: CCR Coal Ash

TRI Log #: 23-002001.1





Mechanical Sieve				Sedimentation (Hydrometer)			
ASTM D6913				ASTM D7928		ASTM D4221	
Sieve Designation		Percent Passing	Gravel / Sand / Fines	Particle Size	Percent Passing	Particle Size	Percent Passing
-	mm			mm		mm	
3 in.	76.2	100.0		- -	- -	- -	- -
2 in.	50.8	100.0		- -	- -	- -	- -
1.5 in.	38.1	100.0		- -	- -	- -	- -
1 in.	25.4	100.0	0.1	- -	- -	- -	- -
3/4 in.	19.0	100.0		- -	- -	- -	- -
1/2 in.	12.7	100.0		- -	- -	- -	- -
3/8 in.	9.51	100.0		- -	- -	- -	- -
No. 4	4.76	99.9		**Hydrometer Log-Linear Interpolation**			
No. 10	2.00	99.7		Particle Size	Percent Passing	Particle Size	Percent Passing
No. 20	0.841	99.1	11.6	mm		mm	
No. 40	0.420	98.4		0.002	- -	0.002	- -
No. 60	0.250	97.4		N m,2µm,d	-	N m,2µm,nd	-
No. 140	0.106	91.9		Percent Dispersion		-	
No. 200	0.074	88.3	88.3				

Atterberg Limits	
ASTM D4318, Method A : Multipoint, Air Dried	
Liquid Limit	NL
Plastic Limit	NP
Plastic Index	- -
(NL = No Liquid Limit, NP = No Plastic Limit)	

Particle Size Log-Linear Interpolation					
D_x	85	60	50	30	10
mm	- -	- -	- -	- -	- -

Cu	- -	Cc	- -

USCS Classification (ASTM D2487)
- -

Moisture Content (%)	ASTM D2216	- -
Organic Content (%)	ASTM D2974-C	- -
Carbonate Content (%)	ASTM D4373	- -
Specific Gravity	ASTM D854	- -

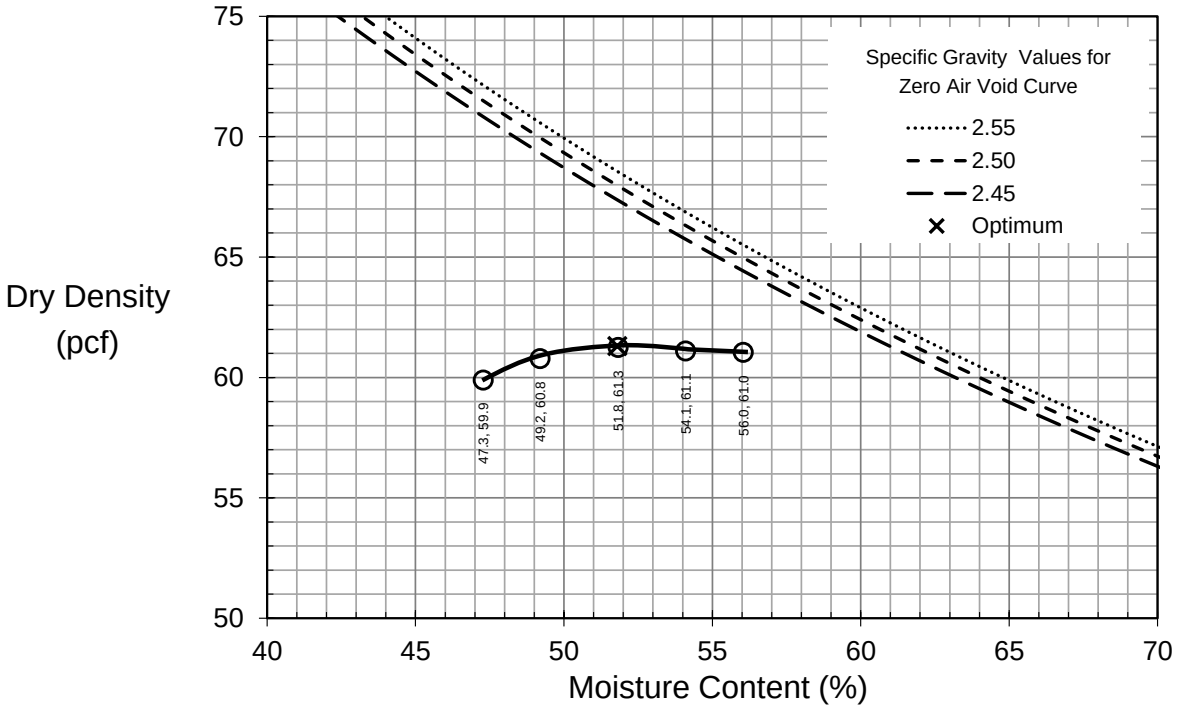
Kelby Broussard 7/13/2023
Analysis & Quality Review/Date

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

Laboratory Compaction Characteristics of Soil Using Standard Effort (ASTM D698)

Client: Auckland Consulting, L.L.C.
Project: 2022-007 AEP Welsh LF- Interface Testing
Sample ID: CCR Coal Ash
TRI Log #: 23-002001.1

Compaction Effort	-	Standard
Method	-	A
Rammer Type	-	Automatic
Maximum Dry Density	pcf	61.3
Optimum Water Content	%	51.8



Kelby Broussard, 7/11/2023
Quality Review / Date

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TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting, L.L.C.
Project: 2022-007 AEP Welsh LF- Interface Testing
Sample: CCR Coal Ash

TRI Log #: 23-002001.1
Test Method: ASTM D4767

Specimens				
Identification	1	2	3	4
Depth/Elev. (ft)	-	-	-	-
Eff. Consol. Stress (psi)	8.0	16.0	32.0	-
Initial Specimen Properties				
Avg. Diameter (in)	2.00	2.00	2.00	-
Avg. Height (in)	4.50	4.50	4.50	-
Avg. Water Content (%)	51.8	51.8	51.8	-
Bulk Density (pcf)	88.4	88.7	88.4	-
Dry Density (pcf)	58.2	58.4	58.2	-
Specific Gravity (Assumed)	2.75			
Saturation (%)	73.2	73.5	73.1	-
Void Ratio, n	1.95	1.94	1.95	-
B-Value, End of Saturation	0.95	0.95	0.97	-

Test Setup	
Specimen Condition	Remolded
Specimen Preparation	Kneading and Impact Compaction, Six Lifts
Mounting Method	Wet
Consolidation	Isotropic

Post-Consolidation / Pre-Shear				
Void Ratio	1.94	1.87	1.87	-

Shear / Post-Shear				
Rate of Strain (%/hr)	1.00	1.00	1.00	-
Avg. Water Content (%)	63.1	63.3	62.9	-

At Failure								
Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$				Ratio, $(\sigma_1'/\sigma_3')_{max}$			
Axial Strain at Failure (%), $\varepsilon_{a,f}$	15.0	15.0	15.0	-	14.1	10.3	9.8	-
Minor Effective Stress (psi), $\sigma_3'_f$	6.2	7.9	12.6	-	6.2	7.6	12.1	-
Principal Stress Difference (psi), $(\sigma_1-\sigma_3)_f$	17.0	26.2	36.5	-	17.0	25.4	35.4	-
Pore Water Pressure, Δu_f (psi)	1.8	7.9	19.4	-	1.7	8.0	19.9	-
Major Effective Stress (psi), $\sigma_1'_f$	23.2	34.1	49.1	-	23.2	33.0	47.5	-
Secant Friction Angle (degrees)	35.4	38.6	36.3	-	35.5	38.8	36.5	-
Effective Friction Angle (degrees)	36.0				36.3			
Effective Cohesion (psi)	0.3				0.3			

Note: The presented M-C parameters are based on a linear regression in modified stress space, across all assigned effective consolidation stresses. This fit does not purported to capture typical curvature of envelopes that may, in particular, be observed across broader range in effective stresses. Please note that the stresses associated with peak principal stress ratio and peak principal stress difference are presented in tabular form on the first page of the report. There are alternate interpretations to theses two failure criterion including but not limited to strain compatibility and post-peak.

Jeffrey A. Kuhn , Ph.D., P.E., 7/31/2023
Analysis & Quality Review/Date

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Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting, L.L.C.
Project: 2022-007 AEP Welsh LF- Interface Testing
Sample: CCR Coal Ash

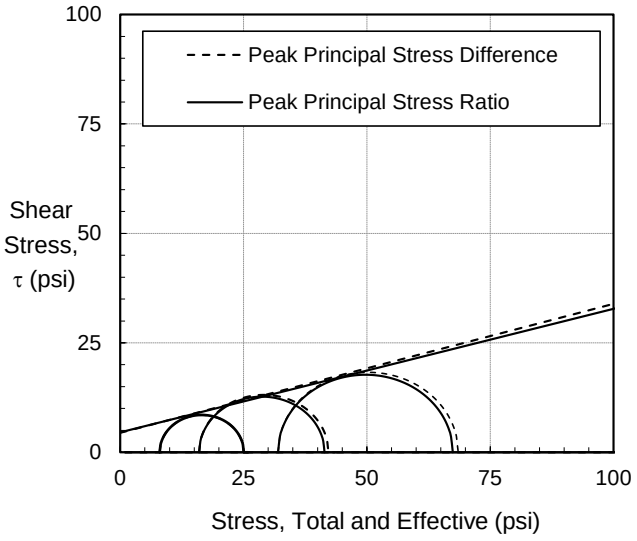
TRI Log #: 23-002001.1
Test Method: ASTM D4767

R / "Total Stress" Envelope			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Friction Angle (deg)	ϕ_R	16.4	15.8
Cohesion (psi)	c_R	4.4	4.6

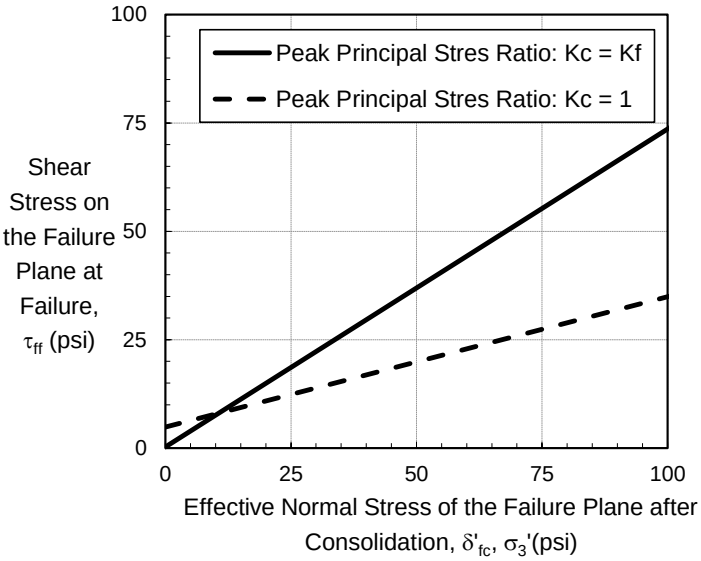
Kc = Kf Envelope, Effective Stress Envelope (Duncan et al. 1990)			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	ϕ'	36.0	36.3
Effective Cohesion (psi)	c'	0.3	0.3

Kc = 1 (τ_{ff} vs σ'_{fc}) Envelope, Total Stress Envelope (Duncan et al. 1990)			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Friction Angle (deg)	$d_{Kc=1}$	17.7	16.7
Cohesion (psi)	$\psi_{Kc=1}$	4.8	4.9

R / "Total Stress" Envelope



Three-Stage Rapid Drawdown Envelopes



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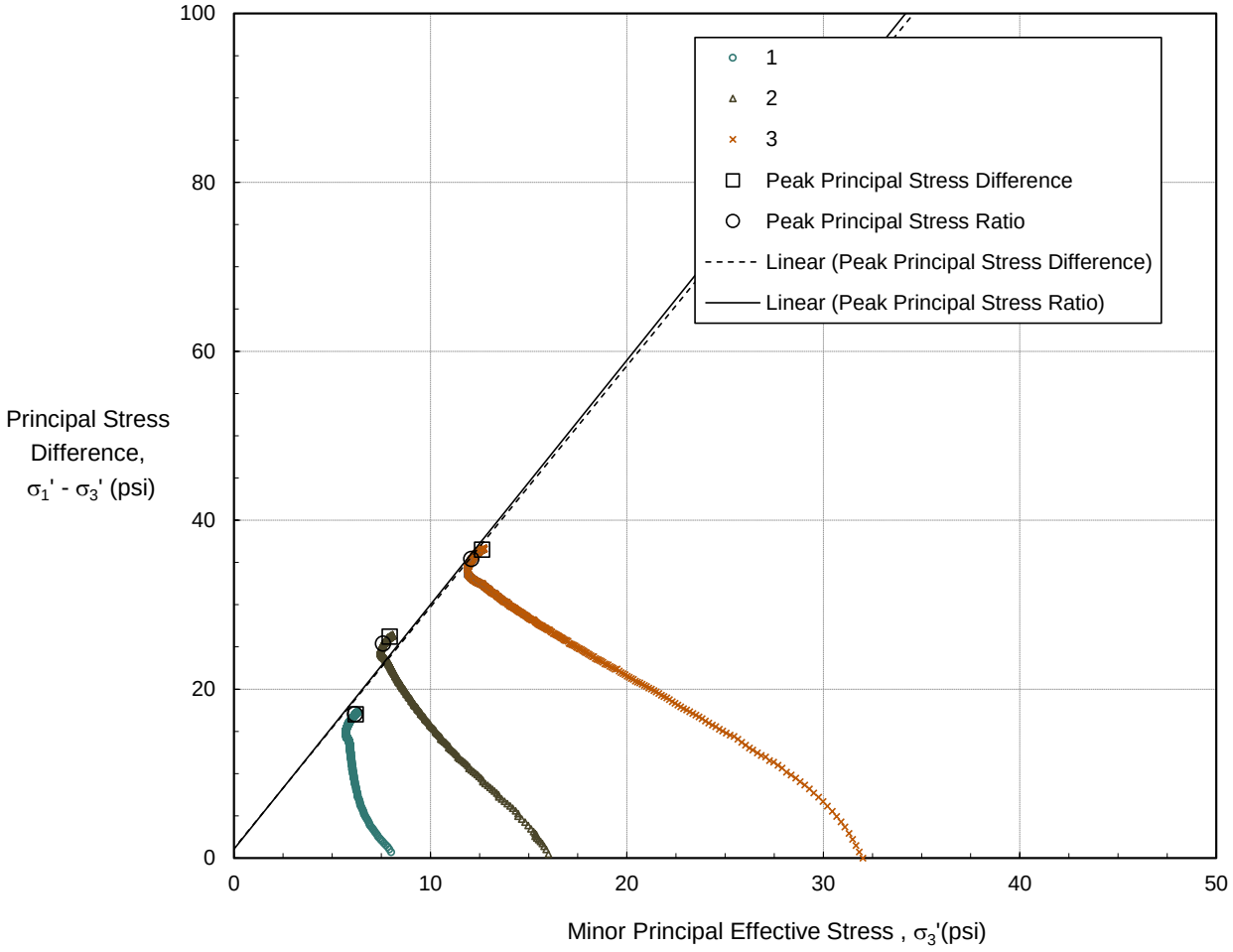
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Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting, L.L.C.
Project: 2022-007 AEP Welsh LF- Interface Testing
Sample: CCR Coal Ash

TRI Log #: 23-002001.1
Test Method: ASTM D4767

Modified Mohr-Coulomb



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	36.0	36.3
Effective Cohesion (psi)	0.3	0.3

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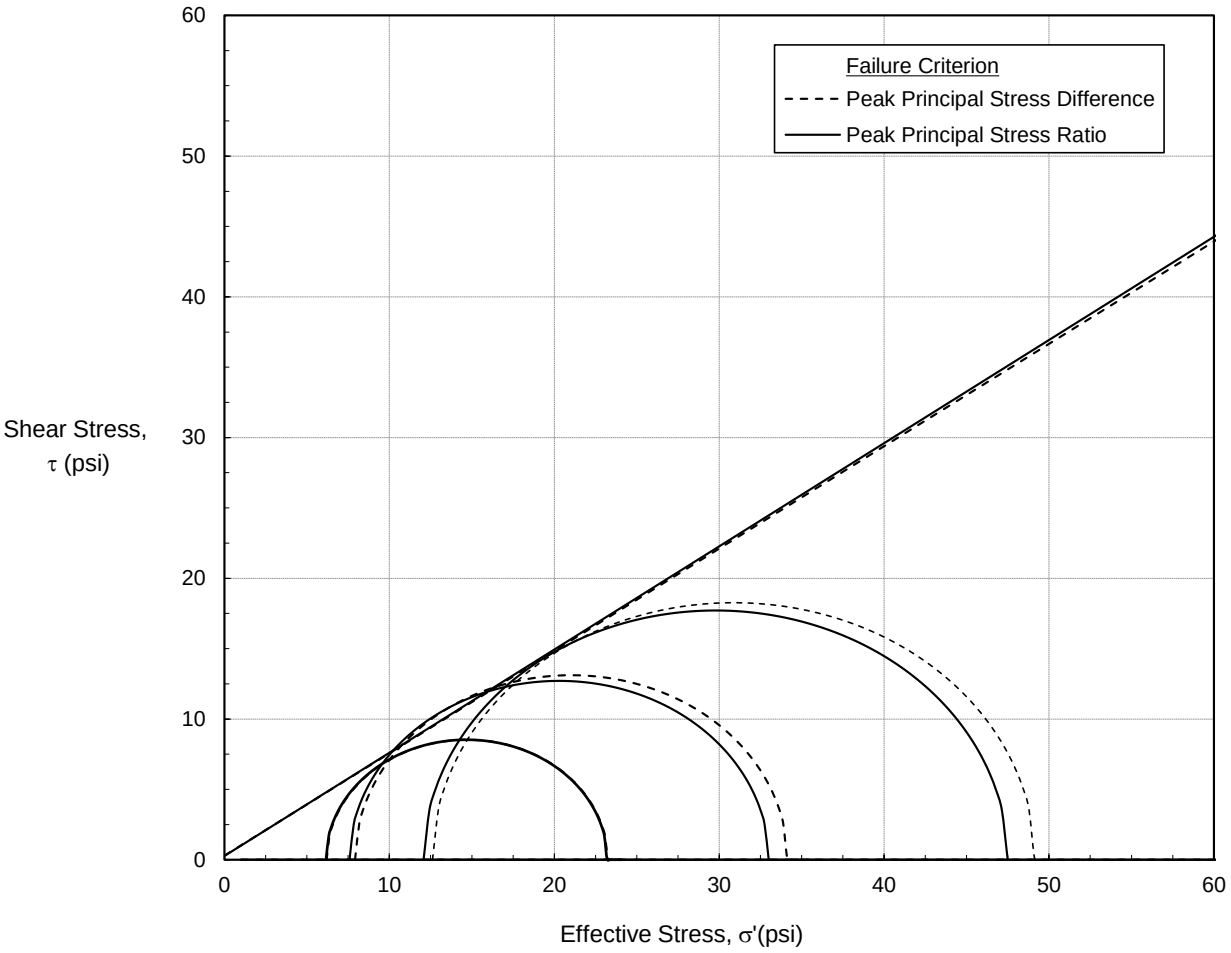
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Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting, L.L.C.
Project: 2022-007 AEP Welsh LF- Interface Testing
Sample: CCR Coal Ash

TRI Log #: 23-002001.1
Test Method: ASTM D4767

Mohr-Coulomb



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	36.0	36.3
Effective Cohesion (psi)	0.3	0.3

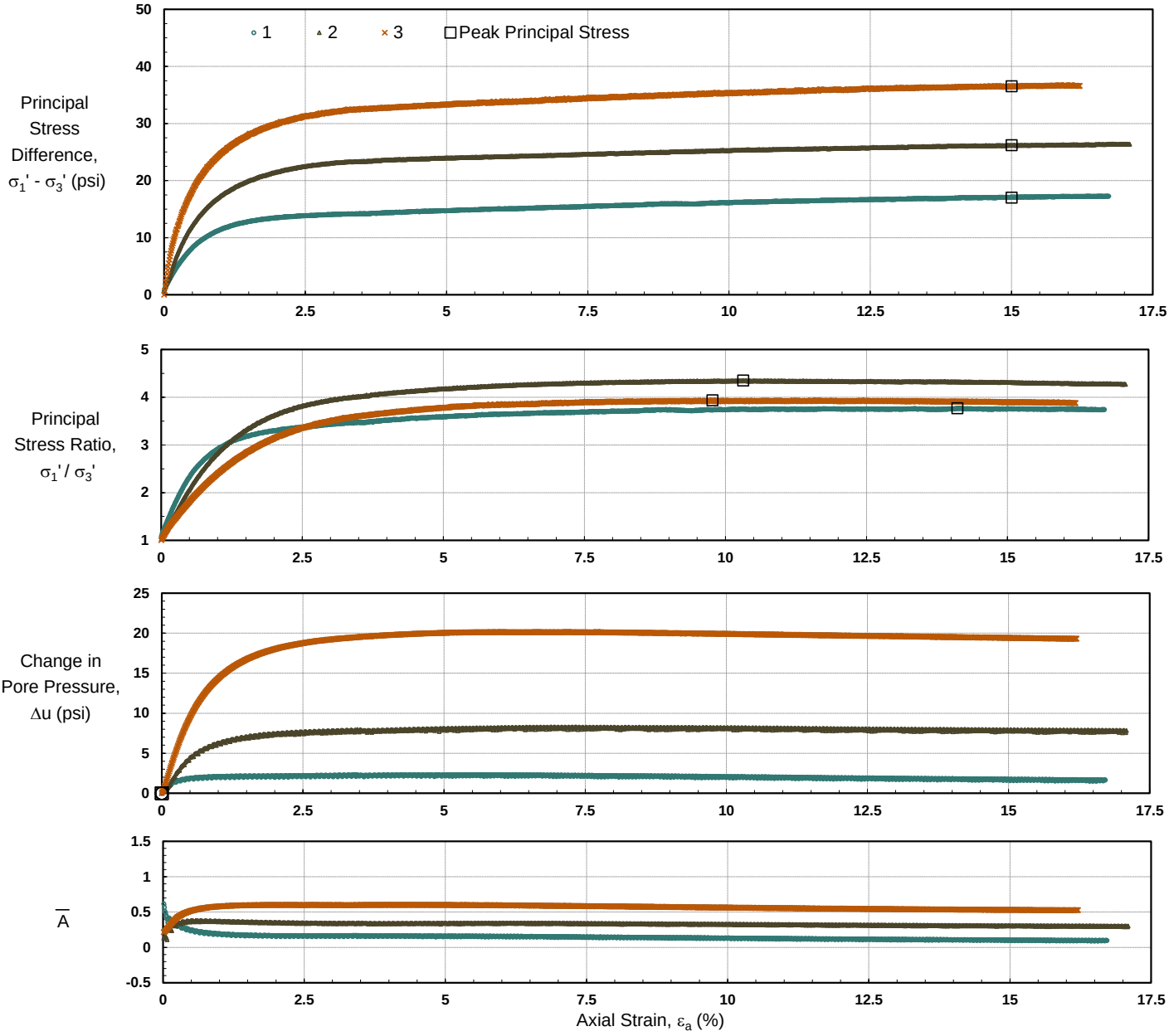
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Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting, L.L.C.
Project: 2022-007 AEP Welsh LF- Interface Testing
Sample: CCR Coal Ash

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Test Method: ASTM D4767



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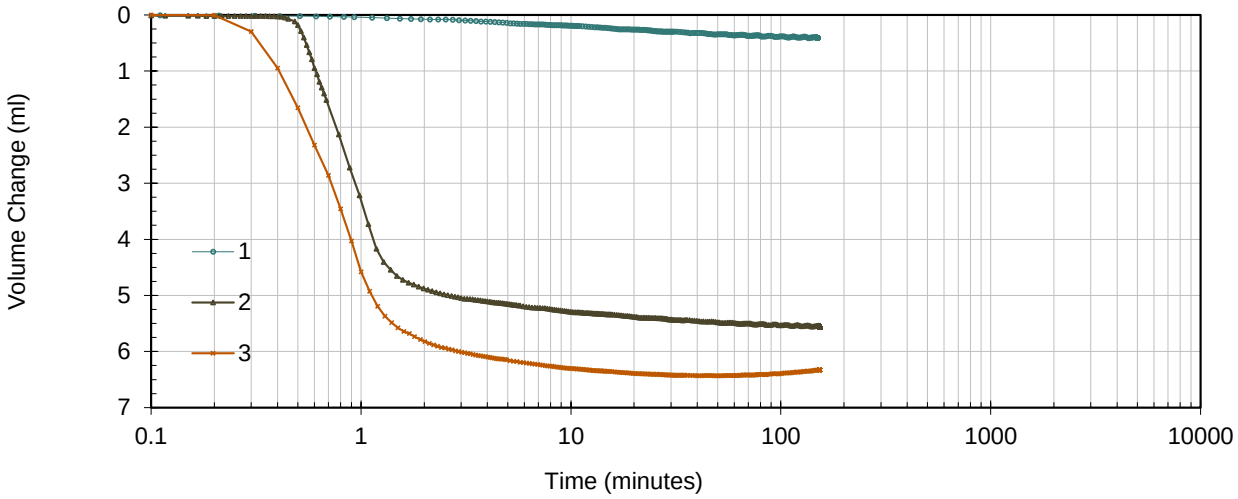
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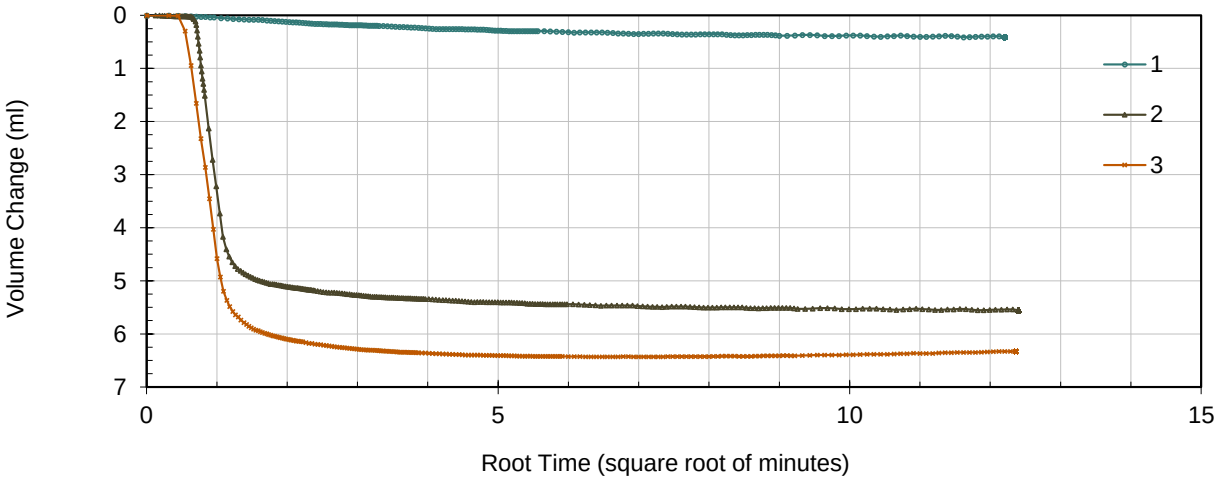
Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting, L.L.C.
Project: 2022-007 AEP Welsh LF- Interface Testing
Sample: CCR Coal Ash

TRI Log #: 23-002001.1
Test Method: ASTM D4767

Consolidation





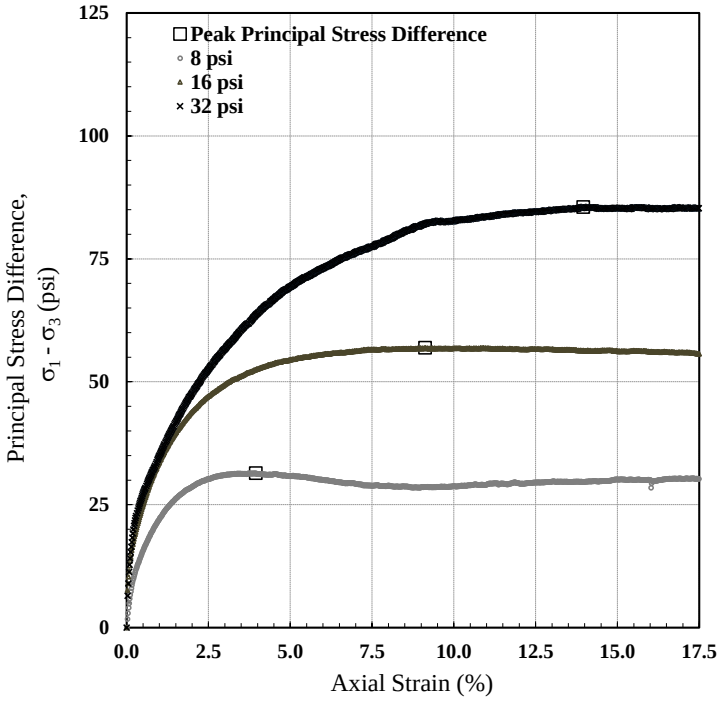
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Unconsolidated-Undrained (Q) Triaxial Compression

Client: Auckland Consulting, L.L.C.
Project: 2022-007 AEP Welsh LF- Interface Testing
Sample: CCR Coal Ash

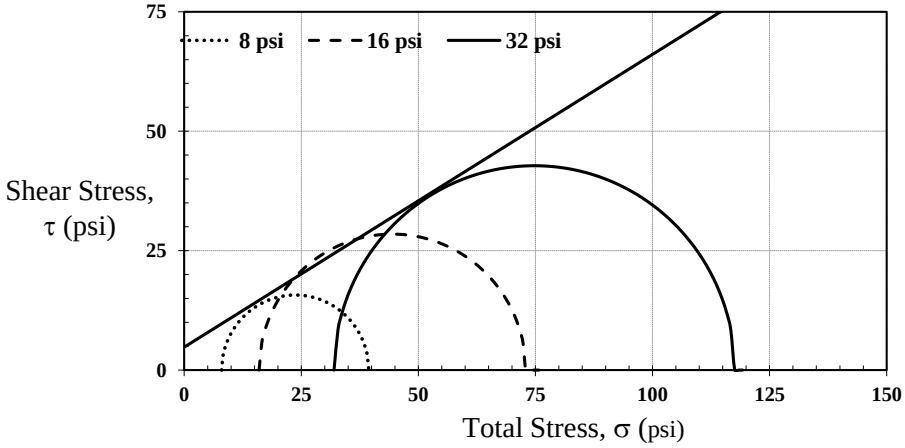
TRI Log #: 2001.1
Test Method: ASTM D2850



Samples			
Sample I.D.	-	-	-
Depth/Elev. (ft)	-	-	-
Minor Principal Stress (psi)	8.0	16.0	32.0
Initial Properties			
Avg. Diameter (in)	1.99	2.00	2.00
Avg. Height (in)	4.62	4.60	4.66
Avg. Water Content (%)	50.6	50.6	50.7
Bulk Density (pcf)	86.8	86.8	85.7
Dry Density (pcf)	57.7	57.6	56.9
Saturation (%)	70.4	70.4	69.0
Void Ratio	1.98	1.98	2.02
Specific Gravity (Assumed)	2.75	2.75	2.75

At Failure			
Failure Criterion	Maximum Deviator Stress		
Rate of Strain (%/hr)	60	60	60
Axial Strain at Failure (%)	3.9	9.1	14.0
Minor Total Stress (psi)	8.0	16.0	32.0
Major Total Stress (psi)	39.4	72.9	117.6
Principal Stress Diff. (psi)	31.4	56.9	85.6
S_u (psi)	15.7	28.5	42.8
S_u / σ_3	2.0	1.8	1.3

Total Stress Envelope	
Friction Angle (deg)	31.5
Cohesion (psi)	4.8



Jeffrey A. Kuhn , Ph.D., P.E., 7/21/2023
Analysis & Quality Review/Date

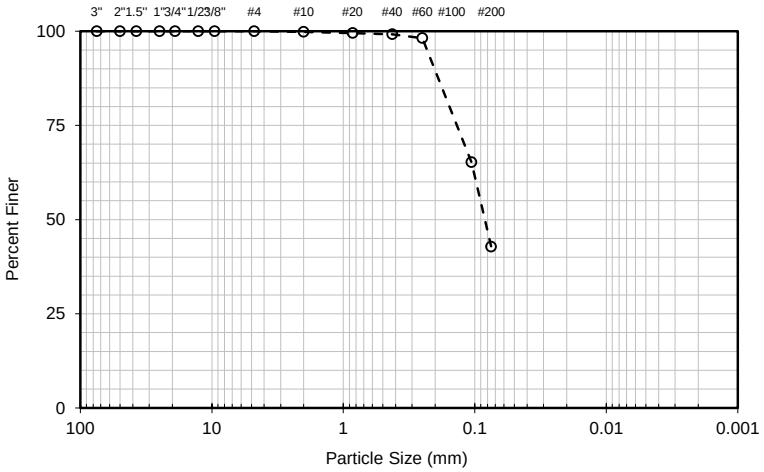
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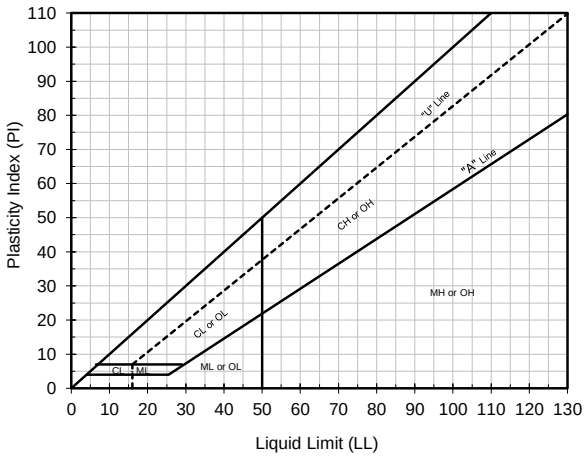
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Particle Size, Atterberg Limit, and USCS Analyses for Soils

Client: Auckland Consulting, L.L.C.
Project: Auckland Consulting, L.L.C.
Sample ID: Borrow Soil

TRI Log #: 23-002001.2





Mechanical Sieve				Sedimentation (Hydrometer)			
ASTM D6913				ASTM D7928		ASTM D4221	
Sieve Designation		Percent Passing	Gravel / Sand / Fines	Particle Size	Percent Passing	Particle Size	Percent Passing
-	mm			mm		mm	
3 in.	76.2	100.0	0.0	- -	- -	- -	- -
2 in.	50.8	100.0		- -	- -	- -	- -
1.5 in.	38.1	100.0		- -	- -	- -	- -
1 in.	25.4	100.0		- -	- -	- -	- -
3/4 in.	19.0	100.0		- -	- -	- -	- -
1/2 in.	12.7	100.0		- -	- -	- -	- -
3/8 in.	9.51	100.0		- -	- -	- -	- -
No. 4	4.76	100.0	57.2	Hydrometer Log-Linear Interpolation			
No. 10	2.00	99.8		Particle Size	Percent Passing	Particle Size	Percent Passing
No. 20	0.841	99.5		mm		mm	
No. 40	0.420	99.2		0.002	- -	0.002	- -
No. 60	0.250	98.1		N m,2µm,d	-	N m,2µm,nd	-
No. 140	0.106	65.2		Percent Dispersion	-		
No. 200	0.074	42.8	42.8				

Atterberg Limits	
ASTM D4318, Method A : Multipoint, Air Dried	
Liquid Limit	NL
Plastic Limit	NP
Plastic Index	- -
(NL = No Liquid Limit, NP = No Plastic Limit)	

Particle Size Log-Linear Interpolation					
D_x	85	60	50	30	10
mm	1.8E-01	9.8E-02	8.4E-02	- -	- -

Cu	- -	Cc	- -

USCS Classification (ASTM D2487)
- -

Moisture Content (%)	ASTM D2216	- -
Organic Content (%)	ASTM D2974-C	- -
Carbonate Content (%)	ASTM D4373	- -
Specific Gravity	ASTM D854	- -

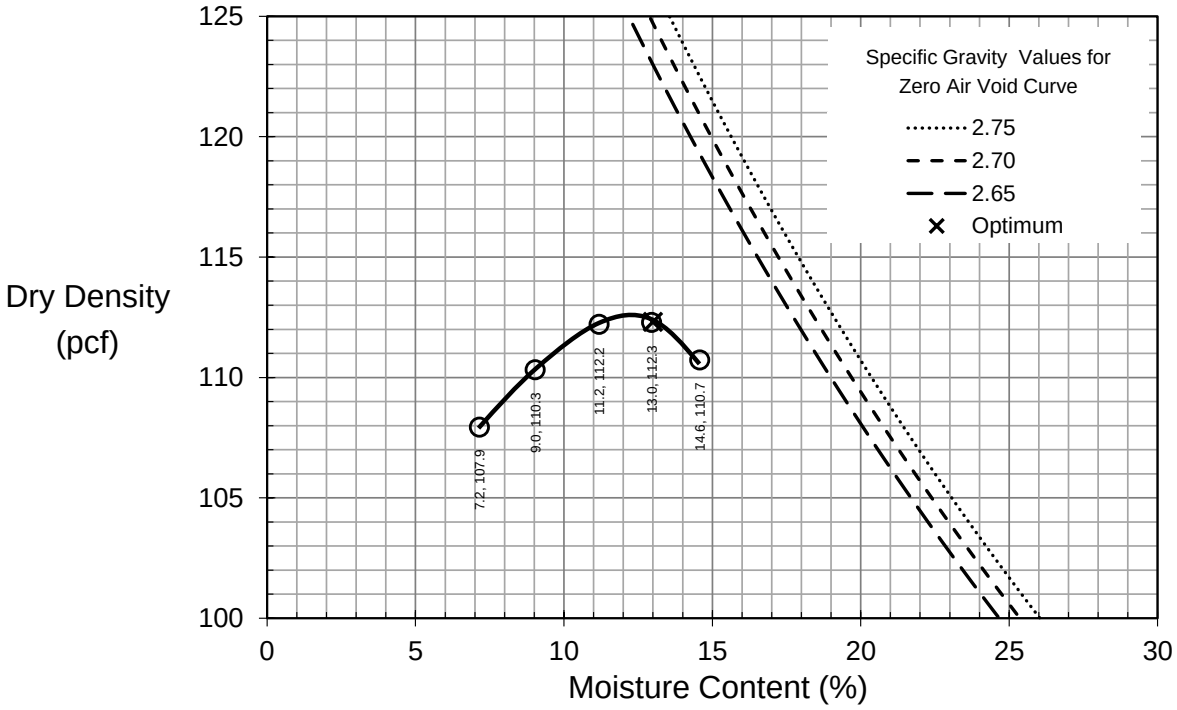
Kelby Broussard 7/13/2023
Analysis & Quality Review/Date

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Laboratory Compaction Characteristics of Soil Using Standard Effort (ASTM D698)

Client: Auckland Consulting, L.L.C.
Project: 2022-007 AEP Welsh LF- Interface Testing
Sample ID: Borrow Soil
TRI Log #: 23-002001.2

Compaction Effort	-	Standard
Method	-	A
Rammer Type	-	Automatic
Maximum Dry Density	pcf	112.3
Optimum Water Content	%	13.0



Kelby Broussard, 6/30/2023
Quality Review / Date

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Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting, L.L.C.
Project: 2022-007 AEP Welsh LF- Interface Testing
Sample: Borrow Soil

TRI Log #: 23-002001.2
Test Method: ASTM D4767

Specimens				
Identification	1	2	3	4
Depth/Elev. (ft)	-	-	-	-
Eff. Consol. Stress (psi)	8.0	16.0	32.0	-
Initial Specimen Properties				
Avg. Diameter (in)	2.00	2.00	2.00	-
Avg. Height (in)	4.50	4.50	4.50	-
Avg. Water Content (%)	13.0	13.0	13.0	-
Bulk Density (pcf)	120.4	120.8	120.4	-
Dry Density (pcf)	106.5	106.9	106.6	-
Specific Gravity (Assumed)	2.75			
Saturation (%)	58.5	59.1	58.6	-
Void Ratio, n	0.61	0.61	0.61	-
B-Value, End of Saturation	0.88	0.89	0.84	-

Test Setup	
Specimen Condition	Remolded
Specimen Preparation	Kneading and Impact Compaction, Six Lifts
Mounting Method	Wet
Consolidation	Isotropic

Post-Consolidation / Pre-Shear				
Void Ratio	0.60	0.58	0.59	-

Shear / Post-Shear				
Rate of Strain (%/hr)	1.00	1.00	1.00	-
Avg. Water Content (%)	20.8	19.7	18.8	-

At Failure								
Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$				Ratio, $(\sigma_1'/\sigma_3')_{max}$			
Axial Strain at Failure (%), $\varepsilon_{a,f}$	15.0	15.0	15.0	-	3.5	4.5	6.1	-
Minor Effective Stress (psi), $\sigma_3'_f$	16.6	29.0	35.2	-	11.6	20.5	28.4	-
Principal Stress Difference (psi), $(\sigma_1-\sigma_3)_f$	44.9	77.4	94.2	-	32.6	57.8	79.0	-
Pore Water Pressure, Δu_f (psi)	-8.3	-13.0	-3.1	-	-3.4	-4.5	3.7	-
Major Effective Stress (psi), $\sigma_1'_f$	61.5	106.5	129.4	-	44.2	78.3	107.4	-
Secant Friction Angle (degrees)	35.1	34.9	34.9	-	35.8	35.8	35.6	-
Effective Friction Angle (degrees)	34.7				35.4			
Effective Cohesion (psi)	0.3				0.3			

Note: The presented M-C parameters are based on a linear regression in modified stress space, across all assigned effective consolidation stresses. This fit does not purported to capture typical curvature of envelopes that may, in particular, be observed across broader range in effective stresses. Please note that the stresses associated with peak principal stress ratio and peak principal stress difference are presented in tabular form on the first page of the report. There are alternate interpretations to theses two failure criterion including but not limited to strain compatibility and post-peak.

Jeffrey A. Kuhn , Ph.D., P.E., 7/31/2023
Analysis & Quality Review/Date

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Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting, L.L.C.
Project: 2022-007 AEP Welsh LF- Interface Testing
Sample: Borrow Soil

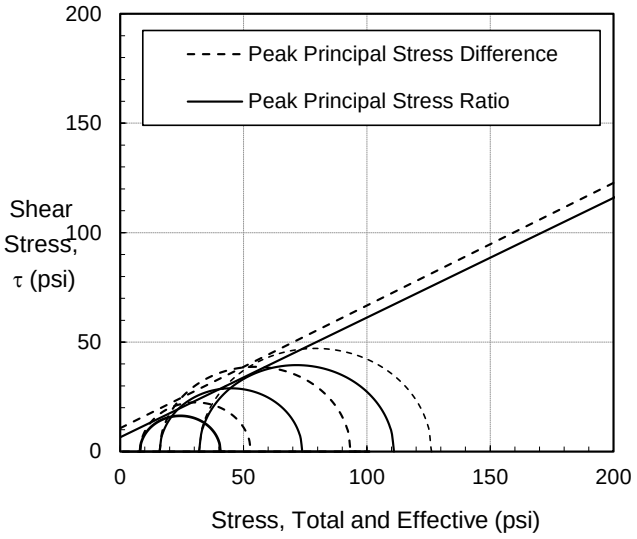
TRI Log #: 23-002001.2
Test Method: ASTM D4767

R / "Total Stress" Envelope			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Friction Angle (deg)	ϕ_R	29.3	28.7
Cohesion (psi)	c_R	10.7	6.5

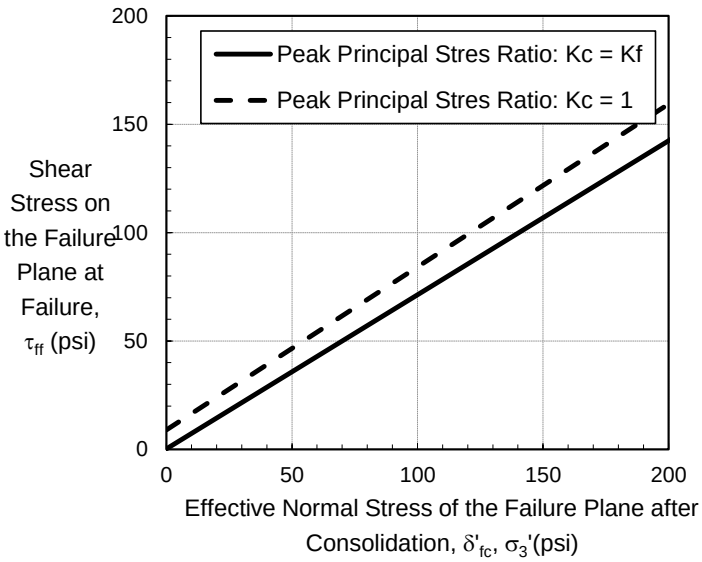
Kc = Kf Envelope, Effective Stress Envelope (Duncan et al. 1990)			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	ϕ'	34.7	35.4
Effective Cohesion (psi)	c'	0.3	0.3

Kc = 1 (τ_{ff} vs σ'_{fc}) Envelope, Total Stress Envelope (Duncan et al. 1990)			
Failure Criterion: Peak Principal Stress		Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Friction Angle (deg)	$d_{Kc=1}$	38.2	36.9
Cohesion (psi)	$\psi_{Kc=1}$	15.0	9.0

R / "Total Stress" Envelope



Three-Stage Rapid Drawdown Envelopes



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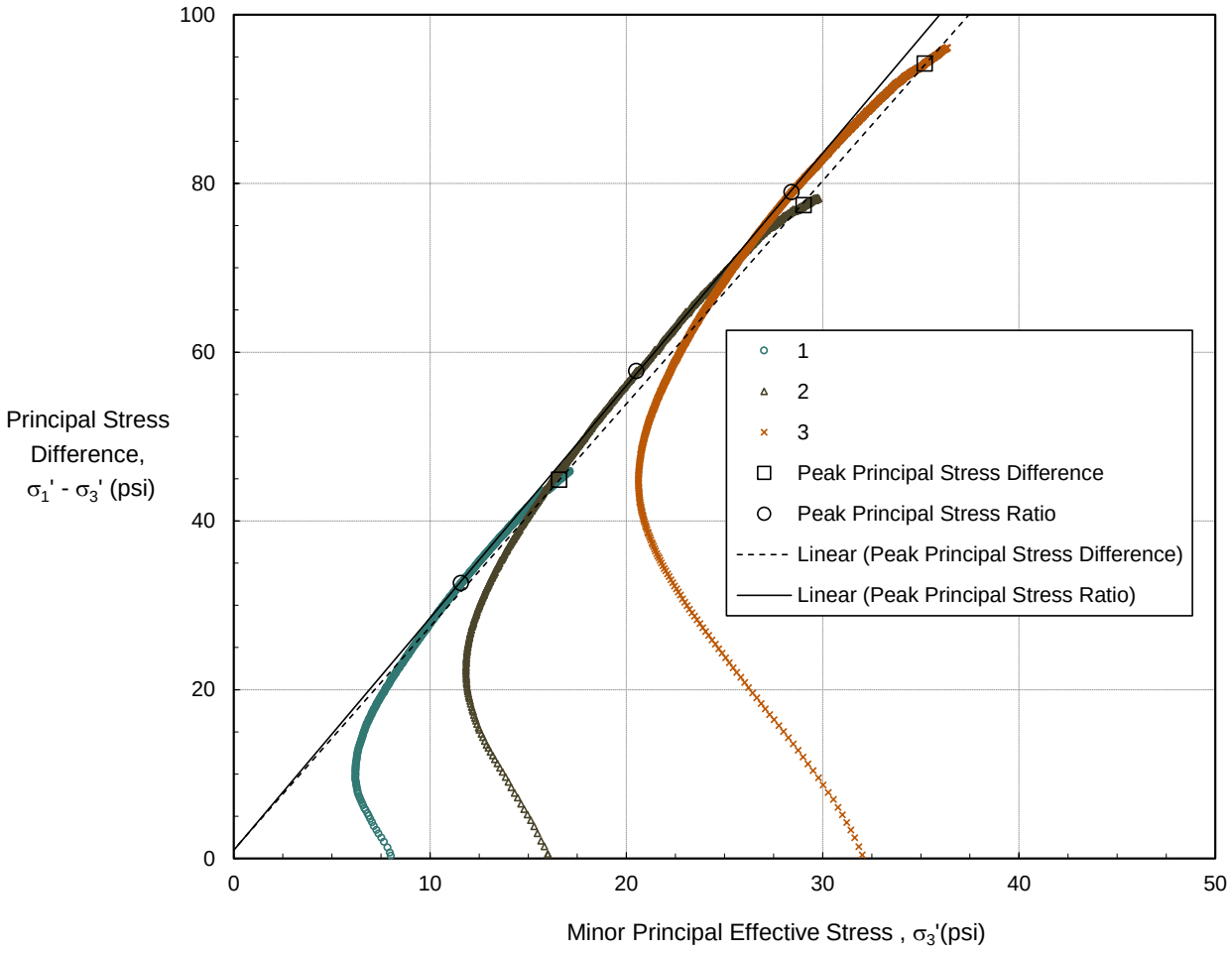
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Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting, L.L.C.
Project: 2022-007 AEP Welsh LF- Interface Testing
Sample: Borrow Soil

TRI Log #: 23-002001.2
Test Method: ASTM D4767

Modified Mohr-Coulomb



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	34.7	35.4
Effective Cohesion (psi)	0.3	0.3

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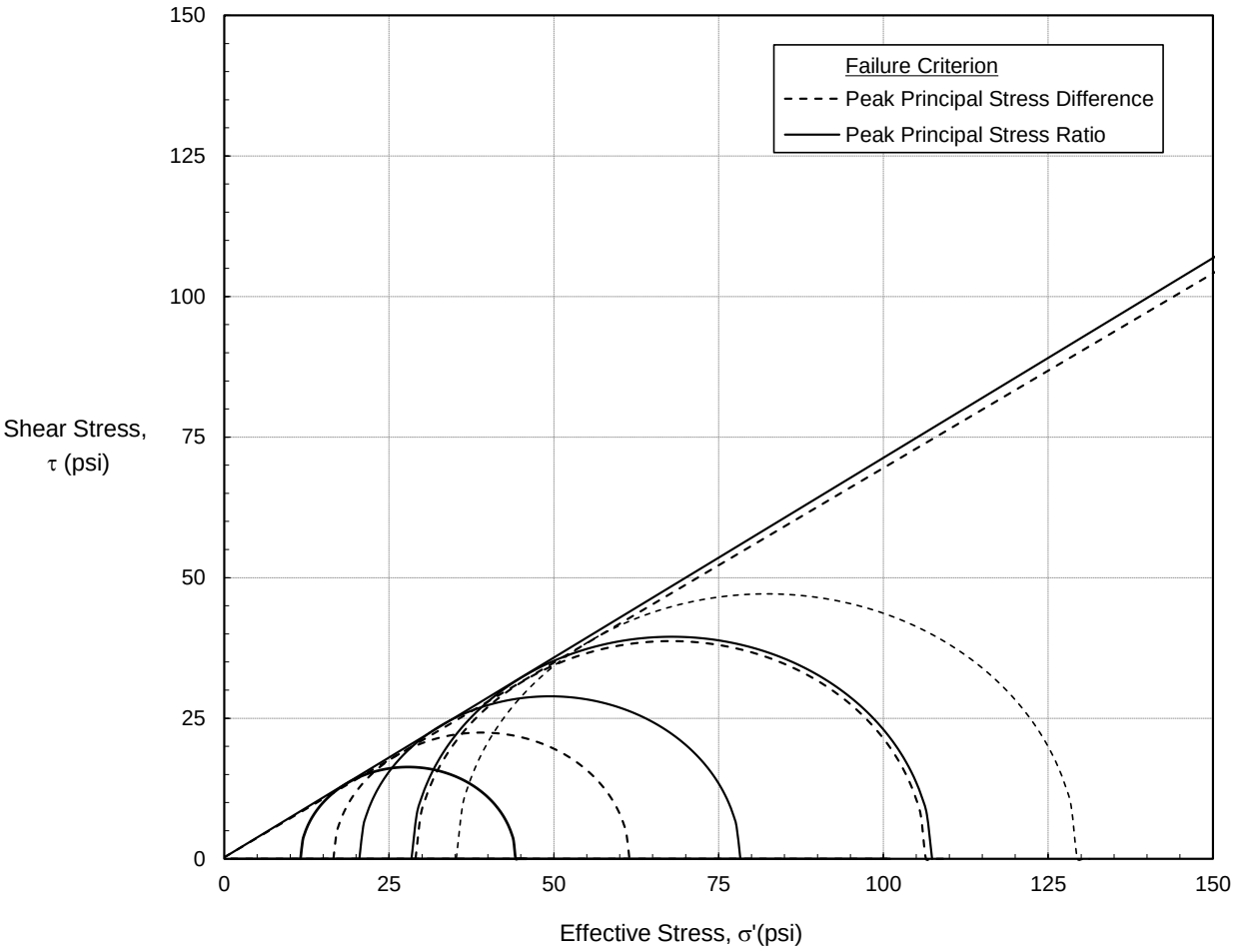
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Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting, L.L.C.
Project: 2022-007 AEP Welsh LF- Interface Testing
Sample: Borrow Soil

TRI Log #: 23-002001.2
Test Method: ASTM D4767

Mohr-Coulomb



Failure Criterion: Peak Principal Stress	Difference, $(\sigma_1'-\sigma_3')_{max}$	Ratio, $(\sigma_1'/\sigma_3')_{max}$
Effective Friction Angle (deg)	34.7	35.4
Effective Cohesion (psi)	0.3	0.3

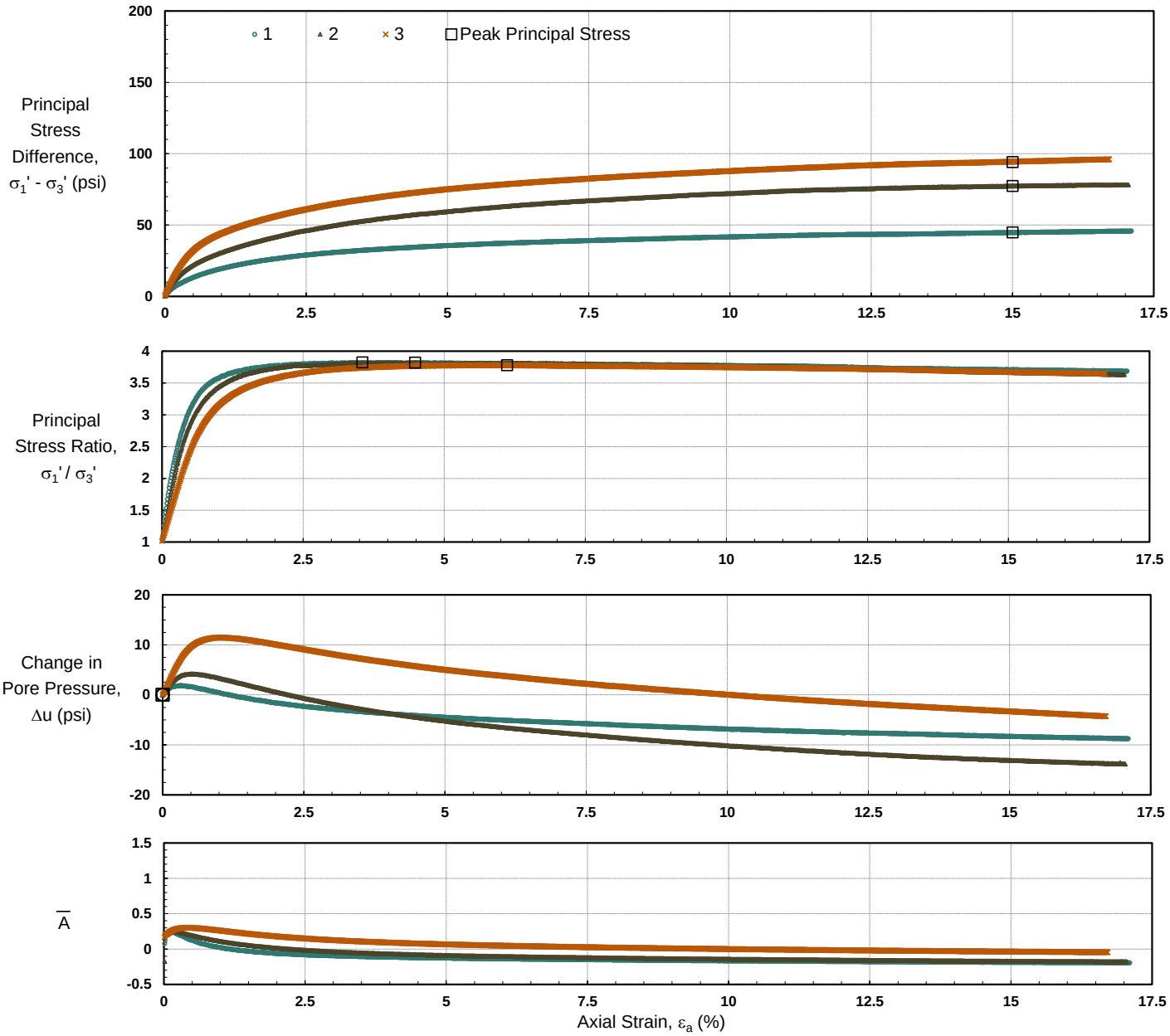
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Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting, L.L.C.
Project: 2022-007 AEP Welsh LF- Interface Testing
Sample: Borrow Soil

TRI Log #: 23-002001.2
Test Method: ASTM D4767



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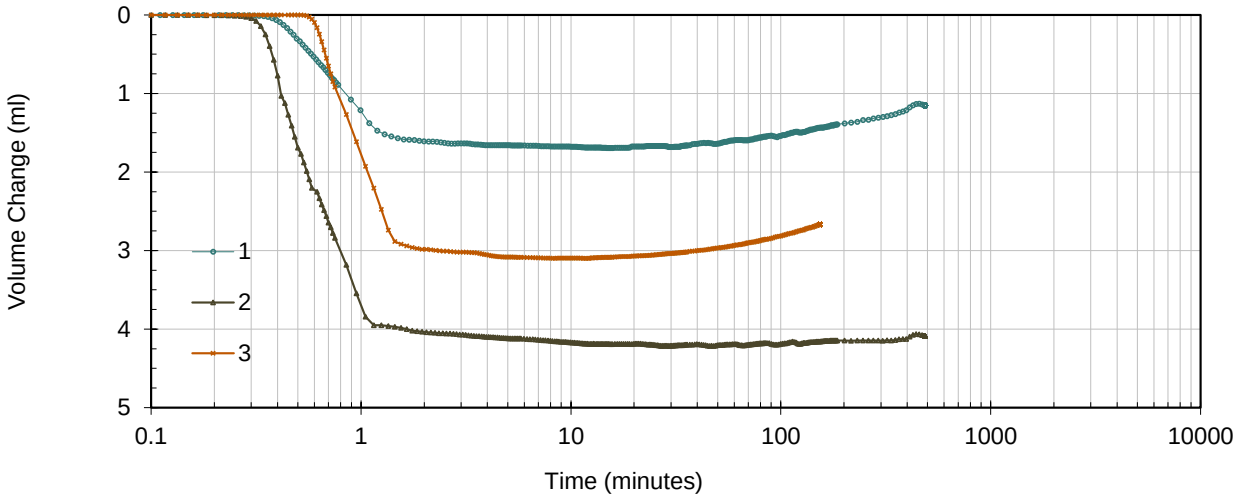
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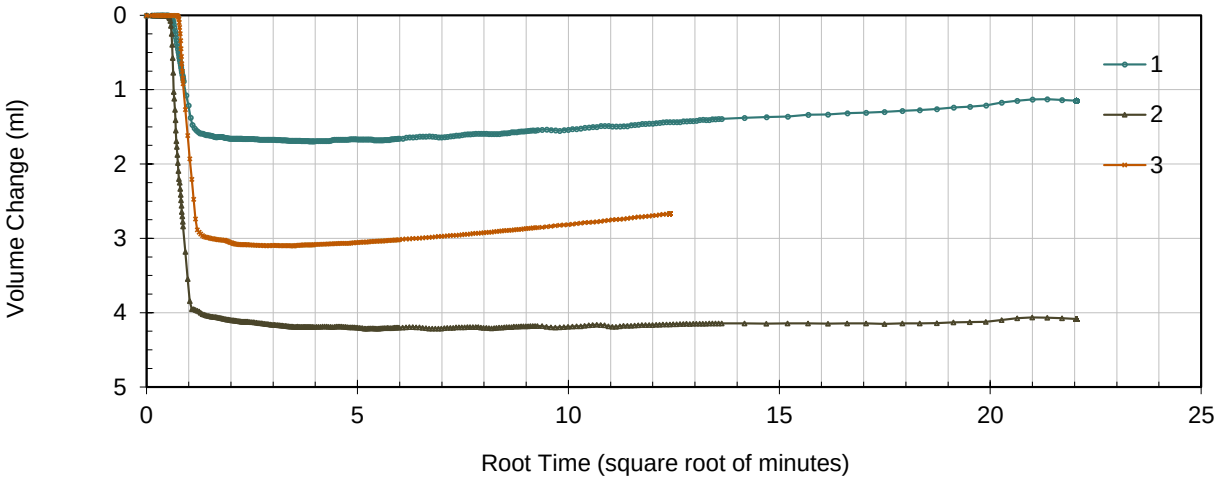
Consolidated-Undrained Triaxial Compression

Client: Auckland Consulting, L.L.C.
Project: 2022-007 AEP Welsh LF- Interface Testing
Sample: Borrow Soil

TRI Log #: 23-002001.2
Test Method: ASTM D4767

Consolidation





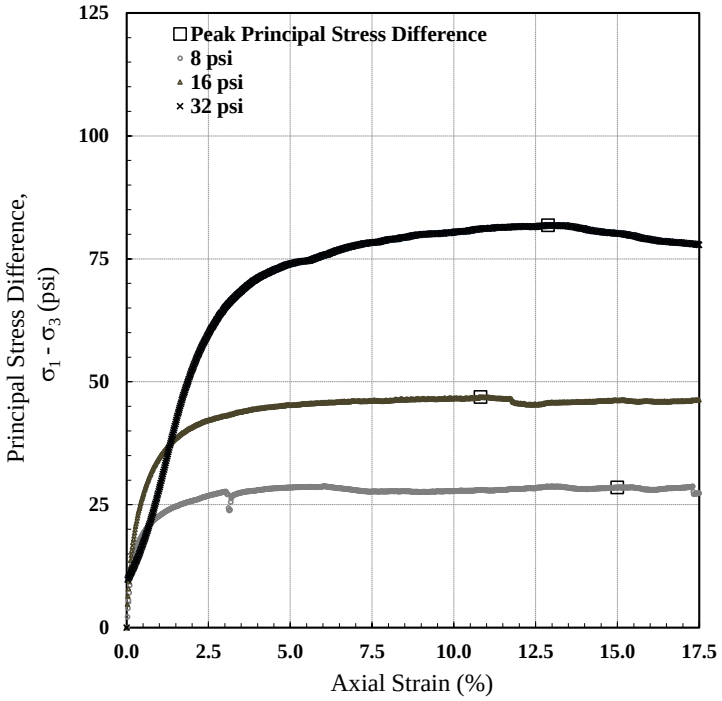
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Unconsolidated-Undrained (Q) Triaxial Compression

Client: Auckland Consulting, L.L.C.
Project: 2022-007 AEP Welsh LF- Interface Testing
Sample: Borrow Soil

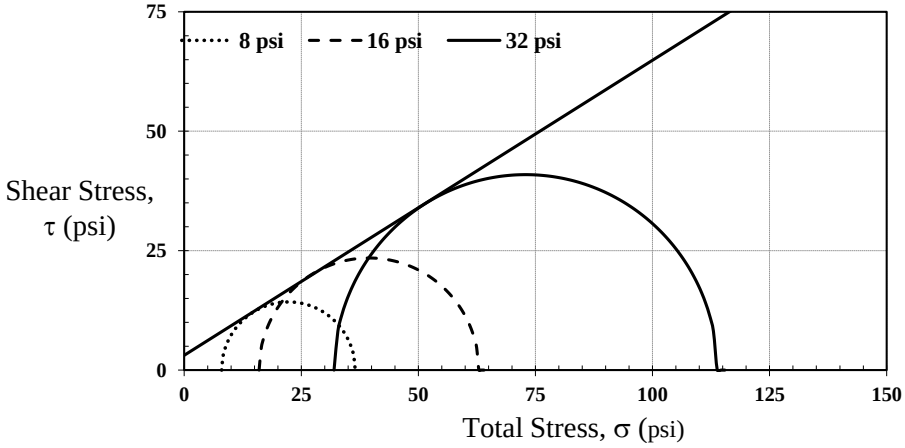
TRI Log #: 2001.2
Test Method: ASTM D2850



Samples			
Sample I.D.	-	-	-
Depth/Elev. (ft)	-	-	-
Minor Principal Stress (psi)	8.0	16.0	32.0
Initial Properties			
Avg. Diameter (in)	1.99	1.99	2.00
Avg. Height (in)	4.56	4.58	4.64
Avg. Water Content (%)	12.7	12.8	12.8
Bulk Density (pcf)	120.8	119.5	117.5
Dry Density (pcf)	107.1	105.9	104.1
Saturation (%)	58.0	56.7	54.2
Void Ratio	0.60	0.62	0.65
Specific Gravity (Assumed)	2.75	2.75	2.75

At Failure			
Failure Criterion	Maximum Deviator Stress		
Rate of Strain (%/hr)	60	60	60
Axial Strain at Failure (%)	15.0	10.8	12.9
Minor Total Stress (psi)	8.0	16.0	32.0
Major Total Stress (psi)	36.5	62.9	113.8
Principal Stress Diff. (psi)	28.5	46.9	81.8
S_u (psi)	14.3	23.5	40.9
S_u / σ_3	1.8	1.5	1.3

Total Stress Envelope	
Friction Angle (deg)	31.7
Cohesion (psi)	3.1



Jeffrey A. Kuhn , Ph.D., P.E., 7/21/2023
Analysis & Quality Review/Date

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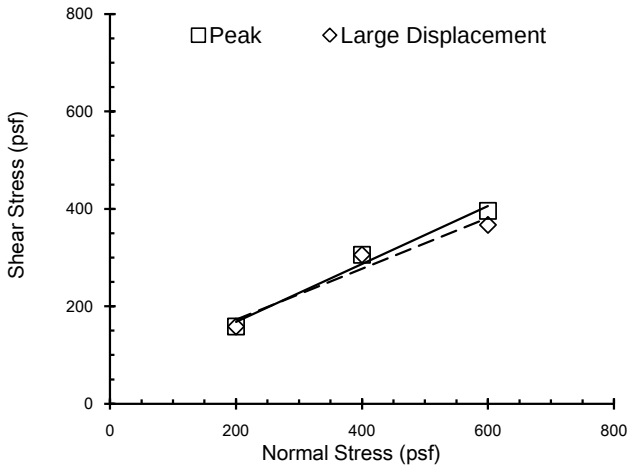
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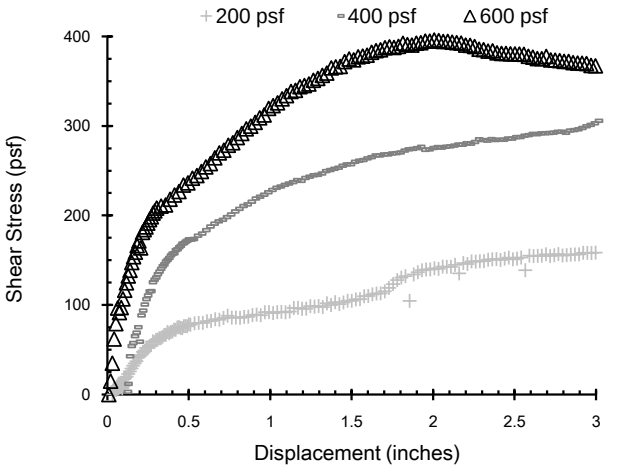
Large Scale Direct Shear Test (ASTM D3080 Modified)

Client: Auckland Consulting, L.L.C.
Project: 2022-007 AEP Welsh LF- Interface Testing

TRI Log #: 23-002001-1
Richard S. Lacey, P.E. 7/20/2023
Analysis & Quality Review/Date

CCR Coal Ash vs. Intermediate Cover (Borrow Soil)





Test Results, Linear Regression			
Mohr-Coulomb Parameters		Peak	Large Displacement
Friction Angle	Degrees	30.7	27.5
Y-intercept or Adhesion	psf	49	69
Minimum Secant Angle	Degrees	33.4	31.5

Note - Large Displacement Values Reported for 3.0 inches of Displacement

Test Conditions		
Upper Box	CCR Coal Ash [58.23 pcf @ OMC 51.8%]	
Lower Box	Intermediate Cover (Borrow Soil) [106.68 pcf @ OMC 13%]	
Conditioning	Wet - Loading applied and Interface flooded for a minimum of 24 hours prior to shear.	
Shearing Rate	inches/minute	0.04

Test Notes

Shearing occurred at the interface at all stresses.

Specimen No.		-	1	2	3
Normal Stress		psf	200	400	600
Box Edge Dimension		in	12	12	12
Bearing Slide Resistance		lbs	10	12	14
Peak	Shear Stress	psf	158	306	396
	Secant Angle	deg.	38.4	37.4	33.4
Large Displacement	Shear Stress	psf	158	306	367
	Secant Angle	deg.	38.4	37.4	31.5

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

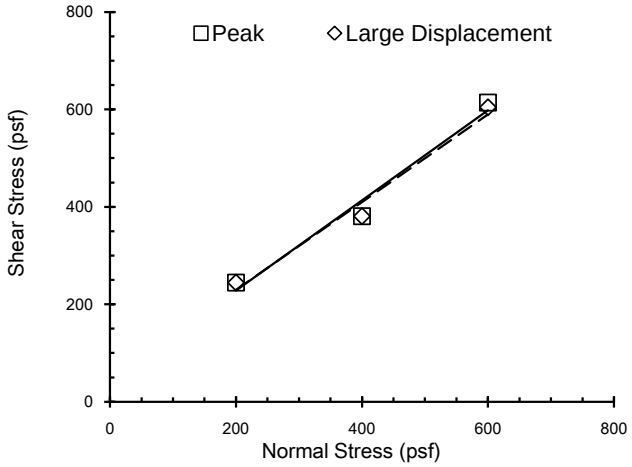
TRI ENVIRONMENTAL, INC.
9063 BEE CAVES RD. – AUSTIN, TX 78733 – USA | PH: 800.880.TEST OR 512.263.2101

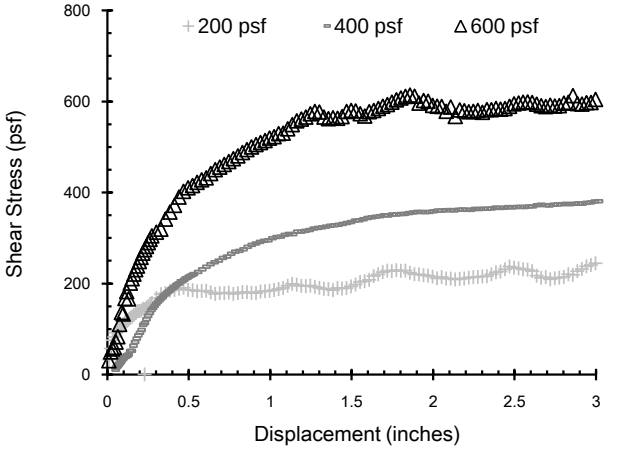
Shear Strength of Soil-Geosynthetic Interface by Direct Shear (ASTM D5321)

Client: Auckland Consulting, L.L.C.
Project: 2022-007 AEP Welsh LF- Interface Testing

TRI Log #: 23-002001-2
Richard S. Lacey, P.E. 7/24/2023
Analysis & Quality Review/Date

Borrow Soil (Int. Cover Soil) vs.
Agru SGNGM 50 mil LLDPE (GTA0115460014) [spike surface up]





Test Results, Linear Regression			
Mohr-Coulomb Parameters		Peak	Large Displacement
Friction Angle	Degrees	42.7	42.0
Y-intercept or Adhesion	psf	44	50
Minimum Secant Angle	Degrees	43.6	43.6

Note - Large Displacement Values Reported for 3.0 inches of Displacement

Test Conditions		
Upper Box	Borrow Soil (Int. Cover Soil) ω = 13.0 % γ_d = 106.7 pcf	
Lower Box	Agru SGNGM 50 mil LLDPE (GTA0115460014) [spike surface up]	
Conditioning	Wet - Loading applied and Interface flooded for a minimum of 24 hours prior to shear.	
Shearing Rate	inches/minute	0.04

Test Notes

Shearing occurred at the interface at all stresses.

Specimen No.		-	1	2	3
Normal Stress		psf	200	400	600
Box Edge Dimension		in	12	12	12
Bearing Slide Resistance		lbs	10	12	14
Peak	Shear Stress	psf	245	381	614
	Secant Angle	deg.	50.7	43.6	45.7
Large Displacement	Shear Stress	psf	245	381	604
	Secant Angle	deg.	50.7	43.6	45.2
Spike Height, Avg. of 5 Meas.		mils	19	15	15

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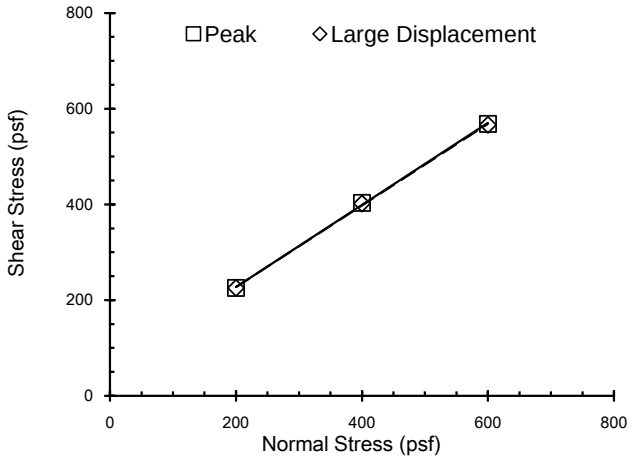
TRI Environmental, Inc.
9063 Bee Caves Rd. – Austin, TX 78733 – USA | Ph: 800.880.TEST or 512.263.2101

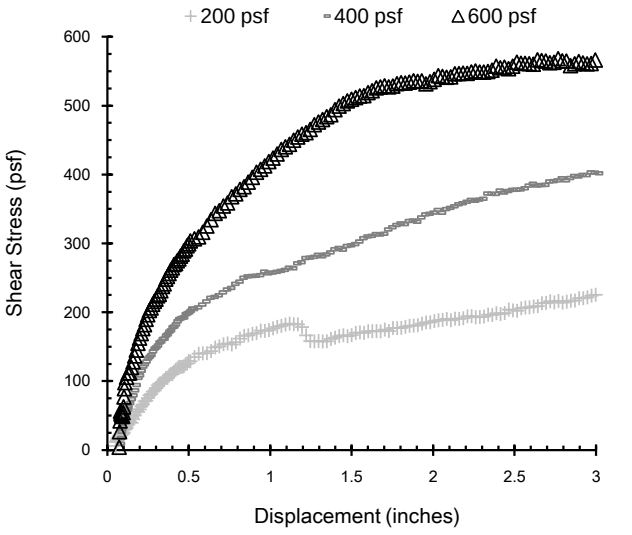
Multi-Layered Interface Friction Test (ASTM D5321 Modified)

Client: Auckland Consulting, L.L.C.
Project: 2022-007 AEP Welsh LF- Interface Testing

TRI Log #: 23-002001-3
Richard S. Lacey, P.E. 7/21/2023
Analysis & Quality Review/Date

CCR Coal Ash vs Agru SGNGM 50 mil LLDPE (GTA0115460014) vs. Intermediate Cover (Borrow Soil)





Test Results, Linear Regression			
Mohr-Coulomb Parameters		Peak	Large Displacement
Friction Angle	Degrees	40.6	40.4
Y-intercept or Adhesion	psf	56	57
Minimum Secant Angle	Degrees	43.4	43.3

Note - Large Displacement Values Reported for 3.0 inches of Displacement

Test Conditions		
Upper Box	CCR Coal Ash [58.23 pcf @ OMC 51.8%]	
Floating	Agru SGNGM 50 mil LLDPE (GTA0115460014) [spikes down, nubs up]	
Lower Box	Intermediate Cover (Borrow Soil) [106.68 pcf @ OMC 13%]	
Conditioning	Wet - Int. Cover surface sprayed with water. SGNGM and Ash placed. Loading applied and Interface flooded for a minimum of 24 hours prior to shear.	
Shearing Rate	inches/minute	0.04

Test Notes

Shearing occurred at the Ash vs SGNGM interface at all stresses.

Specimen No.		-	1	2	3
Normal Stress		psf	200	400	600
Box Edge Dimension		in	12	12	12
Bearing Slide Resistance		lbs	10	12	14
Peak	Shear Stress	psf	225	403	568
	Secant Angle	deg.	48.4	45.2	43.4
Large Displacement	Shear Stress	psf	225	402	566
	Secant Angle	deg.	48.4	45.1	43.3
Asperity Height*	Top	mils	173	171	175
	Bottom	mils	55	18	16

The testing herein is based upon accepted industry practice as well as the test method listed. Test results reported herein do not apply to samples other than those tested. TRI neither accepts responsibility for nor makes claim as to the final use and purpose of the material. TRI observes and maintains client confidentiality. TRI limits reproduction of this report, except in full, without prior approval of TRI.

TRI Environmental, Inc.
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CCR Landfill: Final Closure
Stability and Settlement Assessment
Welsh Power Plant
Auckland Project No. 2023-007

Referenced Information and Data

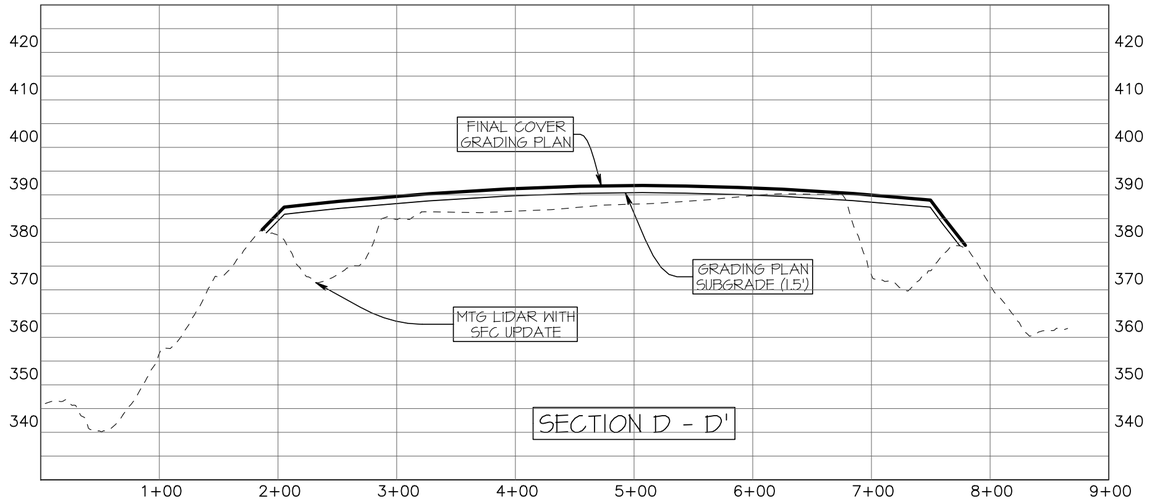
Project Drawings for the Welsh Landfill – Closure Grading Plan
(Optimized 3H:1V Side Slope Version, April 2023);
MTG Engineers and Surveyors

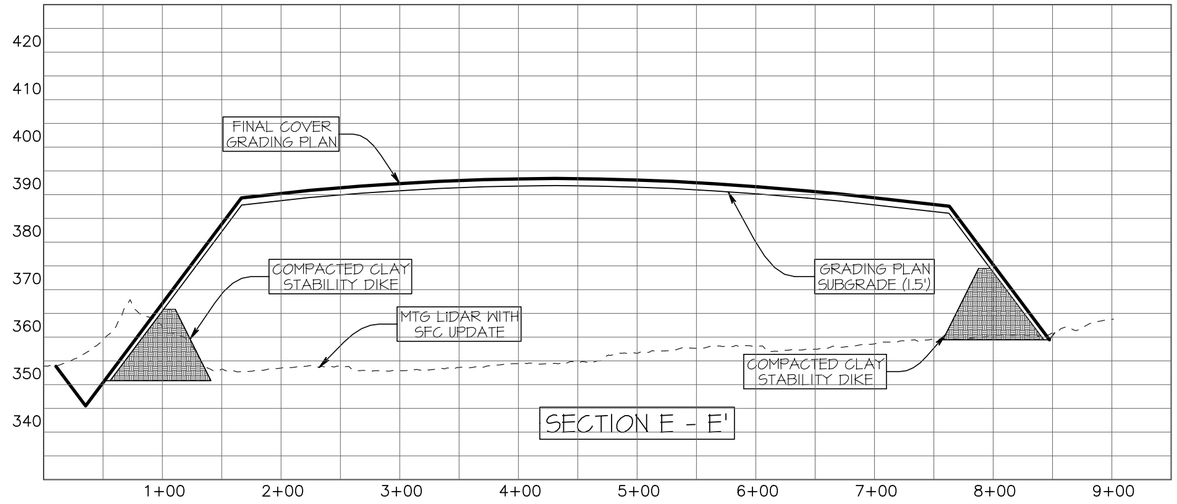
WELSH ASH LANDFILL - CLOSURE GRADING PLAN
OPTIMIZED 3H:1V SIDESLOPE VERSION

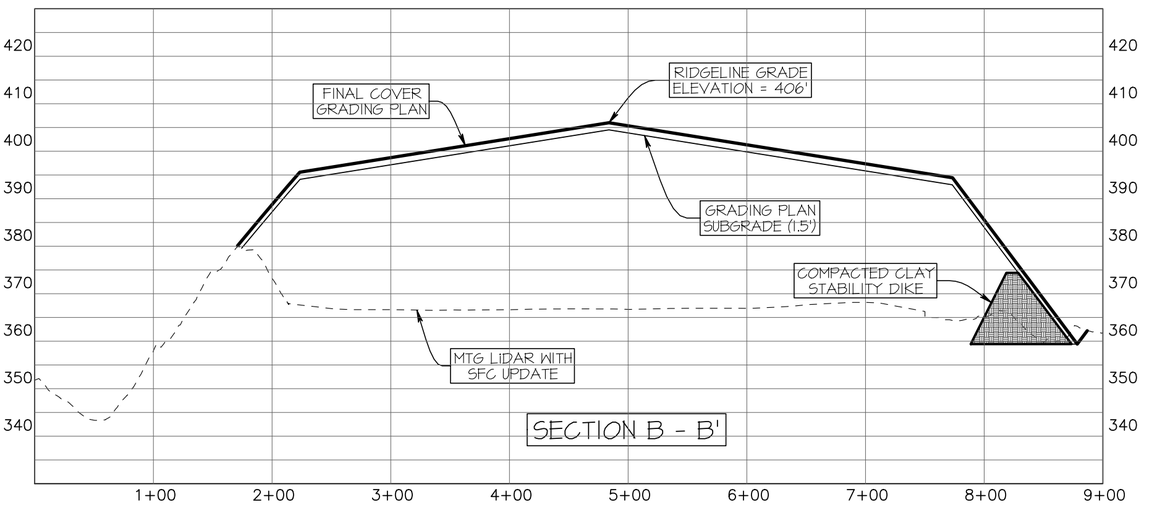
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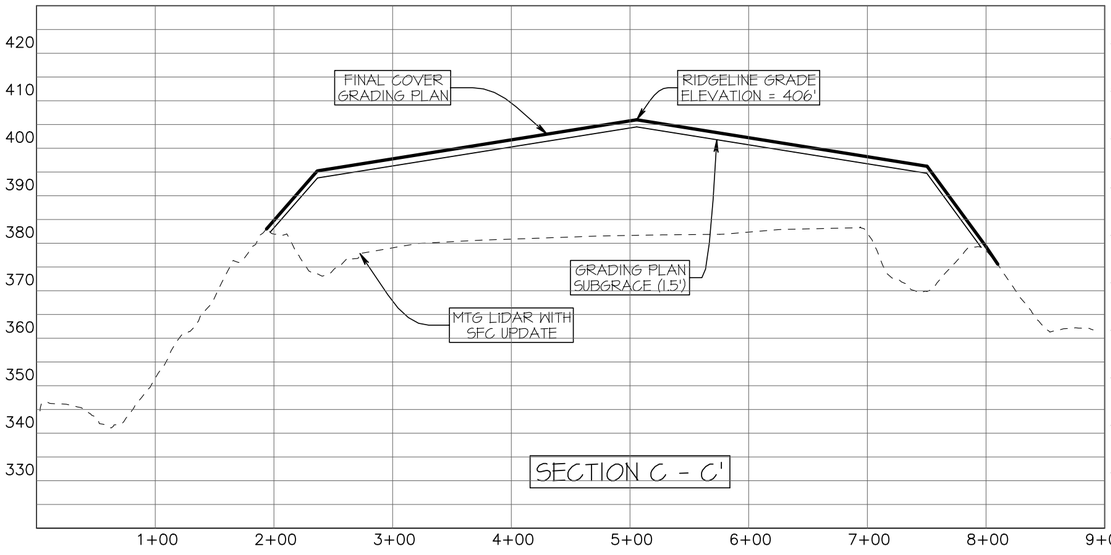
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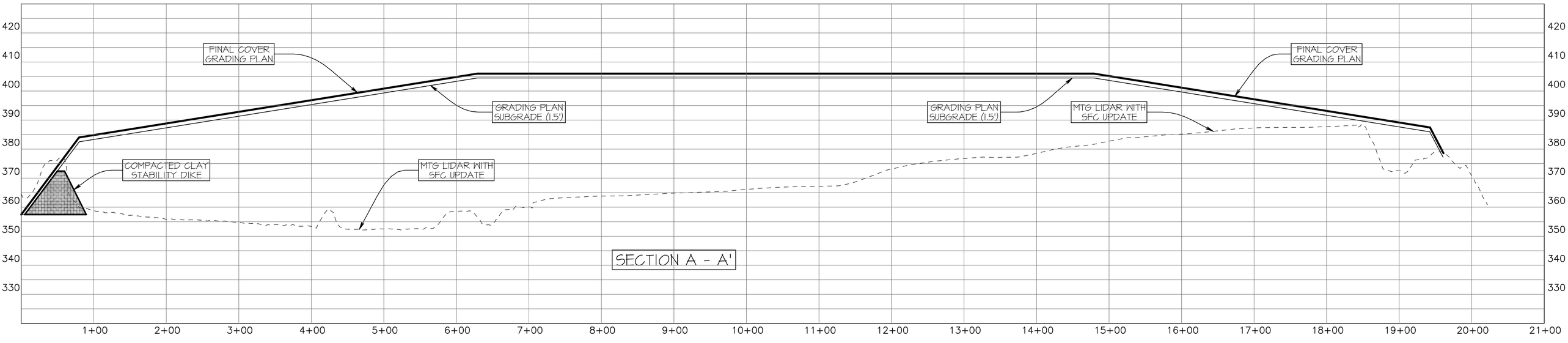
GRAPHIC SCALE 1" = 50'


FINAL COVER GRADING PLAN
GRADING PLAN SUBGRADE (1.5')
MTG LIDAR WITH SFC UPDATE
SECTION D - D'
420
410
400
390
380
370
360
350
340
1+00
2+00
3+00
4+00
5+00
6+00
7+00
8+00
9+00


FINAL COVER GRADING PLAN
COMPACTED CLAY STABILITY DIKE
MTG LIDAR WITH SFC UPDATE
GRADING PLAN SUBGRADE (1.5')
COMPACTED CLAY STABILITY DIKE
SECTION E - E'
420
410
400
390
380
370
360
350
340
1+00
2+00
3+00
4+00
5+00
6+00
7+00
8+00
9+00


FINAL COVER GRADING PLAN
RIDGELINE GRADE ELEVATION = 406'
GRADING PLAN SUBGRADE (1.5')
COMPACTED CLAY STABILITY DIKE
MTG LIDAR WITH SFC UPDATE
SECTION B - B'
420
410
400
390
380
370
360
350
340
1+00
2+00
3+00
4+00
5+00
6+00
7+00
8+00
9+00


FINAL COVER GRADING PLAN
RIDGELINE GRADE ELEVATION = 406'
GRADING PLAN SUBGRADE (1.5')
MTG LIDAR WITH SFC UPDATE
SECTION C - C'
420
410
400
390
380
370
360
350
340
330
1+00
2+00
3+00
4+00
5+00
6+00
7+00
8+00
9+00


FINAL COVER GRADING PLAN
GRADING PLAN SUBGRADE (1.5')
COMPACTED CLAY STABILITY DIKE
MTG LIDAR WITH SFC UPDATE
GRADING PLAN SUBGRADE (1.5')
MTG LIDAR WITH SFC UPDATE
FINAL COVER GRADING PLAN
SECTION A - A'
420
410
400
390
380
370
360
350
340
330
1+00
2+00
3+00
4+00
5+00
6+00
7+00
8+00
9+00
10+00
11+00
12+00
13+00
14+00
15+00
16+00
17+00
18+00
19+00
20+00
21+00

CCR Landfill: Final Closure
Stability and Settlement Assessment
Welsh Power Plant
Auckland Project No. 2023-007

Referenced Information and Data

Phase 1 Landfill Seepage Evaluation and Final Stability of Vertical Expansion, Geotechnical Investigation – Final Report, ETTL Job No. G4207-14 (April 2015)

Geotechnical Investigation

AEP-Southwestern Electric Power Company

Phase 1 Landfill Seepage Evaluation and Vertical Expansion
Pittsburg, Texas

Submitted to

AEP-Southwestern Electric Power Company
Pittsburg, Texas

Prepared by

ETTL Engineers & Consultants Inc.
Tyler, Texas

April 2015

Table 5.0.1 – Soil Laboratory Testing Procedures		
Test	**Test Method**	**Number of Tests**
Drained Conditions		
Unconsolidated-Undrained Triaxial Compression Test for Cohesive Soils	ASTM D 2850	4
Consolidated-Undrained Triaxial Compression Test for Cohesive Soils	ASTM D 4767	5

The above laboratory tests were performed in general accordance with applicable ASTM, U.S. Army Corps of Engineers procedures, and/or generally accepted practice. It should be noted that reference to ASTM or other standard procedures does not imply that all cross-referenced procedures in ASTM or other standards have been used, or that all ASTM or other procedures used have been followed exactly. Only those ASTM or other standard procedures and/or portions of procedures, which, in the professional judgment of the geotechnical engineer of record for this report, are applicable, appropriate, and necessary for this particular project, have been used or followed. Details regarding these tests are included on the logs (APPENDIX A) and in the Laboratory Test Reports of APPENDIX B.

5.1 Test Specimen Preparation

Because of the relative difficulty of obtaining intact, undisturbed samples of the ash, strength tests were conducted on remolded specimens. The specimens were prepared with care to avoid over-compaction. That is, the specimens were compacted such that they did not exceed the confining stress to be used in the test (except for native clays which were assumed to be used in construction of the cap and which were molded to approximately 95% of ASTM D698). Thus shear strength parameters for remolded specimens represent the properties of normally consolidated ash, which is a conservatively realistic way to represent them. Only that portion of the sample finer than the #10 sieve was used to remold strength specimens. In some cases some of this material contained cemented particles.

Specimens for permeability were molded to approximately 95% ASTM D698 as predicted by correlations with index properties.

6.0 LANDFILL AND FOUNDATION STRATIGRAPHY & PROPERTIES

Detailed on the boring logs are the specific types and depths of the various ash and soil strata encountered.

6.1 Regional Geology

The landfill is situated over an outcrop of the Queen City Sand. Characteristic lithologies of this formation are light gray to brownish gray, fine- to medium-grained quartz sand and gray to brown clay, occasionally silty and slightly lignitic. Ironstone concretions, sometimes occurring as ledges, are common within the formation. In outcrop, the Queen City weathers to a mottled red and white color.

It is possible that the fat clay encountered at elevations ranging approximately from 320 to 330 beneath the subject area is the top of the Reklaw formation. The Reklaw Formation includes, from top down, Marquez and Newby Members which are not separately mapped. The Marquez Member, is comprised of clay and silt, carbonaceous, lentils of glauconitic clay ironstone, brownish black, reddish brown; and weathers light brown to light gray.

6.2 Foundation Soil Stratigraphy

The native soil profile beneath the landfill consists generally of 5' to 15' of lean clay (CL) and/or fat clay (CH) that is generally soft to medium stiff directly beneath the landfill and medium stiff to very stiff otherwise, overlying a varying thickness of very dense silty sand (SM) / sandy silt (ML), which is underlain by a basal hard fat clay (CH).

6.3 Landfill Ash Deposits

The ash currently varies in thickness generally from 25' to 33'. It characterized by a large range of grain size distributions and classifies generally as very loose to medium dense silty sand (SM), clayey sand (SC), silt (ML) and elastic silt (MH). Localized zones can be cemented. We have identified basically four types of ash, designated as follows, including estimated % of total landfill contents (based on the ratio of the sum of the thicknesses of each type from each boring to the sum of the total ash thickness from each boring):

- Economizer ash, Dark Brown and Grayish Brown (visual appearance of small glass beads) (SM, SC) – 44%
- Bottom ash, black (MH) – 10%
- Ash mixture, dark gray and dark brown (MH, sandy ML/MH) – 13%
- Fly ash, Light brown and grayish brown, some cementing (SM, SC, sandy ML/MH) – 33%

The location of each of the 4 types in the landfill is random. There is no regular layering. It was generally quite common for the upper 10' – 15' to be denser (or perhaps stronger due to some cementing) than the remaining ash below the estimated perched water level. The predicted engineering properties of each of the ashes are listed on the logs and/or TABLE 6.5.1 – ENGINEERING PROPERTIES in Section 6.5 of this report.

6.4 Seismic Design

Due to the relatively low ground acceleration potential of the area, seismicity is not generally a concern. However, an initial screening analysis was performed.

6.4.1 GROUND MOTION PARAMETERS

The source of seismic data is the U S Geological Survey website, utilizing the *NEHRP Recommended Seismic Provisions*, FEMA P-750, 2009 Edition:

http://earthquake.usgs.gov/designmaps/us/application.php
http://geohazards.usgs.gov/eqprob/2009/index.php

Based on the soil stratigraphy in the surficial 100', the site is categorized as Class D. The site

coordinates used for reference are: 33.04776 N, 94.84488 W. The assumed risk category is Category I, II, III (non-essential facilities).

With the above information as input, the website computed applicable seismic parameters, a report of which is included in APPENDIX E. In summary the salient parameters for this analysis for a return period of 2,500 years (probability of 2% in 50 years) are:

- Peak Ground Acceleration (Free Field) - PGA = 0.093g
- Spectral Acceleration (short period, 0.2 second) – S_{Ms} = 0.197g
- Spectral Acceleration (long period, 1.0 second) – S_{M1} = 0.161g
- Site Coefficient F_a = 1.6
- Site Coefficient F_v = 2.4
- Site Coefficient F_{PGA} = 1.6

In keeping with recommendations of the MSHA Engineering and Design Manual (cited below), section **7.7.3.7 Simplified Design Ground Motion for Areas of Low Seismic Hazard**, the maximum credible earthquake for the site is determined by generating an earthquake probability map with a return period $\geq$ 10,000 years (a somewhat arbitrary return period to satisfy a "very low probability of occurrence" criterion which would be conservative for this type of facility) for earthquakes within 50km of a given site. This map is included in APPENDIX E. This simplified approach to determining the maximum credible earthquake applies only to areas of low seismic hazard such as characterize much of the central and eastern US (as well as this site). Based on this analysis:

- Maximum Credible Earthquake Magnitude, M_w = 5.5 (generally recognized minimum for design—The probability map in APPENDIX E indicates an even lower probability than 1:10,000 years for this EQ)

In addition for liquefaction screening analysis, the MSHA Manual recommends that the Free Field, Site-Adjusted PGA (2,500 year return interval) be multiplied by 1.5 to obtain the PGA corresponding to the maximum credible earthquake:

- PGA for Liquefaction Screening Analysis (Maximum Credible Earthquake within 50km) = 0.093g x 1.5 = 0.14g

6.4.2 LIQUEFACTION SCREENING ANALYSIS

Per the *FEDERAL GUIDELINES FOR DAM SAFETY, Earthquake Analyses and Design of Dams (*FEMA 65*),* FEMA 2005, Section I.E.1, a basic seismic study was conducted to assess the potential for liquefaction. In general, very loose, granular material below a groundwater table indicates susceptibility. However, except for an isolated pocket or two detected in our borings, all of the ash is either too fine (-#200 > 35%) or is above the perched water, or is cemented, indicating that the majority is not susceptible to liquefaction. In addition, the fact that possibly susceptible zones are in isolated pockets indicates that the risk of detrimental deformation or failure due to liquefaction is very low. However, an analysis was performed in the event that a given zone could possibly be typical of an extensive pocket (although the borings gave no indication of this).

TABLE 6.5.1 - REPRESENTATIVE ENGINEERING PROPERTIES

Stratum Color Classification(s)	Peak / Post Peak Shear Strength				Unconsolidated Undrained (UU) c (psf)[19] /Confining Pressure (psi)	Hydraulic Conductivity (cm/sec)	Range of Plasticity Index	Range of % Passing No. 200 Sieve	Predicted Range Dry Unit Wt. (pcf)	Predicted Range Moist Unit Wt. (pcf)	Saturated Unit Wt. (pcf) / MC (%)
	Effective (Drained)		Total (Undrained)								
	c' (psf)	ϕ'	c (psf)	ϕ							
Economizer Ash Dk. Br., Grayish Br. SM, SC	171 / 72	39.4 / 37.6	NA	NA	NA	2.95E-04[3]	NP - 12	25 - 50	78 – 83 (82)[17]	---	111[10]/34
Bottom Ash Black MH	801 / NA	37.7 / NA	NT	NT	NT	8.03E-07	19 - 42	96 - 100	35 – 45[6] (41)[17]	---	85[6]- 88[10]/104
Ash Mixture Dk. Gray, Dk. Brown MH, Sandy ML / MH	130	43.7	1,140	18.5	2,120/10[4] 2,780/20[4] 4,030/40[4]	NT	NP – 15 (10)[17]	62 – 96 (89)[17]	33 - 37[6] (42)[17]	---	85[6]- 83[10]/99
Fly Ash Lt. Br. / Grayish Br. SM, SC, Sand ML / MH	431 / 386	40.9 / 37.1	NT	NT	NT	NT	NP - 5	36 – 82[11]	39 – 95[6,7] (77)[17]	---	85[6]- 109[10]/41
Predicted Composite Ash Properties for Design	387[8]	35.3[8]	580[9]	25.4[9]	1,190[18]	---	---	---	71	85 - 100[14]	96 - 105[14]
Upper Native Clay Red, Lt. Br & Lt. Gray SC, Sandy CL / CH[15][16]	NT	NT	NT	NT	1,400/21[2] 1,500/18[2] 2,400/24[2] 2,100/21[2]	9.66E-08(CL) 1.13E-08(CH) 1.40E-08(CL)	9 - 50	39 - 95	99 - 110	123 – 131	130[5]
Remolded Upper Clay Reddish Br & Lt. Gray CH w/ Sand[1]	345	26.3	446	16.1	1,580/10[4] 1,980/20[4]	1.59E-07[1]	42	78	96	119	128
Remolded Upper Clay Reddish Br & Lt. Brown Sandy CL[1]	0	35.8	230	23.5	1,580/10[4] 3,100/20[4]	2.32E-05[1]	11	62.6	109 - 111	127 - 130	130
Upper Native Clay Reddish Br & Lt. Gray CH[16]	187	32.6	360	18.2	2,090/10[4] 3,430/40[4]	NT	38	85.8	98 - 103	124 - 127	130
Lower Native Clay Dark Brown CH[16]	101	31.1	446	16.3	1,440/10[4] 2,750/40[4]	NT	35 - 42	90 - 99	100 - 105	120 - 125	130[5]

Stratum Color Classification(s)	Peak / Post Peak Shear Strength[1]				Unconsolidated Undrained c (psf) /Confining Pressure (psi)	Hydraulic Conductivity (cm/sec)	Range of Plasticity Index	Range of % Passing No. 200 Sieve	Predicted Range Dry Unit Wt. (pcf)	Predicted Range Moist Unit Wt. (pcf)	Saturated Unit Wt. (pcf)
	Effective (Drained)		Total (Undrained)								
	c' (psf)	ϕ'	c (psf)	ϕ							
Interbedded Layer Light Brown SM, SP-SM	0.0	34(5)	NA	NA	NA	NT	NP	21 - 46	90 - 95	110 - 115	130(5)
Interbedded Layer Light Gray ML, Sandy ML	0.0	32(5)	NA	NA	NA	NT	NP - 3	50 - 87	90 -95	110 - 115	130(5)

(1) Samples Remolded at 95% predicted Maximum Dry Density

(2) Peak Unconsolidated/Undrained Triaxial Compression at insitu moisture content.

(3) Predicted by Beyer's Equation

(4) Shear strength from Unconsolidated/Undrained Triaxial Compression for saturated specimens at 10, 20 & 40 psi confining pressure.

(5) Predicted Values

(6) Measured from Trimmed SPT Samples

(7) Upper range is cemented fly ash

(8) Calculated weighted average of the four ash components based on their percentage of the overall landfill contents, using post peak data points from each test. Power curve fit variables a = 2.7619 and b = 0.8534. This normally consolidated representation of strength is believed conservative for the new ash to be placed with some nominal compaction.

(9) Crude estimate of c = 1.5 * c' and tan(ϕ) = 0.5 * tan(ϕ')

(10) Measured from direct shear or permeability specimens consolidated to approximately 10 psi

(11) Affected by cemented particles in sample. Uncemented material is finer

(12) Shear strength properties are based on tests on the portion of sample finer than #10 sieve, but which contains some cemented particles. Does not reflect cemented strength which is likely to be significantly higher.

(13) The post-peak values of this ash were used to represent the lower bound strength. Power curve fit variables a = 1.398 and b = 0.9303

(14) Lighter weights are, in some cases, conservative for stability analyses

(15) Fully softened strength (drained) is predicted (Re: aforementioned paper by Dr. Gregory) to be characterized by the equation (%Clay size fraction = 42% by hydrometer testing of CH constituent):

Drained fully softened shear strength = 0.8672*(eff normal stress)^0.9326.

(16) Shear strength measured on trimmed Shelby tube specimens

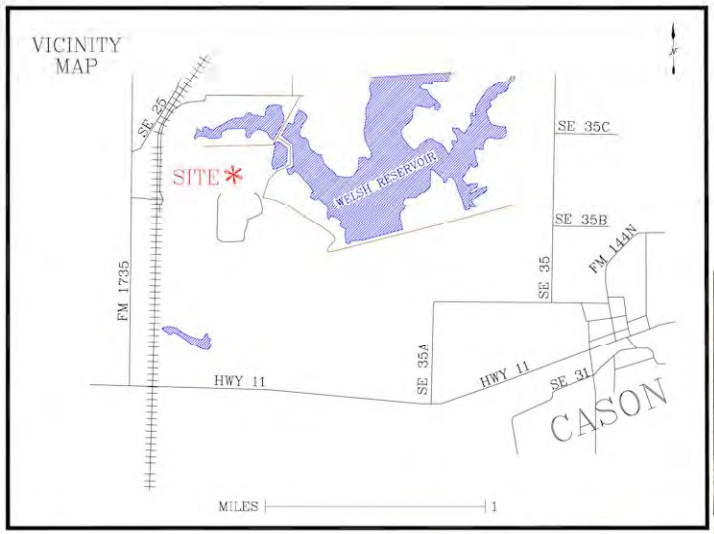
(17) Properties of test specimens

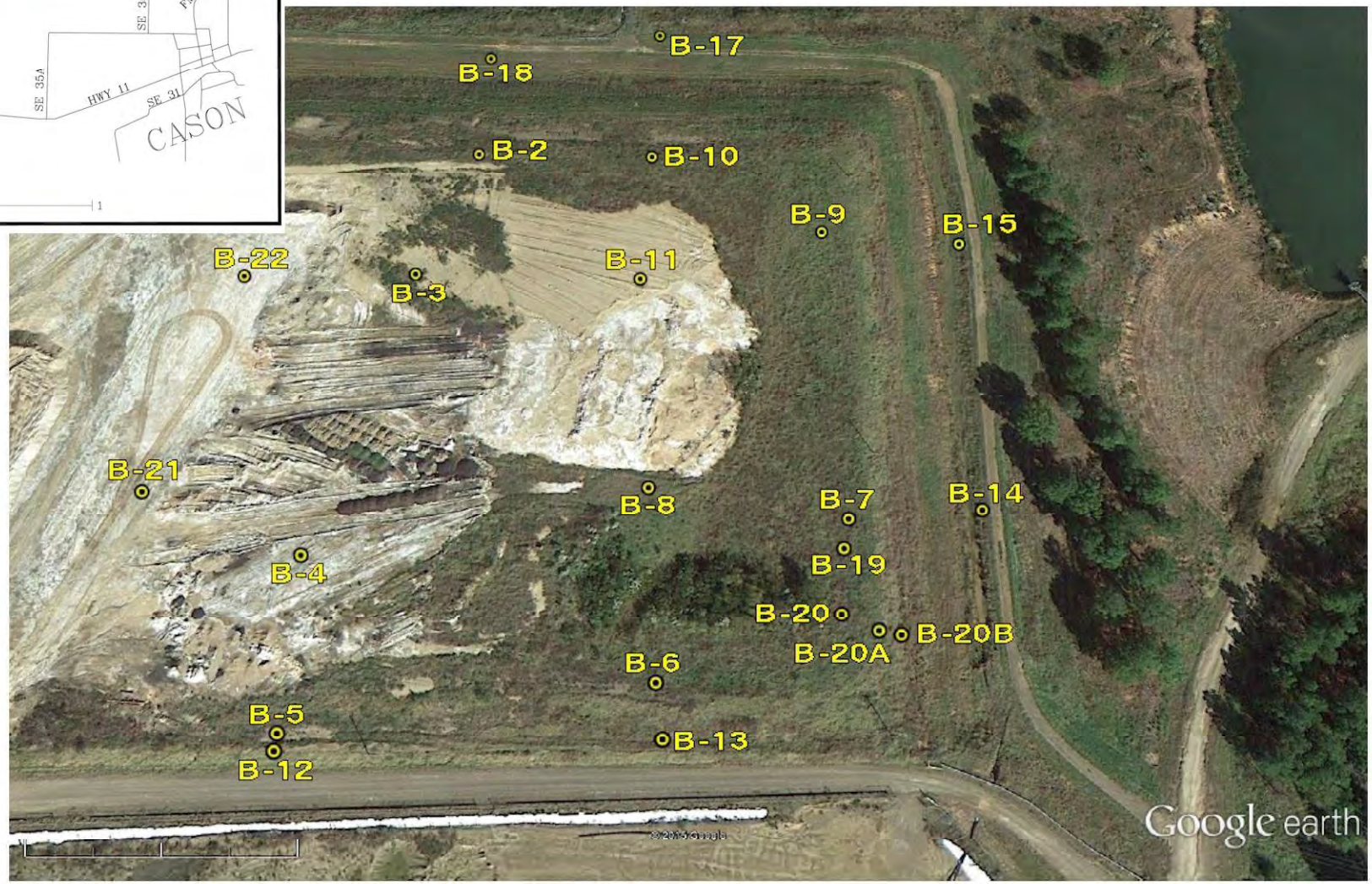
(18) Calculated from CU parameters at 1284 psf preconsolidation pressure (i.e. @ base of level 1 ash, i.e. beneath 26' of ash submerged in 18' of water)

(19) Lower bound UU values estimated from lowest test value of undrained shear strength * .85.

NT = Not tested
NP = Non-Plastic
NA = Not Applicable

APPENDIX A





feet 600

ETTL ENGINEERS & CONSULTANTS MAIN OFFICE 1717 East Erwin Tyler, Texas 75702 (903) 595-4421	PHASE I FLY ASH STORAGE AREA EMBANKMENT SEEPAGE & VERTICAL EXPANSION INVESTIGATION WELSH POWER STATION CASON, TEXAS	PLATE 1 - PLAN OF BORINGS		APPROVED BY:
		JOB.NO.: G4207-14		DRAWN BY: A.K.B.
		DATE: NOV. 2014	SCALE: AS SHOWN	

LOG OF BORING B-2

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX
PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/8/14
SURFACE ELEVATION 373.8

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	ML	ASH (SILT WITH GRAVEL(ML)) medium dense; light grayish brown; with coarse-grained sand and lightly cemented gravel pieces; dry	N=13					46				59	+40 Sieve=27% +4 Sieve=16%
5	SM	ASH (SILTY SAND(SM)) medium dense; dark brown and light brown; with coarse-grained sand and lightly cemented gravel pieces --loose; moist	N=29 N=18 N=9					40				40	+40 Sieve=19% +4 Sieve=2%
10													
15	MH	ASH (ELASTIC SILT(MH)) very loose; black; with fine-grained sand and lightly cemented gravel pieces; saturated	N=0					200	134	92	42	100	+40 Sieve=0% +4 Sieve=0%
20	SM	ASH (SILTY SAND(SM)) very loose; dark brown; with coarse-grained sand and lightly cemented gravel pieces; moist	N=1										
25		--loose; dark brown and light brown; with coarse-grained sand and lightly cemented gravel pieces; moist	N=7					91				61	+40 Sieve=11% +4 Sieve=1%
30	CL	SANDY LEAN CLAY(CL) medium stiff; dark brown and black; with fine-grained sand and cemented gravel pieces; saturated	N=6					18	30	15	15	63	+40 Sieve=1% +4 Sieve=0%

Egc @ 28-43' & Er @ 43-60'

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Water level @ 13'.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04890°, W94.84451°
Driller: Tommy Cook
Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-2 (cont.)

ETTL ENGINEERS & CONSULTANTS

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PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX
PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/8/14
SURFACE ELEVATION 373.8

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. #)
35	SC		Eqc @ 28-43' & Er @ 43-60'		CLAYEY SAND(SC) dense; light brown, light gray and reddish brown; moist; with fine-grained sand; mottled	P=3.5 P=2.75	110	1.39	4.3	21	18 16	30	15	15	39	+40 Sieve=0% +4 Sieve=0%
40	SM				SILTY SAND(SM) very dense; light brown, yellowish brown and light gray; moist; mottled; with fine-grained sand	N=78					21				24	+40 Sieve=0% +4 Sieve=0%
45	CH				FAT CLAY(CH) very stiff; dark brown and light brown; moist; with sand seams; laminated	N=27					25	62	26	36	96	+40 Sieve=2% +4 Sieve=0%
50					--dark brown with light gray; moist; with silt seams	P=4.0	98				24					
55																
60					--hard; dark brown; moist	N=37										
					Bottom of Boring @ 60'											

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 @ 13'.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04890°, W94.84451°
Driller: Tommy Cook
Logger: B.Hobbs/O.Sanderson

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LOG OF BORING B-3

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas **DRILL RIG:** D-50

PROJECT NO.: G4207-146 **BORING TYPE:** Rotary Wash/Flight Auger

DATE 10/24/14

SURFACE ELEVATION 380.5

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	SM	ASH (SILTY SAND(SM)) medium dense; grayish brown; with lightly cemented gravel pieces; moist	N=11						
5									
	MH	ASH (SANDY ELASTIC SILT(MH)) loose; dark brown; with lightly cemented gravel pieces; wet	N=8	73	61	57	4	70	+40 Sieve=9% +4 Sieve=0%
10			N=9						
15									
	MH	ASH (ELASTIC SILT(MH)) very loose; grayish brown and light brown; lightly cemented; moist	N=4	135	104	99	5	91	+40 Sieve=2% +4 Sieve=0%
20									
	CL	SANDY LEAN CLAY(CL) soft; reddish brown and light brown; moist; mottled	N=6						
25									
		--very stiff; light gray and reddish brown; moist; blocky; mottled; with ferric partings	N=16						
30									

Eqc @ 23-40'

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

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 8' while drilling. Water level @ 15' 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: N33.04845°, W94.84451°

Driller: Tommy Cook

Logger: O.Sanderson

LOG OF BORING B-3 (cont.)

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PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: D-50
PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/24/14
SURFACE ELEVATION 380.5

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(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35		ML	Eqc @ 23-40'	SILT(ML) dense; light gray; moist	N=42					27	29	26	3	87	+40 Sieve=0% +4 Sieve=0%
40		SP SM		POORLY GRADED SAND WITH SILT(SP-SM) very dense; light grayish brown	N=50/4.5"										
				Bottom of Boring @ 40'											

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

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 8' while drilling. Water level @ 15' and open upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04845°, W94.84451°
Driller: Tommy Cook
Logger: O.Sanderson

LOG OF BORING B-4

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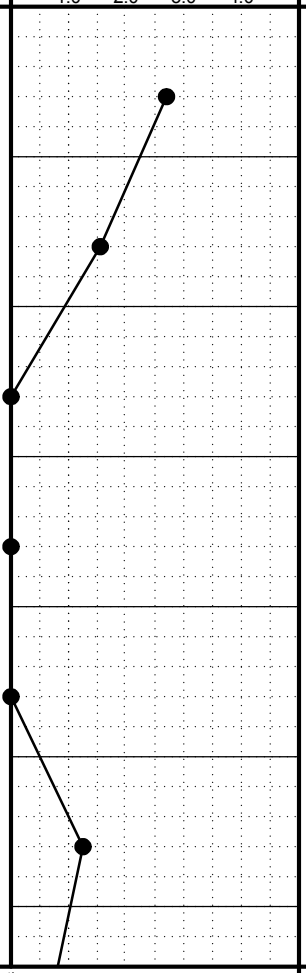
PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX
PROJECT NO.: G4207-146
BORING TYPE: Hollow Stem Auger

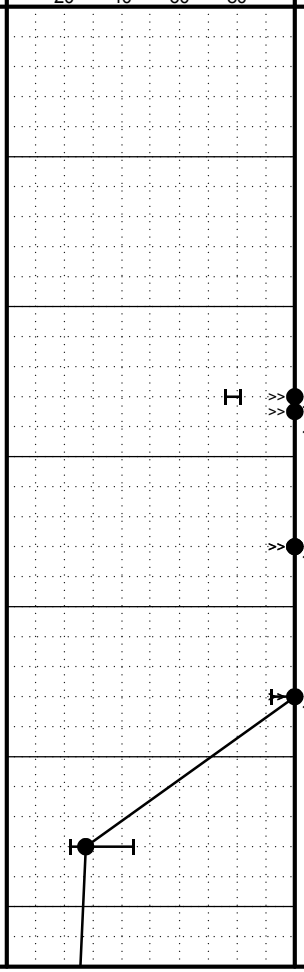
DATE 10/8/14
SURFACE ELEVATION 377.6

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	SM	ASH (SILTY SAND(SM)) very dense; dark brown with light brown; with coarse-grained sand, and lightly cemented gravel pieces; dry	N=54										
5		--medium dense	N=31										
10	MH	ASH (ELASTIC SILT WITH SAND(MH)) very loose; light brown; with black ash seams; wet	N=0	39				106 119	81	76	5	82	+40 Sieve=10% +4 Sieve=1%
15	MH	ASH (ELASTIC SILT(MH)) very loose; black and dark gray; wet	N=0	35				139					
20	MH	ASH (GRAVELLY ELASTIC SILT WITH SAND(MH)) very loose; black and dark gray with light brown; with lightly cemented gravel pieces; wet	N=0					100	113	92	21	66	+40 Sieve=30% +4 Sieve=25%
25	CL	LEAN CLAY(CL) very stiff; grayish brown and reddish brown; mottled; moist	N=25					27	44	22	22	95	+40 Sieve=1% +4 Sieve=0%
30													

SAMPLES | GEOLOGIC UNIT | WATER LEVEL

Eqc @ 28-40'





Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Water level @ 13' 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: N33.04776°, W94.84488°
Driller: Tommy Cook
Logger: B.Hobbs/O.Sanderson

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LOG OF BORING B-4 (cont.)

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX

PROJECT NO.: G4207-146
BORING TYPE: Hollow Stem Auger

DATE 10/8/14

SURFACE ELEVATION 377.6

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. #)
35		CH	Eqc @ 28-40'		FAT CLAY(CH) stiff; dark brown; moist; laminated; with sand seams	N=14					25	64	28	36	99	+40 Sieve=0% +4 Sieve=0%
40					--gray and yellowish brown; moist; mottled	P=3.0 P=4.5+	99	2.35	3.8	24	24					
					Bottom of Boring @ 40'											

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)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Water level @ 13' 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: N33.04776°, W94.84488°
Driller: Tommy Cook
Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-5

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PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX

PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/8/14

SURFACE ELEVATION 372.9

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	ATTERBERG LIMITS(%) PLASTIC LIMIT (PL)	ATTERBERG LIMITS(%) PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	GM	ASH (SILTY GRAVEL WITH SAND(GM)) very loose; light brown and dark brown; with lightly cemented gravel pieces and coarse-grained sand; moist	N=3					45				28	+40 Sieve=56% +4 Sieve=43%
5			N=0										
10													
15	CL	--black; saturated SANDY LEAN CLAY WITH GRAVEL(CL) stiff; light brown, gray and reddish brown; moist; mottled; with medium-grained sand	N=10					41	26	17	9	54	+40 Sieve=23% +4 Sieve=22%
20		--very stiff	N=18										
25	CH	FAT CLAY WITH SAND(CH) very stiff; light gray and reddish brown; moist; mottled	N=18					26	60	22	38	78	+40 Sieve=0% +4 Sieve=0%
30		--with sand pockets; mottled; moist	P=2.25	100				25					
		Bottom of Boring @ 30'											

Ecp @ 16-30'

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 13' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
Hole terminated @ 30' due to water loss.

GPS Coordinates: N33.04717°, W94.84486°
Driller: Tommy Cook
Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-6

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

DRILL RIG: B-61 HDX

PROJECT NO.: G4207-146

BORING TYPE: Rotary Wash/Flight Auger

DATE 10/10/14

SURFACE ELEVATION 370.8

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DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	SM	ASH (SILTY SAND(SM)) loose; dark brown and light brown; with coarse-grained sand and lightly cemented gravel pieces; moist	N=10							
5										
10			N=7		58				39	+40 Sieve=17% +4 Sieve=3%
15	MH	ASH (ELASTIC SILT(MH)) very loose; black and dark gray; wet	N=3	45	99					
20		--wet	N=0		129	96	92	4	96	+40 Sieve=1% +4 Sieve=0%
25	CH	FAT CLAY WITH SAND(CH) stiff; gray and reddish brown; moist; mottled	N=9							
30					29	54	18	36	72	+40 Sieve=10% +4 Sieve=5%

GEOLOGIC UNIT: Eqc @ 23.5-53' & Er @ 53-60'

WATER LEVEL: ▽ @ 10'

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)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 10' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04729°, W94.84386°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-6 (cont.)

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

DRILL RIG: B-61 HDX

PROJECT NO.: G4207-146

BORING TYPE: Rotary Wash/Flight Auger

DATE 10/10/14

SURFACE ELEVATION 370.8

ETTL ENGINEERS & CONSULTANTS

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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(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35		SM		SILTY SAND(SM) very dense; light brown, gray and reddish brown; mottled; moist	N=62					26	25	22	3	25	+40 Sieve=3% +4 Sieve=0%
40		ML		SANDY SILT(ML) very dense; light gray; moist; saturated	N=50/5"					26				56	+40 Sieve=0% +4 Sieve=0%
45			Eqc @ 23.5-53' & Er @ 53-60'	--with clay seams	N=57										
50		ML		SILT WITH SAND(ML) very dense; light gray; moist	N=93					25				76	+40 Sieve=0% +4 Sieve=0%
55		CH		FAT CLAY(CH) very stiff; dark brown; with silt seams; moist	N=27	103				28	72	24	48	95	+40 Sieve=0% +4 Sieve=0%
60				Bottom of Boring @ 60'											

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 @ 10' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04729°, W94.84386°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-7

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PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

DRILL RIG: B-61 HDX

PROJECT NO.: G4207-146

BORING TYPE: Rotary Wash/Flight Auger

DATE 10/10/14

SURFACE ELEVATION 368.8

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	ML	ASH (SANDY SILT(ML)) loose; dark brown; with lightly cemented gravel pieces; moist	N=10					20				53	+40 Sieve=10% +4 Sieve=5%
5		--very loose; wet	N=0	33				>>159					
10	SM	ASH (SILTY SAND(SM)) very loose; dark brown; with coarse-grained sand; wet	N=2					97				40	+40 Sieve=9% +4 Sieve=2%
15	MH	ASH (SANDY ELASTIC SILT(MH)) very loose; grayish brown; moist	N=4	37				>>127					
20		--cemented ash seam	Tx=50/2"										
25	CL	SANDY LEAN CLAY(CL) brown with red and light gray; wet	Tx=10/6"										
30		--very stiff; light gray, reddish brown and light brown; moist; mottled	P=3.0										

Eqc @ 23.5-43' & Er @ 43-60'

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 8' 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: N33.04771°, W94.84330°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-7 (cont.)

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PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX

PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/10/14

SURFACE ELEVATION 368.8

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35		--light grayish brown and yellowish brown; laminated with silt; with fine-grained sand	N=25					26	43	17	26	68	+40 Sieve=0% +4 Sieve=0%
40	SM	SILTY SAND(SM) very dense; light gray; with coarse-grained sand; moist	N=83					28				38	+40 Sieve=0% +4 Sieve=0%
45	CH	FAT CLAY(CH) hard; dark brown with light gray; with silt seams; moist	N=37					26	62	20	42	92	+40 Sieve=1% +4 Sieve=0%
50			P=4.5+										
55			P=4.5+										
60		Bottom of Boring @ 60'	P=4.5+										

GEOLOGIC UNIT: Eqc @ 23.5-43' & Er @ 43-60'
WATER LEVEL

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)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 8' 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: N33.04771°, W94.84330°
Driller: Tommy Cook
Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-8

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas **DRILL RIG:** D-50

PROJECT NO.: G4207-146 **BORING TYPE:** Hollow Stem Auger

DATE 10/24/14

SURFACE ELEVATION 370.0

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Tyler, Texas 75702
(903) 595-4421

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	MH	ASH (SANDY ELASTIC SILT(MH)) very loose; grayish brown; with lightly cemented gravel pieces; moist	N=3					46	50	46	4	60	+40 Sieve=19% +4 Sieve=4%
5													
	MH	ASH (SANDY ELASTIC SILT(MH)) very loose; dark brown; with lightly cemented gravel pieces; wet	N=0										
10			N=1					70	55	53	2	68	+40 Sieve=10% +4 Sieve=1%
15													
	MH	ASH (ELASTIC SILT(MH)) very loose; dark grayish brown; moist	N=2										
20													
	CL	SANDY LEAN CLAY(CL) soft; reddish brown and light brown; wet; mottled	N=4					21	28	16	12	63	+40 Sieve=6% +4 Sieve=4%
25													
		--very stiff; light grayish brown and reddish brown; moist; layered; with ferric partings	N=18										
30													

Eqc @ 23-40'

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)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 6' while drilling. Water level @ 18' 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: N33.04779°, W94.84389°

Driller: Tommy Cook

Logger: O.Sanderson

LOG OF BORING B-8 (cont.)

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: D-50

PROJECT NO.: G4207-146
BORING TYPE: Hollow Stem Auger

DATE 10/24/14

SURFACE ELEVATION 370.0

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT / WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	Natural Moisture Content and Atterberg Limits	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35		ML	Eqc @ 23-40'	SILT(ML) dense; light gray; moist; with clay seams	N=36											
40		SP SM		POORLY GRADED SAND WITH SILT(SP-SM) very dense; light gray; moist	N=50/4"											
				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 @ 6' while drilling. Water level @ 18' and open upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04779°, W94.84389°
Driller: Tommy Cook
Logger: O.Sanderson

LOG OF BORING B-9

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX
PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/9/14
SURFACE ELEVATION 371.0

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	SM	ASH (SILTY SAND(SM)) loose; dark brown and light brown; with coarse-grained sand and lightly cemented gravel pieces; moist	N=10					22				44	+40 Sieve=12% +4 Sieve=1%
5													
8	MH	ASH (SANDY ELASTIC SILT(MH)) very loose; black and dark gray; saturated	N=0					90	61	61	NP	62	+40 Sieve=3% +4 Sieve=0%
10													
15		--with coarse-grained sand and lightly cemented gravel pieces; moist	N=2										
20		--gray and light gray --light brown; cemented layer from 20' to 25'	N=50/3"	96				21					
25			Tx=50/1.5" Tx=50/0"					36					
28	CH	FAT CLAY WITH SAND(CH) stiff; light gray and reddish brown; mottled; moist	P=1.75	106	1.52	13.4	18	26 21	70	20	50	83	+40 Sieve=1% +4 Sieve=0%
30													

Eqc @ 28-43' & Er @ 43-60'

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.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04861°, W94.84332°
Driller: Tommy Cook
Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-9 (cont.)

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

DRILL RIG: B-61 HDX

PROJECT NO.: G4207-146

BORING TYPE: Rotary Wash/Flight Auger

DATE 10/9/14

SURFACE ELEVATION 371.0

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
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(903) 595-4421

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(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35		CL		SANDY LEAN CLAY(CL) hard; light brown, reddish brown and light gray; moist; mottled	N=65										
40		SM		SILTY SAND(SM) very dense; light brown and gray; moist; with coarse-grained sand	N=60					26				46	+40 Sieve=0% +4 Sieve=0%
45		CH	Eqc @ 28-43' & Er @ 43-60'	FAT CLAY(CH) very stiff; dark brown and gray; with silt seams; moist	N=29										
50					P=4.5+					19	54	19	35	98	+40 Sieve=0% +4 Sieve=0%
55					P=4.5+										
60				Bottom of Boring @ 60'	P=4.5+										

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 @ 8' 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: N33.04861°, W94.84332°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-10

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX
PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/8/14
SURFACE ELEVATION 373.2

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	SC	ASH (CLAYEY SAND(SC)) loose; dark brown and light brown; with coarse-grained sand and lightly cemented gravel pieces; moist	N=7					24	31	19	12	41	+40 Sieve=21% +4 Sieve=11%
5			N=3										
10	MH	ASH (ELASTIC SILT(MH)) very loose; black; moist	N=0										
15		--wet											
20	SM	ASH (SILTY SAND WITH GRAVEL(SM)) very dense; light brown and dark brown; with lightly cemented gravel pieces and coarse-grained sand; moist; cemented layer from 17.5' to 21'	N=50/1"					56				14	+40 Sieve=71% +4 Sieve=28%
25		--cemented layer from 23' to 27'	N=50/4"										
30	CL	SANDY LEAN CLAY(CL) medium stiff; grayish brown and yellowish brown; saturated; mottled	N=4					19	23	14	9	57	+40 Sieve=1% +4 Sieve=0%

GEOLOGIC UNIT: Eqc @ 27-43' & Er @ 43-60'
WATER LEVEL: ▽

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)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 13' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04895°, W94.84390°
Driller: Tommy Cook
Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-10 (cont.)

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX

PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/8/14

SURFACE ELEVATION 373.2

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. #)
35						P=1.25 P=1.0	107	2.10	6.1	21	22					
40		SC			CLAYEY SAND(SC) medium dense; reddish brown and grayish brown; moist; mottled	N=23					22	25	17	8	27	+40 Sieve=3% +4 Sieve=0%
45		CH	Eqc @ 27-43' & Er @ 43-60'		FAT CLAY(CH) very stiff; dark brown with light gray; with silt seams; moist	N=18					25	64	24	40	90	+40 Sieve=7% +4 Sieve=0%
50					--hard	P=4.5+										
55						P=4.5+										
60					Bottom of Boring @ 60'											

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

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 13' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04895°, W94.84390°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-11

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas **DRILL RIG:** D-50

PROJECT NO.: G4207-146 **BORING TYPE:** Rotary Wash/Flight Auger

DATE 10/24/14

SURFACE ELEVATION 376.6

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	MH	ASH (SANDY ELASTIC SILT(MH)) very dense; light brownish gray; lightly cemented; moist	N=49						
5		--medium dense	N=14	67	57	52	5	66	+40 Sieve=10% +4 Sieve=1%
10	SM	ASH (SILTY SAND(SM)) very loose; black; with coarse-grained sand and lightly cemented gravel pieces; moist	N=2	57				22	+40 Sieve=43% +4 Sieve=1%
15		Eqc @ 33-40'							
20	MH	ASH (ELASTIC SILT(MH)) loose; black; wet	N=6						
25	SM	ASH (SILTY SAND(SM)) very dense; grayish brown; moist; with coarse-grained sand and lightly cemented gravel pieces	N=50/3.5"	45				28	+40 Sieve=58% +4 Sieve=13%
30	ML	ASH (SILT(ML)) medium dense; light grayish brown and black; moist; lightly cemented	N=16						

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)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 13' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04844°, W94.84393°

Driller: Tommy Cook

Logger: O.Sanderson

LOG OF BORING B-11 (cont.)

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas **DRILL RIG:** D-50

PROJECT NO.: G4207-146 **BORING TYPE:** Rotary Wash/Flight Auger

DATE 10/24/14

SURFACE ELEVATION 376.6

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

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. #)
35		CL	Eqc @ 33-40'		SANDY LEAN CLAY(CL) medium stiff;light brown and reddish brown; moist; mottled	N=8					18	27	16	11	54	+40 Sieve=2% +4 Sieve=0%
40		SM			SILTY SAND(SM) dense; light brown; moist	N=51										
					Bottom of Boring @ 40'											

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

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 13' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04844°, W94.84393°

Driller: Tommy Cook

Logger: O.Sanderson

LOG OF BORING B-12

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG:

PROJECT NO.: G4207-146
BORING TYPE: Flight Auger

DATE 10/15/14

SURFACE ELEVATION 361.7

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. #)
0		CL			LEAN CLAY WITH SAND(CL) stiff; light gray and reddish brown; moist; mottled	P=3.75										
5		CL			SANDY LEAN CLAY(CL) stiff; light brown, light gray and reddish brown; moist; mottled	N=15					16	33	19	14	58	+40 Sieve=1% +4 Sieve=0%
10					--grayish brown and brown; moist	N=11										
15		CH	Eqc		FAT CLAY WITH SAND(CH) stiff; light gray and reddish brown; moist; mottled; with ferric seams	P=3.75										
20		CL			LEAN CLAY(CL) stiff; light gray and brownish gray; moist; layered with silt	N=14					24	39	19	20	93	+40 Sieve=1% +4 Sieve=0%
25		ML		▽	SILT WITH SAND(ML) very dense; light brown and yellowish brown; moist; with clay seams	N=53										
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

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Water level @ 27' 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: N33.04713°, W94.84486°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

LOG OF BORING B-13

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG:

PROJECT NO.: G4207-146
BORING TYPE: Flight Auger

DATE 10/15/14

SURFACE ELEVATION 361.4

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. #)
0		CL			LEAN CLAY WITH SAND(CL) medium stiff; reddish brown with light gray; moist	N=7					20	45	17	28	76	+40 Sieve=1% +4 Sieve=0%
5		CL			SANDY LEAN CLAY(CL) very stiff; light brown, gray and reddish brown; moist; mottled	P=4.0										
10		SC			CLAYEY SAND(SC) medium dense; grayish brown; moist	N=11										
		CH	Eqc		FAT CLAY WITH SAND(CH) medium stiff; reddish brown and light gray; moist; mottled											
15						N=8					22	54	20	34	79	+40 Sieve=1% +4 Sieve=0%
20		CL			LEAN CLAY(CL) very stiff; light gray and grayish brown; moist; layered with silt	N=21										
25		ML		▼	SILT WITH SAND(ML) very dense; light gray and yellowish brown; wet; with clay seams	N=50/5"					24				80	+40 Sieve=0% +4 Sieve=0%
30					Bottom of Boring @ 30'											

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 @ 28' and open upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.047160°, W94.84384°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

LOG OF BORING B-14

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

PROJECT NO.: G4207-146

DRILL RIG:

BORING TYPE: Flight Auger

DATE 10/14/14

SURFACE ELEVATION 347.2

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) medium stiff; yellowish brown with reddish brown; dry; with clay seams	N=9										
5	ML	SANDY SILT(ML) medium dense; grayish brown; moist; with clay seams	N=11					108	17	17	NP	68	+40 Sieve=1% +4 Sieve=1%
10	CL	SANDY LEAN CLAY(CL) very stiff; light gray and gray; moist	P=4.0										
15		--light gray and grayish brown; moist; layered with silt	N=34					26	40	16	24	67	+40 Sieve=1% +4 Sieve=0%
20	SP SM	POORLY GRADED SAND WITH SILT(SP-SM) medium dense; yellowish brown, light gray and reddish brown; wet	N=27					25				10	+40 Sieve=0% +4 Sieve=0%
25	CL	LEAN CLAY(CL) very stiff; dark brown; moist; with silt partings	N=26										
30		Bottom of Boring @ 30'											

GEOLOGIC UNIT: Eqc @ 0-28' & Er @ 28-30'

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)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Water level @ 17' and caved to 23' 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: N33.04774°, W94.84290°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

LOG OF BORING B-15

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

PROJECT NO.: G4207-146

DRILL RIG:

BORING TYPE: Flight Auger

DATE 10/14/14

SURFACE ELEVATION 348.2

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CH	FAT CLAY(CH) stiff; reddish brown and light gray; moist; mottled	N=10										
5		--very stiff; light gray, grayish brown and reddish brown; moist; layered	P=3.75					24	59	21	38	85	+40 Sieve=0% +4 Sieve=0%
10	SM	SILTY SAND(SM) very dense; light brown; dry	N=59					7				12	+40 Sieve=0% +4 Sieve=0%
15		--medium dense; wet	N=21										
20		--very dense	N=56										
25	CL	LEAN CLAY(CL) hard; dark brown; moist; with silt partings	P=4.5					25	45	22	23	92	+40 Sieve=0% +4 Sieve=0%
30		Bottom of Boring @ 30'											

Eqc @ 0-28' & Er @ 28-30'

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

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Water level @ 17' and caved to 19' upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04857°, W94.84286°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

LOG OF BORING B-17

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas **DRILL RIG:**

PROJECT NO.: G4207-146 **BORING TYPE:** Flight Auger

DATE 10/14/14

SURFACE ELEVATION 344.8

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

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(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0		CL		SANDY LEAN CLAY(CL) medium stiff; brown and gray	N=7					13	27	15	12	60	+40 Sieve=1% +4 Sieve=0%
5				--stiff; grayish brown and reddish brown; moist; mottled	N=12										
10		CH	Eqc @ 0-18' & Er @ 18-30'	FAT CLAY(CH) medium stiff; light gray and gray with yellowish brown; moist; layered	P=2.25										
15				--stiff; grayish brown; moist; ferric and silt partings	P=3.5					23	56	22	34	87	+40 Sieve=9% +4 Sieve=2%
20				--dark gray; moist	N=13										
25		CL		LEAN CLAY(CL) stiff; dark brown; moist	N=21										
30				Bottom of Boring @ 30'											

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

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: N33.04942°, W94.84388°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

LOG OF BORING B-18

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas **DRILL RIG:**

PROJECT NO.: G4207-146 **BORING TYPE:** Flight Auger

DATE 10/14/14

SURFACE ELEVATION 345.0

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL ML	SANDY SILTY CLAY(CL-ML) very stiff; light brown; moist	N=7	10	23	17	6	51	+40 Sieve=1% +4 Sieve=0%
10	CL	SANDY LEAN CLAY(CL) very stiff; light brown and light gray; moist	N=16						
15	CH	FAT CLAY(CH) very stiff; grayish brown; moist; with silt partings	N=17	28	55	20	35	95	+40 Sieve=3% +4 Sieve=1%
			P=4.0						
20	CL	LEAN CLAY(CL) very stiff; dark brown and light brown; moist; with clay stone partings; slickensided	N=20						
25			N=16						
30		Bottom of Boring @ 30'							

Eqc @ 0-13' & Er @ 13-30'

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

DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)

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: N33.04931°, W94.84451°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

LOG OF BORING B-19

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

PROJECT NO.: G4207-146

DRILL RIG:

BORING TYPE: Flight Auger

DATE 10/15/14

SURFACE ELEVATION 368.4

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)	ATTERBERG LIMITS(%) PLASTIC LIMIT (PL)	ATTERBERG LIMITS(%) PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0		SM			ASH (SILTY SAND(SM)) very loose; dark brown; with coarse-grained sand and lightly cemented gravel pieces; dry	N=4					32				28	+40 Sieve=33% +4 Sieve=9%
5					--loose; black; with coarse-grained sand and lightly cemented gravel pieces; dry	N=5										
10				▽	--saturated @ 12'											
		ML			ASH (SANDY SILT(ML)) very loose; grayish brown; lightly cemented	N=2					92				62	+40 Sieve=5% +4 Sieve=0%
15						N=3										
20					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 @ 12' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04763°, W94.84332°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

LOG OF BORING B-20

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG:

PROJECT NO.: G4207-146
BORING TYPE: Flight Auger

DATE 10/15/14

SURFACE ELEVATION 368.4

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(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0		SM			ASH (SILTY SAND(SM)) loose; dark brown; dry; lightly cemented gravel pieces	N=9					26				33	+40 Sieve=32% +4 Sieve=13%
5					--with clay seams	N=10										
10		SM		▼	ASH (SILTY SAND(SM)) very loose; grayish brown; with lightly cemented gravel pieces; wet	N=1					92				50	+40 Sieve=7% +4 Sieve=0%
15		MH			ASH (ELASTIC SILT(MH)) very loose; gray and black; wet	N=1										
20					Bottom of Boring @ 20'											

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)

Water Level Est.: ▽ Measured: ▼ Perched: ⧩

Water Observations: Water level @ 12' and caved to 14' 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: N33.04746°, W94.84334°
Driller: Lewis Drilling, Inc.
Logger: O.Sanderson

LOG OF BORING B-20A

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

DRILL RIG:

PROJECT NO.: G4207-146

BORING TYPE: Hand Auger

DATE 12/12/14

SURFACE ELEVATION 365.1

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION
0		SC			ASH (CLAYEY SAND(SC)) dark brown; moist; with coarse-grained sand and sand mix
		SM			SILTY SAND(SM) yellowish brown
		GP GM			POORLY GRADED GRAVEL WITH SILT AND SAND(GP-GM) black; dry; with lignite gravel
		MH			ASH (SANDY ELASTIC SILT(MH)) dark brown; moist; with sand mix and roots
5		MH		▽	ASH (ELASTIC SILT(MH)) black; wet
		ML			ASH (SANDY SILT(ML)) grayish brown; wet; with coarse-grained sand; with sand mix
		SM			SILTY SAND(SM) grayish brown; wet; with coarse-grained sand and poorly graded gravel
10					Bottom of Boring @ 10'

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	PLASTIC LIMIT	PLASTICITY INDEX
LL	PL	PI

MINUS #200 SIEVE (%)

OTHER TESTS PERFORMED (Page Ref. #)

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 are approximate

GPS Coordinates: N33.047419°, W94.843238°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-20B

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

PROJECT NO.: G4207-146

DRILL RIG:

BORING TYPE: Hand Auger

DATE 12/12/14

SURFACE ELEVATION 359.2

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION
0		MH			ASH (ELASTIC SILT(MH)) black; wet; with organics
		SM			SILTY SAND(SM) brown; wet; with coarse-grained sand and gravel
		SM			SILTY SAND(SM) grayish brown; wet; with fine-grained sand and lignite pieces
5		MH			ASH (ELASTIC SILT(MH)) dark gray; wet; with sand mix
		ML			ASH (SANDY SILT(ML)) grayish brown; wet; with sand mix
		MH			ASH (ELASTIC SILT(MH)) grayish brown; wet; with clay mix
		MH			ASH (ELASTIC SILT(MH)) dark gray; wet
10					Bottom of Boring @ 10'

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: Seepage @ 0' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates are approximate

GPS Coordinates: N33.047409°, W94.843177°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-21

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG:

PROJECT NO.: G4207-146
BORING TYPE: Flight Auger

DATE 10/15/14

SURFACE ELEVATION 376.2

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	SM	ASH (SILTY SAND(SM)) very loose; light brown; with lightly cemented gravel pieces; dry	N=4					36				39	+40 Sieve=13% +4 Sieve=1%
5	MH	ASH (ELASTIC SILT(MH)) very loose; grayish brown; lightly cemented; dry	N=4										
10		--with cemented seams	Tx=50/0.5" Tx=50/0.5"										
15		--grayish brown; wet	N=1					132	109	93	16	89	+40 Sieve=5% +4 Sieve=0%
20	SM	ASH (SILTY SAND WITH GRAVEL(SM)) very dense; grayish brown; wet	N=50/4"					52				26	+40 Sieve=63% +4 Sieve=23%
25	CL	SANDY LEAN CLAY(CL) very stiff; light gray and reddish brown; moist; mottled	N=18										
30		Bottom of Boring @ 30'											

Eqc @ 28-30'

Water Level Est.: Measured: Perched:

Water Observations: Seepage @ 17' while drilling.Water level @ 20' and caved to 24' 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: N33.04777°, W94.84538°
Driller: Lewis Drilling, Inc.
Logger: O.Sanderson

LOG OF BORING B-22

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

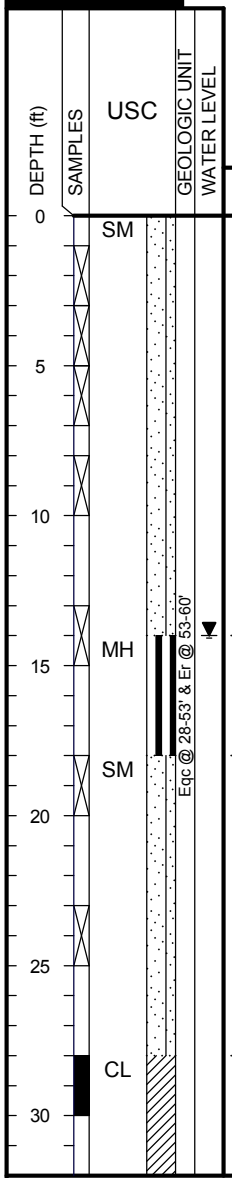
DRILL RIG: B-61 HDX

PROJECT NO.: G4207-146

BORING TYPE: Rotary Wash/Flight Auger

DATE 10/7/14

SURFACE ELEVATION 376.4



MATERIAL DESCRIPTION

		FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SM	ASH (SILTY SAND(SM)) dense; light grayish brown; with coarse-grained sand and lightly cemented gravel pieces; dry	N=50/5"					35				44	+40 Sieve=40% +4 Sieve=9%
	--medium dense; dark brown with light brown	N=15										
	--loose	N=8					29				43	+40 Sieve=32% +4 Sieve=13%
		N=5										
		N=0										
MH	ASH (ELASTIC SILT WITH SAND(MH)) very loose; light brown and dark brown; with lean clay, fine-grained sand and lightly cemented gravel pieces; wet						103	87	76	11	80	+40 Sieve=9% +4 Sieve=1%
SM	ASH (SILTY SAND(SM)) very loose; light grayish brown; with coarse-grained sand and lightly cemented gravel pieces; wet	N=0										
		N=3					54				36	+40 Sieve=40% +4 Sieve=12%
CL	SANDY LEAN CLAY(CL) stiff; reddish brown and light gray; wet; mottled	P=1.5										

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

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Water level @ 14'.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.048131°, W94.845329°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-22 (cont.)

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX

PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/7/14

SURFACE ELEVATION 376.4

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35		--light gray, yellowish brown and reddish brown; moist; with fine-grained sand; mottled	P=3.75					23	43	18	25	50	+40 Sieve=14% +4 Sieve=9%
	SM	SILTY SAND(SM) medium dense; light brown and yellowish brown; moist; with fine-grained sand											
		--loose; light gray and light brown; moist; with fine-grained sand	P=1.0										
40													
			N=9					27				21	+40 Sieve=1% +4 Sieve=0%
45													
		--yellowish brown; moist; with fine-grained sand	N=6										
50													
	CH	FAT CLAY(CH) stiff; dark brown, light brown and light gray; moist; mottled	P=1.5										
55													
			P=4.0										
60		Bottom of Boring @ 60'											

Eqc @ 28-53' & Er @ 53-60'

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 @ 14'.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.048131°, W94.845329°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

KEY TO SOIL CLASSIFICATIONS AND SYMBOLS

UNIFIED SOIL CLASSIFICATION SYSTEM [m]

Major Divisions		Letter	Symbol	Color	Name
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW		Red	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP			Poorly-graded gravels or gravel-sand mixtures, little or no fines
		GM		Yellow	Silty gravels, gravel-sand-clay mixtures.
		GC			Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW		Red	Well-graded sands or gravelly sands, little or no fines
		SP			Poorly-graded sands or gravelly sands, little or no fines
		SM		Yellow	Silty sands, sand-silt mixtures
		SC			Clayey sands, sand-clay mixtures
FINED GRAINED SOILS	SILTS AND CLAYS LL < 50	ML		Green	Inorganic silts and very fine sands, rock flour, fine sandy silts, gravelly silts or silts with slight plasticity
		CL			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		OL			Organic silts and organic silt-clays of low plasticity.
	SILTS AND CLAYS LL > 50	MH		Blue	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH			Inorganic clays of high plasticity, fat clays
		OH			Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS		Pt		Orange	Peat and other highly organic soils

TERMS CHARACTERIZING SOIL STRUCTURE

SLICKENSIDED-having inclined planes of weakness that are slick and glossy in appearance

FISSURED-containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical

LAMINATED (VARVED)-composed of thin layers of varying color and texture, usually grading from sand or silt at the bottom to clay at the top

CRUMBLY-cohesive soils which break into small blacks or crumbs on drying.

CALCAREOUS-containing appreciable quantities of calcium carbonate, generally nodular.

WELL GRADED-having wide range in grain sizes and substantial amounts of all inermediate particle sizes.

POORLY GRADED-predominantly of one grain size (uniformly graded) or having a range of sizes with some intermediate size missing (gap or skip graded).

SYMBOLS FOR TEST DATA

M/C = 15 - Natural moisture content in percent

δ = 95 - - Dry unit weight in lbs/cu ft.

Qu = 1.23 - Unconfined compression strength in tons/sq. ft.

Qc = 1.68 (21 psi) - Confined compression strength at indicated lateral pressure.

51-21-30 - Liquid limit, Plastic limit and Plasticity index.

30% FINER - Percent finer than No. 200 mesh sieve.

30 B/F - Blows per foot, standard penetration test.

▼ - Ground water table.

TERMS DESCRIBING CONSISTENCY OF SOIL (2)

COARSE GRAINED SOILS		FINE GRAINED SOIL		
DESCRIPTIVE TERM	NO. BLOWS/FT. STANDARD PEN. TEST	DESCRIPTIVE TERMS	NO. BLOWS/FT. STANDARD PEN. TEST	UNCONFINED COMPRESSION TONS PER SQ.FT.
Very loose	0-4	Very Soft	< 2	< 0.25.
Loose	4-10	Soft	2 - 4	0.25 - 0.50
Medium Dense	10-30	Medium Stiff	4 - 8	0.50 - 1.00
Dense	30-50	Stiff	8 - 15	1.00 - 2.00
Very Dense	over 50	Very Stiff	15 - 30	2.00 - 4.00
		Hard	over 30	over 4.00

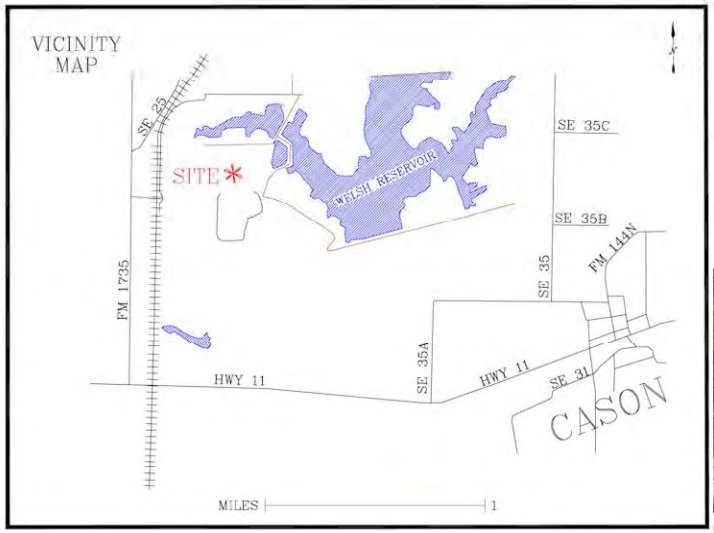
Field classification for "Consistency" is determined with a 0.25" diam. penetrometer.

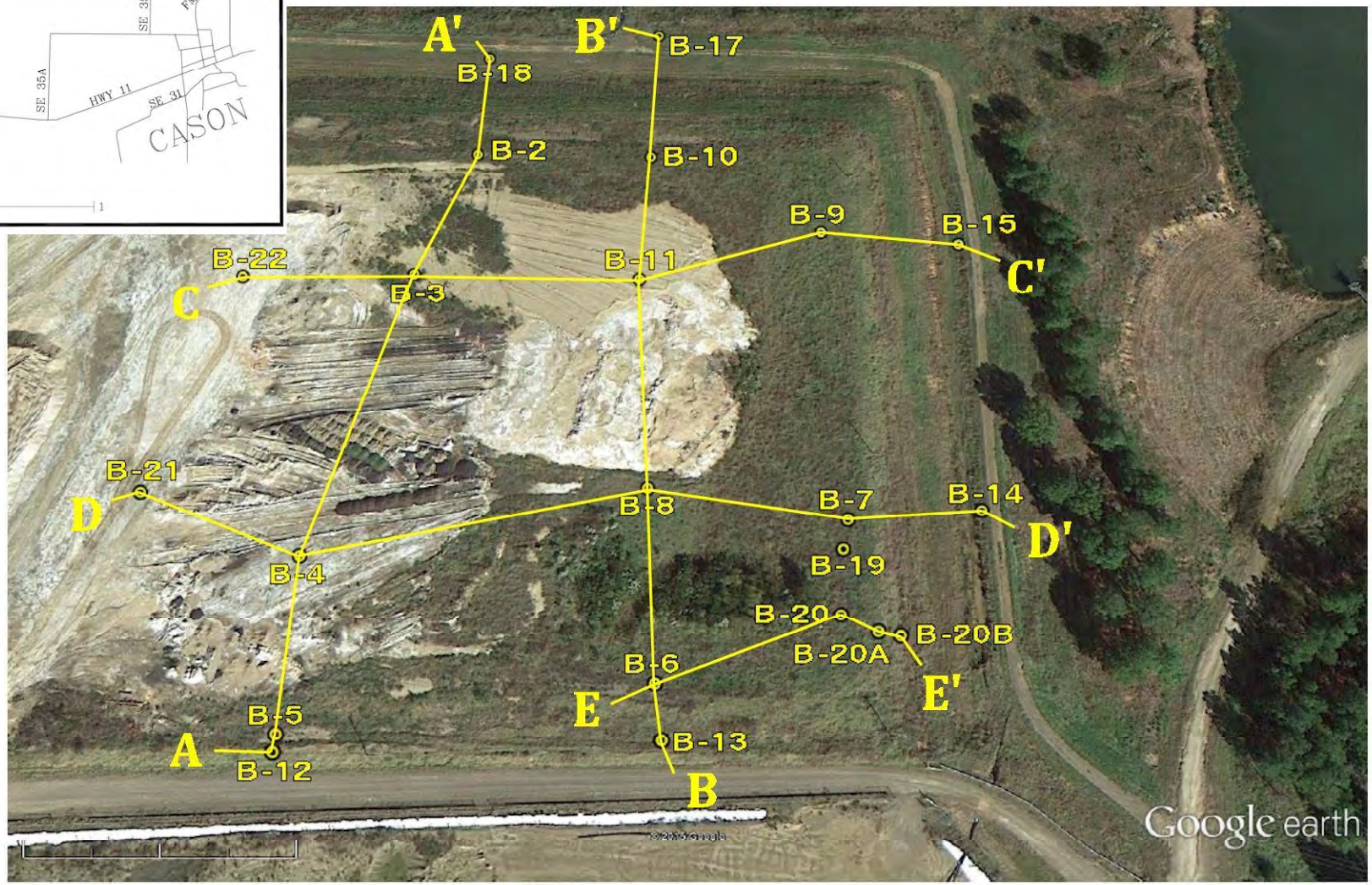
SAMPLER TYPES



Shelby Tube | Rock Core | Split Spoon | Auger | No Recovery

1 - From Waterways Experiment Station Technical Memorandum No. 3-367
2 - From "Soil Mechanics in Engineering Practice" by Terzeghi and Pock

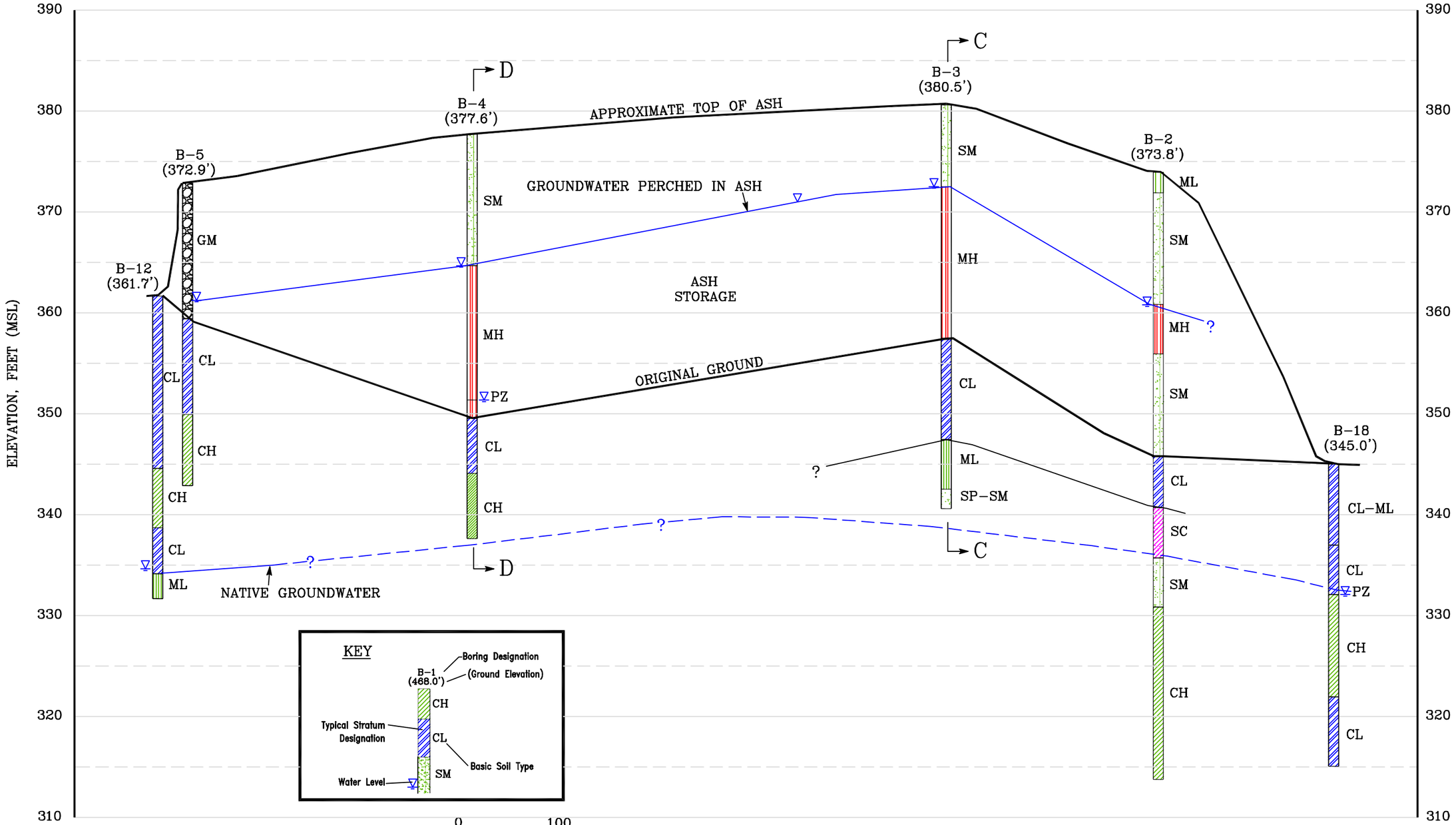




feet 600

ETTL ENGINEERS & CONSULTANTS MAIN OFFICE 1717 East Erwin Tyler, Texas 75702 (903) 595-4421	PHASE I FLY ASH STORAGE AREA EMBANKMENT SEEPAGE & VERTICAL EXPANSION INVESTIGATION WELSH POWER STATION CASON, TEXAS	KEY TO GEOLOGICAL PROFILES		APPROVED BY:
		JOB.NO.: G4207-14		DRAWN BY: A.K.B.
		DATE: NOV. 2014	SCALE: AS SHOWN	

GEOLOGIC PROFILE A–A'



KEY

HORIZONTAL SCALE = 0 50 100 FEET

VERTICAL SCALE = 0 5 10 FEET

ETTL ENGINEERS & CONSULTANTS MAIN OFFICE 1717 Edst Erwin Tyler, Texas 75702 (903) 595–4421	PHASE I FLY STORAGE AREA EMBANKMENT SEEPAGE & VERTICAL EXPANSION INVESTIGATION WELSH POWER STATION CASON, TEXAS	GEOLOGICAL PROFILE A–A' JOB No.: G4207–14 DATE: DEC. 2014 / SCALE: AS SHOWN	APPROVED BY: DRAWN BY: A.K.B.

GEOLOGIC PROFILE B–B'

B

B'

C

D

ELEVATION, FEET (MSL)

380
370
360
350
340
330
320
310

B–13 (361.4')
B–6 (370.8')
B–8 (370.0')
B–11 (376.6')
B–10 (373.2')
B–17 (344.8')

APPROXIMATE TOP OF ASH

GROUNDWATER PERCHED IN ASH

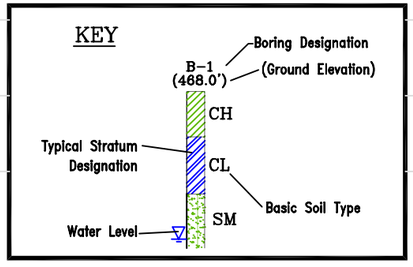
ASH STORAGE

ORIGINAL GROUND

NATIVE GROUNDWATER

CL
SC
CH
ML
SM
MH
PZ
SP–SM

KEY



HORIZONTAL SCALE = 0 50 100 FEET

VERTICAL SCALE = 0 5 10 FEET

ETTL ENGINEERS & CONSULTANTS MAIN OFFICE 1717 Edst Erwin Tyler, Texas 75702 (903) 595–4421	PHASE I FLY STORAGE AREA EMBANKMENT SEEPAGE & VERTICAL EXPANSION INVESTIGATION WELSH POWER STATION CASON, TEXAS	GEOLOGICAL PROFILE B–B'		APPROVED BY:
		JOB No.: G4207–14		DRAWN BY: A.K.B.
		DATE: DEC. 2014	SCALE: AS SHOWN	

GEOLOGIC PROFILE C–C'

C

C'

ELEVATION, FEET (MSL)

390
380
370
360
350
340
330
320
310

A

B

B-22 (376.4')

B-3 (380.5')

B-11 (376.6')

B-9 (371.0')

B-15 (348.2')

APPROXIMATE TOP OF ASH

GROUNDWATER PERCHED IN ASH

ASH STORAGE

ORIGINAL GROUND

NATIVE GROUNDWATER

?

PZ

SM
MH
CL
ML
SP-SM
SC
CH

KEY

Boring Designation

B-1 (468.0') (Ground Elevation)

Typical Stratum Designation

Basic Soil Type

Water Level

HORIZONTAL SCALE = 0 50 100 FEET

VERTICAL SCALE = 0 5 10 FEET

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 Edst Erwin
Tyler, Texas 75702
(903) 595-4421

PHASE I FLY STORAGE AREA
EMBANKMENT SEEPAGE & VERTICAL
EXPANSION INVESTIGATION
WELSH POWER STATION
CASON, TEXAS

GEOLOGICAL PROFILE C–C'

JOB No.: G4207-14

DATE: DEC. 2014

SCALE: AS SHOWN

APPROVED BY:

DRAWN BY: A.K.B.

GEOLOGIC PROFILE D–D'

D

D'

A

A

B

B

B–21
(376.2')

B–4
(377.6')

B–8
(370.0')

B–7
(368.8')

B–14
(347.2')

APPROXIMATE TOP OF ASH

GROUNDWATER PERCHED IN ASH

ASH
STORAGE

ORIGINAL GROUND

NATIVE GROUNDWATER

SM

MH

SM

CL

SM

MH

PZ

CL

CH

CL

PZ

ML

SP–SM

MH

ML

PZ

CL

SM

CH

CL

ML

CL

SP–SM

CL

?

ELEVATION, FEET (MSL)

380
370
360
350
340
330
320
310
300

KEY

Boring Designation

B–1
(466.0')

(Ground Elevation)

CH

Typical Stratum Designation

CL

Basic Soil Type

SM

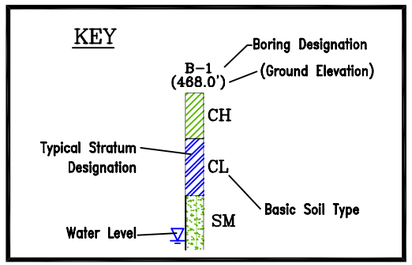
Water Level

HORIZONTAL SCALE = 0 50 100 FEET

VERTICAL SCALE = 0 5 10 FEET

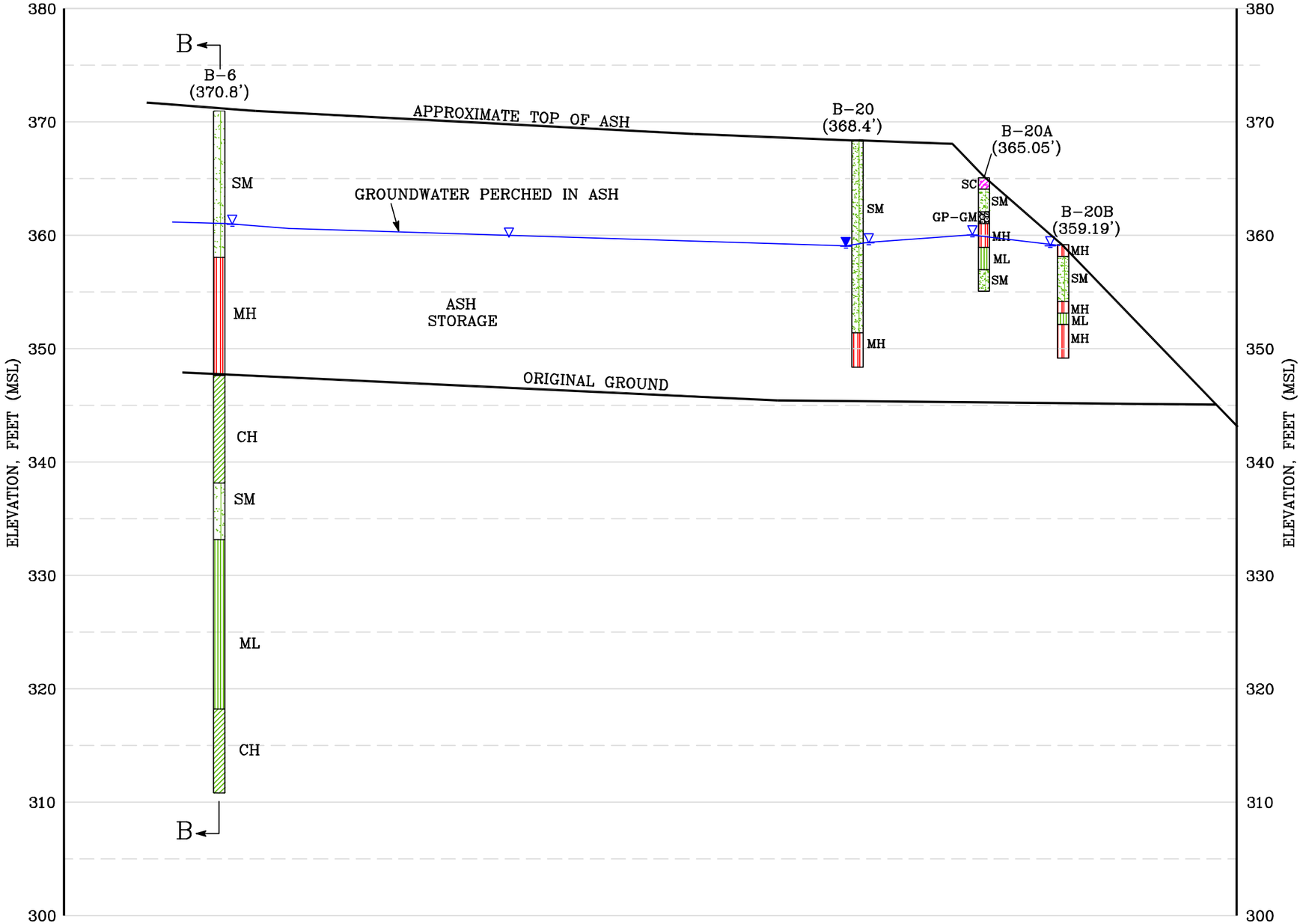
ETTL ENGINEERS & CONSULTANTS MAIN OFFICE 1717 Edst Erwin Tyler, Texas 75702 (903) 595–4421	PHASE I FLY STORAGE AREA EMBANKMENT SEEPAGE & VERTICAL EXPANSION INVESTIGATION WELSH POWER STATION CASON, TEXAS	GEOLOGICAL PROFILE D–D'		APPROVED BY:
		JOB No.: G4207–14		DRAWN BY: A.K.B.
		DATE: DEC. 2014	SCALE: AS SHOWN	

GEOLOGIC PROFILE E–E'

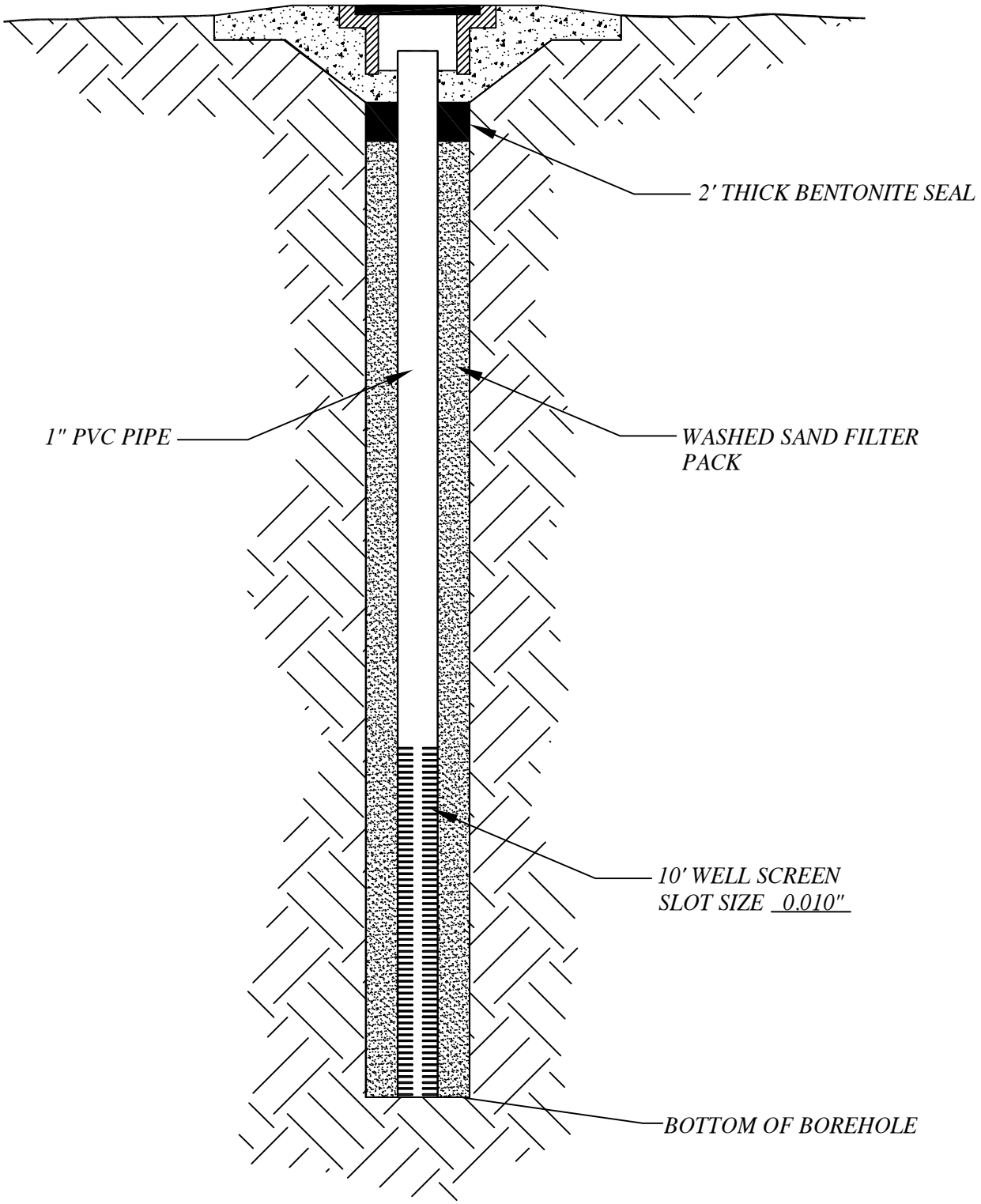








ETTL ENGINEERS & CONSULTANTS MAIN OFFICE 1717 Edst Erwin Tyler, Texas 75702 (903) 595–4421	PHASE I FLY STORAGE AREA EMBANKMENT SEEPAGE & VERTICAL EXPANSION INVESTIGATION WELSH POWER STATION CASON, TEXAS	GEOLOGICAL PROFILE E–E'		APPROVED BY:
		JOB No.: G4207–14		DRAWN BY: A.K.B.
		DATE: DEC. 2014	SCALE: AS SHOWN	



ETTL ENGINEERS & CONSULTANTS
MAIN OFFICE
1717 East Erwin Tyler, Texas 75702
Phone: (903) 595-4421
Texas Registered Engineering Firm #F3208

WHITEHOUSE LAKE DAM
(LAKE TYLER)
TX00245

TYPICAL OPEN STANDPIPE PIEZOMETER (OSP) DETAIL

JOB No.: G3763-12

DATE: NOV. 2012

SCALE: N.T.S.

APPROVED BY:

DRAWN BY: K.C.R

APPENDIX B – Laboratory Testing

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

LABORATORY INDEX TEST DATA SUMMARY SHEET

PROJECT: Phase 1 Ash Storage Embankment Investigaiton
JOB NUMBER: G 4207-14
LOCATION: Welsh Power Plant: Cason, Texas
CLEINT: AEP, Welsh Power Plant
PROJECT MANAGER: Steve Richards

Boring No.	Depth (ft.)	Soil Class	Description of Sample	USCS Classification	Atterberg Limits			Moisture Content (%)	Minus #200 Sieve (%)	+ # 40 Sieve (%)	+ # 4 Sieve (%)	Compression Tests					Swell Tests				Sample No.
					LL	PL	PI					Dry Density (pcf)	Moisture Content (%)	Compressive Strength (tsf)	Failure Strain (%)	Confining Pressure (psi)	Moisture Content Before Test (%)	Moisture Content, After Test(%)	Free Swell (%)	Restraining Pressure (psf)	
B-1	1-3	SM		Silty sand	0	0	0	34.5	43.7	39.9	8.7										
B-1	5-7	SM		Silty sand	0	0	0	29.2	43.1	31.5	12.7										
B-1	13-15	MH		Elastic Silt with Sand	87	76	11	102.8	80.0	8.5	1.3										
B-1	23-25	SM		Silty sand	0	0	0	54.1	35.8	39.8	12.1										
B-1	33-35	CL		Sandy Lean Clay	43	18	25	22.9	50.1	13.5	9.1										
B-1	43-45	SM		Silty sand	0	0	0	26.6	20.9	0.6	0.0										
B-2	1-3	ML		Sandy Silt with Gravel	0	0	0	46.2	58.6	27.1	15.7										
B-2	8-10	SM		Silty sand	0	0	0	39.8	40.3	18.8	1.6										
B-2	13-15	MH		Elastic Silt	134	92	42	199.6	99.7	0.0	0.0										
B-2	23-25	ML		Sandy Silt	0	0	0	91.3	60.5	11.3	1.3										
B-2	28-30	CL		Sandy Lean Clay	30	15	15	17.8	62.9	0.7	0.0										
B-2	33-35	SC		Clayey sand	30	15	15	17.9	38.8	0.3	0.0										
B-2	38-40	SM		Silty sand	0	0	0	21.2	23.6	0.1	0.0										
B-2	43-45	CH		Fat Clay	62	26	36	25.4	96.2	1.7	0.0										
B-4	13-15	MH		Elastic Silt with Sand	81	76	5	106.4	82.1	9.6	0.7										
B-4	23-25	MH		Gravelly Elastic Silt	113	92	21	100.1	65.6	30.3	25.0										
B-4	28-30	CL		Lean Clay	44	22	22	27.4	95.1	0.6	0.0										
B-4	33-35	CH		Fat Clay	64	28	36	25.1	98.6	0.2	0.0										

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

LABORATORY INDEX TEST DATA SUMMARY SHEET

PROJECT: Phase 1 Ash Storage Embankment Investigaiton
JOB NUMBER: G 4207-14
LOCATION: Welsh Power Plant: Cason, Texas
CLEINT: AEP, Welsh Power Plant
PROJECT MANAGER: Steve Richards

Boring No.	Depth (ft.)	Soil Class	Description of Sample	USCS Classification	Atterberg Limits			Moisture Content (%)	Minus #200 Sieve (%)	+ # 40 Sieve (%)	+ # 4 Sieve (%)	Compression Tests					Swell Tests				Sample No.
					LL	PL	PI					Dry Density (pcf)	Moisture Content (%)	Compressive Strength (tsf)	Failure Strain (%)	Confining Pressure (psi)	Moisture Content Before Test (%)	Moisture Content, After Test(%)	Free Swell (%)	Restraining Pressure (psf)	
B-3	8-10	MH		Sandy Elastic Silt	61	57	4	73.4	69.7	8.6	0.6										
B-3	18-20	MH		Elastic Silt	104	99	5	135.1	91.3	1.5	0.0										
B-3	33-35	ML		Silt	29	26	3	26.8	87.4	0.0	0.0										
B-8	3-5	MH		Sandy Elastic Silt	50	46	4	46.0	60.1	18.9	3.8										
B-8	13-15	MH		Sandy Elastic Silt	55	53	2	69.6	67.6	9.6	1.4										
B-8	23-25	CL		Sandy Lean Clay	28	16	12	20.6	63.2	6.0	3.8										
B-11	8-10	MH		Sandy Elastic Silt	57	52	5	66.6	66.0	9.8	0.5										
B-11	13-15	SM		Silty sand	0	0	0	57.3	22.0	42.6	1.4										
B-11	23-25	SM		Silty sand	0	0	0	45.1	28.0	57.6	13.1										
B-11	33-35	CL		Sandy Lean Clay	27	16	11	17.8	54.2	1.6	0.1										
B-12	7-9	CL		Sandy Lean Clay	33	19	14	15.7	58.3	0.9	0.4										
B-12	22-44	CL		Lean Clay	39	19	20	23.5	93.3	0.7	0.0										

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

LABORATORY INDEX TEST DATA SUMMARY SHEET

PROJECT: Phase 1 Ash Storage Embankment Investigaiton
JOB NUMBER: G 4207-14
LOCATION: Welsh Power Plant: Cason, Texas
CLEINT: AEP, Welsh Power Plant
PROJECT MANAGER: Steve Richards

Boring No.	Depth (ft.)	Soil Class	Description of Sample	USCS Classification	Atterberg Limits			Moisture Content (%)	Minus #200 Sieve (%)	+ # 40 Sieve (%)	+ # 4 Sieve (%)	Compression Tests					Swell Tests				Sample No.
					LL	PL	PI					Dry Density (pcf)	Moisture Content (%)	Compressive Strength (tsf)	Failure Strain (%)	Confining Pressure (psi)	Moisture Content Before Test (%)	Moisture Content, After Test(%)	Free Swell (%)	Restraining Pressure (psf)	
B-5	3-5	GM		Silty gravel with sand	0	0	0	45.3	27.9	56.1	43.1										
B-5	13-15	CL		Sandy Lean Clay with Gravel	26	17	9	41.3	53.6	23.2	22.0										
B-5	23-25	CH		Fat Clay with Sand	60	22	38	25.8	78.0	0.2	0.0										
B-6	8-10	SM		Silty sand	0	0	0	57.5	39.1	17.1	3.3										
B-6	18-20	MH		Elastic Silt	96	92	4	128.9	96.1	0.5	0.0										
B-6	28-30	CH		Fat Clay with Sand	54	18	36	28.6	72.0	9.7	4.6										
B-6	33-55	SM		Silty sand	25	22	3	25.9	24.9	2.9	0.4										
B-6	38-40	ML		Sandy Silt	0	0	0	25.8	56.3	0.0	0.0										
B-6	48-50	ML		Silt with Sand	0	0	0	25.2	76.4	0.0	0.0										
B-6	53-55	CH		Fat Clay	72	24	48	27.5	94.6	0.1	0.0										
B-7	3-5	ML		Sandy Silt	0	0	0	20.0	52.9	10.4	5.3										
B-7	13-15	SM		Silty sand	0	0	0	97.1	39.7	9.1	2.1										
B-7	33-35	CL		Sandy Lean Clay	43	17	26	25.9	67.6	0.4	0.0										
B-7	38-40	SM		Silty sand	0	0	0	28.3	37.7	0.3	0.0										
B-7	43-45	CH		Fat Clay	62	20	42	26.1	91.5	0.9	0.0										

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

LABORATORY INDEX TEST DATA SUMMARY SHEET

PROJECT: Phase 1 Ash Storage Embankment Investigaiton
JOB NUMBER: G 4207-14
LOCATION: Welsh Power Plant: Cason, Texas
CLEINT: AEP, Welsh Power Plant
PROJECT MANAGER: Steve Richards

Boring No.	Depth (ft.)	Soil Class	Description of Sample	USCS Classification	Atterberg Limits			Moisture Content (%)	Minus #200 Sieve (%)	+ # 40 Sieve (%)	+ # 4 Sieve (%)	Compression Tests					Swell Tests				Sample No.
					LL	PL	PI					Dry Density (pcf)	Moisture Content (%)	Compressive Strength (tsf)	Failure Strain (%)	Confining Pressure (psi)	Moisture Content Before Test (%)	Moisture Content, After Test(%)	Free Swell (%)	Restraining Pressure (psf)	
B-9	3-5	SM		Silty sand	0	0	0	21.7	43.5	11.5	1.3										
B-9	8-10	MH		Sandy Elastic Silt	61	61	0	90.2	62.4	2.5	0.0										
B-9	23-25	GP		Poorly graded gravel with sand	0	0	0	36.0	1.3	97.3	56.1										
B-9	28-30	CH		Fat Clay with Sand	70	20	50	26.0	83.1	1.3	0.4										
B-9	38-40	SM		Silty sand	0	0	0	26.3	45.5	0.0	0.0										
B-9	48-50	CH		Fat Clay	54	19	35	19.0	98.0	0.2	0.0										
B-10	3-5	SC		Clayey sand	31	19	12	24.3	40.5	21.1	11.4										
B-10	18-20	SM		Silty sand with gravel	0	0	0	56.4	13.7	71.0	28.2										
B-10	28-30	CL		Sandy Lean Clay	23	14	9	19.4	57.4	0.9	0.3										
B-10	38-40	SC		Clayey sand	25	17	8	22.1	27.3	2.5	0.3										
B-10	43-45	CH		Fat Clay	64	24	40	25.0	89.6	6.9	0.0										

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

LABORATORY INDEX TEST DATA SUMMARY SHEET

PROJECT: Phase 1 Ash Storage Embankment Investigaiton
JOB NUMBER: G 4207-14
LOCATION: Welsh Power Plant: Cason, Texas
CLEINT: AEP, Welsh Power Plant
PROJECT MANAGER: Steve Richards

Boring No.	Depth (ft.)	Soil Class	Description of Sample	USCS Classification	Atterberg Limits			Moisture Content (%)	Minus #200 Sieve (%)	+ # 40 Sieve (%)	+ # 4 Sieve (%)	Compression Tests					Swell Tests				Sample No.
					LL	PL	PI					Dry Density (pcf)	Moisture Content (%)	Compressive Strength (tsf)	Failure Strain (%)	Confining Pressure (psi)	Moisture Content Before Test (%)	Moisture Content, After Test(%)	Free Swell (%)	Restraining Pressure (psf)	
B-13	3-5	CL		Lean Clay with Sand	45	17	28	19.8	75.9	0.8	0.0										
B-13	17-19	CH		Fat Clay with Sand	54	20	34	21.6	79.1	0.8	0.0										
B-13	27-29	ML		Silt with Sand	0	0	0	24.2	79.5	0.2	0.0										
B-14	8-10	ML		Sandy Silt	17	17	0	108.3	67.5	1.3	1.3										
B-14	18-20	CL		Sandy Lean Clay	40	16	24	25.7	67.1	0.5	0.0										
B-14	23-25	SP-SM		Poorly graded sand with silt	0	0	0	25.1	10.2	0.0	0.0										
B-15	8-10	CH		Fat Clay	59	21	38	23.7	85.3	0.4	0.0										
B-15	13-15	SM		Silty sand	0	0	0	7.1	12.4	0.0	0.0										
B-15	28-30	CL		Lean Clay	45	22	23	25.3	92.2	0.3	0.0										
B-17	3-5	CL		Sandy Lean Clay	27	15	12	12.9	59.8	1.0	0.0										
B-17	18-20	CH		Fat Clay	56	22	34	23.4	86.9	9.3	1.5										
B-18	3-5	CL-ML		Sandy Silty Clay	23	17	6	10.4	51.4	0.9	0.3										
B-18	13-15	CH		Fat Clay	55	20	35	28.0	94.8	2.8	0.5										
B-19	3-5	SM		Silty sand	0	0	0	31.7	28.1	33.1	9.3										
B-19	13-15	ML		Sandy Silt	0	0	0	92.0	61.8	4.5	0.2										
B-20	3-5	SM		Silty sand	0	0	0	26.0	33.1	31.5	12.7										
B-20	13-15	SM		Silty sand	0	0	0	91.8	49.9	6.7	0.3										
B-21	3-5	SM		Silty sand	0	0	0	36.4	38.7	13.3	0.8										
B-21	18-20	MH		Elastic Silt	109	93	16	132.0	89.1	5.0	0.0										
B-21	23-25	SM		Silty sand with gravel	0	0	0	52.3	26.4	63.2	23.3										

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

LABORATORY INDEX TEST DATA SUMMARY SHEET, COMPOSITE SAMPLES USED IN STRENGHT TESTING

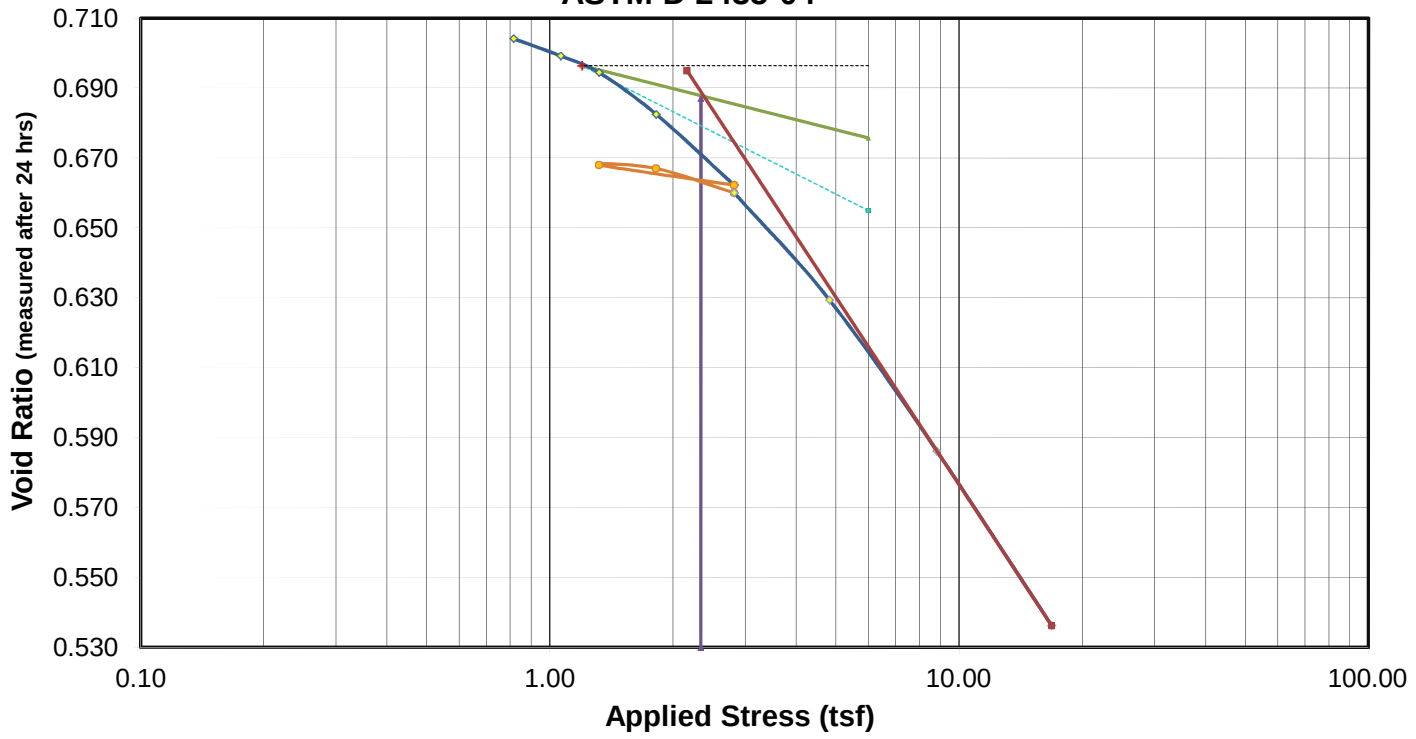
PROJECT: Phase 1 Ash Storage Embankment Investigaiton
JOB NUMBER: G 4207-14
LOCATION: Welsh Power Plant: Cason, Texas
CLEINT: AEP, Welsh Power Plant
PROJECT MANAGER: Steve Richards

Boring No.	Depth (ft.)	Soil Class	Description of Sample	USCS Classification	Atterberg Limits			Moisture Content (%)	Minus #200 Sieve (%)	+ # 40 Sieve (%)	+ # 4 Sieve (%)	Compression Tests					Swell Tests				Sample No.
					LL	PL	PI					Dry Density (pcf)	Moisture Content (%)	Compressive Strength (tsf)	Failure Strain (%)	Confining Pressure (psi)	Moisture Content Before Test (%)	Moisture Content, After Test(%)	Free Swell (%)	Restraining Pressure (psf)	
Dam Embankment	Sandy CL	CL		Sandy Lean Clay	29	18	11	12.1	62.6	0.6	0.0										#1
Dam Embankment	Fat Clay	CH		Fat Clay with Sand	62	20	42	22.0	78.0	1.9	0.0										#2
Dark Gray Ash	CU	MH		Elastic Silt	97	87	10	0.0	89.2	0.0	0.0										
Black Ash	DS/Consol.	MH		Elastic Silt	100	81	19		100.0												
B-11	18-20	MH		Elastic Silt	124	107	17		97.4												

One-Dimensional Consolidation

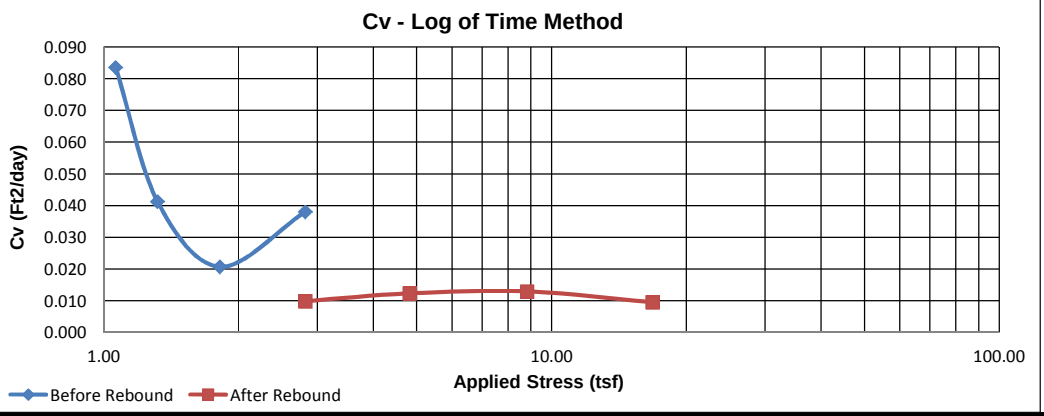
Consolidation Test Report

ASTM D 2435-04



C_c	e_o	C_r (0.82sf - 1.06tsf)	Preconsolidation Pressure (tsf)	C_r (rebound)
0.178	0.706	0.043	2.34	0.018

Applied Load (tsf)	Void Ratio (e)	Cv (ft^2/day)
0.00	0.706	-
0.82	0.704	-
1.06	0.699	0.084
1.32	0.694	0.041
1.82	0.682	0.021
2.82	0.662	0.038
1.32	0.668	0.027
1.82	0.667	Not Cal.
2.82	0.660	0.010
4.82	0.629	0.012
8.82	0.586	0.013
16.81	0.536	0.010
Estimated OCR		
1.1		



Sample and Test Data

Boring:	B-2	Depth:	48'-50'	
Material Description:	Dark Brown Fat with Light Gray Clay, (CH)			
LL	PL	PI	-200%	Assumed S.G.
N/T	N/T	N/T	N/T	2.680
Initial MC	Final MC	Initial Dry Unit Weight (lb/ft^3):		97.9
23.5%	21.6%	Final Dry Unit Weight (lb/ft^3):		108.7
Initial Sat. %	Final Sat. %	Test method:		B
89.3%	100.0%	Condition:		Inundated
Initial e	Final e	Consolidometer		
0.706	0.536	Soil Test		G 268
Molding:	Trimmed undisturbed Shelby tube sample			

Project Information

Project:	Phase 1 Ash Stroage Embankment Investigation		
Location:	Cason,Texas		
Job Number:	G 4207-14		
Client:	AEP, Welsh power Plant		
Technician:	Owen Sanderson	Date:	1-Dec-14

Main Office: 1717 East Erwin Street Tyler, Texas 75702 Phone: 903-595-4421 Fax: 903-595-6113

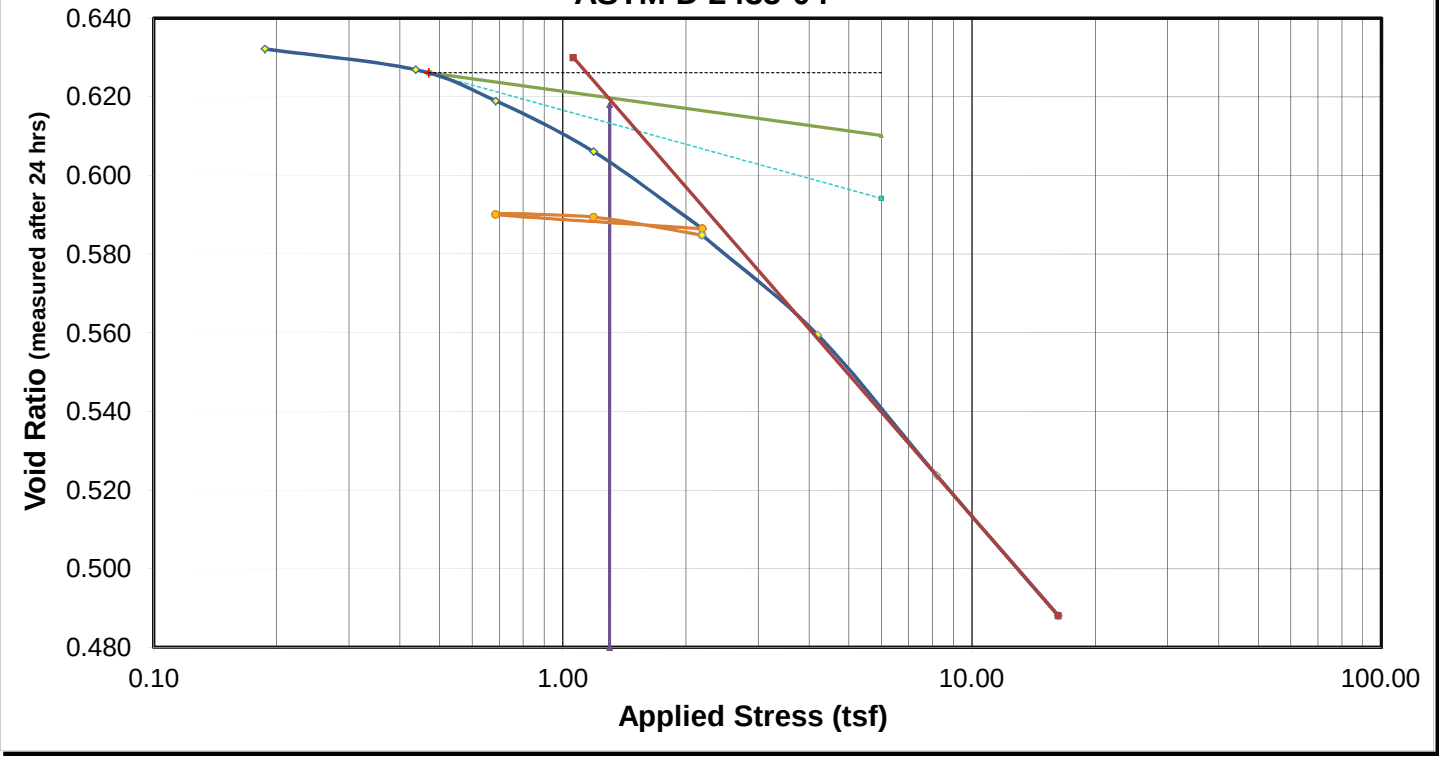
Longview Branch: 707 West Cotton Street Longview, TX 75604-5505 Phone: 903-758-0915 Fax: 903-758-8245

Texarkana Branch: 210 Beech Street Texarkana, Arkansas 71854 Phone: 870-772-0013 Fax: 870-216-2413

Arlington Branch: 2000 E. Randol Mill Rd. Suite 613 Arlington, TX 76011 Phone: 817-962-0048 Fax: 817-962-0025

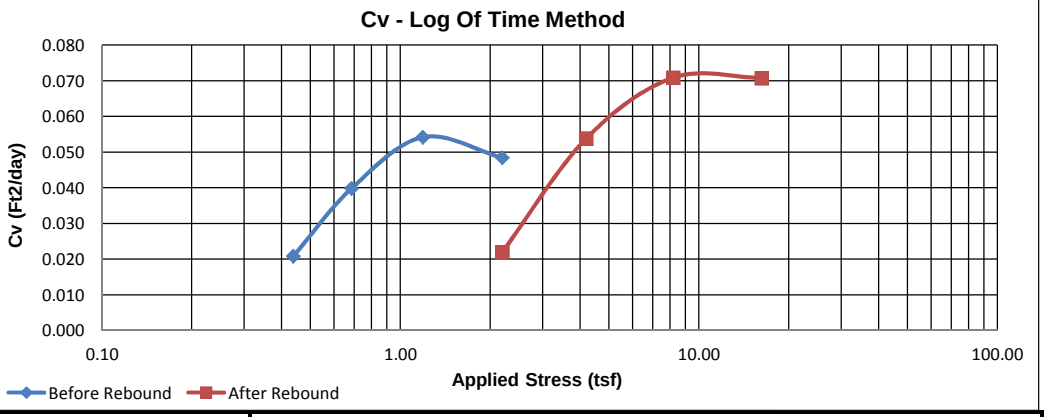
Consolidation Test Report

ASTM D 2435-04



C_c	e_o	C_r (0.19tsf - 0.44tsf)	Preconsolidation Pressure (tsf)	C_r (rebound)
0.120	0.637	0.014	1.30	0.007

Applied Load (tsf)	Void Ratio (e)	Cv (ft^2/day)
0.00	0.637	-
0.19	0.632	-
0.44	0.627	0.021
0.69	0.619	0.040
1.19	0.606	0.054
2.19	0.586	0.048
0.69	0.590	0.036
1.19	0.589	Not Cal.
2.19	0.585	0.022
4.19	0.559	0.054
8.19	0.524	0.071
16.21	0.488	0.071
Estimated OCR		
0.9		



Sample and Test Data

Boring:	B-9	Depth:	28'-30'	
Material Description:	Reddish Brown & Light Gray Fat Clay with sand, (CH)			
LL	PL	PI	-200%	Assumed S.G.
70	20	50	83.1	2.680
Initial MC	Final MC	Initial Dry Unit Weight (lb/ft^3):		102.0
23.0%	18.6%	Final Dry Unit Weight (lb/ft^3):		112.2
Initial Sat. %	Final Sat. %	Test method:		B
96.8%	100.0%	Condition:		Inundated
Initial e	Final e	Consolidometer		
0.637	0.488	Soil Test		G 270
Molding:	Trimmed undisturbed Shelby tube sample			

Project Information

Project:	Phase 1 Ash Stroage Embankment Investigation		
Location:	Carson,Texas		
Job Number:	G 4207-14		
Client:	AEP, Welsh power Plant		
Technician:	Owen Sanderson	Date:	1-Dec-14

Main Office: 1717 East Erwin Street Tyler, Texas 75702 Phone: 903-595-4421 Fax: 903-595-6113

Longview Branch: 707 West Cotton Street Longview, TX 75604-5505 Phone: 903-758-0915 Fax: 903-758-8245

Texarkana Branch: 210 Beech Street Texarkana, Arkansas 71854 Phone: 870-772-0013 Fax: 870-216-2413

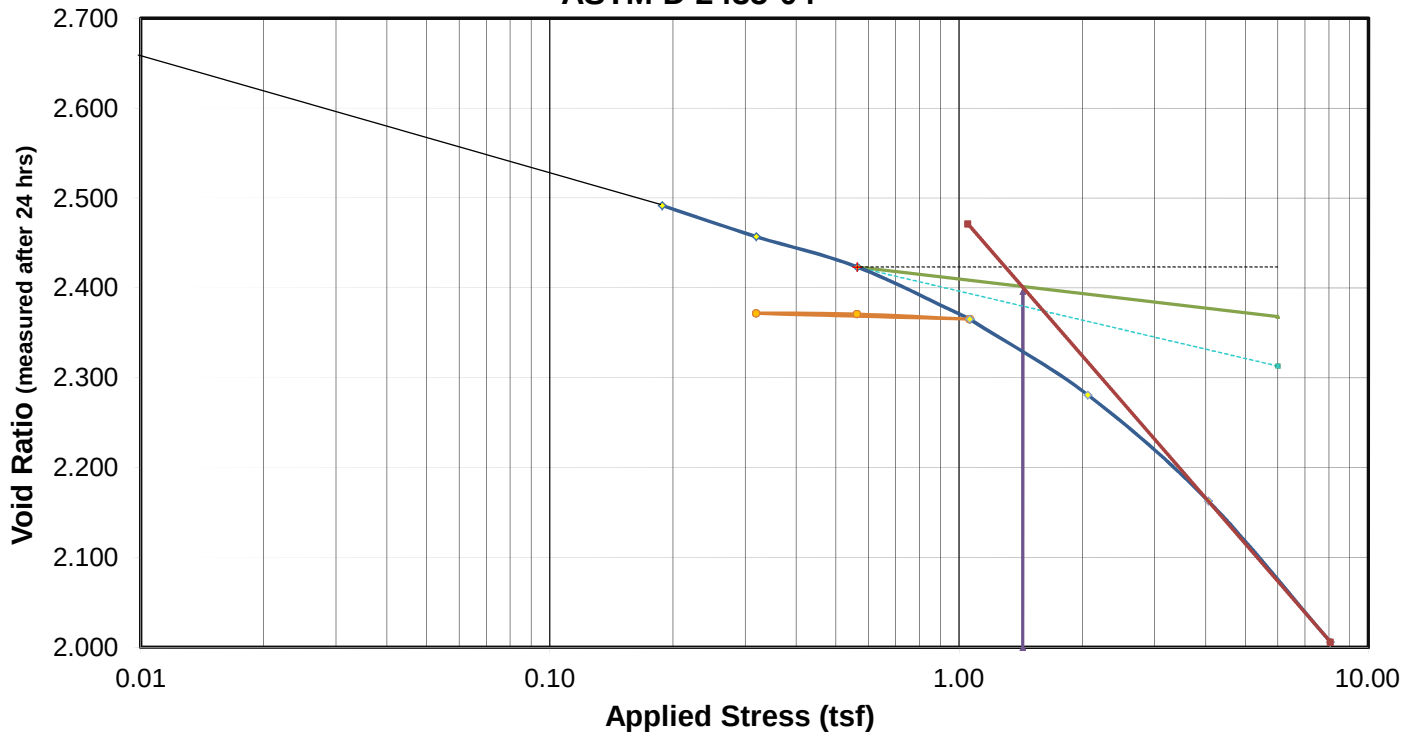
Arlington Branch: 2000 E. Randol Mill Rd. Suite 613 Arlington, TX 76011 Phone: 817-962-0048 Fax: 817-962-0025

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

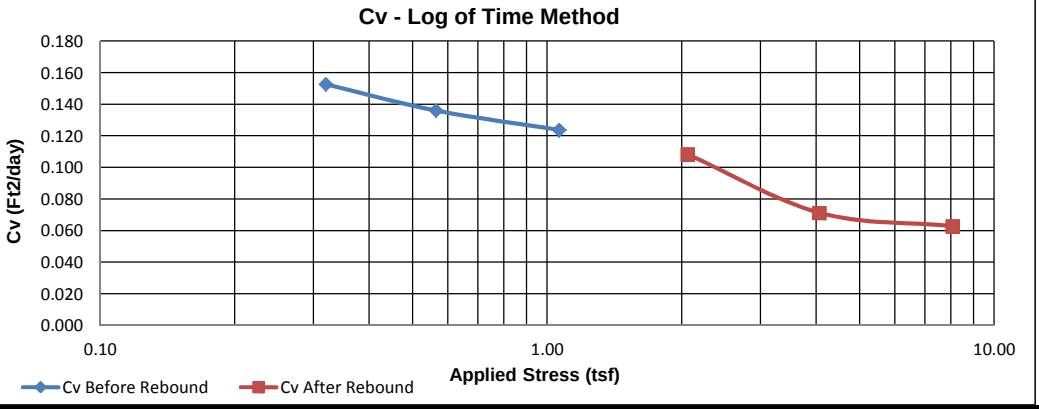
Consolidation Test Report

ASTM D 2435-04



C_c	e_o	C_r (0.063sf - 0.188tsf)	Preconsolidation Pressure (tsf)	C_r (rebound)
0.526	2.512	0.151	1.43	0.012

Applied Load (tsf)	Void Ratio (e)	Cv (ft^2/day)
0.010	2.512	-
0.063	2.497	-
0.188	2.492	Not Cal.
0.320	2.457	0.153
0.564	2.423	0.136
1.06	2.365	0.124
0.32	2.372	Not Cal.
0.56	2.371	Not Cal.
1.06	2.365	Not Cal.
2.06	2.281	0.108
4.06	2.163	0.071
8.07	2.006	0.063
Estimated OCR		
2.1		



Sample and Test Data

Boring:	B-6	Depth:	13'-20'	
Material Description:				
LL	PL	PI	-200%	Measured S.G.
100	81	19	100	2.320
Initial MC	Final MC	Initial Dry Unit Weight (lb/ft^3):		41.2
110.9%	89.4%	Final Dry Unit Weight (lb/ft^3):		48.1
Initial Sat. %	Final Sat. %	Test method:		B
100%	100%	Condition:		Inundated
Initial e	Final e	Consolidometer		
2.512	2.006	Soil Test		G 264

Project Information

Project:	Phase 1 Ash Stroage Embankment Investigation		
Location:	Cason,Texas		
Job Number:	G 4207-14		
Client:	AEP, Welsh power Plant		
Technician:	Owen Sanderson	Date:	1-Dec-14

Notes;

Sample pre-consolidated to a normal load of 9.5 psi = 0.684 tsf. Sample disturbance during placement in the cutting ring.

Main Office: 1717 East Erwin Street Tyler, Texas 75702 Phone: 903-595-4421 Fax: 903-595-6113

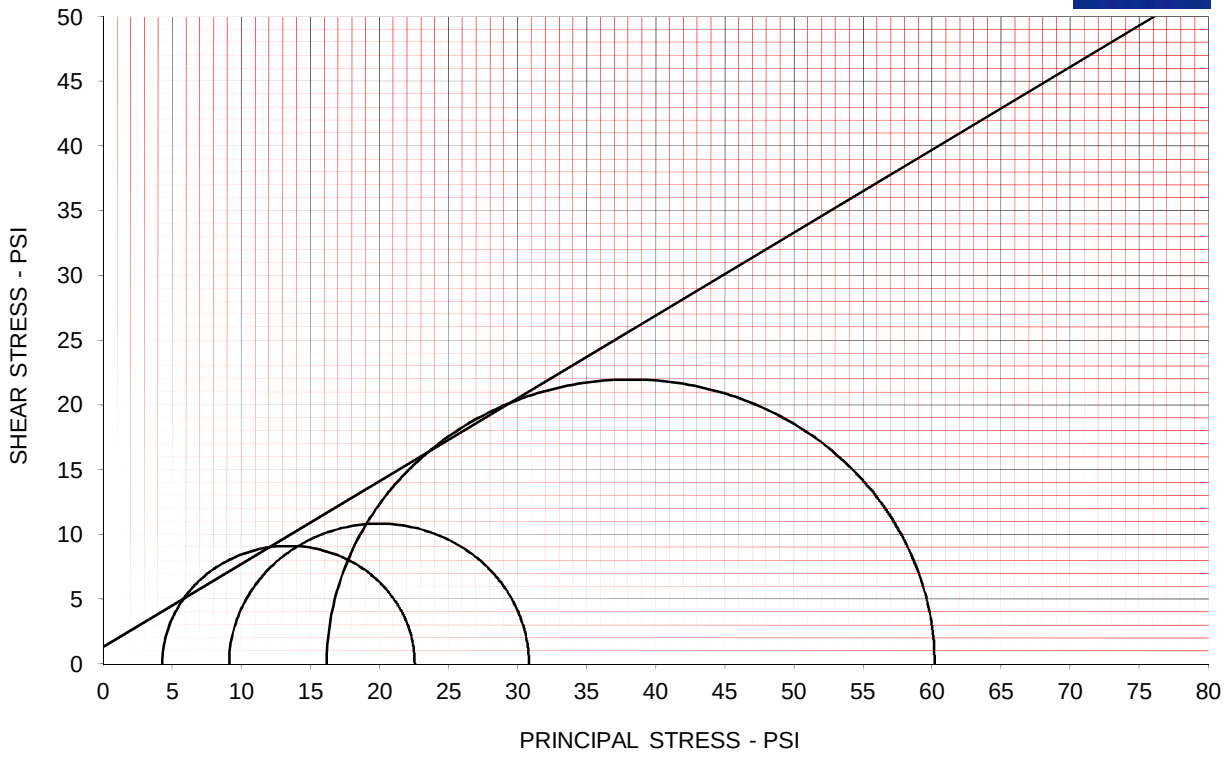
Longview Branch: 707 West Cotton Street Longview, TX 75604-5505 Phone: 903-758-0915 Fax: 903-758-8245

Texarkana Branch: 210 Beech Street Texarkana, Arkansas 71854 Phone: 870-772-0013 Fax: 870-216-2413

Arlington Branch: 2000 E. Randol Mill Rd. Suite 613 Arlington, TX 76011 Phone: 817-962-0048 Fax: 817-962-0025

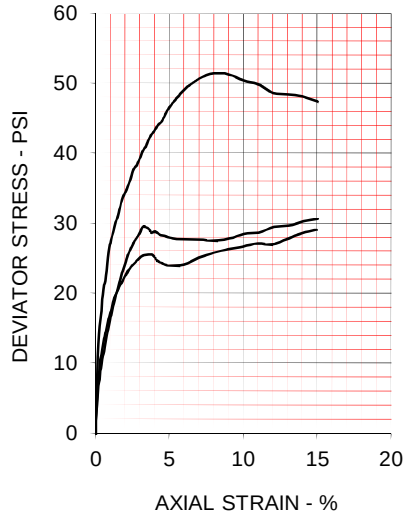
Consolidated Undrained Triaxial Compression

ASTM D4767 - CU TRIAXIAL SHEAR TEST REPORT



GREGORY GEOTECHNICAL SOFTWARE

EFFECTIVE STRESS PARAMETERS	ϕ ' = 32.6 deg	c' = 1.3 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	22.8	24.4	26.5	
Dry Density - pcf	103.4	97.6	97.7	
Diameter - inches	1.43	1.44	1.45	
Height - inches	3.18	3.26	3.18	
AT TEST				
Final Moisture - %	24.2	26.7	25.7	
Dry Density - pcf	104.5	100.1	102.6	
Calculated Diameter (in.)	1.43	1.42	1.43	
Height - inches	3.17	3.22	3.10	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	18.26	21.69	43.98	
Total Pore Pressure - psi	65.7	70.9	83.8	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.2	1.8	4.2	
σ_1' Failure - psi	22.53	30.79	60.15	
σ_3' Failure - psi	4.27	9.10	16.17	

TEST DESCRIPTION

TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: Undistrubed Shelby Tube, Trimmed
DESCRIPTION: Light Gray & Redd. Brown Fat Clay, (CH)
SAMPLE LOCATION: B-5 28'-30'
ASSUMED SPECIFIC GRAVITY: 2.67
LL: 58 PI: 38 %-200: 85.8 % Clay Fraction: 42.4
REMARKS: Calculated at peak Pore Pressure

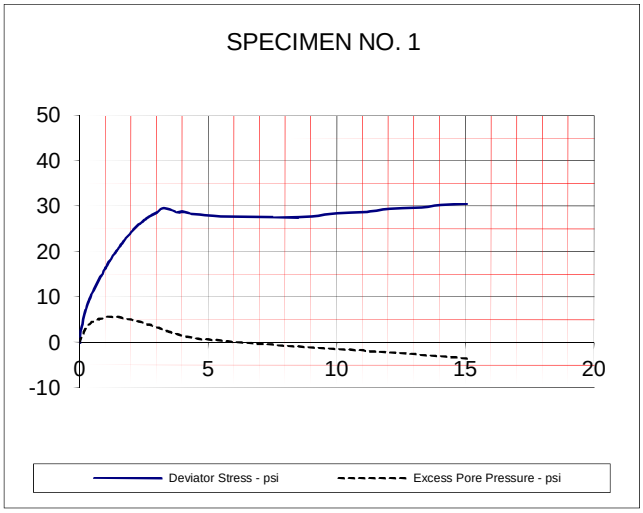
PROJECT INFORMATION

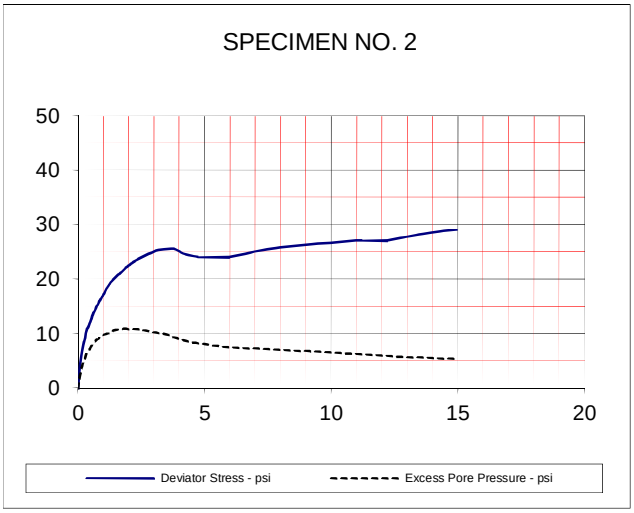
PROJECT:Phase1 Ash Strorage Area Embankment Investigation
LOCATION: Cason, Texas
PROJECT NO: G 4207-146
CLIENT: AEP, Welsh Power Plant
DATE: 12/4/12

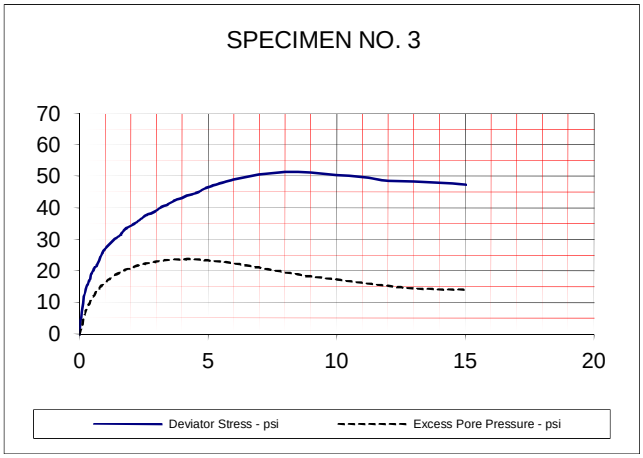
ETTL Engineers & Consultants

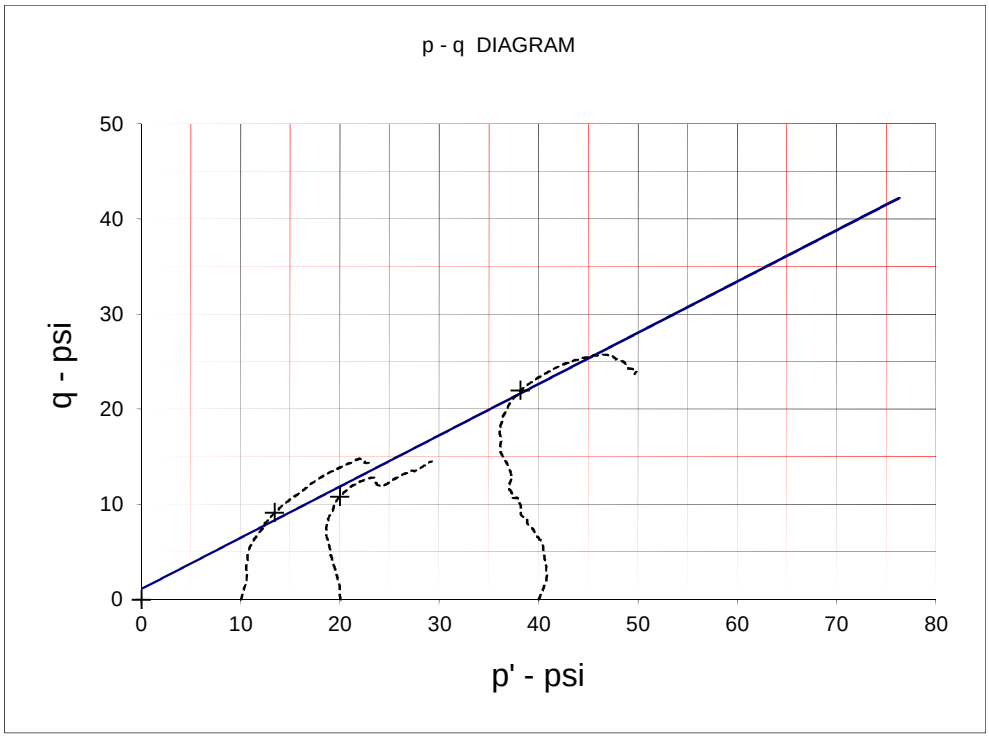
PLATE: B-CD.1

C.U. B-5 28'-30', Native upper Clay, GG Program





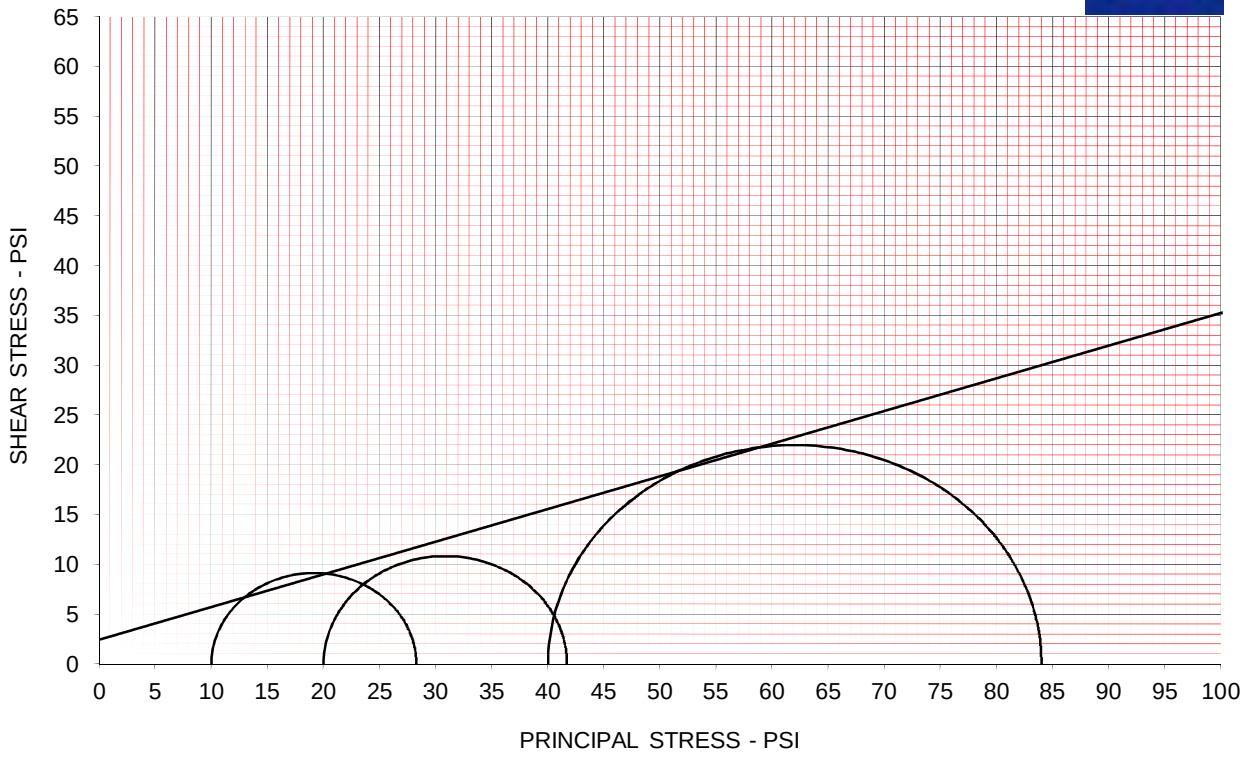




EFFECTIVE STRESS PARAMETERS	R^2 = 0.982	α (deg) = 28.3	a (psi) = 1.1
PROJECT:Phase1 Ash Strorage Area Embankment Investigation		TYPE OF TEST & NO: CD Triaxial - CD-1	
PROJECT NO: G 4207-146		***ETTL Engineers & Consultants***	PLATE: B-CD.2
DESCRIPTION: Light Gray & Redd. Brown Fat Clay, (CH)			

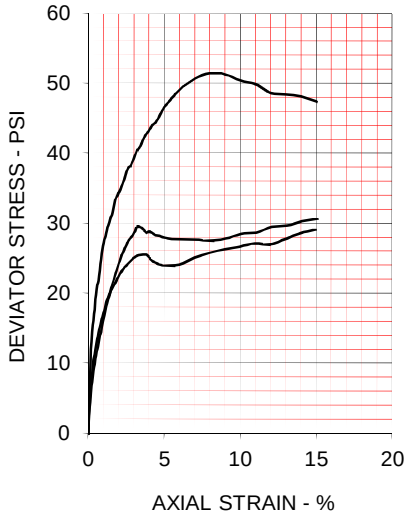
C.U. B-5 28'-30', Native upper Clay, GG Program

ASTM D4767 - CU TRIAXIAL SHEAR TEST REPORT



GREGORY GEOTECHNICAL SOFTWARE

TOTAL STRESS PARAMETERS	ϕ = 18.2 deg	c = 2.5 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	22.8	24.4	26.5	
Dry Density - pcf	103.4	97.6	97.7	
Diameter - inches	1.43	1.44	1.45	
Height - inches	3.18	3.26	3.18	
AT TEST				
Final Moisture - %	24.2	26.7	25.7	
Dry Density - pcf	104.5	100.1	102.6	
Calculated Diameter (in.)	1.43	1.42	1.43	
Height - inches	3.17	3.22	3.10	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	18.26	21.69	43.98	
Total Pore Pressure - psi	65.7	70.9	83.8	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.2	1.8	4.2	
σ_1 Failure - psi	28.26	41.69	83.98	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: Undistrubed Shelby Tube, Trimmed
DESCRIPTION: Light Gray & Redd. Brown Fat Clay, (CH)
SAMPLE LOCATION: B-5 28'-30'
ASSUMED SPECIFIC GRAVITY: 2.67
LL: 58 PI: 38 %-200: 85.8 % Clay Fraction: 42.4
REMARKS: Calculated at peak Pore Pressure

PROJECT INFORMATION

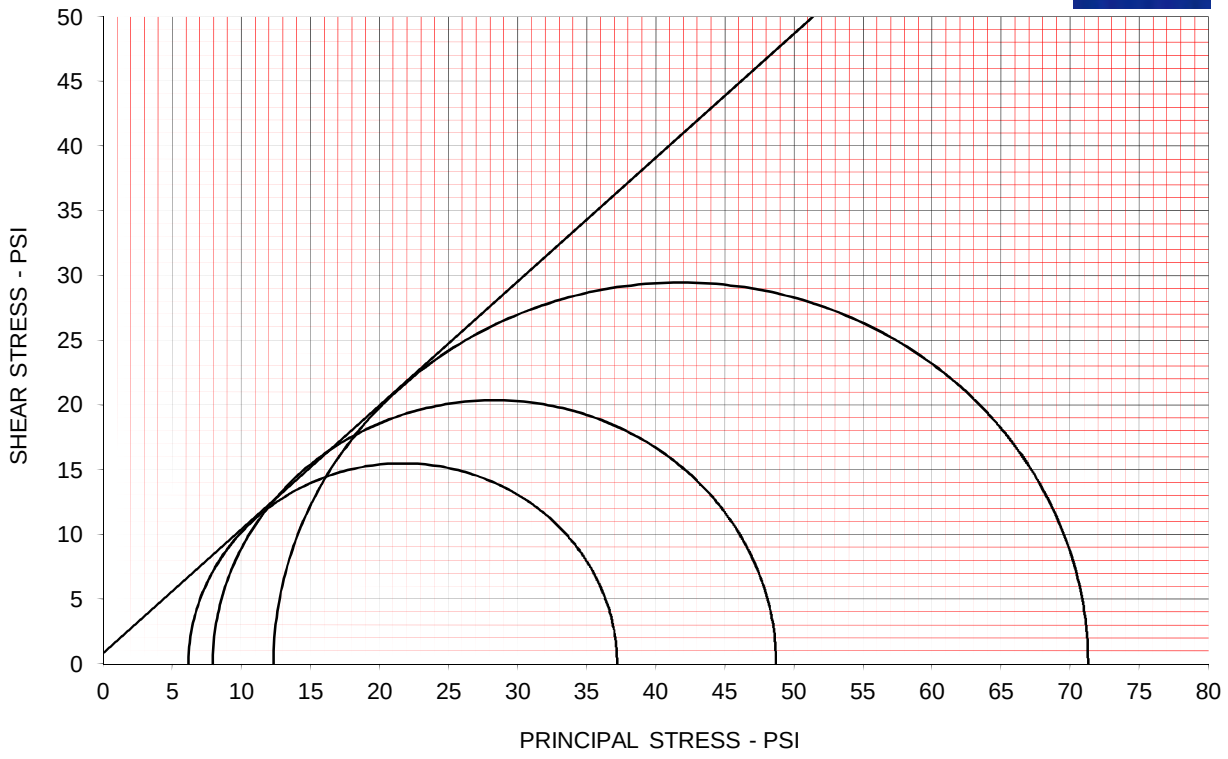
PROJECT:Phase1 Ash Strorage Area Embankment Investigation
LOCATION: Cason, Texas
PROJECT NO: G 4207-146
CLIENT: AEP, Welsh Power Plant
DATE: 12/4/12

ETTL Engineers & Consultants

PLATE: B-CD.3

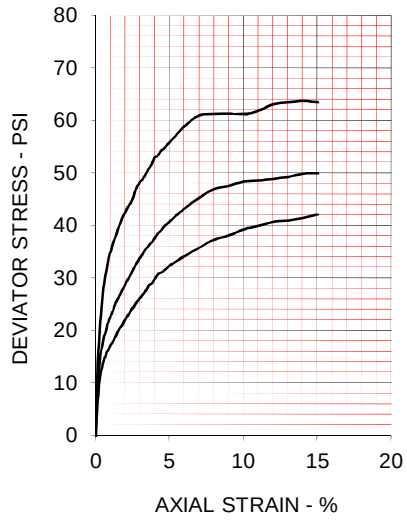
C.U. B-5 28'-30', Native upper Clay, GG Program

ASTM D4767 - CU TRIAXIAL SHEAR TEST REPORT



GREGORY GEOTECHNICAL SOFTWARE

EFFECTIVE STRESS PARAMETERS	ϕ ' = 43.7 deg	c' = 0.9 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	111.7	109.3	104.2	
Dry Density - pcf	41.5	42.4	43.4	
Diameter - inches	1.40	1.40	1.40	
Height - inches	3.00	2.99	2.90	
AT TEST				
Final Moisture - %	99.1	99.4	95.2	
Dry Density - pcf	41.8	43.0	45.3	
Calculated Diameter (in.)	1.39	1.39	1.38	
Height - inches	2.98	2.97	2.85	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	31.01	40.76	58.95	
Total Pore Pressure - psi	63.8	72.1	87.7	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	4.4	5.0	6.0	
σ_1' Failure - psi	37.17	48.68	71.26	
σ_3' Failure - psi	6.16	7.92	12.31	

TEST DESCRIPTION

TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: SPT Samples, Pre-consolidated to 7, 14, 28psi
DESCRIPTION: Dk Gray Elastic Silt, (MH), Comp. Bottom Ash
SAMPLE LOCATION: Composite Sample B-8(18'-20') & B-20(17'-19')
ASSUMED SPECIFIC GRAVITY: 2.6
LL: 97 PL: 87 PI: 10 Percent -200: 89.2
REMARKS: Calculated Maximum Stress Ratio

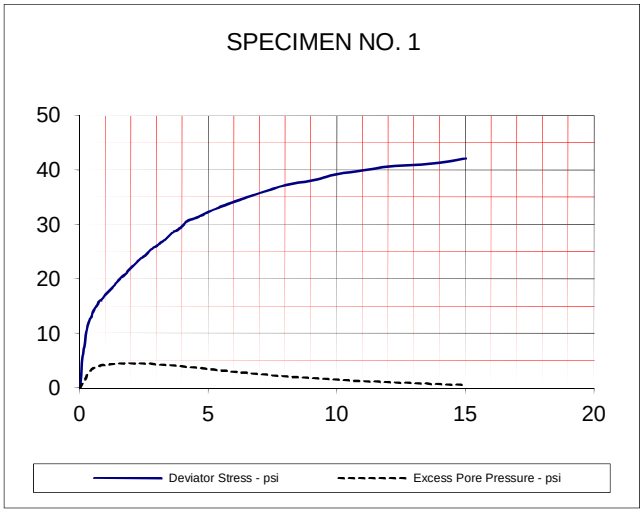
PROJECT INFORMATION

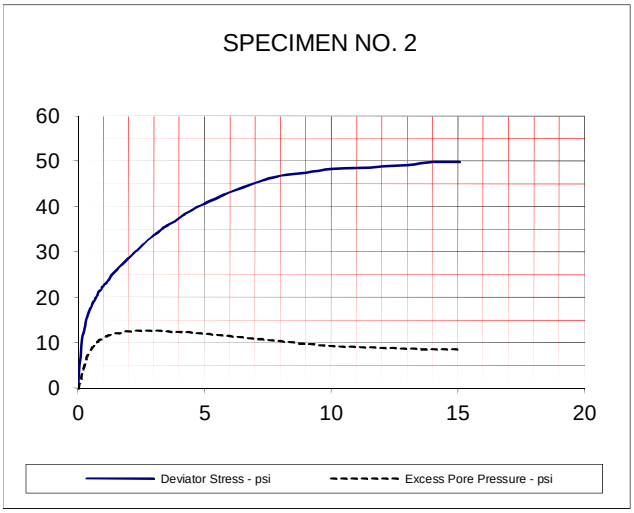
PROJECT:Phase1 Ash Strorage Area Embankment Investigation
LOCATION: Cason, Texas
PROJECT NO: G 4207-146
CLIENT: AEP, Welsh Power Plant
DATE: 12/16/12

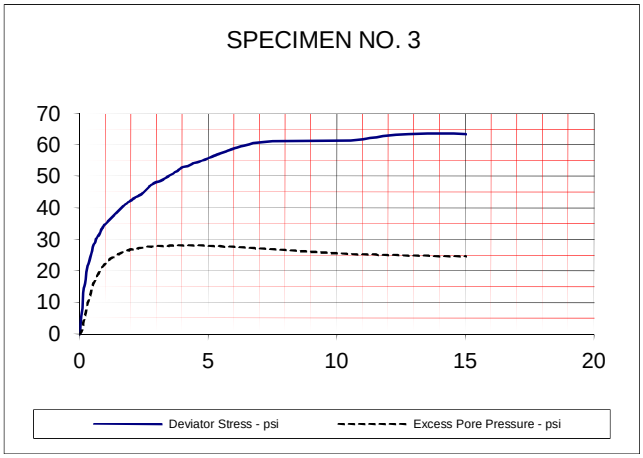
ETTL Engineers & Consultants

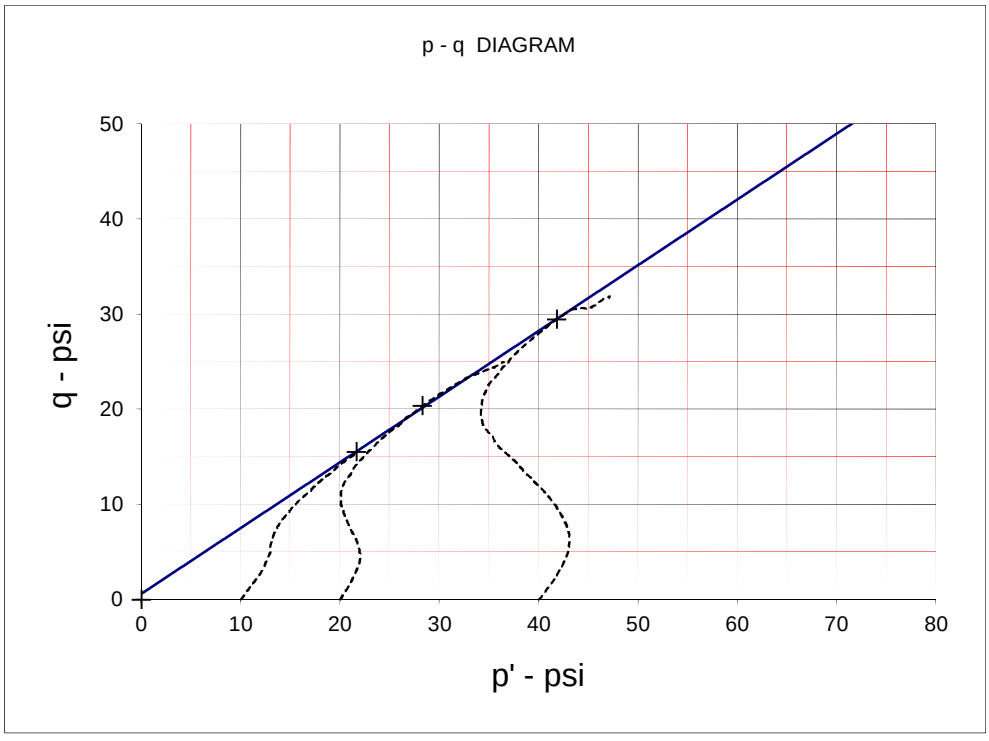
PLATE: B-CD.1

C.U. B-8(18'-20') & B-20(17'-19') Dark Gray Plastic Fly Ash, GG Program





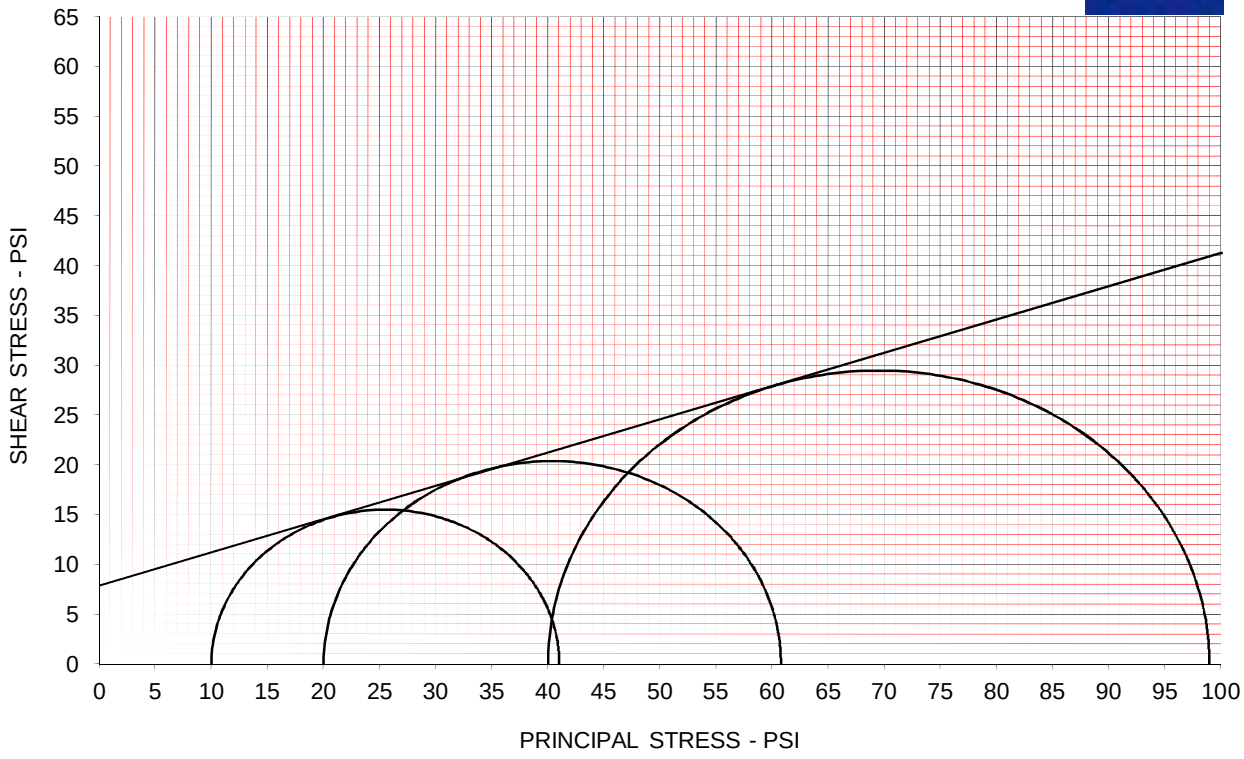




EFFECTIVE STRESS PARAMETERS	R^2 = 1.000	α (deg) = 34.7	a (psi) = 0.6
PROJECT:Phase1 Ash Strorage Area Embankment Investigation		TYPE OF TEST & NO: CD Triaxial - CD-1	
PROJECT NO: G 4207-146		***ETTL Engineers & Consultants***	PLATE: B-CD.2
DESCRIPTION: Dk Gray Elastic Silt, (MH), Comp. Bottom Ash			

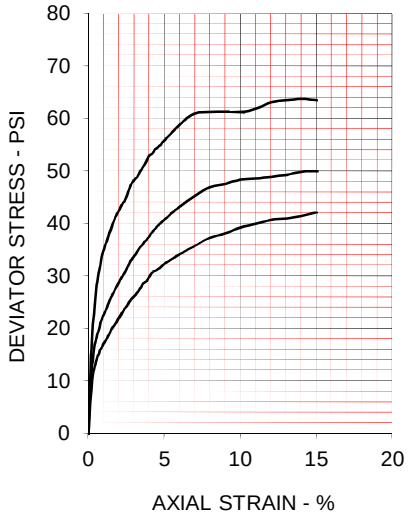
C.U. B-8(18'-20') & B-20(17'-19') Dark Gray Plastic Fly Ash, GG Program

ASTM D 4767 - CU TRIAXIAL SHEAR TEST REPORT



GREGORY GEOTECHNICAL SOFTWARE

TOTAL STRESS PARAMETERS	ϕ = 18.5 deg	c = 7.9 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	111.7	109.3	104.2	
Dry Density - pcf	41.5	42.4	43.4	
Diameter - inches	1.40	1.40	1.40	
Height - inches	3.00	2.99	2.90	
AT TEST				
Final Moisture - %	99.1	99.4	95.2	
Dry Density - pcf	41.8	43.0	45.3	
Calculated Diameter (in.)	1.39	1.39	1.38	
Height - inches	2.98	2.97	2.85	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	31.01	40.76	58.95	
Total Pore Pressure - psi	63.8	72.1	87.7	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	4.4	5.0	6.0	
σ_1 Failure - psi	41.01	60.76	98.95	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: SPT Samples, Pre-consolidated to 7, 14, 28psi
DESCRIPTION: Dk Gray Elastic Silt, (MH), Comp. Bottom Ash
SAMPLE LOCATION: Composite Sample B-8(18'-20') & B-20(17'-19')
ASSUMED SPECIFIC GRAVITY: 2.6
LL: 97 PL: 87 PI: 10 Percent -200: 89.2
REMARKS: Calculated Maximum Stress Ratio

PROJECT INFORMATION

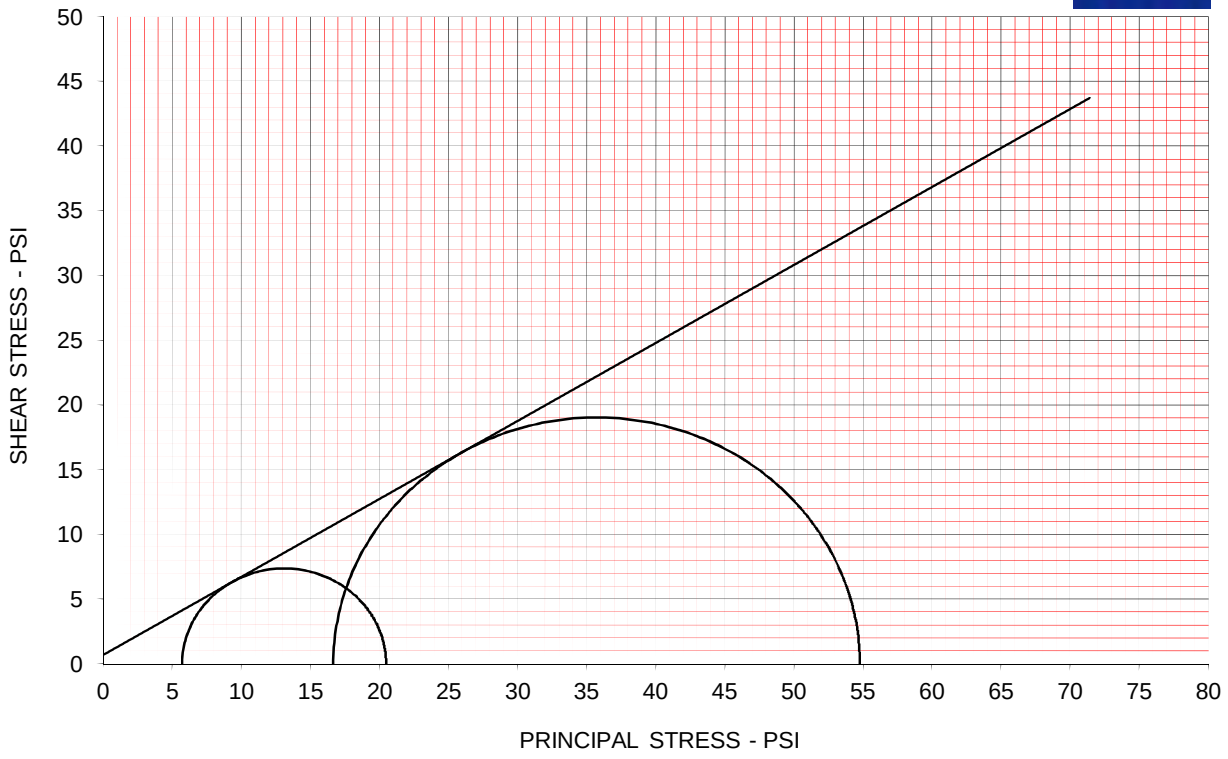
PROJECT:Phase1 Ash Strorage Area Embankment Investigation
LOCATION: Cason, Texas
PROJECT NO: G 4207-146
CLIENT: AEP, Welsh Power Plant
DATE: 12/16/12

ETTL Engineers & Consultants

PLATE: B-CD.3

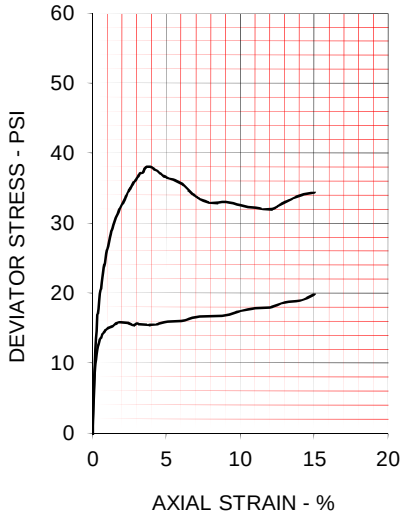
C.U. B-8(18'-20') & B-20(17'-19') Dark Gray Plastic Fly Ash, GG Program

ASTM D4767 - CU TRIAXIAL SHEAR TEST REPORT



GREGORY GEOTECHNICAL SOFTWARE

EFFECTIVE STRESS PARAMETERS	ϕ' = 31.1 deg	c' = 0.7 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	21.8	23.5		
Dry Density - pcf	105.4	100.2		
Diameter - inches	2.03	2.04		
Height - inches	4.03	4.01		
AT TEST				
Final Moisture - %	27.1	24.9		
Dry Density - pcf	105.5	105.0		
Calculated Diameter (in.)	2.08	2.04		
Height - inches	4.16	4.00		
Effect. Cell Pressure - psi	10.0	40.0		
Failure Stress - psi	14.76	38.10		
Total Pore Pressure - psi	64.3	83.6		
Strain Rate - inches/min.	0.00050	0.00050		
Failure Strain - %	0.9	3.8		
σ_1' Failure - psi	20.46	54.74		
σ_3' Failure - psi	5.70	16.64		

TEST DESCRIPTION

TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: Undistrubed Shelby Tube, Trimmed
DESCRIPTION: Dark Brown Fat Clay, (CH)
SAMPLE LOCATION: B-6 53'-55'
ASSUMED SPECIFIC GRAVITY: 2.67
LL: NT PL: NT PI: NT Percent -200: NT
REMARKS: Calculated at peak Sigma1' - Sigma3'

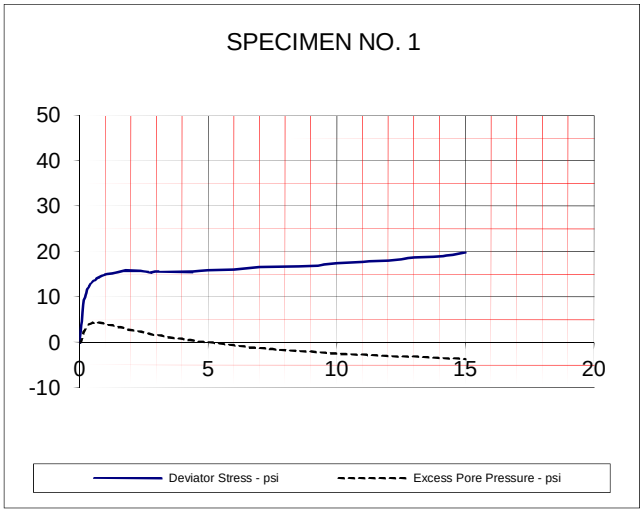
PROJECT INFORMATION

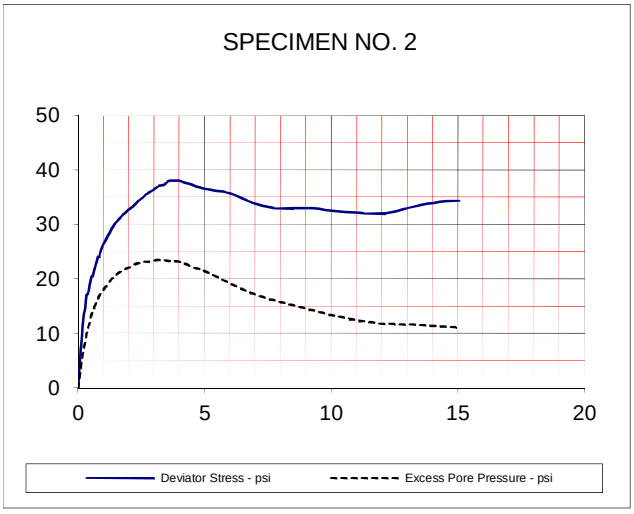
PROJECT:Phase1 Ash Strorage Area Embankment Investigation
LOCATION: Cason, Texas
PROJECT NO: G 4207-146
CLIENT: AEP, Welsh Power Plant
DATE: 12/4/12

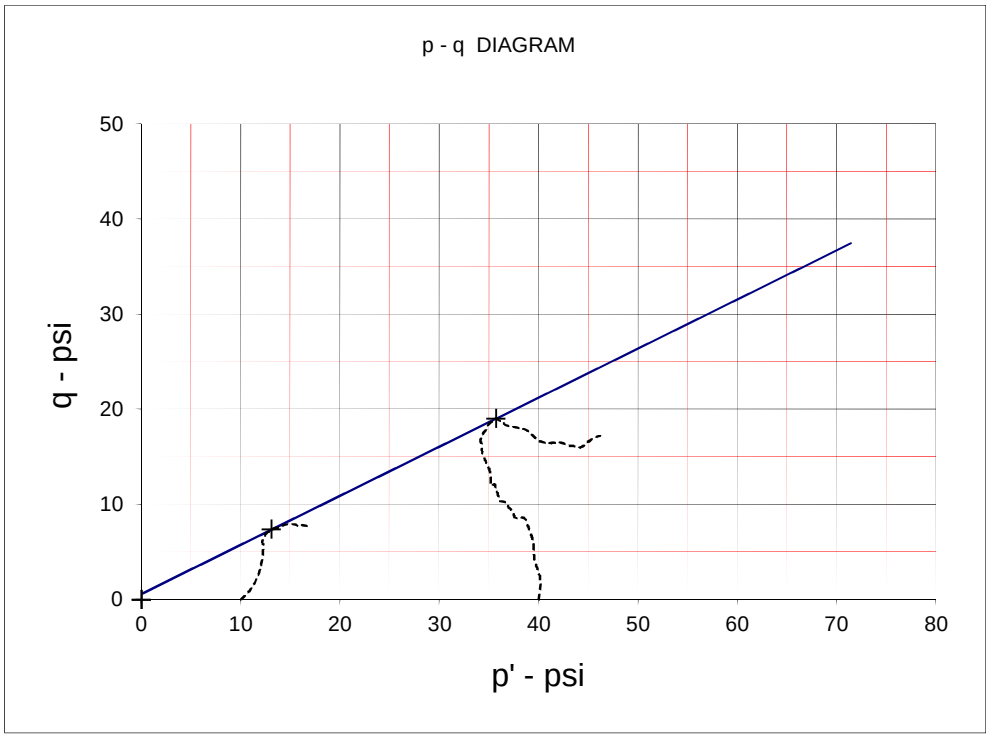
ETTL Engineers & Consultants

PLATE: B-CD.1

C.U. B-9 53'-55', Native lower Clay, GG Program, 2 point



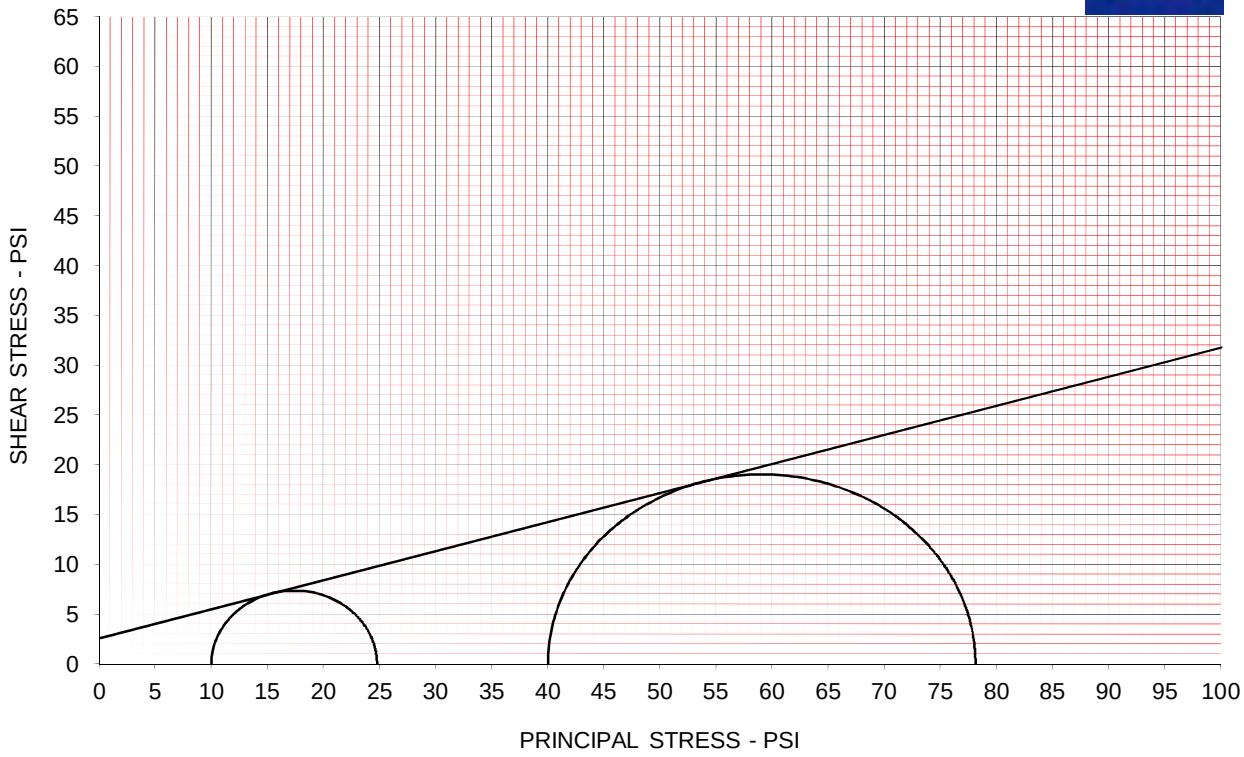




EFFECTIVE STRESS PARAMETERS	R^2 = 1.000	α (deg) = 27.3	a (psi) = 0.6
PROJECT:Phase1 Ash Strorage Area Embankment Investigation		TYPE OF TEST & NO: CD Triaxial - CD-1	
PROJECT NO: G 4207-146		***ETTL Engineers & Consultants***	PLATE: B-CD.2
DESCRIPTION: Dark Brown Fat Clay, (CH)			

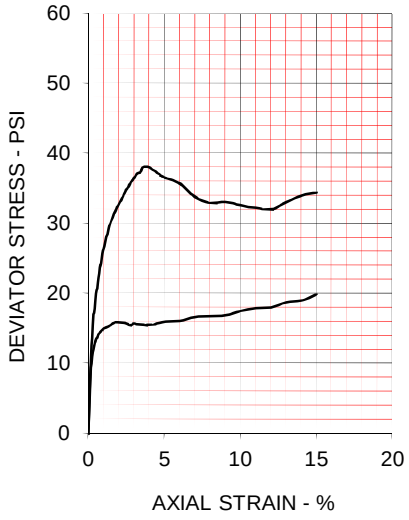
C.U. B-9 53'-55', Native lower Clay, GG Program, 2 point

ASTM D4767 - CU TRIAXIAL SHEAR TEST REPORT



GREGORY GEOTECHNICAL SOFTWARE

TOTAL STRESS PARAMETERS	ϕ = 16.3 deg	c = 2.6 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	21.8	23.5		
Dry Density - pcf	105.4	100.2		
Diameter - inches	2.03	2.04		
Height - inches	4.03	4.01		
AT TEST				
Final Moisture - %	27.1	24.9		
Dry Density - pcf	105.5	105.0		
Calculated Diameter (in.)	2.08	2.04		
Height - inches	4.16	4.00		
Effect. Cell Pressure - psi	10.0	40.0		
Failure Stress - psi	14.76	38.10		
Total Pore Pressure - psi	64.3	83.6		
Strain Rate - inches/min.	0.00050	0.00050		
Failure Strain - %	0.9	3.8		
σ_1 Failure - psi	24.76	78.10		
σ_3 Failure - psi	10.00	40.00		

TEST DESCRIPTION

TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: Undistrubed Shelby Tube, Trimmed
DESCRIPTION: Dark Brown Fat Clay, (CH)
SAMPLE LOCATION: B-6 53'-55'
ASSUMED SPECIFIC GRAVITY: 2.67
LL: NT PL: NT PI: NT Percent -200: NT
REMARKS: Calculated at peak Sigma1' - Sigma3'

PROJECT INFORMATION

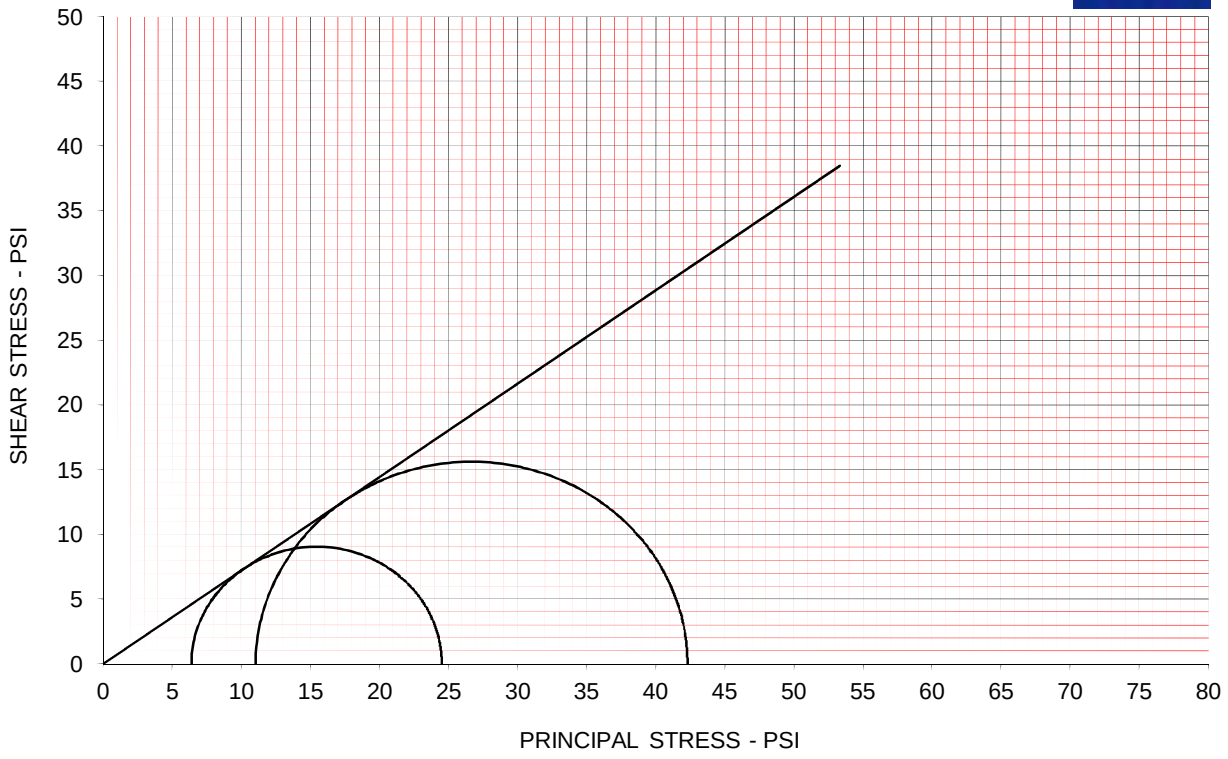
PROJECT:Phase1 Ash Strorage Area Embankment Investigation
LOCATION: Cason, Texas
PROJECT NO: G 4207-146
CLIENT: AEP, Welsh Power Plant
DATE: 12/4/12

ETTL Engineers & Consultants

PLATE: B-CD.3

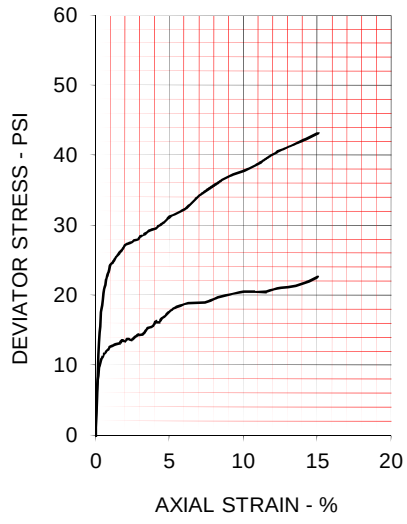
C.U. B-9 53'-55', Native lower Clay, GG Program, 2 point

ASTM D4767 - CU TRIAXIAL SHEAR TEST REPORT



GREGORY GEOTECHNICAL SOFTWARE

EFFECTIVE STRESS PARAMETERS	ϕ ' = 35.8 deg	c' = 0.0 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	16.8	16.6		
Dry Density - pcf	108.5	111.3		
Diameter - inches	1.40	1.40		
Height - inches	2.93	2.87		
AT TEST				
Final Moisture - %	19.4	18.4		
Dry Density - pcf	109.1	112.4		
Calculated Diameter (in.)	1.39	1.39		
Height - inches	2.91	2.84		
Effect. Cell Pressure - psi	10.0	19.9		
Failure Stress - psi	18.12	31.25		
Total Pore Pressure - psi	63.7	68.9		
Strain Rate - inches/min.	0.00050	0.00050		
Failure Strain - %	5.3	5.0		
σ_1' Failure - psi	24.49	42.27		
σ_3' Failure - psi	6.37	11.02		

TEST DESCRIPTION

TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: Remolded to 95% of Max Density by the MDI
DESCRIPTION: Redd. Br. & Lt. Br. Sandy Lean Clay, (CL)
SAMPLE LOCATION: Sample #1, Remolded Sandy Lean Clay
ASSUMED SPECIFIC GRAVITY: 2.67
LL: 29 PL: 18 PI: 11 Percent -200: 62.6
REMARKS: Calculated at a stain of 5%, 40 psi point left out

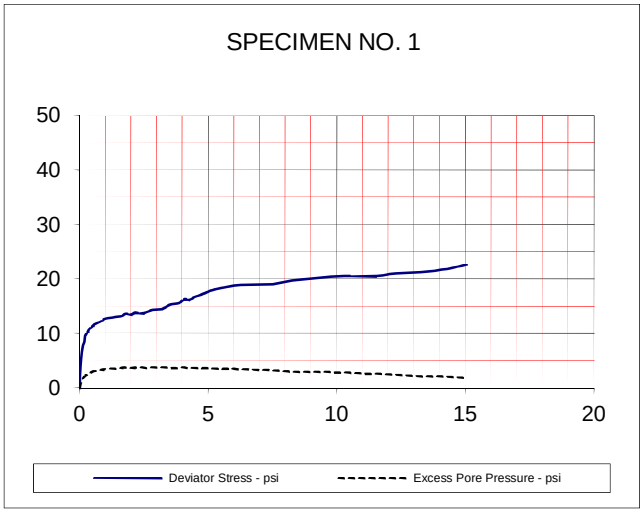
PROJECT INFORMATION

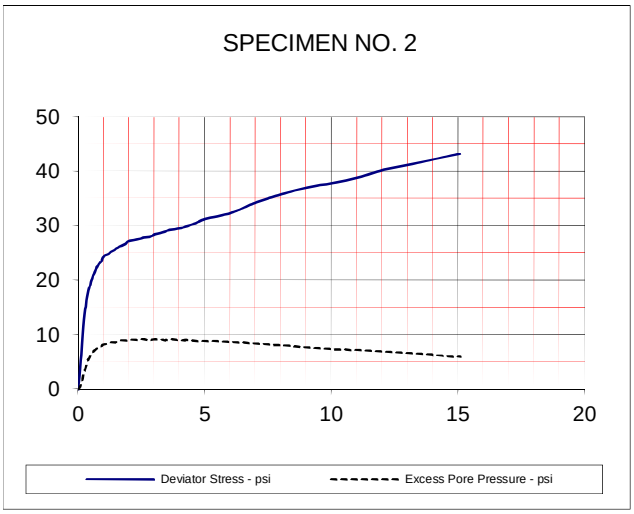
PROJECT:Phase1 Ash Strorage Area Embankment Investigation
LOCATION: Cason, Texas
PROJECT NO: G 4207-146
CLIENT: AEP, Welsh Power Plant
DATE: 12/23/12

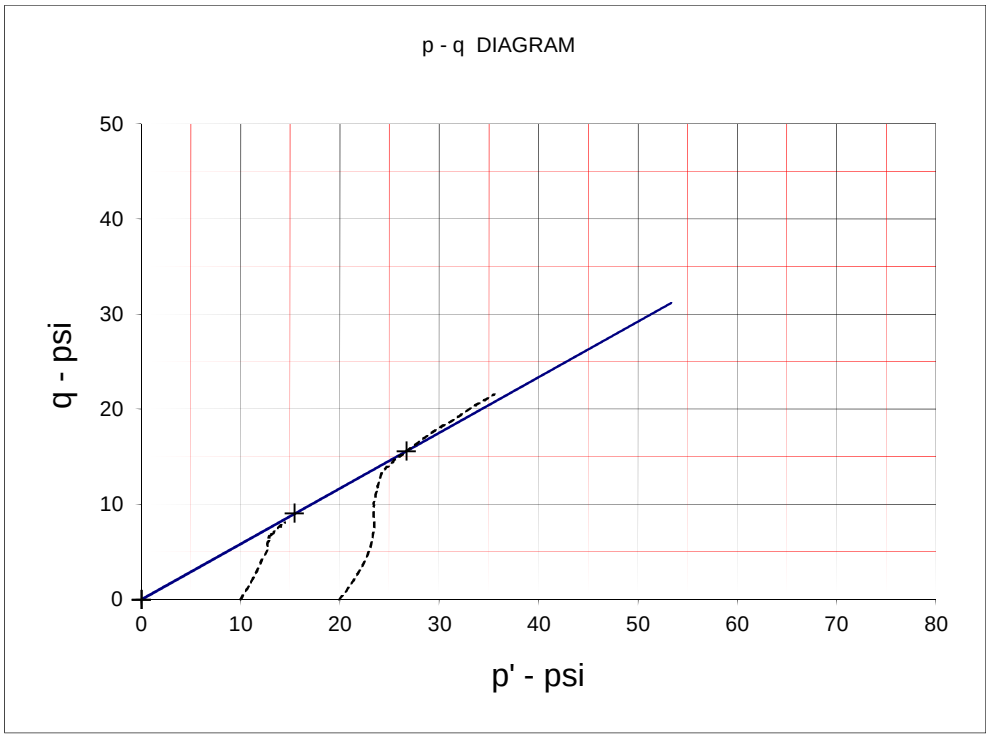
ETTL Engineers & Consultants

PLATE: B-CD.1

C.U. Remolded Native Sandy Lean Clay, GG Program, 2 point 10 & 20 psi



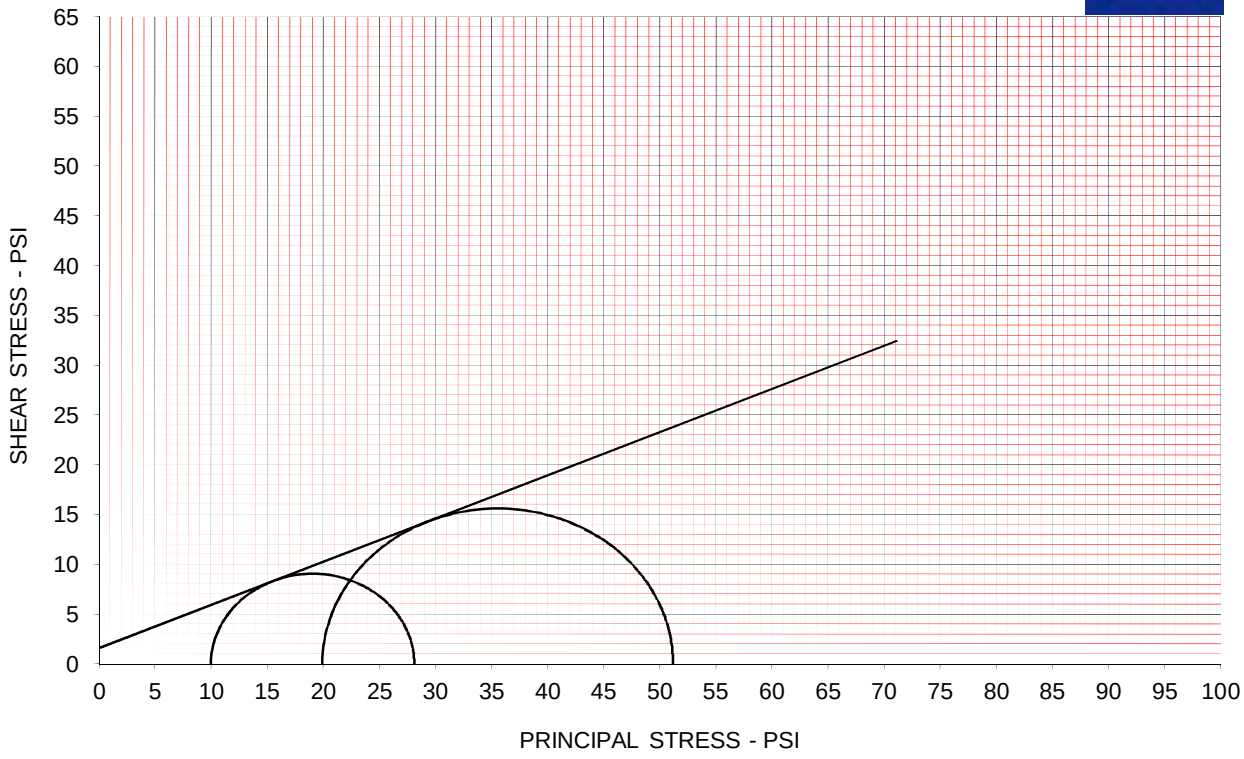




EFFECTIVE STRESS PARAMETERS	R^2 = 1.000	α (deg) = 30.3	a (psi) = 0.0
PROJECT:Phase1 Ash Strorage Area Embankment Investigation		TYPE OF TEST & NO: CD Triaxial - CD-1	
PROJECT NO: G 4207-146		***ETTL Engineers & Consultants***	PLATE: B-CD.2
DESCRIPTION: Redd. Br. & Lt. Br. Sandy Lean Clay, (CL)			

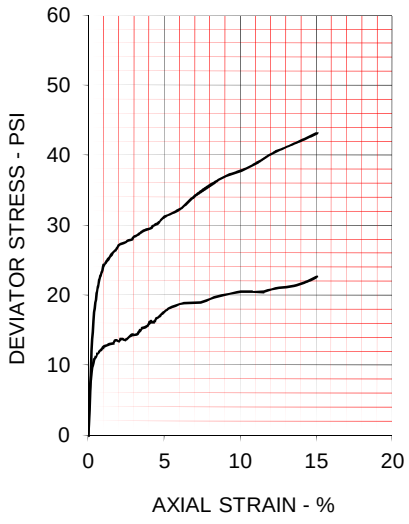
C.U. Remolded Native Sandy Lean Clay, GG Program, 2 point 10 & 20 psi

ASTM D4767 - CU TRIAXIAL SHEAR TEST REPORT



GREGORY GEOTECHNICAL SOFTWARE

TOTAL STRESS PARAMETERS	ϕ = 23.5 deg	c = 1.6 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	16.8	16.6		
Dry Density - pcf	108.5	111.3		
Diameter - inches	1.40	1.40		
Height - inches	2.93	2.87		
AT TEST				
Final Moisture - %	19.4	18.4		
Dry Density - pcf	109.1	112.4		
Calculated Diameter (in.)	1.39	1.39		
Height - inches	2.91	2.84		
Effect. Cell Pressure - psi	10.0	19.9		
Failure Stress - psi	18.12	31.25		
Total Pore Pressure - psi	63.7	68.9		
Strain Rate - inches/min.	0.00050	0.00050		
Failure Strain - %	5.3	5.0		
σ_1 Failure - psi	28.08	51.14		
σ_3 Failure - psi	9.96	19.89		

TEST DESCRIPTION

TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: Remolded to 95% of Max Density by the MDI
DESCRIPTION: Redd. Br. & Lt. Br. Sandy Lean Clay, (CL)
SAMPLE LOCATION: Sample #1, Remolded Sandy Lean Clay
ASSUMED SPECIFIC GRAVITY: 2.67
LL: 29 PL: 18 PI: 11 Percent -200: 62.6
REMARKS: Calculated at a stain of 5%, 40 psi point left out

PROJECT INFORMATION

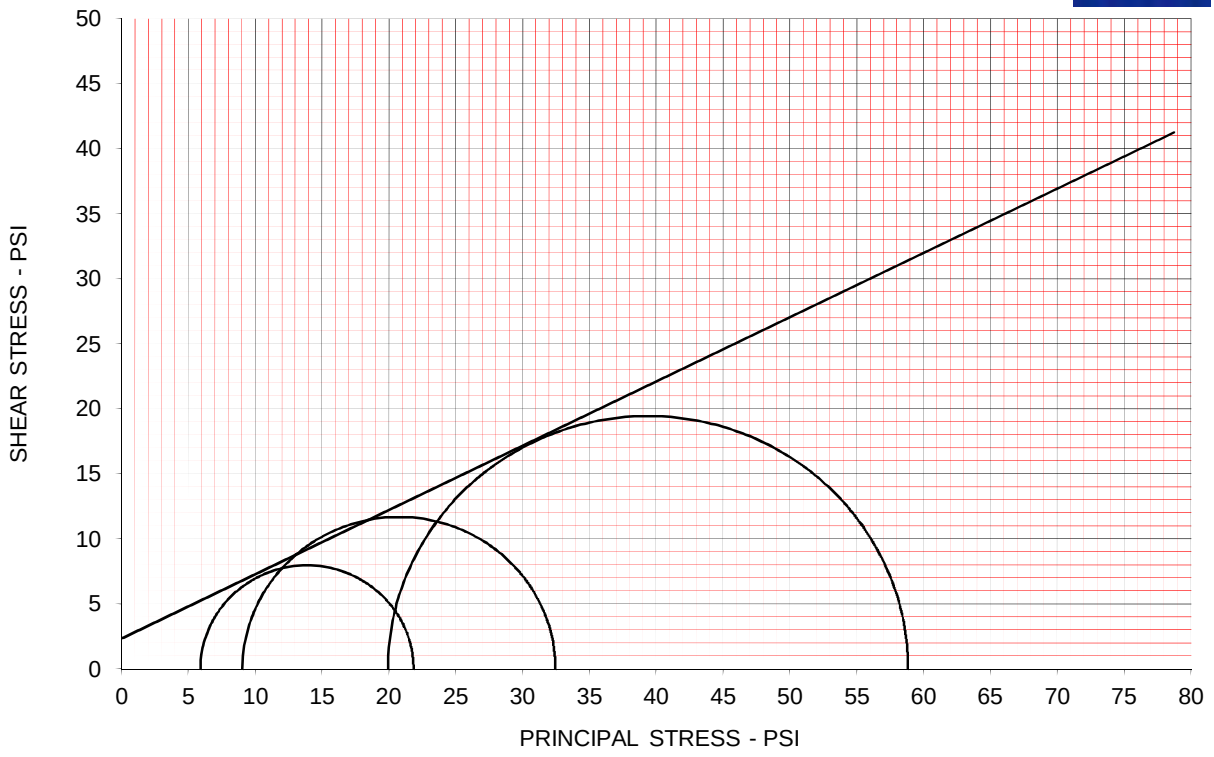
PROJECT:Phase1 Ash Strorage Area Embankment Investigation
LOCATION: Cason, Texas
PROJECT NO: G 4207-146
CLIENT: AEP, Welsh Power Plant
DATE: 12/23/12

ETTL Engineers & Consultants

PLATE: B-CD.3

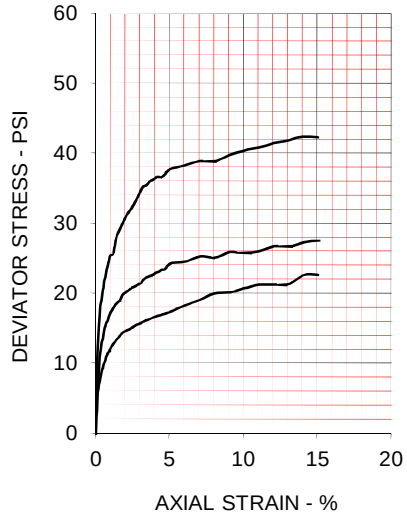
C.U. Remolded Native Sandy Lean Clay, GG Program, 2 point 10 & 20 psi

ASTM D4767 - CU TRIAXIAL SHEAR TEST REPORT



GREGORY GEOTECHNICAL SOFTWARE

EFFECTIVE STRESS PARAMETERS	ϕ ' = 26.3 deg	c' = 2.4 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	23.7	23.7	23.4	
Dry Density - pcf	96.2	96.5	95.8	
Diameter - inches	1.40	1.39	1.39	
Height - inches	2.96	2.80	2.80	
AT TEST				
Final Moisture - %	28.4	26.1	27.8	
Dry Density - pcf	97.3	101.7	98.9	
Calculated Diameter (in.)	1.40	1.37	1.39	
Height - inches	2.98	2.75	2.80	
Effect. Cell Pressure - psi	9.9	20.0	39.9	
Failure Stress - psi	15.94	23.40	38.91	
Total Pore Pressure - psi	64.1	71.0	80.0	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	3.2	4.5	7.0	
σ_1' Failure - psi	21.82	32.43	58.81	
σ_3' Failure - psi	5.88	9.03	19.90	

TEST DESCRIPTION

TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: Remolded to 95% of Max Density by the MDI
DESCRIPTION: Rdsh Brown & Light Gray Fat Clay with sand, (CH)
SAMPLE LOCATION: Sample #2, Remolded Fat Clay
ASSUMED SPECIFIC GRAVITY: 2.67
LL: 62 PL: 20 PI: 42 Percent -200: 78
REMARKS:

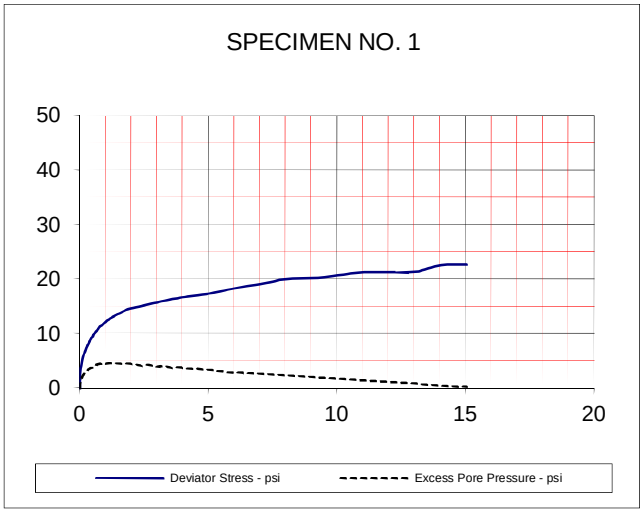
PROJECT INFORMATION

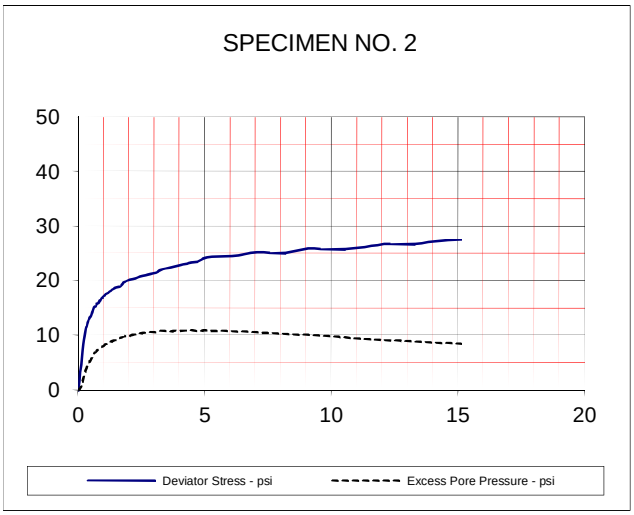
PROJECT:Phase1 Ash Strorage Area Embankment Investigation
LOCATION: Cason, Texas
PROJECT NO: G 4207-146
CLIENT: AEP, Welsh Power Plant
DATE: 12/23/12

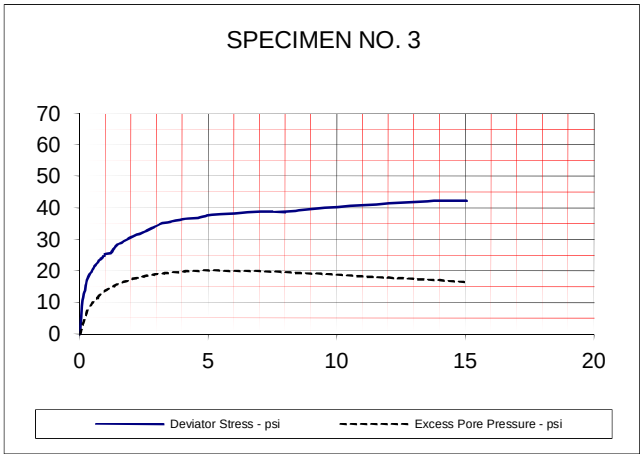
ETTL Engineers & Consultants

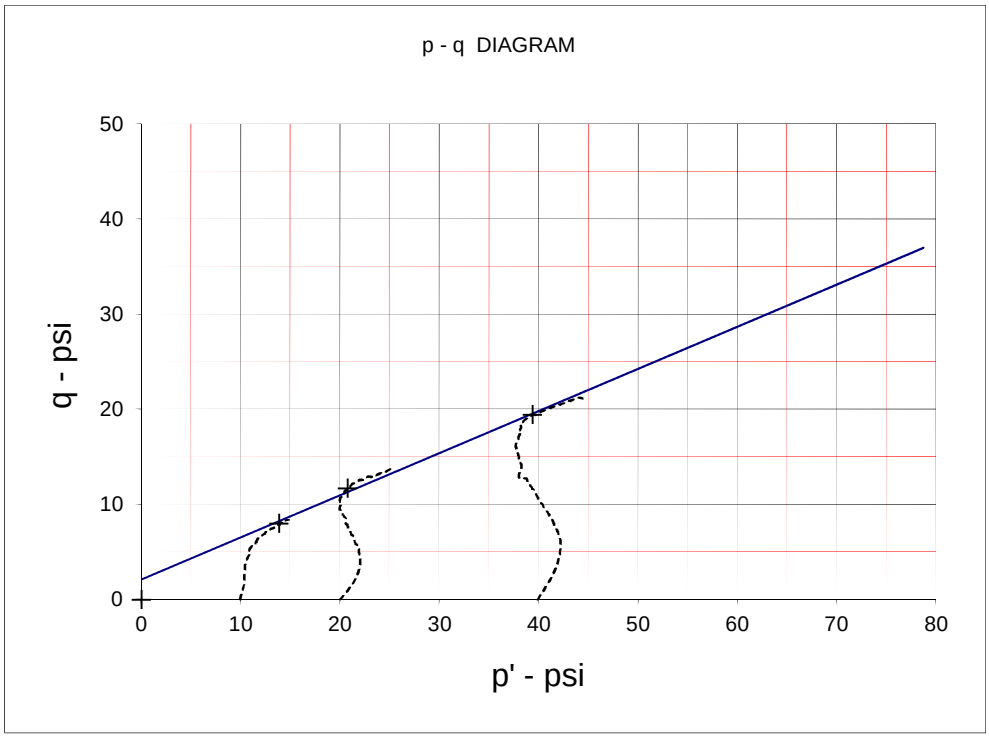
PLATE: B-CD.1

C.U. Remolded Native Fat Clay, GG Program





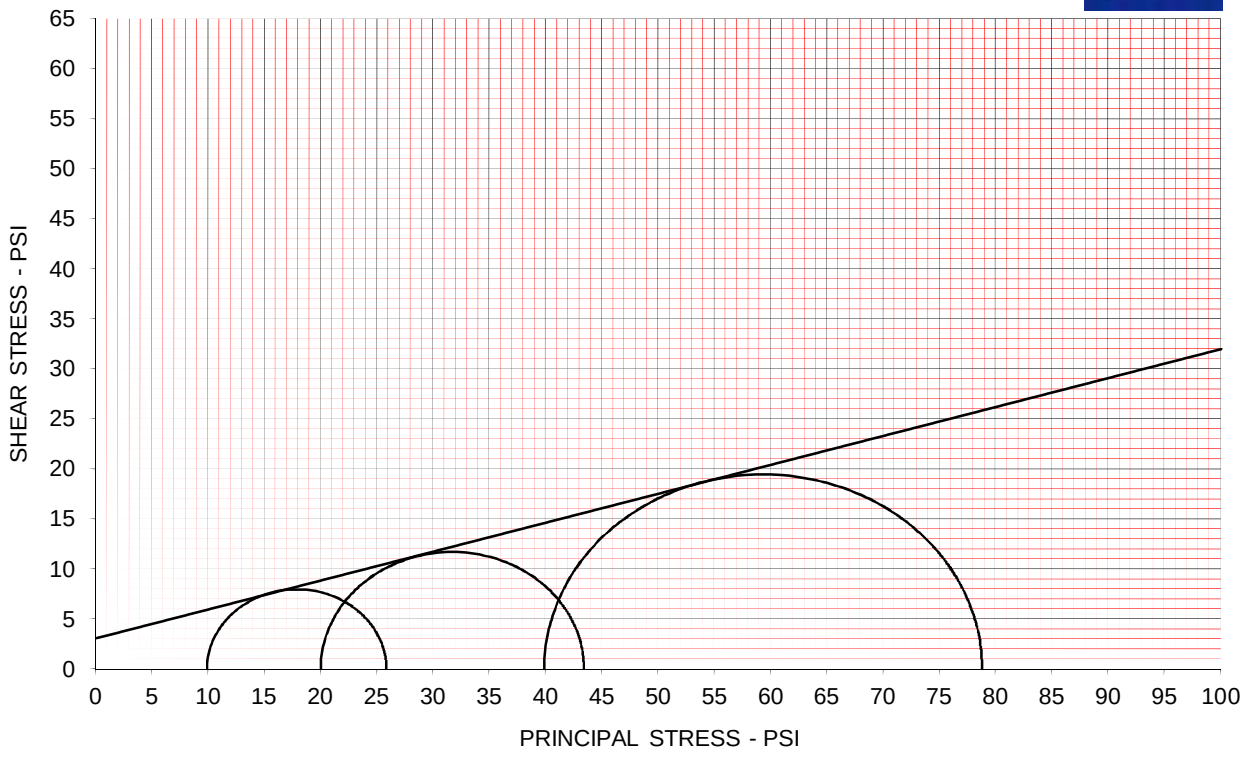




EFFECTIVE STRESS PARAMETERS	R^2 = 0.996	α (deg) = 23.9	a (psi) = 2.1
PROJECT:Phase1 Ash Strorage Area Embankment Investigation		TYPE OF TEST & NO: CD Triaxial - CD-1	
PROJECT NO: G 4207-146		***ETTL Engineers & Consultants***	PLATE: B-CD.2
DESCRIPTION: Rdsh Brown & Light Gray Fat Clay with sand, (CH)			

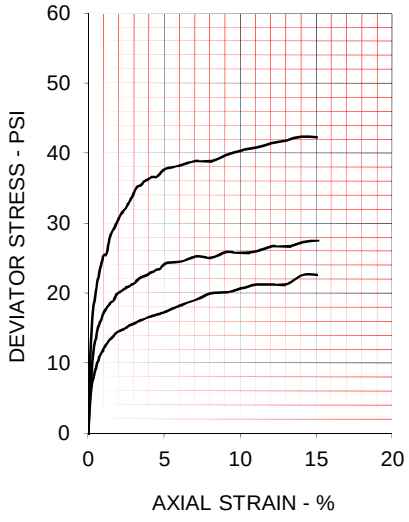
C.U. Remolded Native Fat Clay, GG Program

ASTM D4767 - CU TRIAXIAL SHEAR TEST REPORT



GREGORY GEOTECHNICAL SOFTWARE

TOTAL STRESS PARAMETERS	ϕ = 16.1 deg	c = 3.1 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	23.7	23.7	23.4	
Dry Density - pcf	96.2	96.5	95.8	
Diameter - inches	1.40	1.39	1.39	
Height - inches	2.96	2.80	2.80	
AT TEST				
Final Moisture - %	28.4	26.1	27.8	
Dry Density - pcf	97.3	101.7	98.9	
Calculated Diameter (in.)	1.40	1.37	1.39	
Height - inches	2.98	2.75	2.80	
Effect. Cell Pressure - psi	9.9	20.0	39.9	
Failure Stress - psi	15.94	23.40	38.91	
Total Pore Pressure - psi	64.1	71.0	80.0	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	3.2	4.5	7.0	
σ_1 Failure - psi	25.84	43.40	78.78	
σ_3 Failure - psi	9.90	20.00	39.87	

TEST DESCRIPTION

TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: Remolded to 95% of Max Density by the MDI
DESCRIPTION: Rdsh Brown & Light Gray Fat Clay with sand, (CH)
SAMPLE LOCATION: Sample #2, Remolded Fat Clay
ASSUMED SPECIFIC GRAVITY: 2.67
LL: 62 PL: 20 PI: 42 Percent -200: 78
REMARKS:

PROJECT INFORMATION

PROJECT:Phase1 Ash Strorage Area Embankment Investigation
LOCATION: Cason, Texas
PROJECT NO: G 4207-146
CLIENT: AEP, Welsh Power Plant
DATE: 12/23/12

ETTL Engineers & Consultants

PLATE: B-CD.3

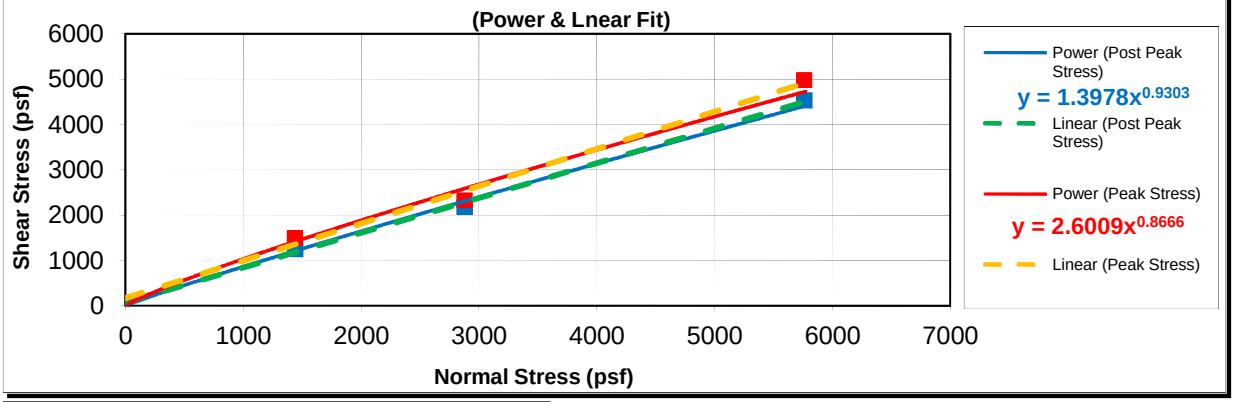
C.U. Remolded Native Fat Clay, GG Program

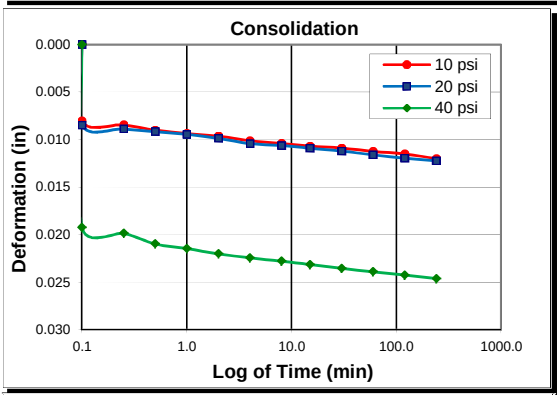
Consolidated Drained Direct Shear

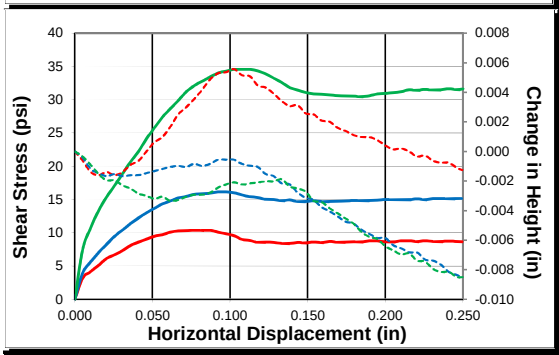
ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

ASTM D 3080 Direct Shear Test Report







	Linear Strength Parameters			
	Post Peak		Peak	
Friction Angle	37.6 (deg)		39.4 (deg)	
Cohesion	0.5 (psi)	72.0 (psf)	1.2 (psi)	170.6 (psf)

Specimen Number	1	2	3
Initial Sample Data			
Moisture Content-(%):	32.4%	33.0%	32.5%
Dry Density-(lb/ft^3):	81.7	81.3	81.6
Degree of Saturation-(%):	89.4%	89.9%	89.6%
Height-(in):	0.996	0.996	0.996
Diameter-(in):	2.50	2.50	2.50
Before Shear Test Data			
Moisture Content-(%):	34.2%	34.0%	33.9%
Dry Density-(lb/ft^3):	82.7	82.3	83.7
Degree of Saturation-(%):	98.3%	95.1%	98.3%
Height after consolidation-(in):	0.985	0.985	0.972
Height after shear-(in):	0.984	0.984	0.971
Normal Stress-(psf):	**1440**	**2880**	**5760**
Post Peak Failure Stress-(psf):	**1249**	**2180**	**4535**
Peak Failure Stress-(psf):	**1498**	**2326**	**4980**
Strain Rate-(in/min):	0.0005	0.0005	0.0005

Project Information

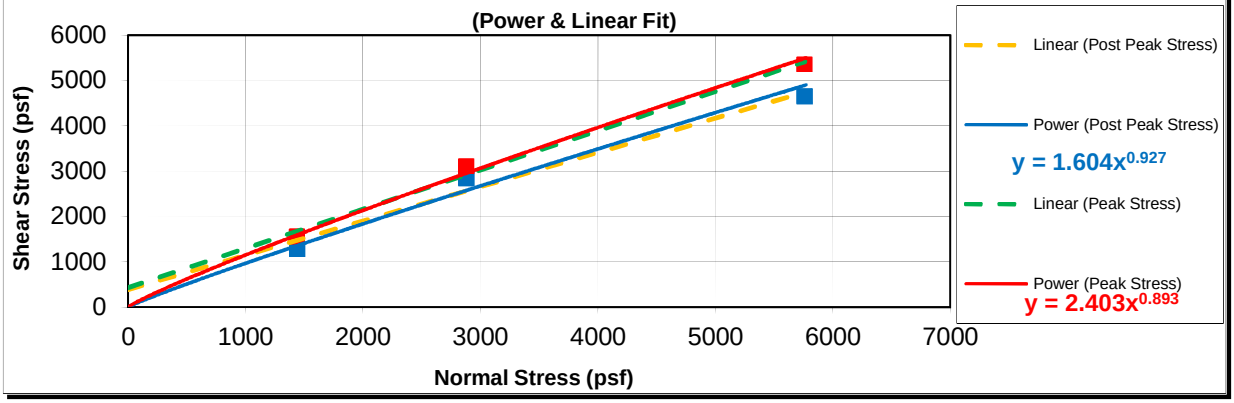
				LL	PL	PI
Project :	Phase 1 Ash Storage Area Embankment Investigation			N/P	N/P	N/P
Client:	AEP, Welch Power Plant					
Project Location:	Cason, Texas			-200%	25	
Material Description:	Dark Grayish Brown Silty Sand, (SM), Economizer Ash					
ETTL Job #:	G 4207-146	**Technician:**	Owen Sanderson	**Remarks**		
Boring;	B-3	**Sample Type:**	Composite SPT			
Depth (ft):	3'-10'	**Molding Method:**	Loosely Compacted in Ring	Particles larger than the No. Sieve removed before remolding.		
Test Date:	December 1, 2014	**Testing Device:**	Humboldt #1			

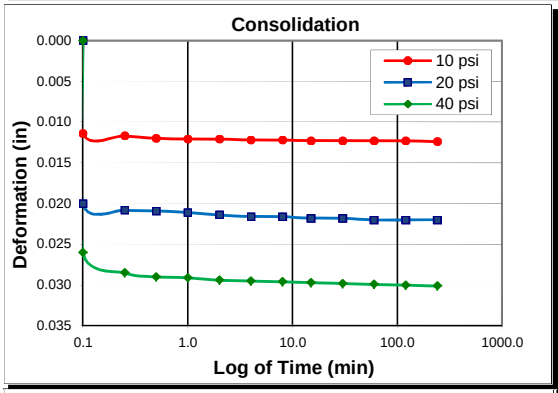
Main Office: 1717 East Erwin Street Tyler, Texas 75702 Phone: 903-595-4421 Fax: 903-595-6113
Longview Branch: 707 West Cotton Street Longview, TX 75604-5505 Phone: 903-758-0915 Fax: 903-758-8245
Texarkana Branch: 210 Beech Street Texarkana, Arkansas 71854 Phone: 870-772-0013 Fax: 870-216-2413
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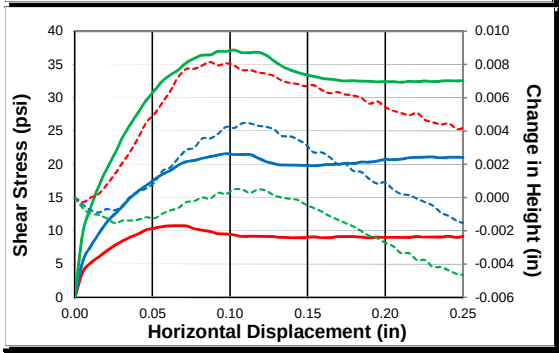
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GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

ASTM D 3080 Direct Shear Test Report







	Linear Strength Parameters			
	Post Peak		Peak	
Friction Angle	37.1 (deg)		40.9 (deg)	
Cohesion	2.68 (psi)	386 (psf)	2.99 (psi)	431 (psf)

Specimen Number	1	2	3
Initial Sample Data			
Moisture Content-(%):	43.7%	42.1%	41.7%
Dry Density-(lb/ft^3):	76.4	77.3	78.2
Degree of Saturation-(%):	100.0%	100.0%	100.0%
Height-(in):	0.989	0.989	0.989
Diameter-(in):	2.50	2.50	2.50
Final Sample Data			
Moisture Content-(%):	41.0%	39.6%	38.4%
Dry Density-(lb/ft^3):	77.0	79.2	81.1
Degree of Saturation-(%):	100.0%	100.0%	100.0%
Height after consolidation-(in):	0.976	0.967	0.959
Height after shear-(in):	0.981	0.965	0.954
Normal Stress-(psf):	**1440**	**2880**	**5760**
Post Peak Failure Stress-(psf):	**1287**	**2848**	**4651**
Peak Failure Stress-(psf):	**1551**	**3110**	**5350**
Strain Rate-(in/min):	0.0003	0.0003	0.0003

Project Information

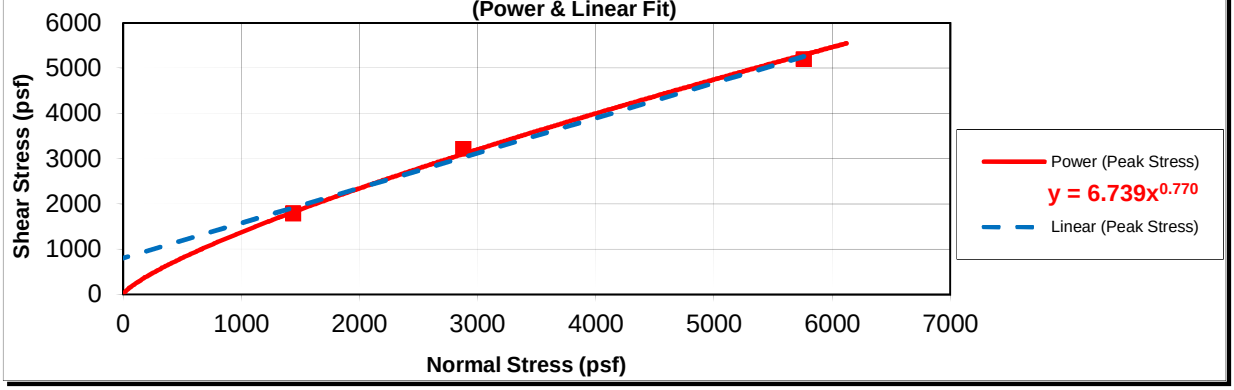
				LL	PL	PI
Project :	Phase 1 Ash Storage Area Embankment Investigation			57	52	5
Client:	AEP, Welch Power Plant					
Project Location:	Cason, Texas			-200%	67	
Material Description:	Lt. Brownish Gray Sandy Elastic Silt, (MH), Fly Ash					
ETTL Job #:	G 4207-146	**Technician:**	Owen Sanderson	**Remarks**		
Boring;	B-2 / B-11	**Sample Type:**	Composite SPT	Particles larger than the No. 10 sieve removed before molding. Sample was lightly cemented		
Depth (ft):	1'-3' / 8'-10'	**Molding Method:**	Loosely Compacted in Ring			
Test Date:	December 8, 2014	**Testing Device:**	Humboldt #1			

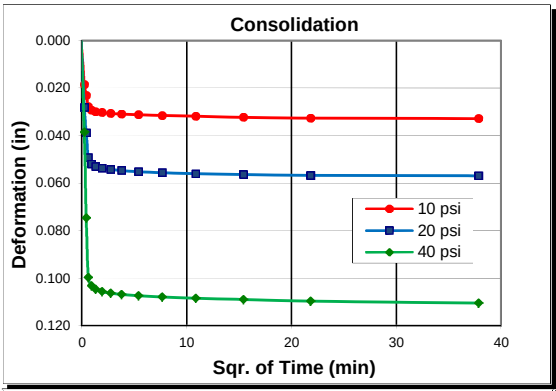
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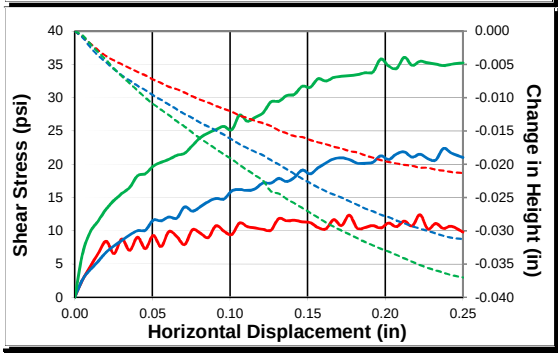
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ASTM D 3080 Direct Shear Test Report







	Linear Strength Parameters			
	Post Peak		Peak	
Friction Angle	-		37.7	
	(deg)		(deg)	
Cohesion			5.56	801
		(psf)		(psf)

Specimen Number	1	2	3
Initial Sample Data			
Moisture Content-(%):	111.9%	108.9%	112.5%
Dry Density-(lb/ft^3):	40.8	41.7	40.7
Degree of Saturation-(%):	100.0%	100.0%	100.0%
Height-(in):	0.970	0.970	0.970
Diameter-(in):	2.50	2.50	2.50
Final Sample Data			
Moisture Content-(%):	104.4%	98.5%	93.7%
Dry Density-(lb/ft^3):	43.2	45.9	47.9
Degree of Saturation-(%):	100.0%	100.0%	100.0%
Height after consolidation-(in):	0.937	0.937	0.860
Height after shear-(in):	0.916	0.906	0.823
Normal Stress-(psf):	**1440**	**2880**	**5760**
Normal Stress-(psi):			
Peak Failure Stress-(psf):	**1787**	**3224**	**5195**
Strain Rate-(in/min):	0.0001	0.0001	0.0001

Project Information

				LL	PL	PI
Project :	Phase 1 Ash Storage Area Embankment Investigation			**100**	**81**	**19**
Client:	AEP, Welch Power Plant					
Project Location:	Cason, Texas			**-200%**	**100**	
Material Description:	Black Elastic Silt, (MH), Bottom Ash					
ETTL Job #:	G 4207-146	**Technician:**	Owen Sanderson	**Remarks**		
Boring;	B-6	**Sample Type:**	Composite SPT, Remolded			
Depth (ft):	13'-20'	**Molding Method:**	Pre-Consolidated to 9 psi			
Test Date:	December 6, 2014	**Testing Device:**	Humboldt #2			

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Grain Size Analysis by Hydrometer

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

Project	Phase 1 Ash Storage Embankment Investigaiton	**Material Origin:**	Geotechnical Boring
Client:	AEP, Welsh Power Plant	**Date Sampled:**	10/7/2014
Job Location:	Cason,Texas	**Sampled By:**	ETTL Drilling Department
ETTL Job No.:	G 4207-146	**Sample Info. Provided By:**	Owen Sanderson, ETTL
Boring / Sample Location:	B-1	**Testing Technician:**	Hermann Walka, P.E.
Sample No.:	composite **Depth (ft.):** 3'-10'	**Test Starting Date:**	12/15/2014
DESCRIPTION:	Dark Brown Silty Sand, (SM) Econamzer Ash	**Test Finishing Date:**	12/17/2014

Starting Masses and Sample Preparation	
Shape of Particles:	Angular
Hardness of Particles:	Soft
Dispersion Device:	Device A
Dispersion Time:	1 minute
Dispersion Agent:	125 mL of a 4% solution of Na -Hex.
Soaking Time:	16 hours
Hydrometer Type:	152H
Starting Mass of Air Dry (whole) sample (g):	173.10
Starting Mass of Oven Dry (whole) sample (g):	165.53
Mass of Air Dry (hydro) Sample (g):	75.00
Mass of Oven Dry (hydro) Sample (g):	71.72
Percent Retained on No. 10 Sieve:	0.00
Specific Gravity:	2.710

D 10 (mm)=	0.0210
D 15 (mm)=	0.0381
D 30 (mm)=	0.0840
D 50 (mm)=	0.2288
D 60 (mm)=	0.3370
D 85 (mm)=	1.007
Cu =	16
Cc =	1

Hydroscopic M.C. of Hydrometer	
Tare Mass (g):	29.92
Tare + Wet Mass (g):	39.98
Tare + Dry Mass (g):	39.54
M.C.%	4.57%

Sieve No.	Mass Retained (g)	%Retained	Grain Dia. (mm)	%Passing
Mechanical Sieve Analysis of Material Retaining on No. 10				
2"	0.00	0.0	50.0	100.0
1"	0.00	0.0	25.0	100.0
3/4"	0.00	0.0	19.0	100.0
3/8"	0.00	0.0	9.50	100.0
No 4	0.00	0.0	4.75	100.0
No 10	0.00	0.0	2.00	100.0
Mechanical Sieve Analysis of Material Retaining on No. 200				
40	24.30	33.9	0.425	66.1
60	34.34	47.9	0.250	52.1
100	43.12	60.1	0.150	39.9
140	43.18	60.2	0.106	39.8
200	53.64	74.8	0.075	25.2

Hydrometer Analysis of Material Passing No. 10 Sieve

Temperature Deg. (C)	Hydrometer Correction	Hydrometer Reading	Corrected Reading	(L)-Hydrometer Factor	(K)-Dia. Factor	(a)-SP.GR. Factor	Time (min)	Grain Dia. (mm)	% Soil Passing
22.0	5.1	21.0	15.9	13.8	0.01308	0.99	0.5	0.0687	22.0
22.0	5.1	17.5	12.4	14.3	0.01308	0.99	1	0.0495	17.2
22.0	5.1	15.5	10.4	14.7	0.01308	0.99	2	0.0355	14.4
22.0	5.1	12.5	7.4	15.2	0.01308	0.99	5	0.0228	10.3
22.0	5.1	11.2	6.1	15.3	0.01308	0.99	15	0.0132	8.5
21.8	5.1	10.0	4.9	15.6	0.01308	0.99	30	0.0094	6.7
21.2	5.3	8.9	3.6	15.8	0.01324	0.99	60	0.0068	4.9
22.0	5.1	7.6	2.5	16.0	0.01308	0.99	120	0.0048	3.5
20.5	5.6	6.0	0.4	16.3	0.01324	0.99	250	0.0034	0.6
21.0	5.4	5.5	0.1	16.3	0.01324	0.99	1440	0.0014	0.1

Measured Specific Gravity of Material Passing No. 10 Sieve, ASTM D 854 Method A

Air Dry M_S (grams)	Bottle #	T_t (deg. C)	M_P (grams)	V_P (mL)	$\rho_{w,t}$ (g/mL)	Oven Dry M_S (grams)	$M_{pw,t}$ (grams)	$M_{pws,t}$ (grams)	SG_t
75.00	12	21.20	162.44	499.09	0.9980	71.72	660.51	705.76	**2.710**

Per ASTM		
% Gravel =	**0.0**	**Gravel** > 4.75 (mm)
% Sand =	**74.8**	4.75 (mm) < **SAND** > .075 (mm)
% Silt =	**24.9**	.075 (mm) < **SILT** > .002 (mm)
%Clay =	**0.3**	**CLAY** < .002 (mm)

Atterberg Limits		
L.L.	P.L.	P.I.
N/P	N/P	N/P

*N/P = Non-Plastic

Note:
Particles larger than the No. 10 sieve removed before conducting test.

Estimated Hydraulic Conductivity by Beyer's equation: $K = C*(d_{10})^{\angle}$ (meters / sec)

$U = (d_{60} / d_{10}) = 16.1$

$C = (4.50E\text{-}3)\log(500 / U) = 6.72E\text{-}03$

$d_{10}^{\angle}$ (mm) = 4.40E-04

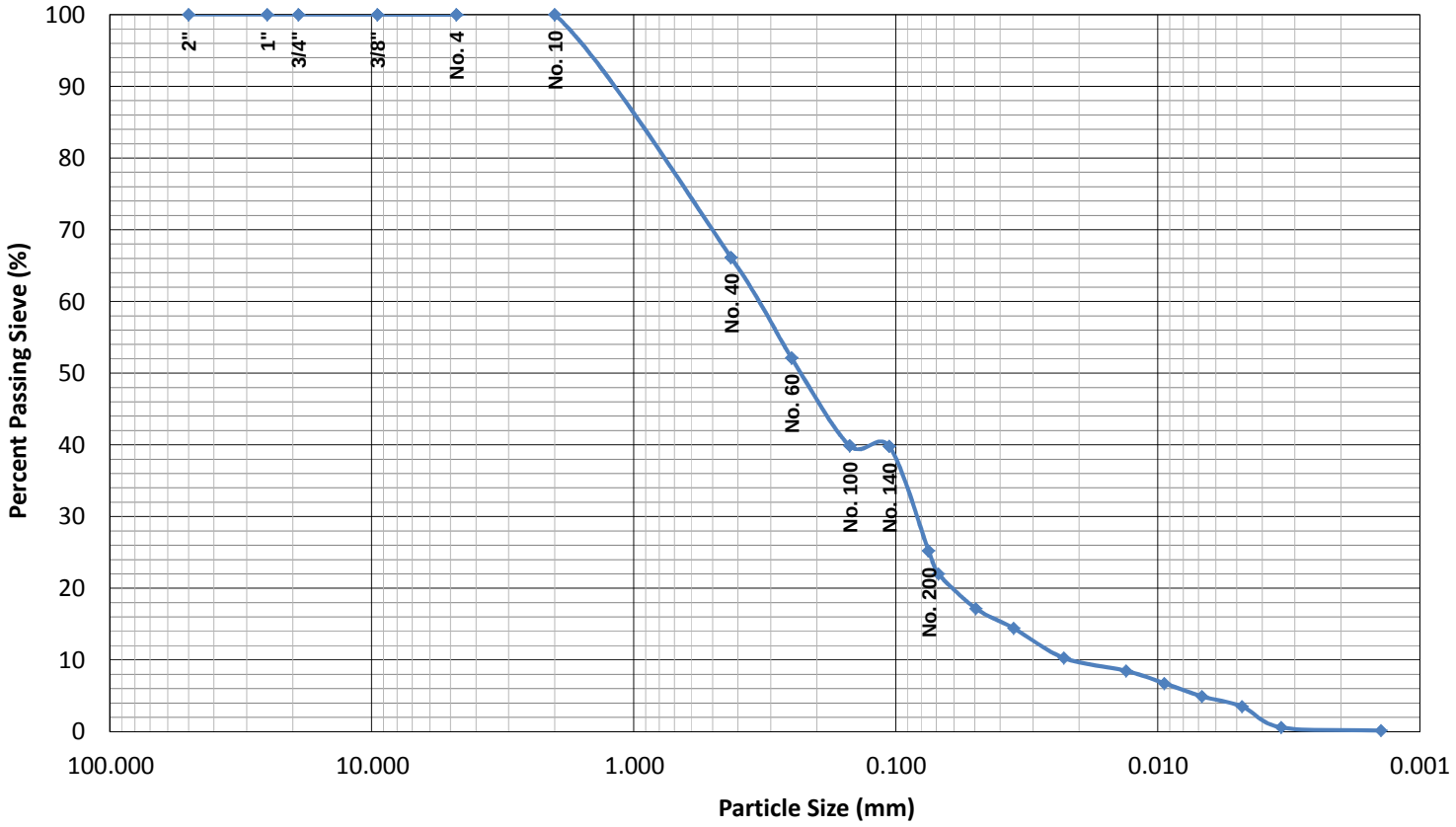
K (cm/sec) = 2.95E-04

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ASTM D 422, Particle Size Distribution Curve By Hydrometer



Sieve No.	Dia. (mm)	% Finer
2"	50.0	100.0
1"	25.0	100.0
3/4"	19.0	100.0
3/8"	9.50	100.0
No. 4	4.75	100.0
No. 10	2.00	100.0
No. 40	0.425	66.1
No. 60	0.250	52.1
No. 100	0.150	39.9
No. 140	0.106	39.8
No. 200	0.075	25.2
Hydrometer Analysis	0.0687	22.0
	0.0495	17.2
	0.0355	14.4
	0.0228	10.3
	0.0132	8.5
	0.0094	6.7
	0.0068	4.9
	0.0048	3.5
	0.0034	0.6
	0.0014	0.1

L.L.	N/P
P.L.	N/P
P.I.	N/P

% Sand	74.8
% Silt	24.9
% Clay	0.3

D_{85}	1.0075
D_{60}	0.3370
D_{50}	0.2288
D_{30}	0.0840
D_{15}	0.0381
D_{10}	0.0210
C_u	16
C_c	1

PROJECT NAME:	Phase 1 Ash Storage Embankment Investigaiton	Location	Sample No.	Depth (ft)	Description and Classification	Specific Gravity	Technician
Client:	AEP, Welsh Power Plant				Dark Brown Silty Sand, (SM) Econamzer Ash		Hermann Walka, P.E.
ETTL Inc. Job #	G 4207-146	B-1	composite	3'-10'		2.710	Date: 12/17/14

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

Project	Phase 1 Ash Storage Embankment Investigaiton	**Material Origin:**	Geotechnical Boring
Client:	AEP, Welsh Power Plant	**Date Sampled:**	10/8/2014
Job Location:	Cason,Texas	**Sampled By:**	ETTL Drilling Department
ETTL Job No.:	G 4207-146	**Sample Info. Provided By:**	Owen Sanderson, ETTL
Boring / Sample Location:	B-5	**Testing Technician:**	Owen Sanderson
Sample No.:	**Depth (ft.):** 28'-30'	**Test Starting Date:**	12/31/2014
DESCRIPTION:	Light Gray & Reddish Borwn Fat Clay, (CH)	**Test Finishing Date:**	12/31/2014

Starting Masses and Sample Preparation	
Shape of Particles:	N/A
Hardness of Particles:	N/A
Dispersion Device:	Device A
Dispersion Time:	1 minute
Dispersion Agent:	125 mL of a 4% solution of Na -Hex.
Soaking Time:	16 hours
Hydrometer Type:	152H
Starting Mass (whole) sample (g):	200.00
Starting Mass of Oven Dry (whole) sample (g):	159.75
Mass of (hydro) Sample (g):	58.84
Mass of Oven Dry (hydro) Sample (g):	47.00
Percent Retained on No. 10 Sieve:	0.00
Assumed Specific Gravity:	2.670

D 10 (mm)=	N/A
D 15 (mm)=	N/A
D 30 (mm)=	N/A
D 50 (mm)=	0.0057
D 60 (mm)=	0.0113
D 85 (mm)=	0.070
Cu =	N/A
Cc =	N/A

Hydroscopic M.C. of Hydrometer	
Tare Mass (g):	31.61
Tare + Wet Mass (g):	55.31
Tare + Dry Mass (g):	50.54
M.C.%	25.20%

Sieve No.	Mass Retained (g)	%Retained	Grain Dia. (mm)	%Passing
Mechanical Sieve Analysis of Material Retaining on No. 10				
2"	0.00	0.0	50.0	100.0
1"	0.00	0.0	25.0	100.0
3/4"	0.00	0.0	19.0	100.0
3/8"	0.00	0.0	9.50	100.0
No 4	0.00	0.0	4.75	100.0
No 10	0.00	0.0	2.00	100.0
Mechanical Sieve Analysis of Material Retaining on No. 200				
40	0.66	1.4	0.425	98.6
60	0.93	2.0	0.250	98.0
100	1.24	2.6	0.150	97.4
140	4.38	9.3	0.106	90.7
200	6.69	14.2	0.075	85.8

Hydrometer Analysis of Material Passing No. 10 Sieve

Temperature Deg. (C)	Hydrometer Correction	Hydrometer Reading	Corrected Reading	(L)-Hydrometer Factor	(K)-Dia. Factor	(a)-SP.GR. Factor	Time (min)	Grain Dia. (mm)	% Soil Passing
21.2	5.3	44.5	39.2	9.9	0.01340	1.00	0.5	0.0596	83.3
21.2	5.3	41.0	35.7	10.6	0.01340	1.00	1	0.0436	75.9
21.2	5.3	39.0	33.7	10.9	0.01340	1.00	2	0.0313	71.6
21.0	5.4	37.0	31.6	11.2	0.01340	1.00	5	0.0201	67.2
21.0	5.4	34.0	28.6	11.7	0.01340	1.00	15	0.0118	60.9
21.0	5.4	31.2	25.8	12.2	0.01340	1.00	30	0.0085	54.9
20.5	5.6	29.5	23.9	12.5	0.01340	1.00	60	0.0061	50.9
20.5	5.6	27.6	22.0	12.7	0.01340	1.00	120	0.0044	46.9
20.5	5.6	26.2	20.6	13.0	0.01340	1.00	250	0.0031	43.9
20.5	5.6	25.0	19.4	13.2	0.01340	1.00	1440	0.0013	41.3

Per ASTM		
% Gravel =	**0.0**	**Gravel** > 4.75 (mm)
% Sand =	**14.2**	4.75 (mm) < **SAND** > .075 (mm)
% Silt =	**43.4**	.075 (mm) < **SILT** > .002 (mm)
%Clay =	**42.4**	**CLAY** < .002 (mm)

Note:

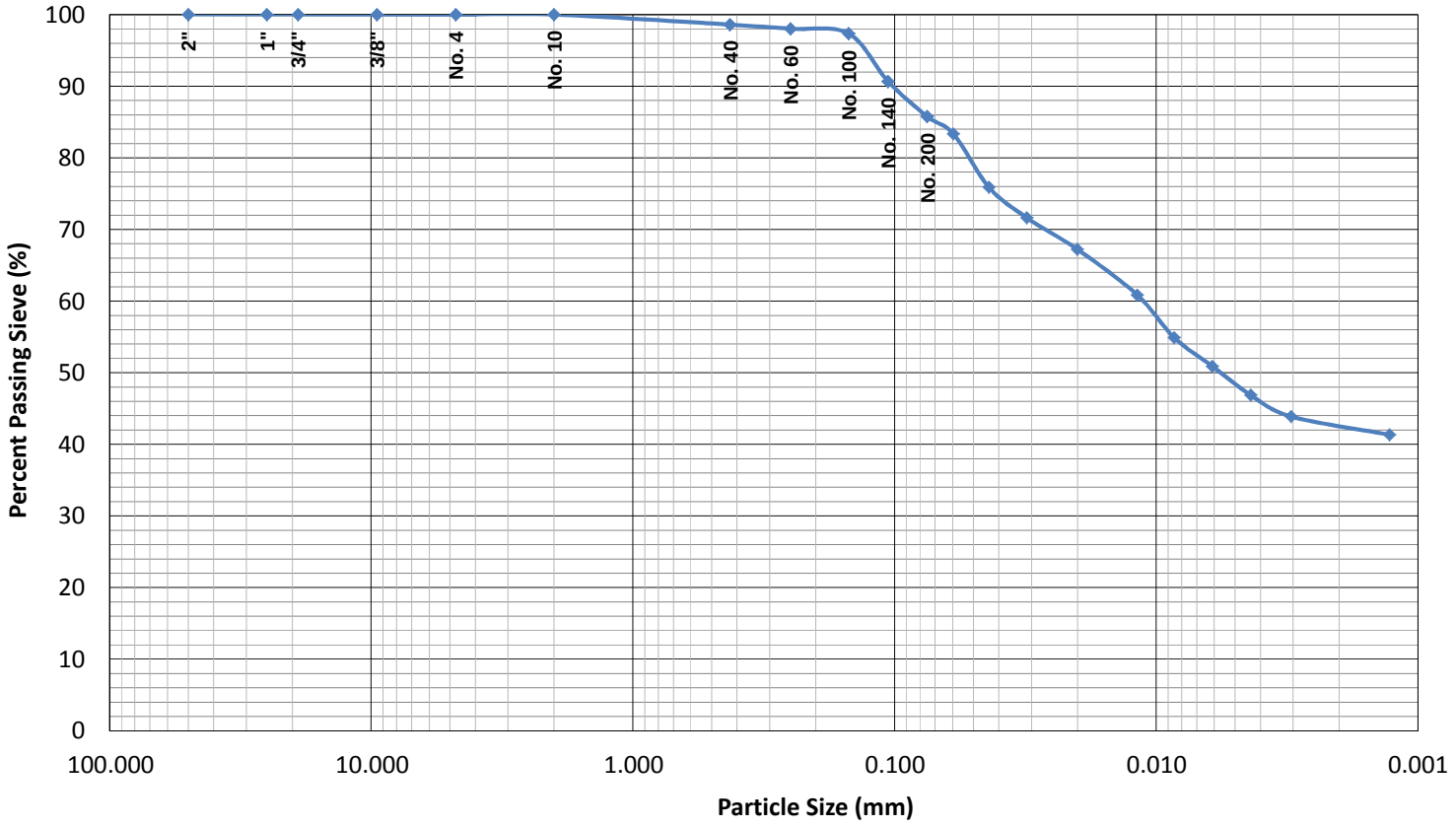
Atterberg Limits		
L.L.	**P.L.**	**P.I.**
58	**20**	**38**

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ASTM D 422, Particle Size Distribution Curve By Hydrometer



Sieve No.	Dia. (mm)	% Finer
2"	50.0	100.0
1"	25.0	100.0
3/4"	19.0	100.0
3/8"	9.50	100.0
No. 4	4.75	100.0
No. 10	2.00	100.0
No. 40	0.425	98.6
No. 60	0.250	98.0
No. 100	0.150	97.4
No. 140	0.106	90.7
No. 200	0.075	85.8
Hydrometer Analysis	0.0596	83.3
	0.0436	75.9
	0.0313	71.6
	0.0201	67.2
	0.0118	60.9
	0.0085	54.9
	0.0061	50.9
	0.0044	46.9
	0.0031	43.9
	0.0013	41.3

L.L.	58
P.L.	20
P.I.	38
% Sand	14.2
% Silt	43.4
% Clay	42.4
D_{85}	0.0698
D_{60}	0.0113
D_{50}	0.0057
D_{30}	N/A
D_{15}	N/A
D_{10}	N/A
C_u	N/A
C_c	N/A

PROJECT NAME:	Phase 1 Ash Storage Embankment Investigaiton	**Location**	**Sample No.**	**Depth (ft)**	**Description and Classification**	**Assumed S.G.**	**Technician**
Client:	AEP, Welsh Power Plant				Light Gray & Reddish Borwn Fat Clay, (CH)		Owen Sanderson
ETTL Inc. Job #	G 4207-146	B-5		28'-30'		2.670	Date: 12/31/14

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

Project	Phase 1 Ash Storage Embankment Investigaiton	**Material Origin:**	Geotechnical Boring
Client:	AEP, Welsh Power Plant	**Date Sampled:**	10/7/2014
Job Location:	Cason,Texas	**Sampled By:**	ETTL Drilling Department
ETTL Job No.:	G 4207-146	**Sample Info. Provided By:**	Owen Sanderson, ETTL
Boring / Sample Location:	B-11	**Testing Technician:**	Hermann Walka, P.E.
Sample No.:	**Depth (ft.):** 18'-20'	**Test Starting Date:**	1/7/2015
DESCRIPTION:	Black Elastic Silt, (MH) Bottom Ash	**Test Finishing Date:**	1/9/2015

Starting Masses and Sample Preparation	
Shape of Particles:	N/A
Hardness of Particles:	N/A
Dispersion Device:	Device A
Dispersion Time:	1 minute
Dispersion Agent:	125 mL of a 4% solution of Na -Hex.
Soaking Time:	16 hours
Hydrometer Type:	152H
Starting Mass of Air Dry (whole) sample (g):	320.00
Starting Mass of Oven Dry (whole) sample (g):	238.12
Mass of Air Dry (hydro) Sample (g):	34.04
Mass of Oven Dry (hydro) Sample (g):	25.33
Percent Retained on No. 10 Sieve:	0.00
Assumed Specific Gravity:	2.32

D 10 (mm)=	N/A
D 15 (mm)=	N/A
D 30 (mm)=	0.0025
D 50 (mm)=	0.0060
D 60 (mm)=	0.0083
D 85 (mm)=	0.025
Cu =	N/A
Cc =	N/A

Hygroscopic M.C. of Hydrometer	
Tare Mass (g):	29.86
Tare + Wet Mass (g):	43.03
Tare + Dry Mass (g):	39.66
M.C.%	34.4%

Sieve No.	Mass Retained (g)	%Retained	Grain Dia. (mm)	%Passing
Mechanical Sieve Analysis of Material Retaining on No. 10				
2"	0.00	0.0	50.0	100.0
1"	0.00	0.0	25.0	100.0
3/4"	0.00	0.0	19.0	100.0
3/8"	0.00	0.0	9.50	100.0
No 4	0.00	0.0	4.75	100.0
No 10	0.00	0.0	2.00	100.0
Mechanical Sieve Analysis of Material Retaining on No. 200				
40	0.00	0.0	0.425	100.0
60	0.00	0.0	0.250	100.0
100	0.26	1.0	0.150	99.0
140	0.38	1.5	0.106	98.5
200	0.65	2.6	0.075	97.4

Hydrometer Analysis of Material Passing No. 10 Sieve

Temperature Deg. (C)	Hydrometer Correction	Hydrometer Reading	Corrected Reading	(L)-Hydrometer Factor	(K)-Dia. Factor	(a)-SP.GR. Factor	Time (min)	Grain Dia. (mm)	% Soil Passing
20.5	5.6	27.5	21.9	12.9	0.01438	1.05	0.5	0.0730	90.9
20.5	5.6	27.0	21.4	12.9	0.01438	1.05	1	0.0516	88.8
20.5	5.6	26.5	20.9	13.0	0.01438	1.05	2	0.0367	86.7
20.5	5.6	26.0	20.4	13.0	0.01438	1.05	5	0.0232	84.7
20.5	5.6	24.0	18.4	13.3	0.01438	1.05	15	0.0135	76.4
20.5	5.6	21.5	15.9	13.8	0.01438	1.05	30	0.0098	66.0
20.0	5.7	18.8	13.1	14.2	0.01456	1.05	60	0.0071	54.1
20.0	5.7	16.8	11.1	14.5	0.01456	1.05	120	0.0051	45.8
19.5	5.9	14.7	8.8	15.0	0.01456	1.05	250	0.0036	36.4
19.5	5.9	10.9	5.0	15.6	0.01456	1.05	1440	0.0015	20.6

Measured Specific Gravity of Material Passing No. 10 Sieve, ASTM D 854 Method A

Air Dry M_S (grams)	Bottle #	T_t (deg. C)	M_P (grams)	V_P (mL)	$\rho_{w,t}$ (g/mL)	Oven Dry M_S (grams)	$M_{pw,t}$ (grams)	$M_{pws,t}$ (grams)	SG_t
17.79	11	25.50	179.23	499.22	0.9969	16.23	676.91	686.14	**2.32**

Per ASTM		
% Gravel =	**0.0**	**Gravel** > 4.75 (mm)
% Sand =	**2.6**	4.75 (mm) < **SAND** > .075 (mm)
% Silt =	**73.1**	.075 (mm) < **SILT** > .002 (mm)
%Clay =	**24.4**	**Clay Fraction** < .002 (mm)

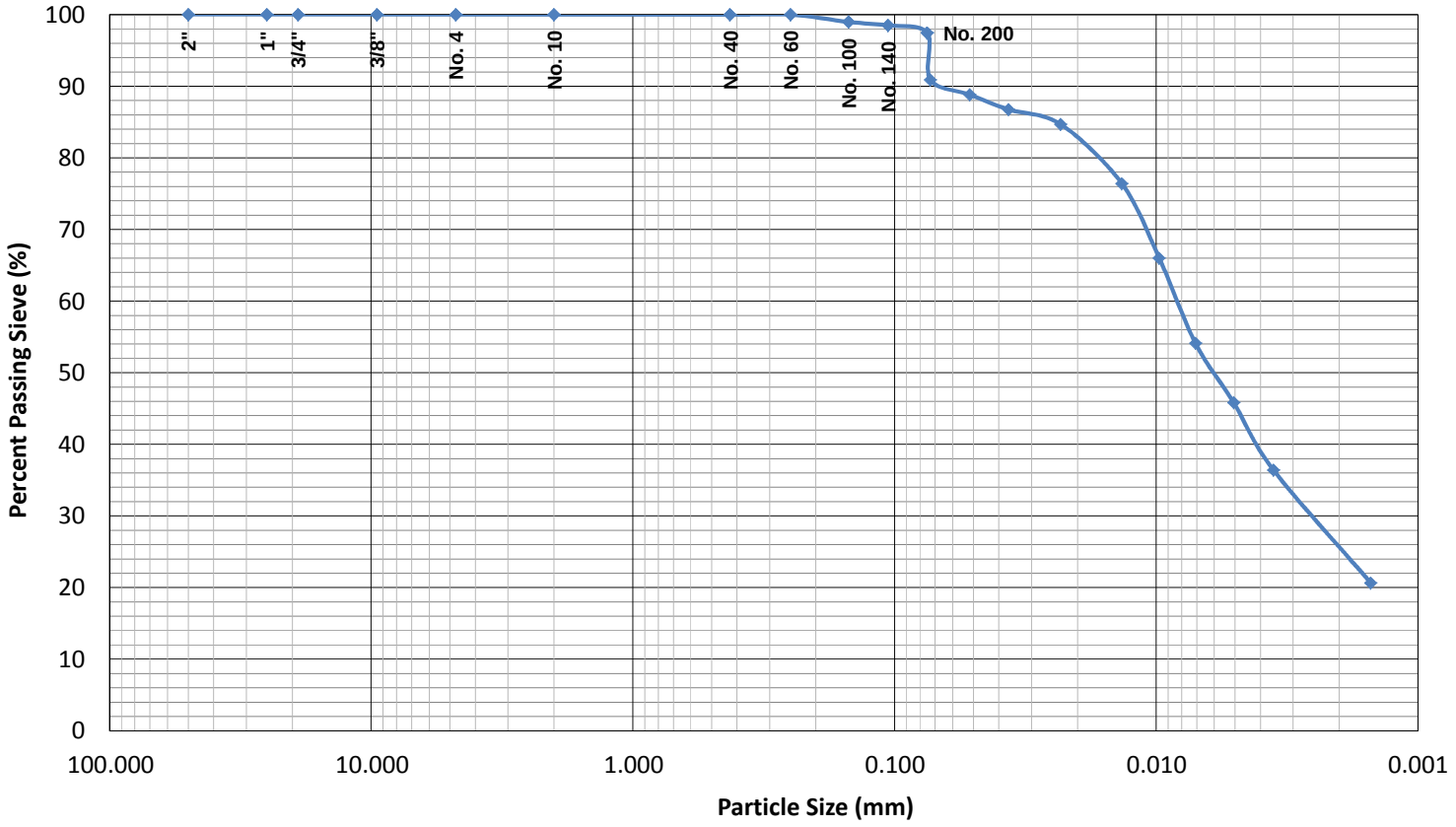
Atterberg Limits		
L.L.	**P.L.**	**P.I.**
124	**107**	**17**

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ASTM D 422, Particle Size Distribution Curve By Hydrometer



Sieve No.	Dia. (mm)	% Finer
2"	50.0	100.0
1"	25.0	100.0
3/4"	19.0	100.0
3/8"	9.50	100.0
No. 4	4.75	100.0
No. 10	2.00	100.0
No. 40	0.425	100.0
No. 60	0.250	100.0
No. 100	0.150	99.0
No. 140	0.106	98.5
No. 200	0.075	97.4
Hydrometer Analysis	0.0730	90.9
	0.0516	88.8
	0.0367	86.7
	0.0232	84.7
	0.0135	76.4
	0.0098	66.0
	0.0071	54.1
	0.0051	45.8
	0.0036	36.4
	0.0015	20.6

L.L.	124
P.L.	107
P.I.	17
% Sand	2.6
% Silt	73.1
% Fines	24.4
D_{85}	0.0249
D_{60}	0.0083
D_{50}	0.0060
D_{30}	0.0025
D_{15}	N/A
D_{10}	N/A
C_u	N/A
C_c	N/A

PROJECT NAME:	Phase 1 Ash Storage Embankment Investigaiton	Location	Sample No.	Depth (ft)	Description and Classification	Assumed S.G.	Technician
Client:	AEP, Welsh Power Plant				Black Elastic Silt, (MH) Bottom Ash		Hermann Walka, P.E.
ETTL Inc. Job #	G 4207-146	B-11		18'-20'		2.450	Date: 01/09/15

Hydraulic Conductivity by Mercury Permeameter

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Hydraulic Conductivity Determination Flexible Wall Permeameter (Mercury Permometer Test) ASTM D 5084, Method E

Project Information

Project: Phase 1 Ash Storage Area Embankment Investigation
Client/Arch./Engr.: AEP, Welch Power Plant
Project Location: Cason, Texas
Job No.: G 4207-146

Sample Information

Location / Boring No: **B-6**
Sample No.: Depth (ft.): **13-20** **ft.**
Material Origin: Geotechncial Boring, Composite SPT sample, Remolded
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Black Elastic Silt, (MH), Bottom Ash
Sampled By: ETTL Drilling Department Date Sampled: 10/11/2014
Technician: Hermann Walka, P.E. Test Date: 12/9/2014

Sample Data

Initial Sample Data

Wet Wt: of Sample :	37.98	g
Diameter :	1.364	in
Length :	1.133	in
Area:	1.462	in^2
Volume :	1.657	in^3
Unit Wt.(wet):	**87.3**	pcf
Unit Wt.(dry):	**41.4**	pcf
Specific Gravity:	2.32	
Calculated % saturation:	102.9	
Void ratio (e) =	2.50	
Porosity (n)=	0.71	
Measured B-Value:	100.0	%

Moisture Content Data

Before Test		After Test	
Tare Wt:	70.78	Tare Wt:	66.59
Wet Wt.+tare:	82.80	Wet Wt.+tare:	102.22
Dry Wt.+tare:	76.48	Dry Wt.+tare:	84.42
Dry Wt. Soil:	5.70	Dry Wt. Soil:	17.83
Water Wt.:	6.32	Water Wt.:	17.80
% moist.:	**110.9**	% moist.:	**99.8**

Molding Properties

Molding/Preparation Method: Pre-consolidated with 9.5 psi, Remolded
Max Dry Density(pcf) = OMC =
% of Max Density = +/- OMC =
LL: 100 PI: 19 -200%: 100

Test Readings

Z_1(Mercury Height Difference @ t_1): 5.2 cm Hydraulic Gradient = 22.61

Reading Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)
12/9/2014	184	5.5	1.162	25.0	0.889	9.43E-07	2.67E-03
12/9/2014	246	5.3	1.362	25.0	0.889	8.48E-07	2.40E-03
12/9/2014	326	5.1	1.562	25.0	0.889	7.54E-07	2.14E-03
12/9/2014	427	4.9	1.762	25.0	0.889	6.68E-07	1.89E-03

Summary Table

Hydraulic conductivity	**k =**	**8.03E-07**	**cm/sec**	**2.28E-03**	**ft/day**
Void Ratio	e =	2.50			
Porosity	n =	0.71			
Bulk Density	γ =	1.40	g/cm^3	87.3	pcf
Water Content	W =	0.74	cm^3/cm^3	(at 20 deg	
Intrinsic Permeability	k_{int} =	8.23E-12	cm^-	(at 20 deg	

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Hydraulic Conductivity Determination Flexible Wall Permeameter (Mercury Permometer Test) ASTM D 5084, Method E

Project Information

Project: Phase 1 Ash Storage Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Project Location: Cason, Texas
Job No.: G 4207-146

Sample Information

Location / Boring No: **Sample #1, Remolded Sandy Lean Clay**
Sample No.: Depth (ft.): **ft.**
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Redd. Brown & Light Brown Sandy Lean Clay, (CL)
Sampled By: ETTL Drilling Department Date Sampled: 10/7/2014
Technician: Hermann Walka, P.E. Test Date: 12/14/2014

Sample Data

Initial Sample Data

Wet Wt: of Sample :	149.82	g
Diameter :	1.399	in
Length :	2.929	in
Area:	1.538	in^2
Volume :	4.504	in^3
Unit Wt.(wet):	**126.7**	pcf
Unit Wt.(dry):	**108.4**	pcf
Assumed Specific Gravity:	2.67	
Calculated % saturation:	83.5	
Void ratio (e) =	0.54	
Porosity (n)=	0.35	
Measured B-Value:	99.0	%

Moisture Content Data

	Before Test	After Test
Tare Wt:	0.00	72.25
Wet Wt.+tare:	149.82	225.47
Dry Wt.+tare:	128.28	200.53
Dry Wt. Soil:	128.28	128.28
Water Wt.:	21.54	24.94
% moist.:	**16.8**	**19.4**

Molding Properties

Molding/Preparation Method: Molded to 95% Max Den. based on MDI
Estimated Max Dry Density(pcf) = 111.5 Est. OMC = 15.0
% of Max Density = 97.3 +/- OMC = 1.8
LL: 29 PI: 11 -200%: 63

Test Readings

Z_1(Mercury Height Difference @ t_1): 2.5 cm Hydraulic Gradient = 4.19

Reading Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)
12/15/2014	24	3.4	0.678	25.0	0.889	2.23E-05	6.33E-02
12/15/2014	32	3.2	0.878	25.0	0.889	2.30E-05	6.52E-02
12/15/2014	41	3.0	1.078	25.0	0.889	2.35E-05	6.67E-02
12/15/2014	51	2.8	1.278	25.0	0.889	2.41E-05	6.84E-02

Summary Table

Hydraulic conductivity	**k =**	**2.32E-05**	**cm/sec**	**6.59E-02**	**ft/day**
Void Ratio	e =	0.54			
Porosity	n =	0.35			
Bulk Density	γ =	2.03	g/cm^3	126.7	pcf
Water Content	W =	0.29	cm^3/cm^3	(at 20 deg	
Intrinsic Permeability	k_{int} =	2.38E-10	cm^-	(at 20 deg	

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Hydraulic Conductivity Determination Flexible Wall Permeameter (Mercury Permometer Test) ASTM D 5084, Method E

Project Information

Project: Phase 1 Ash Storage Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Project Location: Cason, Texas
Job No.: G 4207-146

Sample Information

Location / Boring No: **Sample #2, Remolded Fat Clay**
Sample No.: Depth (ft.): **ft.**
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Redd. Brown & Light Gray Fat Clay with sand, (CH)
Sampled By: ETTL Drilling Department Date Sampled: 10/7/2014
Technician: Hermann Walka, P.E. Test Date: 12/22/2014

Sample Data

Initial Sample Data

Wet Wt: of Sample :	65.86	g
Diameter :	1.395	in
Length :	1.368	in
Area:	1.528	in^2
Volume :	2.091	in^3
Unit Wt.(wet):	**119.9**	pcf
Unit Wt.(dry):	**97.4**	pcf
Assumed Specific Gravity:	2.67	
Calculated % saturation:	86.8	
Void ratio (e) =	0.71	
Porosity (n)=	0.42	
Measured B-Value:	97.0	%

Moisture Content Data

Before Test		After Test	
Tare Wt:	69.11	Tare Wt:	69.60
Wet Wt.+tare:	82.43	Wet Wt.+tare:	139.33
Dry Wt.+tare:	79.93	Dry Wt.+tare:	123.30
Dry Wt. Soil:	10.82	Dry Wt. Soil:	53.70
Water Wt.:	2.50	Water Wt.:	16.03
% moist.:	**23.1**	% moist.:	**29.9**

Molding Properties

Molding/Preparation Method: Molded to 95% Max Den. based on MDI
Estimated Max Dry Density(pcf) = 100.0 Est. OMC = 21.4
% of Max Density = 97.4 +/- OMC = 1.7
LL: 62 PI: 42 -200%: 78

Test Readings

Z_1(Mercury Height Difference @ t_1): 3.6 cm Hydraulic Gradient = 12.88

Reading Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)
12/24/2014	2521	3.7	1.412	24.0	0.910	1.63E-07	4.61E-04
12/24/2014	2809	3.6	1.512	24.0	0.910	1.60E-07	4.54E-04
12/24/2014	3101	3.5	1.612	24.0	0.910	1.58E-07	4.49E-04
12/24/2014	3440	3.4	1.712	24.0	0.910	1.56E-07	4.41E-04

Summary Table

Hydraulic conductivity	**k =**	**1.59E-07**	**cm/sec**	**4.51E-04**	**ft/day**
Void Ratio	e =	0.71			
Porosity	n =	0.42			
Bulk Density	γ =	1.92	g/cm^3	119.9	pcf
Water Content	W =	0.36	cm^3/cm^3	(at 20 deg	
Intrinsic Permeability	k_{int} =	1.63E-12	cm^-	(at 20 deg	

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Hydraulic Conductivity Determination Flexible Wall Permeameter (Mercury Permometer Test) ASTM D 5084, Method E

Project Information

Project: Phase 1 Ash Storage Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Project Location: Cason, Texas
Job No.: G 4207-146

Sample Information

Location / Boring No: **B-13**
Sample No.: | Depth (ft.): **7'-9'** **ft.**
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Reddish Brown, Light Brown & Light Gray Sandy Lean Clay, (CL)
Sampled By: ETTL Drilling Department | Date Sampled: 10/7/2014
Technician: Owen Sanderson, ETTL | Test Date: 2/17/2015

Sample Data

Initial Sample Data

Wet Wt: of Sample :	545.33	g
Diameter :	2.707	in
Length :	2.715	in
Area:	5.754	in^2
Volume :	15.62	in^3
Unit Wt.(wet):	**132.9**	pcf
Unit Wt.(dry):	**114.8**	pcf
Calculated % saturation:	93.2	%
Assumed Specific Gravity:	2.67	
Void ratio (e) =	0.45	
Porosity (n)=	0.31	
Measured B-Value:	99.0	%
Cell Presure:	60.0	psi
Back Presure:	57.0	psi
Max/Min Stress:	3.0	psi

Moisture Content Data

Before Test		After Test	
Tare Wt:	132.79	Tare Wt:	68.95
Wet Wt.+tare:	228.06	Wet Wt.+tare:	619.15
Dry Wt.+tare:	215.09	Dry Wt.+tare:	539.95
Dry Wt. Soil:	82.30	Dry Wt. Soil:	471.00
Water Wt.:	12.97	Water Wt.:	79.20
% moist.:	**15.8**	% moist.:	**16.8**

Molding Properties

Molding/Preparation Method: Trimmed Shelby Tube
Estimated Max Dry Density(pcf) = | Est. OMC =
% of Max Density = | +/- OMC =

LL: 40 PI: 23 -200%: 67.6

Test Readings

Z_1(Mercury Height Difference @ t_1): 5.1 cm Hydraulic Gradient = 9.24

Reading Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)
2/18/2015	870	5.7	0.959	25.0	0.889	1.00E-07	2.83E-04
2/18/2015	1005	5.6	1.059	25.0	0.889	9.68E-08	2.74E-04
2/18/2015	1128	5.5	1.159	25.0	0.889	9.56E-08	2.71E-04
2/18/2015	1263	5.4	1.259	25.0	0.889	9.40E-08	2.66E-04

Summary Table

Hydraulic conductivity	**k =**	**9.66E-08**	**cm/sec**	**2.74E-04**	**ft/day**
Void Ratio	e =	0.45			
Porosity	n =	0.31			
Bulk Density	γ =	2.13	g/cm^3	132.9	pcf
Water Content	W =	0.29	cm^3/cm^3	(at 20 deg (	
Intrinsic Permeability	k_{int} =	9.90E-13	cm^2	(at 20 deg (	

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Hydraulic Conductivity Determination Flexible Wall Permeameter (Mercury Permometer Test) ASTM D 5084, Method E

Project Information

Project: Phase 1 Ash Storage Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Project Location: Cason, Texas
Job No.: G 4207-146

Sample Information

Location / Boring No: **B-15**
Sample No.: | Depth (ft.): **8'-10'** **ft.**
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Grayish Brown & Light Gray with Redd. Brown Fat Clay, (CH) with ferrics partings
Sampled By: ETTL Drilling Department Date Sampled: 10/7/2014
Technician: Owen Sanderson, ETTL Test Date: 2/17/2015

Sample Data

Initial Sample Data

Wet Wt: of Sample :	526.77	g
Diameter :	2.720	in
Length :	2.782	in
Area:	5.811	in^2
Volume :	16.17	in^3
Unit Wt.(wet):	**124.1**	pcf
Unit Wt.(dry):	**98.6**	pcf
Calculated % saturation:	99.9	%
Assumed Specific Gravity:	2.67	
Void ratio (e) =	0.69	
Porosity (n)=	0.41	
Measured B-Value:	99.0	%
Cell Presure:	60.0	psi
Back Presure:	57.0	psi
Max/Min Stress:	3.0	psi

Moisture Content Data

Before Test		After Test	
Tare Wt:	69.46	Tare Wt:	68.14
Wet Wt.+tare:	180.50	Wet Wt.+tare:	605.30
Dry Wt.+tare:	157.70	Dry Wt.+tare:	493.04
Dry Wt. Soil:	88.24	Dry Wt. Soil:	424.90
Water Wt.:	22.80	Water Wt.:	112.26
% moist.:	**25.8**	% moist.:	**26.4**

Molding Properties

Molding/Preparation Method: Trimmed Shelby Tube
Estimated Max Dry Density(pcf) = Est. OMC =
% of Max Density = +/- OMC =

LL: 59 PI: 38 -200%: 85

Test Readings

Z_1(Mercury Height Difference @ t_1): 5.1 cm Hydraulic Gradient = 9.02

Reading Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)
2/18/2015	3480	6.1	0.559	25.0	0.889	1.41E-08	4.00E-05
2/18/2015	4980	6.0	0.659	25.0	0.889	1.18E-08	3.33E-05
2/18/2015	6720	5.9	0.759	25.0	0.889	1.01E-08	2.88E-05
2/18/2015	9420	5.7	0.939	25.0	0.889	9.15E-09	2.59E-05

Summary Table

Hydraulic conductivity	**k =**	**1.13E-08**	**cm/sec**	**3.20E-05**	**ft/day**
Void Ratio	e =	0.69			
Porosity	n =	0.41			
Bulk Density	γ =	1.99	g/cm^3	124.1	pcf
Water Content	W =	0.41	cm^3/cm^3	(at 20 deg (	
Intrinsic Permeability	k_{int} =	1.16E-13	cm^2	(at 20 deg (	

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Hydraulic Conductivity Determination Flexible Wall Permeameter (Mercury Permometer Test) ASTM D 5084, Method E

Project Information

Project: Phase 1 Ash Storage Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Project Location: Cason, Texas
Job No.: G 4207-146

Sample Information

Location / Boring No: **B-22**
Sample No.: Depth (ft.): **33'-35' ft.**
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Grayish Brown, Yellowish Brown & Redd. Brown Sandy Lean Clay, (CL) with sand pockets
Sampled By: ETTL Drilling Department Date Sampled: 10/7/2014
Technician: Owen Sanderson, ETTL Test Date: 2/17/2015

Sample Data

Initial Sample Data

Wet Wt: of Sample :	535.53	g
Diameter :	2.747	in
Length :	2.746	in
Area:	5.925	in^2
Volume :	16.27	in^3
Unit Wt.(wet):	**125.3**	pcf
Unit Wt.(dry):	**103.7**	pcf
Calculated % saturation:	91.7	%
Assumed Specific Gravity:	2.67	
Void ratio (e) =	0.61	
Porosity (n)=	0.38	
Measured B-Value:	99.0	%
Cell Presure:	60.0	psi
Back Presure:	57.0	psi
Max/Min Stress:	3.0	psi

Moisture Content Data

Before Test		After Test	
Tare Wt:	126.74	Tare Wt:	69.07
Wet Wt.+tare:	207.40	Wet Wt.+tare:	617.26
Dry Wt.+tare:	193.47	Dry Wt.+tare:	511.70
Dry Wt. Soil:	66.73	Dry Wt. Soil:	442.63
Water Wt.:	13.93	Water Wt.:	105.56
% moist.:	**20.9**	% moist.:	**23.8**

Molding Properties

Molding/Preparation Method: Trimmed Shelby Tube
Estimated Max Dry Density(pcf) = Est. OMC =
% of Max Density = +/- OMC =

LL: 49 PI: 32 -200%: 61.3

Test Readings

Z_1(Mercury Height Difference @ t_1): 5.2 cm Hydraulic Gradient = 9.33

Reading Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)
2/18/2015	4920	5.9	0.812	25.0	0.889	1.41E-08	4.00E-05
2/18/2015	6720	5.6	1.062	25.0	0.889	1.39E-08	3.95E-05
2/18/2015	9360	5.3	1.412	25.0	0.889	1.39E-08	3.94E-05
2/18/2015	12960	4.8	1.862	25.0	0.889	1.41E-08	4.00E-05

Summary Table

Hydraulic conductivity	**k =**	**1.40E-08**	**cm/sec**	**3.97E-05**	**ft/day**
Void Ratio	e =	0.61			
Porosity	n =	0.38			
Bulk Density	γ =	2.01	g/cm^3	125.3	pcf
Water Content	W =	0.35	cm^3/cm^3	(at 20 deg (	
Intrinsic Permeability	k_{int} =	1.44E-13	cm^2	(at 20 deg (	

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Unit Weight Determination by Direct Measurement

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Laboratory Determination of Density (Unit Weight) of Soil Specimens, ASTM D 7263

Method B, Direct Measurement

Project Information

Project: Phase 1 Ash Storage Area Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Location: Cason, Texas
ETTL Job No.: G 4207-14

Sample Information

Boring No: **B-4**
Sample No.: _____ Depth: **18-20** **ft.** Date Sampled: 10/8/2014
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Black Elastic Silt, (MH) Bottom Ash
Sampled By: ETTL Drilling Department
Technician: Owen Sanderson, ETTL Test Date: 12/30/2014
Sample Type: Disturbed SPT Sample, Trimmed

Test Data

Minimum of 3 Readings

	Diameter (in)	Height (in)	
Diameter (top)	1.386	2.369	Height 1
Diameter (Middle)	1.380	2.374	Height 2
Diameter (bottom)	1.391	2.371	Height 3

Sample Properties

LL	PI	% Passing No. 200

Ave. Diameter (in)	Ave. Height (in)	Area (in^2)	Volume (in^3)	Wet Wt. (g)	Dry Wt. (g)	Total Unit Weight (lbf/ft^3)	Dry Unit Weight (lbf/ft^3)
1.386	2.371	1.508	3.58	77.67	32.5	**82.7**	**34.7**

Ave. Diameter (mm)	Ave. Height (mm)	Area (mm^2)	Volume (L)	Wet Wt. (Kg)	Dry Wt. (Kg)	Total Unit Weight (kN/m^3)	Dry Unit Weight (kN/m^3)
35.20	60.23	973	0.0586	0.0777	0.0325	13.00	5.45

Phase Volumes:

Solids (V_s)	**0.86**	in^3	**Specific Gravity**	**2.32**	**Estimated**	Tare #	O
Voids (Vv)	**2.72**	in^3	**e - Void Ratio**	**3.170**		Tare Wt. (g)	69.49
Water (V_w)	**2.76**	in^3	**η - Total Porosity**	**76.0%**		Wet Wt.(g)	147.1
			Degree of Saturation	**100.0%**		Dry Wt. (g)	102
						ASTM D 2166, Moisture Content	**138.7%**

From Trimmings

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Laboratory Determination of Density (Unit Weight) of Soil Specimens, ASTM D 7263

Method B, Direct Measurement

Project Information

Project: Phase 1 Ash Storage Area Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Location: Cason, Texas
ETTL Job No.: G 4207-14

Sample Information

Boring No: **B-4**
Sample No.: _____ Depth: **13-15** **ft.** Date Sampled: 10/8/2014
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Light Brown Elastic Silt with sand, (MH) Fly Ash
Sampled By: ETTL Drilling Department
Technician: Owen Sanderson, ETTL Test Date: 12/30/2014
Sample Type: Disturbed SPT Sample, Trimmed

Test Data

Minimum of 3 Readings

	Diameter (in)	Height (in)	
Diameter (top)	1.393	2.770	Height 1
Diameter (Middle)	1.357	2.775	Height 2
Diameter (bottom)	1.390	2.779	Height 3

Sample Properties

LL	PI	% Passing No. 200
81	5	82.1

Ave. Diameter (in)	Ave. Height (in)	Area (in^2)	Volume (in^3)	Wet Wt. (g)	Dry Wt. (g)	Total Unit Weight (lbf/ft^3)	Dry Unit Weight (lbf/ft^3)
1.380	2.775	1.496	4.15	93.28	42.5	**85.6**	**39.0**

Ave. Diameter (mm)	Ave. Height (mm)	Area (mm^2)	Volume (L)	Wet Wt. (Kg)	Dry Wt. (Kg)	Total Unit Weight (kN/m^3)	Dry Unit Weight (kN/m^3)
35.05	70.48	965	0.0680	0.0933	0.0425	13.46	6.14

Phase Volumes:

Solids (V_s)	**1.04**	in^3	**Specific Gravity**	**2.50**	**Estimated**	Tare #	T
Voids (Vv)	**3.11**	in^3	**e - Void Ratio**	**2.989**		Tare Wt. (g)	65.13
Water (V_w)	**3.10**	in^3	**η - Total Porosity**	**74.9%**		Wet Wt.(g)	158.36
			Degree of Saturation	**99.8%**		Dry Wt. (g)	107.64
						ASTM D 2166, Moisture Content	**119.3%**

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Laboratory Determination of Density (Unit Weight) of Soil Specimens, ASTM D 7263

Method B, Direct Measurement

Project Information

Project: Phase 1 Ash Storage Area Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Location: Cason, Texas
ETTL Job No.: G 4207-14

Sample Information

Boring No: **B-6**
Sample No.: _____ Depth: **13-15** **ft.** Date Sampled: 10/11/2014
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Black Elastic Silt, (MH) Bottom Ash
Sampled By: ETTL Drilling Department
Technician: Owen Sanderson, ETTL Test Date: 11/26/2014
Sample Type: Disturbed SPT Sample, Trimmed

Test Data

Minimum of 3 Readings

	Diameter (in)	Height (in)	
Diameter (top)	1.450	1.546	Height 1
Diameter (Middle)	1.437	1.546	Height 2
Diameter (bottom)	1.451	1.546	Height 3

Sample Properties

LL	PI	% Passing No. 200
100	19	100.0

Ave. Diameter (in)	Ave. Height (in)	Area (in^2)	Volume (in^3)	Wet Wt. (g)	Dry Wt. (g)	Total Unit Weight (lbf/ft^3)	Dry Unit Weight (lbf/ft^3)
1.446	1.546	1.642	2.54	58.06	29.2	**87.1**	**43.8**

Ave. Diameter (mm)	Ave. Height (mm)	Area (mm^2)	Volume (L)	Wet Wt. (Kg)	Dry Wt. (Kg)	Total Unit Weight (kN/m^3)	Dry Unit Weight (kN/m^3)
36.73	39.27	1059	0.0416	0.0581	0.0292	13.70	6.89

Phase Volumes:

Solids (V_s)	**0.77**	in^3	**Specific Gravity**	**2.32**	**Estimated**	Tare #	C
Voids (Vv)	**1.77**	in^3	**e - Void Ratio**	**2.296**		Tare Wt. (g)	64.48
Water (V_w)	**1.764**	in^3	**η - Total Porosity**	**69.7%**		Wet Wt.(g)	122.48
			Degree of Saturation	**100%**		Dry Wt. (g)	93.67
						ASTM D 2166, Moisture Content	**98.7%**
							From Trimmings

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Laboratory Determination of Density (Unit Weight) of Soil Specimens, ASTM D 7263

Method B, Direct Measurement

Project Information

Project: Phase 1 Ash Storage Area Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Location: Cason, Texas
ETTL Job No.: G 4207-14

Sample Information

Boring No: **B-7**
Sample No.: _____ Depth: **8-10** **ft.** Date Sampled: 10/10/2014
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Dark Gray Elastic Silt, (MH) Composite Bottom Ash
Sampled By: ETTL Drilling Department
Technician: Owen Sanderson, ETTL Test Date: 12/30/2014
Sample Type: Disturbed SPT Sample, Trimmed

Test Data

Minimum of 3 Readings

	Diameter (in)	Height (in)	
Diameter (top)	1.336	2.157	Height 1
Diameter (Middle)	1.307	2.211	Height 2
Diameter (bottom)	1.335	2.170	Height 3

Sample Properties

LL	PI	% Passing No. 200

Ave. Diameter (in)	Ave. Height (in)	Area (in^2)	Volume (in^3)	Wet Wt. (g)	Dry Wt. (g)	Total Unit Weight (lbf/ft^3)	Dry Unit Weight (lbf/ft^3)
1.326	2.179	1.381	3.01	67.40	26.1	**85.3**	**33.0**

Ave. Diameter (mm)	Ave. Height (mm)	Area (mm^2)	Volume (L)	Wet Wt. (Kg)	Dry Wt. (Kg)	Total Unit Weight (kN/m^3)	Dry Unit Weight (kN/m^3)
33.68	55.35	891	0.0493	0.0674	0.0261	13.41	5.19

Phase Volumes:

Solids (V_s)	**0.638**	in^3	**Specific Gravity**	**2.50**	**Estimated**	Tare #	L
Voids (Vv)	**2.372**	in^3	**e - Void Ratio**	**3.718**		Tare Wt. (g)	66.05
Water (V_w)	**2.528**	in^3	**η - Total Porosity**	**78.8%**		Wet Wt.(g)	133.37
			Degree of Saturation	**100%**		Dry Wt. (g)	92.09
						ASTM D 2166, Moisture Content	**158.5%**

From Trimmings

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Laboratory Determination of Density (Unit Weight) of Soil Specimens, ASTM D 7263

Method B, Direct Measurement

Project Information

Project: Phase 1 Ash Storage Area Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Location: Carson, Texas
ETTL Job No.: G 4207-14

Sample Information

Boring No: **B-7**
Sample No.: Depth: **18-20** **ft.** Date Sampled: 10/10/2014
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Dark Grayish Brown Sandy Elastic Silt, (MH) Composite Fly Ash
Sampled By: ETTL Drilling Department
Technician: Owen Sanderson, ETTL Test Date: 12/30/2014
Sample Type: Disturbed SPT Sample, Trimmed

Test Data

Minimum of 3 Readings

	Diameter (in)	Height (in)	
Diameter (top)	1.391	2.635	Height 1
Diameter (Middle)	1.391	2.639	Height 2
Diameter (bottom)	1.416	2.652	Height 3

Sample Properties

LL	PI	% Passing No. 200

Ave. Diameter (in)	Ave. Height (in)	Area (in^2)	Volume (in^3)	Wet Wt. (g)	Dry Wt. (g)	Total Unit Weight (lbf/ft^3)	Dry Unit Weight (lbf/ft^3)
1.399	2.642	1.538	4.06	89.96	39.7	**84.4**	**37.2**

Ave. Diameter (mm)	Ave. Height (mm)	Area (mm^2)	Volume (L)	Wet Wt. (Kg)	Dry Wt. (Kg)	Total Unit Weight (kN/m^3)	Dry Unit Weight (kN/m^3)
35.54	67.11	992	0.0666	0.0900	0.0397	13.25	5.84

Phase Volumes:

Solids (V_s)	**0.971**	in^3	**Specific Gravity**	**2.50**	**Estimated**	Tare #	D
Voids (Vv)	**3.092**	in^3	**e - Void Ratio**	**3.186**		Tare Wt. (g)	66.57
Water (V_w)	**3.076**	in^3	**η - Total Porosity**	**76.1%**		Wet Wt.(g)	156.5
			Degree of Saturation	**99.5%**		Dry Wt. (g)	106.23
						ASTM D 2166, Moisture Content	**126.8%**

From Trimmings

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Laboratory Determination of Density (Unit Weight) of Soil Specimens, ASTM D 7263

Method B, Direct Measurement

Project Information

Project: Phase 1 Ash Storage Area Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Location: Cason, Texas
ETTL Job No.: G 4207-14

Sample Information

Boring No: **B-9**
Sample No.: _____ Depth: **20-21** **ft.** Date Sampled: 10/9/2014
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Light Gray Cemented Fly Ash
Sampled By: ETTL Drilling Department
Technician: Owen Sanderson, ETTL Test Date: 12/29/2014
Sample Type: Trimmed Nx Rock Core

Test Data

Minimum of 3 Readings

	Diameter (in)	Height (in)	
Diameter (top)	1.867	4.316	Height 1
Diameter (Middle)	1.966	4.267	Height 2
Diameter (bottom)	1.950	4.275	Height 3

Sample Properties

LL	PI	% Passing No. 200

Ave. Diameter (in)	Ave. Height (in)	Area (in^2)	Volume (in^3)	Wet Wt. (g)	Dry Wt. (g)	Total Unit Weight (lbf/ft^3)	Dry Unit Weight (lbf/ft^3)
1.928	4.286	2.919	12.51	382.01	314.8	**116.3**	**95.9**

Ave. Diameter (mm)	Ave. Height (mm)	Area (mm^2)	Volume (L)	Wet Wt. (Kg)	Dry Wt. (Kg)	Total Unit Weight (kN/m^3)	Dry Unit Weight (kN/m^3)
48.96	108.86	1883	0.2050	0.3820	0.3148	18.27	15.06

Phase Volumes:

Solids (V_s)	**7.702**	in^3	**Specific Gravity**	**2.50**	**Estimated**	Tare #	G
Voids (Vv)	**4.807**	in^3	**e - Void Ratio**	**0.624**		Tare Wt. (g)	71.12
Water (V_w)	**4.108**	in^3	**η - Total Porosity**	**38.4%**		Wet Wt.(g)	205.74
			Degree of Saturation	**85%**		Dry Wt. (g)	182.07
						ASTM D 2166, Moisture Content	**21.3%**
							From Trimmings

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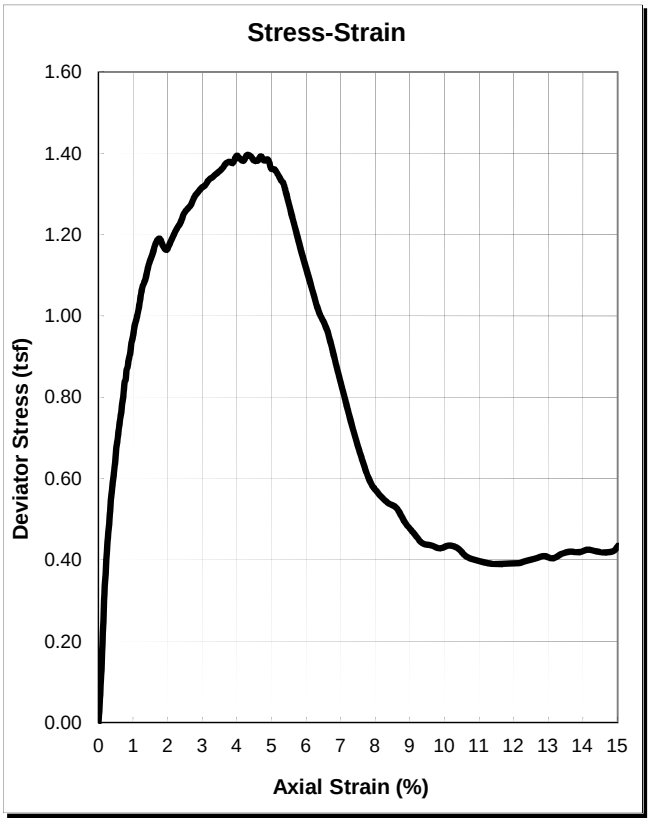
Undrained Unconsolidated Triaxial Compression

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ASTM D 2850 Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

Project: Phase 1 Fly Ash Storage Embankment Investigation
Client: AEP, Welsh Power Plant
Location: Cason, Texas
Material: Lt. Brown, Lt. Gray & Redd. Brown Clayey Sand, (SC)

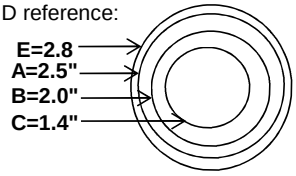


ETTL Project No.:	G 4207-14	
Boring No.:	B-2	
Sample No. / Depth (ft.):	33'-35'	
Specimen Trimming ID:	E	(whole)
Height:	6.515	inches
Diameter:	2.798	inches
Height / Diameter Ratio:	2.33	
Initial Moisture Content:	**16.1%**	(trimmings)
Initial Dry Unit Weight:	**110.0**	lbs./ft^3
Initial Total Unit Weight:	127.7	lbs./ft^3
Specific Gravity:	2.670	(assumed)
Initial Void Ratio:	0.515	
Initial Saturation:	83.6	%
Pocket Pentronmeter:	2.75	tsf
Hand Torvane:	N/T	tsf
Rate of Strain:	1.0	%/min
Chamber Pressure:	**20.7**	**psi**
Peak Strain:	**4.29**	**%**
Cor. Maximum Deviator Stress:	**1.39**	**tsf**
Cor. Maximum Deviator Stress:	2780	psf
Cor. Maximum Deviator Stress:	19.3	psi
Cor. Secant Modulus at 1/2 Peak Stress:	2.63E+05	psf
Strain at 50% Max Stress (e_{50}):	5.30E-03	in/in
Initial Tangent Modulus:	4.39E+05	psf
Atterbergs LL / PI:	30	15
Passing No. 200 Sieve:	38.8	%
Sampling Method:	2.8 in. Shelby Tube	
Type of Specimen:	Undisturbed	

Unconsolidated-Undrained Shear Strength	
1390	psf

Membrane Correction Factor (tsf) = 0.005

Specimen Trimming ID reference:



This test has been run to a maximum % strain of: 15.0

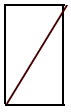
Measured Angle of Fracture from Horizontal: 45

Remarks:

Sketch of Fracture:

Technician: L. Dailey Date: 12/29/2014

Picture of Fracture:



Shear

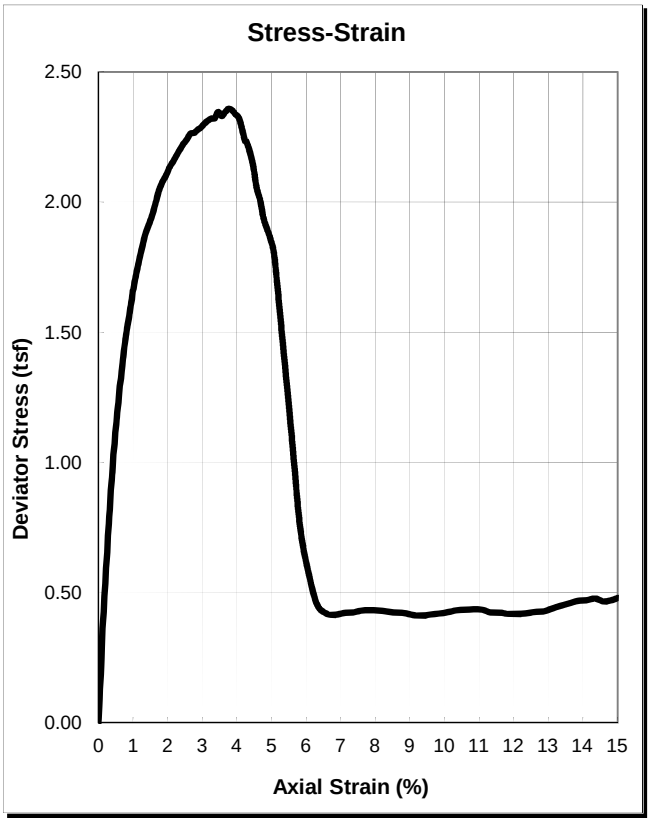
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ASTM D 2850 Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

Project:	Phase 1 Fly Ash Storage Embankment Investigation
Client:	AEP, Welsh Power Plant
Location:	Cason, Texas
Material:	Gray & Yellowish Brown Fat Clay, (CH)

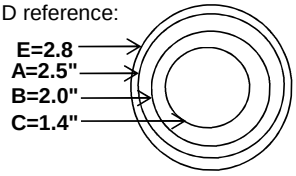


ETTL Project No.:	G 4207-14	
Boring No.:	B-4	
Sample No. / Depth (ft.):	38'-40'	
Specimen Trimming ID:	E	(whole)
Height:	6.523	inches
Diameter:	2.790	inches
Height / Diameter Ratio:	2.34	
Initial Moisture Content:	**24.3%**	(trimmings)
Initial Dry Unit Weight:	**99.0**	lbs./ft^3
Initial Total Unit Weight:	123.0	lbs./ft^3
Specific Gravity:	2.670	(assumed)
Initial Void Ratio:	0.684	
Initial Saturation:	94.8	%
Pocket Pentronmeter:	4.5+	tsf
Hand Torvane:	N/T	tsf
Rate of Strain:	1.0	%/min
Chamber Pressure:	**23.7**	**psi**
Peak Strain:	**3.76**	**%**
Cor. Maximum Deviator Stress:	**2.35**	**tsf**
Cor. Maximum Deviator Stress:	4707	psf
Cor. Maximum Deviator Stress:	32.7	psi
Cor. Secant Modulus at 1/2 Peak Stress:	4.61E+05	psf
Strain at 50% Max Stress (e_{50}):	5.12E-03	in/in
Initial Tangent Modulus:	7.52E+05	psf
Atterbergs LL / PI:	N/T	N/T
Passing No. 200 Sieve:	N/T	%
Sampling Method:	2.8 in. Shelby Tube	
Type of Specimen:	Undisturbed	

Unconsolidated-Undrained Shear Strength	
2353	psf

Membrane Correction Factor (tsf) = 0.005

Specimen Trimming ID reference:



This test has been run to a maximum % strain of: 15.0

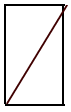
Measured Angle of Fracture from Horizontal: 45

Remarks: Slickensided

Sketch of Fracture:

Technician: L. Dailey Date: 12/29/2014

Picture of Fracture:



Shear

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Arlington Branch: 2000 E. Randol Mill Rd. Suite 613 Arlington, TX 76011 Phone: 817-962-0048 Fax: 817-962-0025

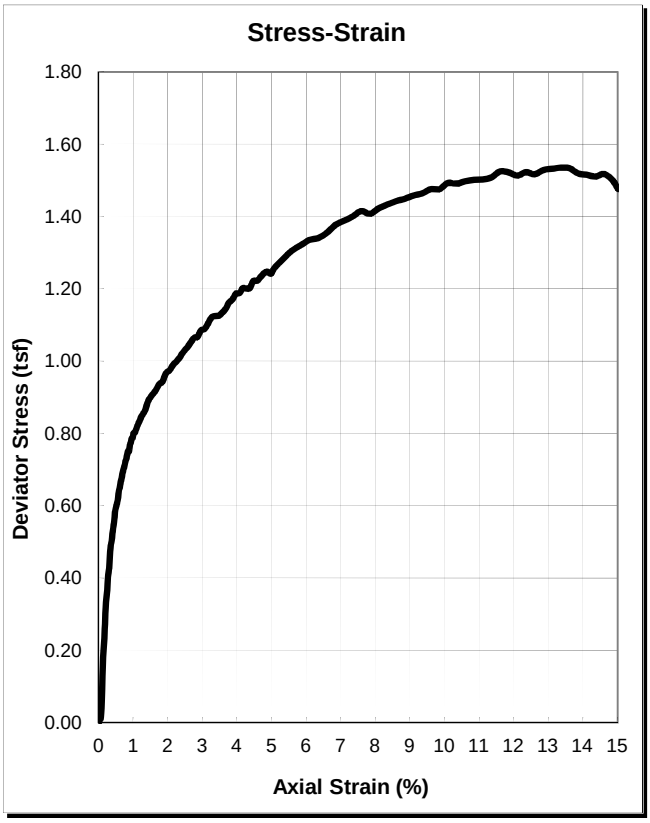
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ASTM D 2850 Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

Project:	Phase 1 Fly Ash Storage Embankment Investigation
Client:	AEP, Welsh Power Plant
Location:	Cason, Texas
Material:	Light Gray & Redd. Brown Fat Clay with sand, (CH)

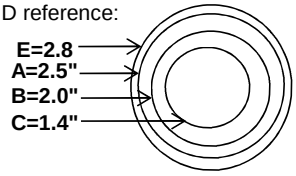


ETTL Project No.:	G 4207-14	
Boring No.:	B-9	
Sample No. / Depth (ft.):	28'-30'	
Specimen Trimming ID:	E	(whole)
Height:	6.496	inches
Diameter:	2.774	inches
Height / Diameter Ratio:	2.34	
Initial Moisture Content:	**21.1%**	(trimmings)
Initial Dry Unit Weight:	**105.5**	lbs./ft^3
Initial Total Unit Weight:	127.8	lbs./ft^3
Specific Gravity:	2.670	(assumed)
Initial Void Ratio:	0.579	
Initial Saturation:	97.3	%
Pocket Pentronmeter:	1.75	tsf
Hand Torvane:	N/T	tsf
Rate of Strain:	1.0	%/min
Chamber Pressure:	**17.6**	**psi**
Peak Strain:	**13.4**	**%**
Cor. Maximum Deviator Stress:	**1.52**	**tsf**
Cor. Maximum Deviator Stress:	3037	psf
Cor. Maximum Deviator Stress:	21.1	psi
Cor. Secant Modulus at 1/2 Peak Stress:	1.85E+05	psf
Strain at 50% Max Stress (e_{50}):	8.29E-03	in/in
Initial Tangent Modulus:	6.22E+05	psf
Atterbergs LL / PI:	70	50
Passing No. 200 Sieve:	83.1	%
Sampling Method:	2.8 in. Shelby Tube	
Type of Specimen:	Undisturbed	

Unconsolidated-Undrained Shear Strength	
1518	psf

Membrane Correction Factor (tsf) = 0.017

Specimen Trimming ID reference:



This test has been run to a maximum % strain of: 15.0

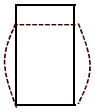
Measured Angle of Fracture from Horizontal: N/A

Remarks:

Sketch of Fracture:

Technician: L. Dailey Date: 12/29/2014

Picture of Fracture:



Barrel

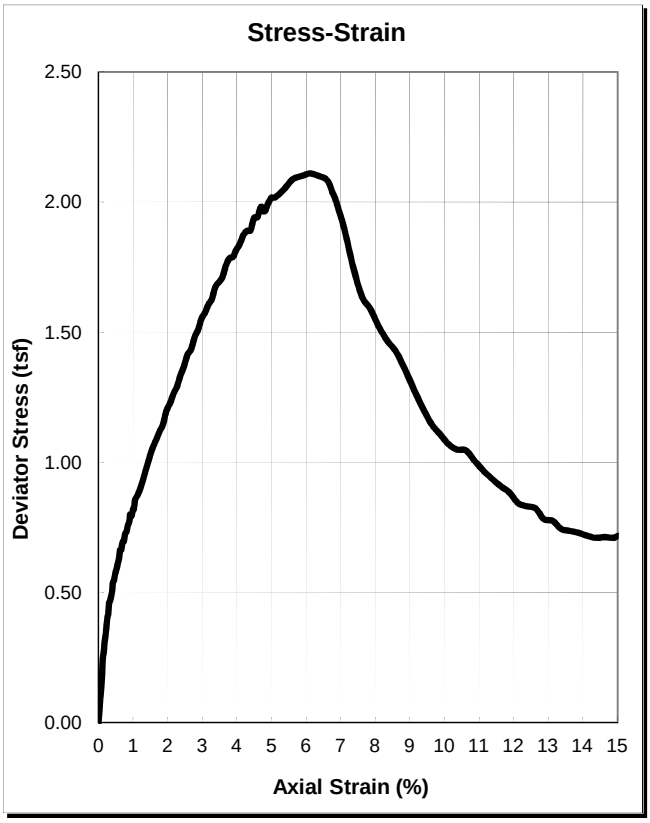
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ASTM D 2850 Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

Project:	Phase 1 Fly Ash Storage Embankment Investigation
Client:	AEP, Welsh Power Plant
Location:	Cason, Texas
Material:	Redd. Brown & Graysish Br. Sandy Lean Clay, (CL)

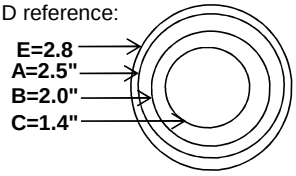


ETTL Project No.:	G 4207-14	
Boring No.:	B-10	
Sample No. / Depth (ft.):	33'-35'	
Specimen Trimming ID:	B	(trimmed)
Height:	4.452	inches
Diameter:	2.056	inches
Height / Diameter Ratio:	2.17	
Initial Moisture Content:	**22.1%**	(trimmings)
Initial Dry Unit Weight:	**107.4**	lbs./ft^3
Initial Total Unit Weight:	131.1	lbs./ft^3
Specific Gravity:	2.670	(assumed)
Initial Void Ratio:	0.552	
Initial Saturation:	100.0	%
Pocket Pentronmeter:	1.00	tsf
Hand Torvane:	N/T	tsf
Rate of Strain:	1.0	%/min
Chamber Pressure:	**20.7**	**psi**
Peak Strain:	**6.11**	**%**
Cor. Maximum Deviator Stress:	**2.10**	**tsf**
Cor. Maximum Deviator Stress:	4199	psf
Cor. Maximum Deviator Stress:	29.2	psi
Cor. Secant Modulus at 1/2 Peak Stress:	1.37E+05	psf
Strain at 50% Max Stress (e_{50}):	1.54E-02	in/in
Initial Tangent Modulus:	4.83E+05	psf
Atterbergs LL / PI:	N/T	N/T
Passing No. 200 Sieve:	N/T	%
Sampling Method:	Sample Trimmed, Shelby Tube	
Type of Specimen:	Undisturbed	

Unconsolidated-Undrained Shear Strength	
2099	psf

Membrane Correction Factor (tsf) = 0.010

Specimen Trimming ID reference:



This test has been run to a maximum % strain of: 15.0

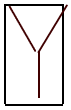
Measured Angle of Fracture from Horizontal: N/A

Remarks:

Sketch of Fracture:

Technician: L. Dailey Date: 12/29/2014

Picture of Fracture:



Cone

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APPENDIX C
Piezometer Data

WELSH POWER PLANT - PHASE 1 LANDFILL - PIEZOMETER DATA

Adjusted Water Elevation (feet)

PIEZOMETER	B-4	B-8	B-11	B-17	B-18	B-19	AD-1	AD-9	AD-11	AD-13	AD-14	Primary Pond	Secondary Pond
Top of Casing	381.32	375.12	381.37	348.76	348.71	372.78	357.57	343.09	342.18	347.00	345.43	336.2	340.01
Total Depth	45.09	44.59	44	32.56	32.49	25.29	28.71	37.15	22.1	19.2	21.27		
Date													
11/9/2014	350.68	339.44	355.43	333.14	333.03	356.29	337.49	330.18	327.97	332.01	330.17		
11/14/2014	350.71	339.29	355.32	332.74	332.76	356.14	337.34	329.76	327.93	331.89	329.99	333.15	329.69
11/18/2014	349.42	338.82	353.295	332.645	332.74	357.07	337.67	329.92	328.29	332	330.23		
11/25/2014	350.7	338.88	355.07	332.71	332.52	356.23	337.11	329.19	327.78	332.17	330.44	333.1	
12/3/2014	350.97	339.22	355.22	332.76	332.585	356.18	337.26	329.77	327.97	332.4	330.73	332.9	329.7
12/9/2014	351.03	339.2	355.1	332.86	332.51	355.93	336.67	329.99	327.83	332.38	330.88	332.9	329.5
12/16/2014	351.19	339.3	354.89	332.88	332.79	356.25	337.22	330.04	327.75	332.86	331.53	332.9	
12/23/2014	351.07	339.04	355.29	333.09	332.96	355.36	337.4	330.42	328.01	332.75	331.35	333.08	
High	351.2	339.4	355.4	333.1	333.0	357.1	337.7	330.4	328.3	332.9	331.5	333.2	329.7
Low	349.4	338.8	353.3	332.6	332.5	355.4	336.7	329.2	327.8	331.9	330.0	332.9	329.5
Average	350.7	339.1	355.0	332.9	332.7	356.2	337.3	329.9	327.9	332.3	330.7	333.0	329.6

APPENDIX E
SEISMIC DESIGN PARAMETERS

Design Maps Summary Report

User–Specified Input

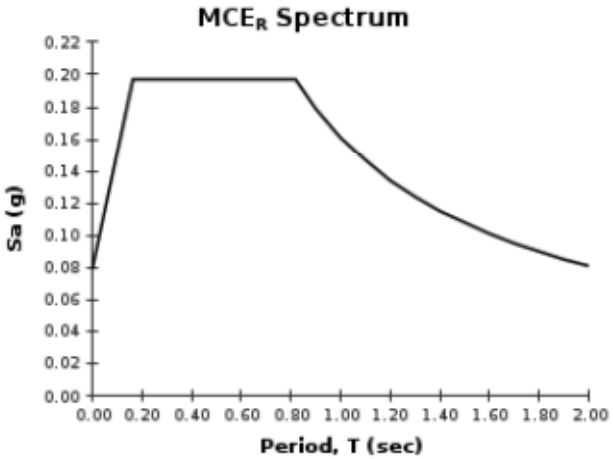
Report Title	AEP Welsh SES - Phase 1 Landfill Vertical Expansion Mon January 19, 2015 17:41:40 UTC
Building Code Reference Document	2009 NEHRP Recommended Seismic Provisions (which utilizes USGS hazard data available in 2008)
Site Coordinates	33.04776°N, 94.84488°W
Site Soil Classification	Site Class D – "Stiff Soil"
Risk Category	I/II/III

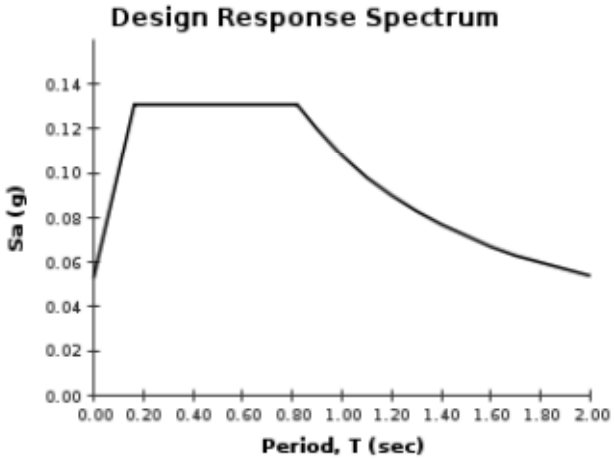


USGS–Provided Output

S_S =	0.123 g	S_{MS} =	0.197 g	S_{DS} =	0.131 g
S_1 =	0.067 g	S_{M1} =	0.161 g	S_{D1} =	0.108 g

For information on how the S_S and S_1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please view the detailed report.





For PGA_M, T_L, C_{RS}, and C_{R1} values, please view the detailed report.

Although this information is a product of the U.S. Geological Survey, we provide no warranty, expressed or implied, as to the accuracy of the data contained therein. This tool is not a substitute for technical subject-matter knowledge.

Design Maps Detailed Report

2009 NEHRP Recommended Seismic Provisions (33.04776°N, 94.84488°W)

Site Class D – "Stiff Soil", Risk Category I/II/III

Section 11.4.1 — Mapped Acceleration Parameters and Risk Coefficients

Note: Ground motion values contoured on Figures 22-1, 2, 5, & 6 below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_{SUH} and S_{SD}) and 1.3 (to obtain S_{1UH} and S_{1D}). Maps in the Proposed 2015 NEHRP Provisions are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 11.4.3.

Figure 22–1: Uniform–Hazard (2% in 50–Year) Ground Motions of 0.2-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B

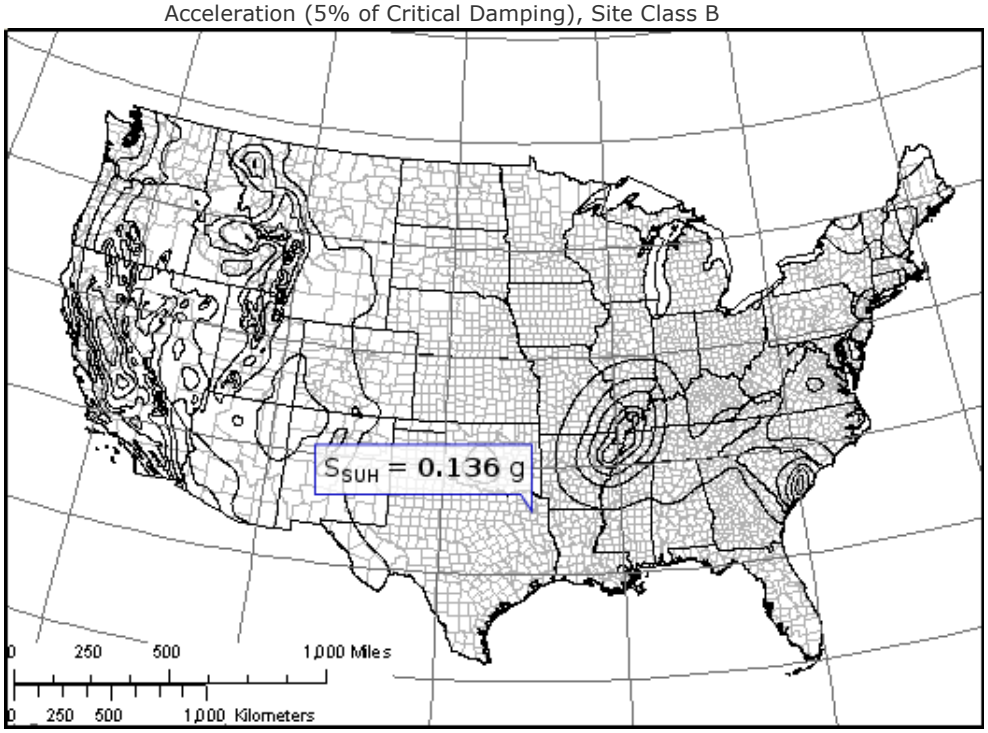
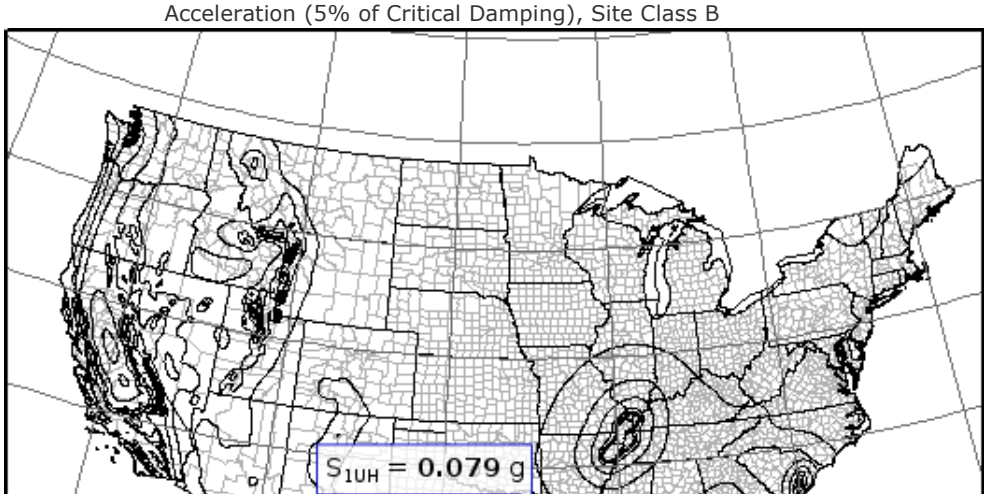


Figure 22–2: Uniform–Hazard (2% in 50–Year) Ground Motions of 1.0-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B



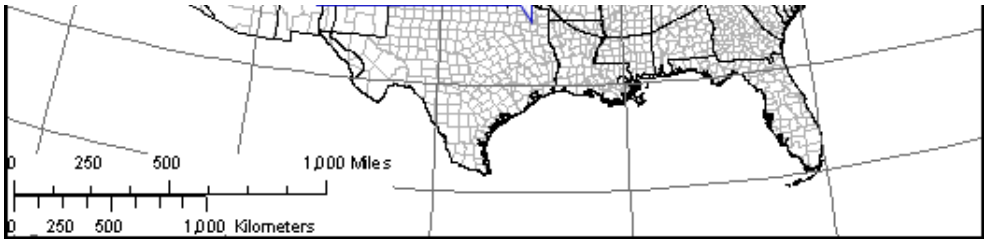

0 250 500 1,000 Miles
0 250 500 1,000 Kilometers

Figure 22–3: Risk Coefficient at 0.2-Second Spectral Response Period

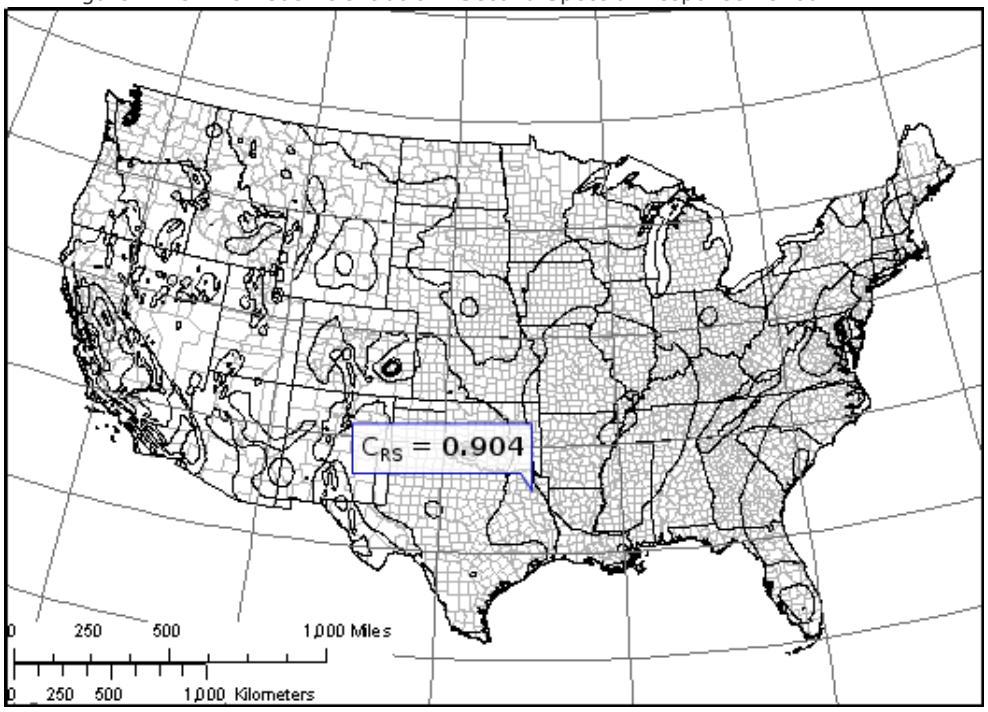


Figure 22–4: Risk Coefficient at 1.0-Second Spectral Response Period

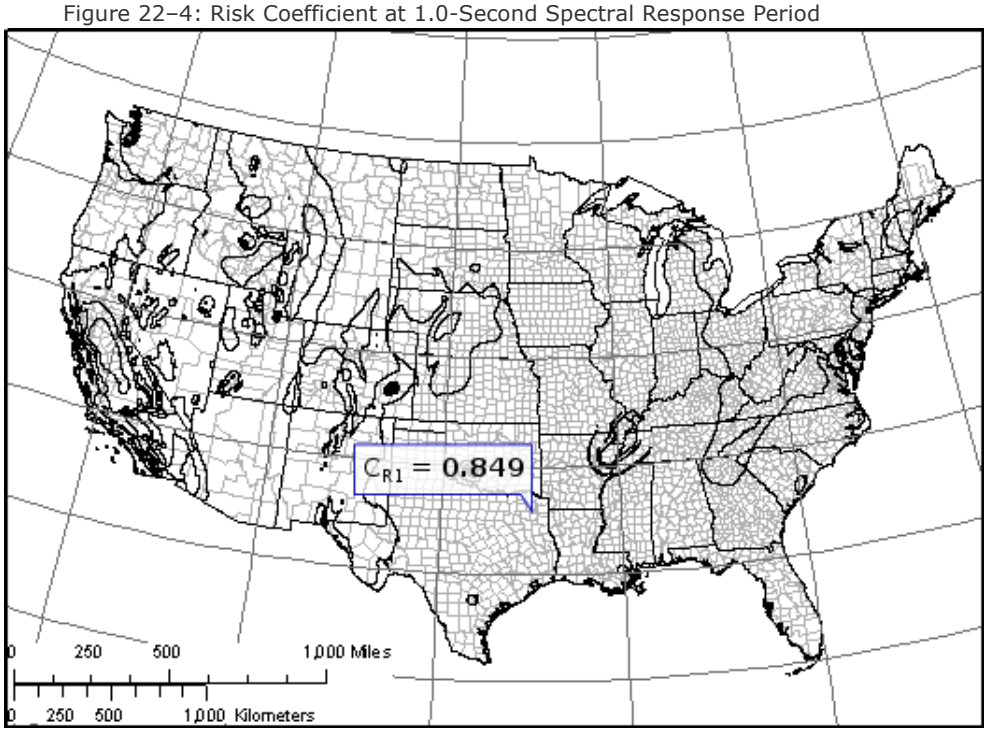


Figure 22–5: Deterministic Ground Motions of 0.2-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B

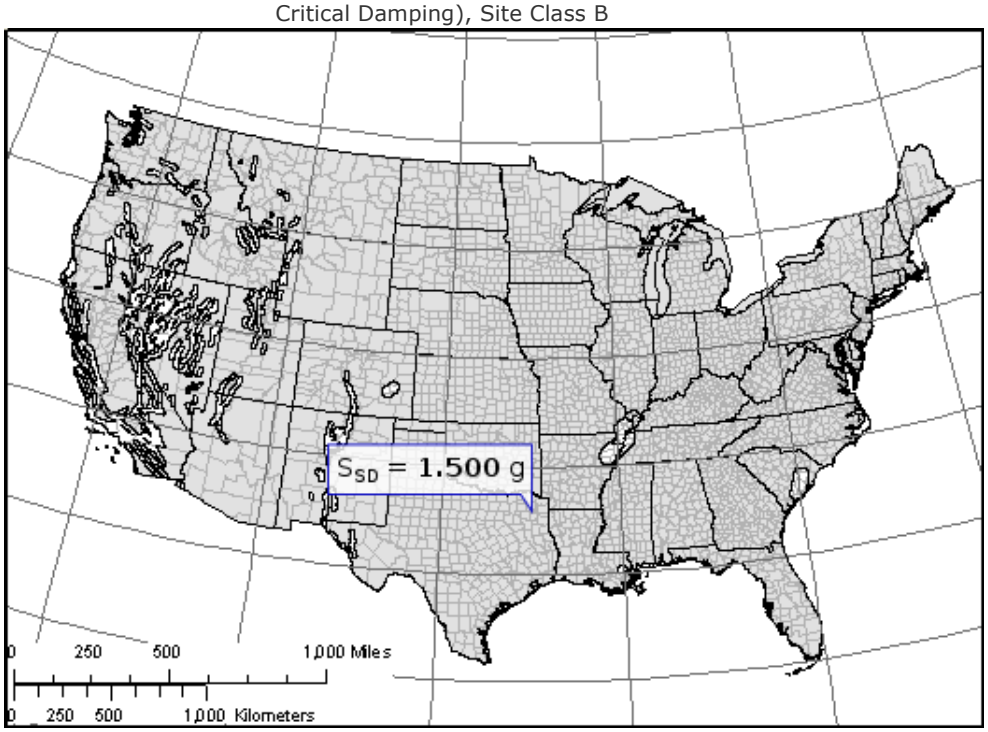
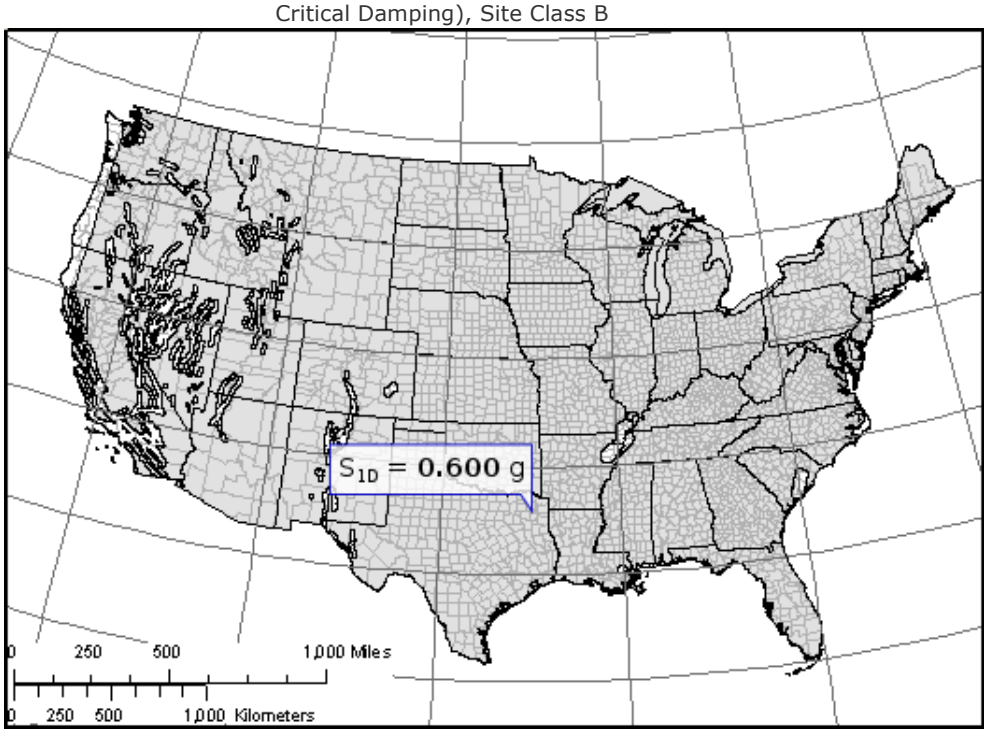


Figure 22–6: Deterministic Ground Motions of 1.0-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B



Section 11.4.2 — Site Class

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Chapter 20.

Table 20.3–1 Site Classification

Site Class	$\overline{v}_s$	$\overline{N}$ or $\overline{N}_{ch}$	$\overline{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index PI > 20, • Moisture content w ≥ 40%, and • Undrained shear strength $\overline{s}_u$ < 500 psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 11.4.3 — Site Coefficients, Risk Coefficients, and Risk–Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameters

Equation (11.4–1):	$C_{RS}S_{SUH}$ = 0.904 x 0.136 = 0.123 g
Equation (11.4–2):	S_{SD} = 1.500 g
S_S ≡ "Lesser of values from Equations (11.4–1) and (11.4–2)" = 0.123 g	
Equation (11.4–3):	$C_{R1}S_{1UH}$ = 0.849 x 0.079 = 0.067 g
Equation (11.4–4):	S_{1D} = 0.600 g
S_1 ≡ "Lesser of values from Equations (11.4–3) and (11.4–4)" = 0.067 g	

Table 11.4–1: Site Coefficient F_a

Site Class	Spectral Response Acceleration Parameter at Short Period				
	$S_S \leq 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = D and S_S = 0.123 g, F_a = 1.600

Table 11.4–2: Site Coefficient F_v

Site Class	Spectral Response Acceleration Parameter at 1–Second Period				
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \geq 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = D and S_1 = 0.067 g, F_v = 2.400

Equation (11.4–5): $S_{MS} = F_a S_S = 1.600 \times 0.123 = 0.197$ g

Equation (11.4–6): $S_{M1} = F_v S_1 = 2.400 \times 0.067 = 0.161$ g

Section 11.4.4 — Design Spectral Acceleration Parameters

Equation (11.4–7): $S_{DS} = \frac{2}{3} S_{MS} = \frac{2}{3} \times 0.197 = 0.131$ g

Equation (11.4–8): $S_{D1} = \frac{2}{3} S_{M1} = \frac{2}{3} \times 0.161 = 0.108$ g

Section 11.4.5 — Design Response Spectrum

Figure 22–7: Long–period Transition Period, T_L (s)

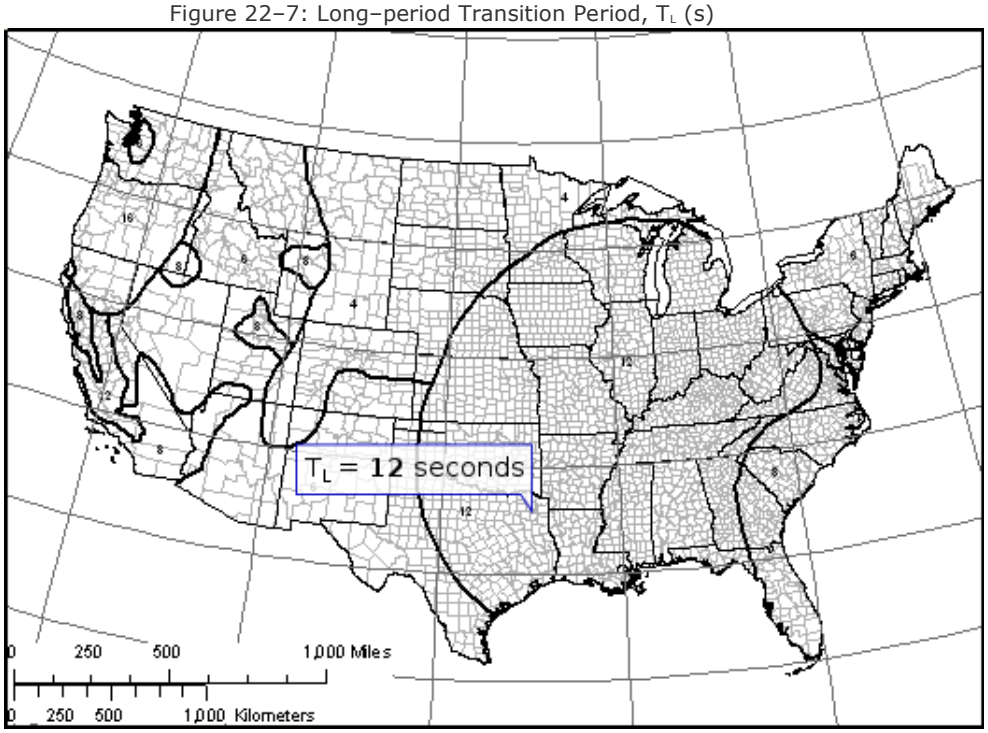
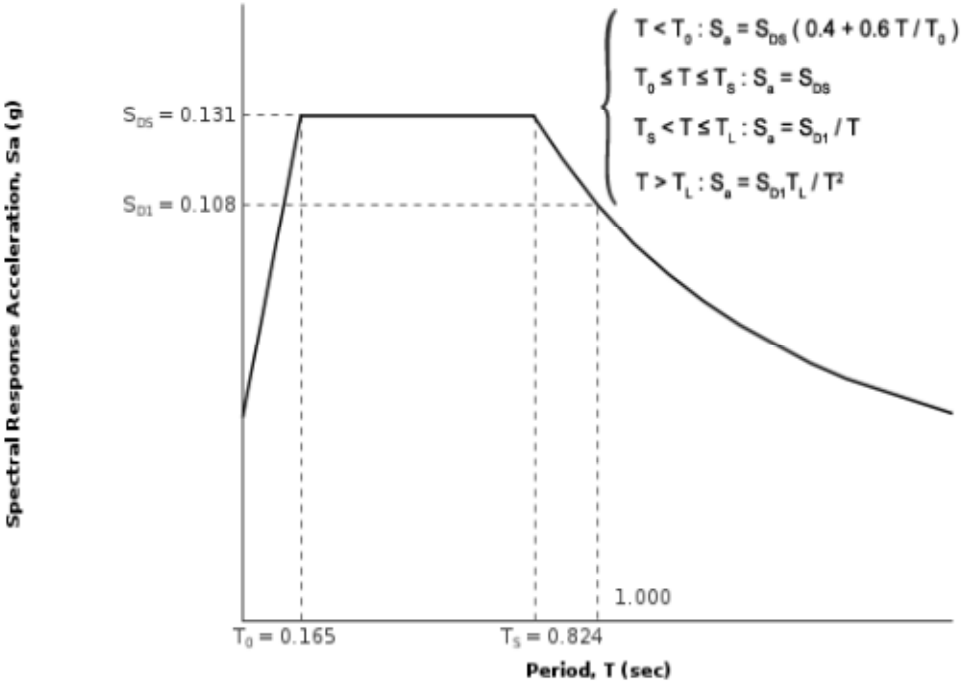
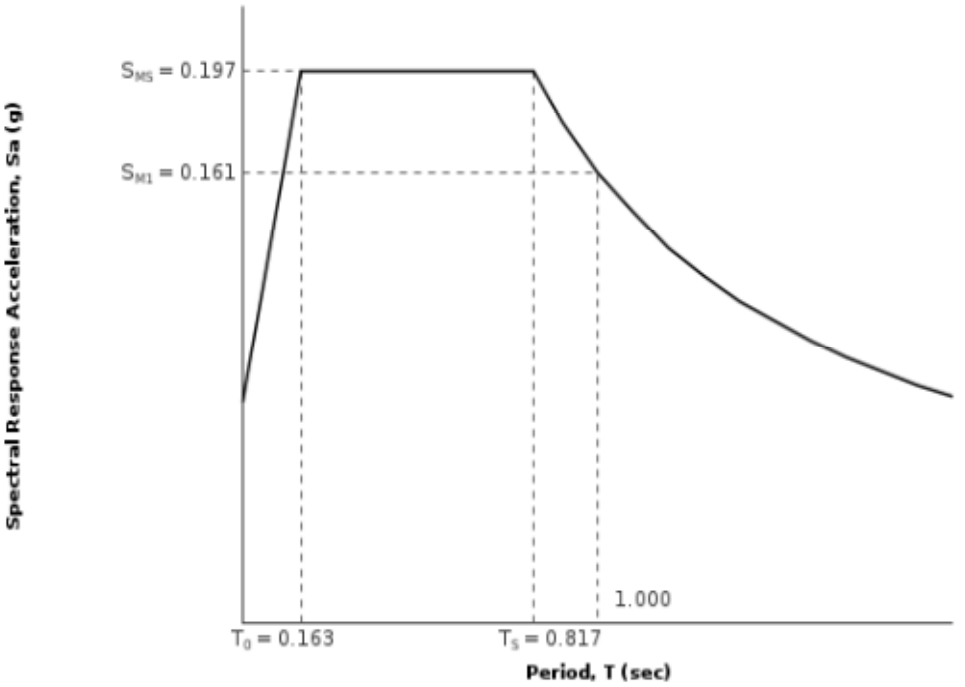


Figure 11.4–1: Design Response Spectrum



Section 11.4.6 — MCE_R Response Spectrum

The MCE_R response spectrum is determined by multiplying the design response spectrum above by 1.5.



Section 11.8.3 — Additional Geotechnical Investigation Report Requirements for Seismic Design Categories D through F

Table 11.8–1: Site Coefficient F_{PGA}

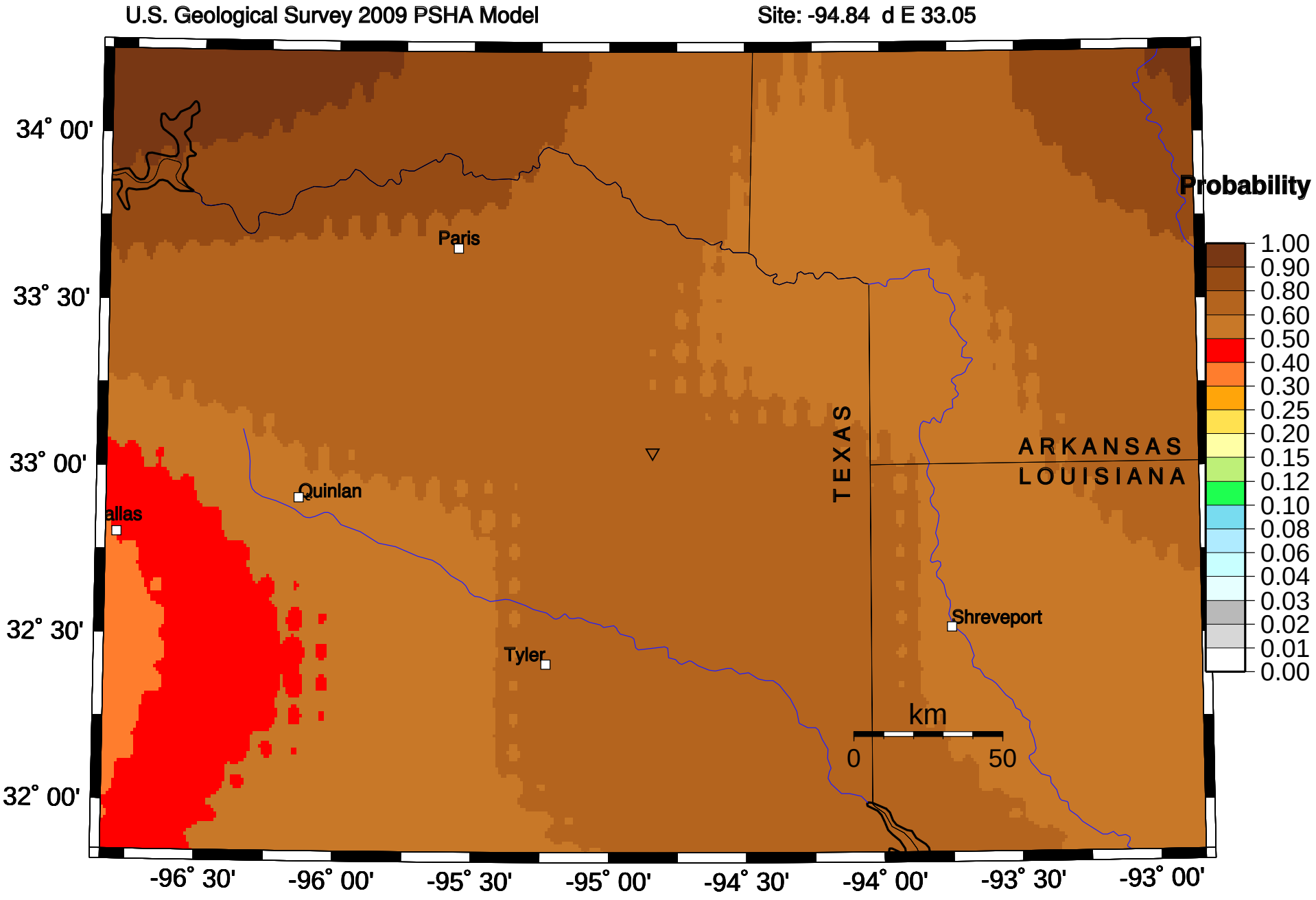
Site Class	Mapped MCE Geometric Mean Peak Ground Acceleration, PGA				
	PGA ≤ 0.10	PGA = 0.20	PGA = 0.30	PGA = 0.40	PGA ≥ 0.50
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of PGA

For Site Class = D and PGA = 0.058 g, F_{PGA} = 1.600

Mapped PGA	PGA = 0.058 g
Equation (11.8–1):	$PGA_M = F_{PGA}PGA = 1.600 \times 0.058 = 0.093$ g

Probability of earthquake with M > 5.0 within 10000 years & 50 km



GMT 2015 Jan 22 01:10:26 **Earthquake probabilities from USGS OFR 08-1128 PSHA. 50 km maximum horizontal distance. Site of interest: triangle. Epicenters mb>5 black circles; rivers blue.**

ATTACHMENT 2B

Phase 2 Landfill (Slope stability, Settlement, and Final Cover System Design Report)

Coal Combustion Residuals (CCR) Landfill: Phase 2 Final Closure Stability and Settlement Assessment

J. Robert Welsh Power Plant
Pittsburg, Texas

Auckland Project No. 2024-033
August 12, 2025

Prepared For:

SWEPCO – AEP Welsh Power Plant
1187 County Road 4865
Pittsburg, Texas 75686

Prepared By:

Auckland Consulting, LLC
Jacksonville, Texas
(903) 483-1568

TBPE Firm Registration No. F-16721
Expires 2/28/2026

Auckland Consulting LLC

August 12, 2025

Mr. Shahriyar Baig, P.E.
SWEPCO – AEP Welsh Power Plant
1 Riverside Plaza
Columbus, Ohio 43215
Email: sbaig@aep.com

RE: CCR Landfill: Phase 2 Final Closure Stability and Settlement Assessment
J. Robert Welsh Power Plant
Pittsburg, Texas
Auckland Project No. 2024-033, FINAL

Dear Mr. Baig:

Auckland Consulting, LLC (Auckland) has completed the following stability and settlement assessment for the above-referenced facility. Services, including requested additional laboratory work were performed in accordance with the authorized scope of work.

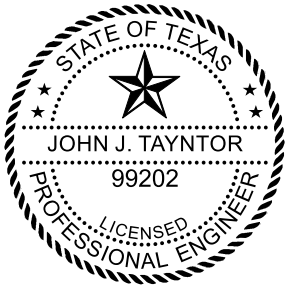
The purpose of this evaluation was to review available subsurface data and provide information pertaining to the stability and settlement data for anticipated site development. The information provided in this report is based on available information and laboratory analysis of collected materials at the site.

We appreciate the opportunity to provide consultation services for the referenced project. If you have any questions regarding the information presented in this report please do not hesitate to contact us.

Best regards,



John J. Tayntor, P.E.
Auckland Consulting LLC
TBPE Registration No. F-16721, Expires 2/28/2026



08/12/2025

Enclosures

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Appendices

1.0 Introduction and Landfill Expansion Information

1.1 Introduction

The following report presents the findings of the recently completed slope stability and settlement analyses for the proposed Phase 2 Final Closure of the existing Coal Combustion Residual (CCR) landfill located at the J. Robert Welsh Power Station (Welsh) near Pittsburg, Texas.

Drilling activities to evaluate the landfill's Phase 2 (western) area began on February 3, 2025, and were completed on February 7, 2025. Soil samples were submitted to the laboratory on February 17, 2025, and the results were provided on March 14, 2025. Additionally, bulk CCR (ash) samples collected by the client from the landfill were sent for material strength testing on May 28, 2025. These results and findings are provided in the Appendix and were used to update the stability models provided herein.

1.2 Referenced Information and Data

The historical subsurface and design data utilized in this assessment were provided by the client and included evaluations completed by MTG Engineers and Surveyors (MTG) titled *Welsh Ash Landfill – Closure Grading Plan, Optimized 3H:1V Side Slope* Version provided April 2023; *Project Drawings for the 2021 Welsh Power Plant BASP Closure-By-Removal and Landfill Modifications, Engineer's Project No. 217001,* dated October 2021; *Welsh Power Plant 2016-2017 Ash Landfill Cap and Cover Project, Soil Cap and Cover Evaluation Report* dated October 27, 2017; *Welsh Power Plant 2018-2019 Ash Landfill Cap and Cover Project (Phase 2) Soil Cap and Cover Evaluation Report* dated September 19, 2019; and *Welsh Power Plant Welsh Ash Landfill Soil Borrow Investigation and Plan* dated January 29, 2018. In addition, subsurface data and laboratory information provided in ETTL Engineers and Consultants, Inc. report titled *Phase 1 Landfill Seepage Evaluation and Final Stability of Vertical Expansion, Geotechnical Investigation – Final Report, ETTL Job No. G4207-14,* dated April 16, 2015, was also utilized in our assessment of the eastern portions of the landfill. Auckland was not involved in the original evaluation discussed in these referenced reports; however, we have made a cursory review of the presented data, and it appears applicable to this assessment.

The proposed elevation data and geometry used in our updated analyses and models are based on information recently provided by MTG titled *Project Drawings for the 2024 Welsh Power Plant Phase 2 Landfill Construction*, *Engineer's Project No. 237008*, dated August 25, 2024, and Sheet No. 300225 dated June 16, 2025. Furthermore, references to current and estimated leachate elevations in the waste material were derived from data provided by piezometers that were abandoned in 2022 and HELP Model estimations.

Final Veneer Stability. The stability evaluation, including supporting laboratory results for the proposed final cover section or veneer, was provided in Auckland's report titled *Coal Combustion Residuals (CCR) Landfill: Final Closure, Stability and Settlement Assessment, J. Robert Welsh Power Plant, Project No. 2023-007* dated October 26, 2023, and is not included here. We understand that the proposed final veneer has not changed; therefore, no additional study was necessary or conducted.

1.3 Design and Model Criteria

Landfill Expansion and Final Closure. The vertical expansion and final closure area encompasses the entire footprint of the existing landfill, covering approximately 38 acres. The final closure will accommodate the disposal of material excavated from the Primary Ash Pond and other locations around the Plant. Currently, most of the disposed ash material is located in the central and eastern portions of the landfill, while the western portions are being utilized for fly-ash processing efforts and offsite sales.

It is our understanding that waste placement will be completed in multiple fills or lifts consisting of stable material, along with integrated water control terraces, stability dikes, or berms. The anticipated finished maximum side slopes are 3:1 (horizontal to vertical), with a maximum total waste depth of approximately 79 feet, at maximum proposed elevations of 408 and 425 feet, MSL (west and east areas). The landfill's final cap and cover will comprise a synthetic membrane (ClosureTurf or similar) with underlying intermediate soils. We understand that stability dikes were used in constructing the northern and eastern faces of the landfill; however, no specific design and construction information was available, and therefore, these features were not included in our evaluation.

The critical slope sections or areas of potential soil sensitivity (slope stability analysis) based on existing and landfill geometry are identified as the North, East and West Sections. These critical sections are depicted in Figure 2, provided in the Appendix.

The surcharge load used for settlement analyses is based on the loads created by the aforementioned fill placement and a compacted ash unit weight of approximately 100 pounds per cubic foot (pcf). The actual build-out and placement of ash material may differ from what is shown in Figure 3; however, the design geometry has been simplified for modeling purposes. The settlement analysis considers both the potential immediate (or elastic) and long-term consolidation of foundation soils. Compression of placed, compacted, and landfilled ash materials for this assessment is assumed to be negligible. Tolerances for maximum and differential settlement are currently unknown for the planned liner and leachate collection systems.

West Landfill Slope and Stability Dike. Preliminary design schematics indicate that the West Stability Dike (or embankment) will generally extend along the western slope and wrap to the south and north of the landfill boundary. The stability dike is expected to continue from the existing south stability dike, with an anticipated maximum height of 15 feet, a crest width of approximately 10 feet, and inside and outside side slopes of 3:1 (H:V), respectively. Per the client's request, stability modeling of the proposed west slope was completed with and without the stability dike.

Borrow material for the stability dike is assumed to consist of onsite lean or fat clay (CL or CH) material identified as Sample No. 2 in the referenced reports. No additional subsurface investigation or laboratory testing was performed.

2.0 Field and Laboratory Testing

2.1 Field Activities

The subsurface exploration involved advancing six borings across the western portions of the existing landfill. These borings were completed to approximate termination depths ranging from 40 to 60 feet. After completion, boreholes were filled (full depth) with a bentonite-cement grout using a tremie line. Boring BH2 was initially located in the vicinity of a stormwater detention basin, and subsequently relocated to avoid soft conditions at the time of field activities. Boring locations are provided in Figure 1 in the Appendix.

Drilling Methods. Field operations were conducted in general accordance with ASTM procedures or other accepted practices. Soil borings were drilled using a track-mounted Geoprobe drilling rig equipped with a rotary head and hollow-stem augers (HSA).

Soil Sampling. Sample intervals were semi-continuous in the upper 10 feet of each boring, followed by five-foot intervals unless directed otherwise by the onsite engineer. Split-spoon (Standard Penetration Test, SPT) or disturbed samples were collected in general accordance with ASTM Standard Method D 1586. Relatively undisturbed soil samples were obtained using tube samplers in accordance with ASTM D 1587 and extruded in the field. All samples were sealed in plastic to protect against moisture loss. The soil shear strength of undisturbed samples was initially assessed using a calibrated hand penetrometer.

The collected samples were subsequently examined and selected for laboratory testing by a geotechnical engineer.

Boring Logs. The general subsurface soil and groundwater conditions observed during field activities are outlined in the boring logs located in this report's Appendix. The information provided in the boring logs includes groundwater levels, laboratory test results, penetration resistance, and soil classifications according to the Unified Soil Classification System (USCS).

Groundwater Level Measurements. Observations of groundwater levels recorded during field activities are detailed in the boring logs included in the Appendix of this report.

2.2 Laboratory Testing Program

Laboratory testing was conducted on selected samples to aid in the classification of the encountered soils and to assess the physical and engineering properties of the subsurface soils. Testing was also carried out on collected bulk samples of ash material to determine material strength properties. Results from these laboratory tests are available on boring logs or in individual test reports included in the Appendix. Laboratory tests were performed in accordance with ASTM procedures cited in the table below.

Laboratory Test	Test Designation
Atterberg Liquid Limit and Plastic Limit Determination	ASTM D4318
Percentage Soil Passing No. 200 Sieve	ASTM D1140
Particle Size Analysis for Soils	ASTM D6913
Moisture Content Determination	ASTM D2216
One-Dimensional Consolidation of Soils	ASTM D2435
Multi-Stage Consolidated – Undrained Triaxial Compression	ASTM D4767, Modified
Unconsolidated Undrained (UU) Triaxial Compression	ASTM D2850
Direct Shear Consolidated Drained Test	ASTM D3080
Standard Proctor (Moisture -Density Compaction Test)	ASTM D698
Consolidated Undrained (CU) Triaxial Compression	ASTM D4767

Soil samples not utilized in laboratory testing will be retained for approximately 30 days from report issuance date and then disposed of unless requested in writing by the client.

3.0 Site Conditions

3.1 General

Interpretation of soil and groundwater conditions for the project site is based on information obtained from our recent fieldwork and referenced documents. Subsurface conditions may vary in areas not evaluated.

3.2 Subsurface Soil Stratigraphy

The generalized subsurface profile for the Phase 2 area consists of medium dense to dense clayey sand (SC) and silty sand (SM), stiff to hard lean clay (CL), and fat clay (CH) overlying dense to very dense silty clayey sand (SC-SM) and clayey sand (SC). The soils encountered in the western portions of the landfill are predominantly similar to those found in the eastern portions.

For the eastern portions of the landfill, the generalized subsurface stratigraphy and soil profiles are based on subsurface information provided by ETTL in their report titled *Phase 1 Landfill Seepage Evaluation and Final Stability of Vertical Expansion, Geotechnical Investigation – Final Report, ETTL Job No. G4207-14* dated April 16, 2015 (referenced sections included in the Appendix). These profiles indicate that soils underlying the landfill generally consist of soft to medium stiff lean and fat clay (CL/CH) overlying very dense silty sand (SM) and sandy silt (ML), underlain by hard fat clay (CH).

The borehole logs referenced in the Appendix of this report offer additional information on subsurface soil properties, soil engineering properties, and relative stratigraphy, and they should be reviewed for more detail.

3.3 Groundwater Referenced Data

Groundwater levels below the landfill were not monitored as part of this evaluation. However, based on recent measurements of up- and downgradient monitoring wells provided in the *Annual Groundwater Monitoring Report, Landfill CCR Management Unit,* dated January 2025, we have assumed a groundwater elevation of 335 feet and 345 feet, MSL, for the east and west landfill areas, respectively.

Groundwater levels may fluctuate due to climatic and seasonal variations, as well as changes in land use or drainage patterns, and should be verified prior to construction. The installation of piezometers to assess long-term groundwater conditions and for follow-up monitoring was not included in the scope of services.

4.0 Slope Stability Analyses

4.1 General

Model sections and material strength parameters used for stability analyses of the completed landfill are based on recent findings and referenced previous studies conducted at the Welsh Power Plant. Soil parameters are presented in the respective stability model analysis graphic. Probable failure planes were analyzed using the analytical slope stability software SLIDE, developed by Rocscience, Inc. The evaluation methods used in SLIDE are classified as limit equilibrium methods of analysis, in which each individual shear plane is examined to determine the resulting shear stress at the point of failure. The Bishop Method of analysis, which assesses circular failure planes through the slope, was employed for this evaluation. Block or wedge failure analysis was conducted to evaluate factors of safety for specific failures occurring at the liner interface.

The profiles utilized in the stability analyses generally depict the North, East, and West Sections (with and without) the Stability Dike upon completion of disposal activities with a maximum section waste height ranging between 79 and 48 feet, respectively. These sections were selected because they represent the deepest areas of potential waste placement and subsurface soil sensitivity to loading. Block or wedge failure analyses were also conducted along the interface of the in-situ clay liner and the disposed of ash. This interface represents a probable slip surface for an assumed homogeneous mass block failure of disposed material. For the results included herein, active support (resisting forces) is assumed to decrease the driving force and assumes no movement has taken place.

Strength parameters of existing soils were determined either by referenced laboratory analyses, available field penetration testing of past evaluations or empirical correlations with soil index properties. Selected soil parameters are presented on the respective stability analyses and following tables.

Summary of Total Stress Soil Parameters North and East Sections			
Material Type	**Unit Weight (pcf)**	**Cohesion (psf)**	**Angle of Internal Friction (degrees)**
New Ash	100	150	12
Existing Ash	100	0	25
Lean/Fat Clay (CL/CH)	125	250	18
Silty Sand/Sandy Silt (SM/ML)	125	0	29
Fat Clay (CH)	125	400	14
NOTE: Properties based on Consolidated-Undrained (CU) Triaxial Testing, assumption of undrained material conditions and field results.			

Summary of Effective Stress Soil Parameters North and East Sections			
Material Type	**Unit Weight (pcf)**	**Cohesion (psf)**	**Angle of Internal Friction (degrees)**
New Ash	100	0	30
Existing Ash	100	0	29
Lean/Fat Clay (CL/CH)	125	150	27
Silty Sand/Sandy Silt (SM/ML)	125	0	34
Fat Clay (CH)	125	300	22
NOTE: Properties based on Consolidated-Undrained (CU) Triaxial Compression, Direct Shear Testing, and field results.			

Summary of Total Stress Soil Parameters West Section and Stability Dike			
Material Type	**Unit Weight (pcf)**	**Cohesion (psf)**	**Angle of Internal Friction (degrees)**
New Ash Fill	100	150	12
Embankment Fill	125	200	15
Clayey Sand/Silty Sand (SC/SM)	125	0	25
Lean/Fat Clay (CL/CH)	125	250	18
Silty Sand/Sandy Silt (SM/ML)	125	0	29
Fat Clay (CH)	125	400	14
NOTE: Properties based on Consolidated-Undrained (CU) Triaxial Testing, assumption of undrained material conditions and field results.			

Summary of Effective Stress Soil Parameters West Section and Stability Dike			
Material Type	**Unit Weight (pcf)**	**Cohesion (psf)**	**Angle of Internal Friction (degrees)**
New Ash Fill	100	0	30
Embankment Fill	125	100	25
Clayey Sand/Silty Sand (SC/SM)	125	0	25
Lean/Fat Clay (CL/CH)	125	150	27
Silty Sand/Sandy Silt (SM/ML)	125	0	34
Fat Clay (CH)	125	300	22
NOTE: Properties based on Consolidated-Undrained (CU) Triaxial Compression, Direct Shear Testing, and field results			

4.2 Probabilistic-Sensitivity Evaluation

To evaluate the effect of leachate elevation variability on the structural stability of the landfill, each slope stability analysis includes a normalized mean statistical analysis. Finite element analysis (FEA) was utilized to assess the safety factors for the probable minimum ($W_{(min)}$) and maximum ($W_{(max)}$) leachate elevations in the landfill. Leachate elevations used in the stability models are based on data from the landfill piezometers and estimates generated by the Hydrologic Evaluation of Landfill Performance (HELP) models. A normalized mean leachate elevation ($W_{(mean)}$) was established

between the maximum and minimum leachate elevations. The analysis evaluated stability and corresponding safety factors in 50 equal increments between the maximum and minimum elevations.

The mean leachate elevations for the North, East, and West Sections used in our analyses are 349, 354, and 364 feet, MSL, respectively. The determination of the modeled failure plane and the corresponding factor of safety in the North and East Sections is based on the mean elevation ($W_{(mean)}$).

4.3 Seismic Loading – End of Construction

For the evaluation of End of Construction with seismic loading conditions, the peak ground acceleration for this location was obtained from the USGS Earthquake Hazards Program website (http://earthquake.usgs.gov/hazards), ASCE 7 Hazard Tool using the ASCE/SEI 7-16 guidance and referenced material in the Appendix. Based on the ASCE/SEI 7-16 guidance, the anticipated site-specific ground acceleration (PGA) is 0.058g (acceleration at rock sites) for a two (2) percent probability of exceedance in 50 years. Correcting for stiff soil sites (Site Classification D and Site Coefficient, F_{PGA} = 1.6) yields an estimated maximum geometric mean peak ground acceleration (PGA_M) of 0.093g (e.g., $PGA_M = [F_{PGA}][PGA] = [1.6][0.058g] = 0.093g$). The seismic coefficient (k) used for pseudo-static analysis is the same as the PGA_M for the site.

4.4 Slope Stability Results

The following table presents the safety factors the slope stability model determines for the end of construction with the referenced maximum assumed disposal height. Simulations were performed using total (including seismic loading) and effective stresses. Model graphical outputs are provided in the Appendix of this report.

The minimum factor of safety (FS) against mass movements is based on information from the Texas Commission on Environmental Quality (TCEQ) for Class 2 Industrial Nonhazardous Landfill facilities.

Summary of Stability Analyses – East Section		
Evaluated Condition	**Factor of Safety[1]**	
	Actual	**Minimum**
End of Construction – Effective Stress	1.7	1.3
End of Construction – Total Stress	1.3	1.3
End of Construction – Seismic Loading	1.0	1.0
End of Construction – Block/Wedge	1.5	1.3
NOTE: 1. Minimum factors of safety based on guidance provided by the Texas Commission on Environmental Quality (TCEQ).		

Summary of Stability Analyses – North Section		
Evaluated Condition	**Factor of Safety[1]**	
	Actual	**Minimum**
End of Construction – Effective Stress	1.7	1.3
End of Construction – Total Stress	1.3	1.3
End of Construction – Seismic Loading	1.0	1.0
End of Construction – Block/Wedge	1.7	1.3
NOTE: 1. Minimum factors of safety based on guidance provided by the Texas Commission on Environmental Quality (TCEQ).		

Summary of Stability Analyses – West Section with Stability Dike		
Evaluated Condition	**Factor of Safety[1]**	
	Actual	**Minimum**
End of Construction – Effective Stress	1.8	1.3
End of Construction – Total Stress	1.3	1.3
End of Construction – Seismic Loading	1.0	1.0
End of Construction – Block/Wedge	1.8	1.3
NOTE: 1. Minimum factors of safety based on guidance provided by the Texas Commission on Environmental Quality (TCEQ).		

Summary of Stability Analyses – West Section without Stability Dike		
Evaluated Condition	**Factor of Safety[1]**	
	Actual	**Minimum**
End of Construction – Effective Stress	1.8	1.3
End of Construction – Total Stress	**1.1[2]**	1.3
End of Construction – Seismic Loading	**0.8[2]**	1.0
End of Construction – Block/Wedge	1.6	1.3
NOTE: 1. Minimum factors of safety based on guidance provided by the Texas Commission on Environmental Quality (TCEQ). 2. The modeled factor of safety is less than minimum.		

Based on the findings of these analyses, the results from the model indicate that the proposed landfill west section expansion without the stability dike is not structurally stable when seismic loading, undrained end of construction, or total stress parameters are modeled. However, the west section with the stability dike (as provided in the design) appears stable under the modeled conditions and mean leachate elevations presented here. Construction of the west section of the landfill should include a stability dike.

5.0 Settlement Analysis

5.1 General

Settlement analyses included evaluating soil profiles and information from our recent findings and referenced data. Settlement analyses were performed using Settle3D software developed by Rocscience. Settle3D is a three-dimensional program for analyzing vertical settlement and consolidation under surface loads. Settle3D calculates three-dimensional stresses due to surface loads; however, settlement (or displacement) and pore pressures are computed in one dimension, assuming that only vertical displacements can occur. Furthermore, the Boussinesq Stress Computation Method of analysis was utilized for this evaluation. The Boussinesq method uses the theory of soil elasticity to calculate the vertical stress under a point load in a homogeneous, semi-infinite half-space.

The review of available laboratory data compiled for this evaluation generally correlates with the previously collected data. Estimated groundwater levels were adjusted in the model to reflect recent field observations and annual reports, as referenced herein.

5.2 Landfill Foundation Soils

The modeled profiles provided herein primarily focus on foundation soils that will consolidate under load. The compressive and consolidation properties of the modeled soils are based on both historical and recent laboratory analyses, along with empirical correlations with field penetration test results outlined in the reference documents. Soil parameters used to evaluate potential estimated settlement are presented in each respective model output. Results from recent and referenced consolidation testing are included in the Appendix. Soil parameters used for evaluating potential estimated settlement are provided in the following table.

Summary of Consolidation Parameters for Cohesive Foundation Soils					
Material Type	**Unit Weight (pcf)**	**C_C[1]**	**C_R[1]**	**OCR**	**e_0**
Lean Clay – Upper (CL_1)	125	0.120	0.014	17	0.637
Fat Clay (CH)	125	0.130	0.037	6.4	0.670
Lean Clay – Lower (CL_2)	125	0.178	0.018	5.7	0.706
NOTE: 1. Compression and recompression indices obtained from 1-D Consolidation laboratory tests and referenced data.					

Summary of Elastic Parameters for Cohesionless Foundation Soils			
Material Type	**Unit Weight (pcf)**	**E_s**	**E_r**
Clayey Sand/Silty Sand (SC/SM)	125	750 ksf	750 ksf

Based on our findings, the material properties of underlying soils are generally uniform across the landfill.

5.3 Settlement Analysis Results

For modeling purposes, the waste placement is considered under final loading conditions and the general grading or geometry presented herein. The proposed placement of waste material will have a depth ranging from approximately 40 feet (EL. 400 feet, MSL) to about 79 feet (EL. 425 feet, MSL), from west to east. As noted earlier, slopes were assumed to have a maximum ratio of 3:1 (horizontal to vertical). The unit weight of the waste was assumed to be 100 pounds per cubic foot (pcf) throughout the entire depth. Model study areas and their corresponding load conditions are illustrated in Figure 3 in the Appendix. The estimated settlement under final waste placement is provided in the following table.

Estimated Settlement Summary – Foundation Soils Phase 2 Final Closure	
Disposal Stage	**Total Settlement [1] (inches)**
Phase 2 Final Closure	8.8
NOTE: 1. Settlement values do not include consolidation of disposed ash material.	

Plots illustrating the final stage and queries as derived from Settle3D and model data are presented in the Appendix of this report.

5.4 Installation of Settlement Plates - Optional

The installation of settlement plates at various locations throughout the disposal area should be considered to monitor and document actual settlement as ash disposal elevation increases. Collected data from settlement plates would provide actual settlement data points, allowing the correlation and comparison to the estimated modeled settlement values provided above. In the event observed settlement values (as obtained from settlement plates) exceed those estimates provided herein, the height and extent of the landfill might require additional review or modification to prevent structural failure.

6.0 West Stability Dike Construction Recommendations

6.1 General

The following offers general construction guidance for the West Stability Dike and may include conditions not encountered at this specific site. For additional information, please refer to the design schematics and engineering design.

6.2 Onsite Borrow Soils

At the time this report was prepared, various onsite borrow areas were being evaluated for suitability for this project. Prior to use in stability dike or embankment construction, borrow soils should be laboratory tested (including for dispersive characteristics) to meet the minimum shear strength (total and effective stress) design criteria (cohesion [c] and internal friction angle [phi, Φ]) utilized in the stability assessment provided herein. Advanced laboratory testing, engineering review and additional model analysis may be required prior to use of selected borrow material(s) and should be anticipated prior to construction.

6.3 Subgrade Preparation

Prior to construction of the slope foundation and embankment foundation, topsoil, organics, pooled water and loose (or saturated) soils should be removed. After removal of vegetation and topsoil, the exposed embankment subgrade should be proofrolled to confirm stability. Proofrolling should be performed with a fully loaded tandem axle dump truck or similar equipment with a minimum gross weight of 20 tons (recommended). Proofrolling should consist of several overlapping passes. If proofrolling is not feasible due to spatial constraints, then areas should be hand probed and verified firm and stable by a qualified soil technician. Any identified loose or yielding areas should be excavated to firm soil and replaced with properly placed select fill or approved fill material. Dependent on subgrade conditions during construction, the use of a bridge lift may be necessary.

Subgrade soils should be stable before placement of fill material. Subgrade stability should be verified by proofroll inspection. Subsequent to proofrolling and immediately prior to placement of select fill, the exposed subgrade should be scarified and compacted to a minimum 95% Standard Proctor (ASTM D 698) of the maximum dry density ranging from one percent below (-1%) of optimum moisture content to three percent above (+3%) Standard Proctor and the excavation backfilled with properly placed (moisture and density controlled) approved fill material to finished grade elevation.

During placement of soils for the modifications, the existing embankment should be benched with successive lifts to allow uniformity and continuity between the existing embankment and placed soil. Bench widths made into the existing embankment should range between 1½ to two (2) feet per lift. Prior to placement, organics and topsoil should be removed from the existing embankment.

6.4 Approved Fill Criteria

Stability Dike (Embankment) Material. Material used for construction of the stability dike should consist of clayey sand (SC), sandy lean clay (CL) or sandy fat clay (CH) material with a liquid limit between 20 and 50 and plasticity index between 15 and 40. Core material should have a minimum 40% passing the No. 200 sieve. All fill should be free of organics (or debris), have a maximum particle size of three (3) inches and relatively consistent material properties throughout.

Fill material should be placed in thin, loose lifts not exceeding eight (8) inches, and moisture content between optimum and three percentage points above (+3%) the optimum moisture content and compacted to a minimum 95% of the maximum density as determined by Standard Proctor test (ASTM D 698). Water should be added uniformly and mixed thoroughly into the soil by disking or scarifying.

Cover Material. Salvaged topsoil or similar soils should be utilized along the side slopes of the completed stability dike to promote vegetative growth and reduce erosion. Topsoil should not be used in the core construction of the stability dike. Soils used for vegetative cover may require augmentation with fertilizer and lime to establish and promote growth.

6.5 Construction Inspection and Quality Control

During construction activities, continued laboratory testing of borrow material is crucial to the project. Soils that do not meet the minimum criteria provided herein or per design plans should not be used for stability dike embankment construction. Prior to commencement of construction activities, borrow sources should be identified, laboratory tested and approved to minimize delay (and rework) and placement of soils.

The following are minimum recommended field-testing criteria:

- One (1) field moisture density test for every 2,000 cubic yards of compacted fill (at least one [1] test per lift);
- One (1) field moisture density test for every 200 cubic yards of compacted fill in trenches or around structures (at least one [1] test per lift);
- Conduct ongoing and periodic classification testing of borrow material to include Atterberg Limits, Percentage of Fines and Crumb Tests;
- Maintain a maximum loose lift thickness of eight (8) inches during embankment compaction; and
- Each lift should be tested (and documented) and inspected prior to placement of subsequent lifts.

Fill placement should be monitored by an experienced field engineer or engineering technician. Additional testing may be required if observations of material placement warrant.

Engineering design and details should be reviewed for additional testing criteria during construction activities.

6.6 Dewatering

Based on the proposed modifications and available subsurface information, dewatering of the site is not expected. However, if conditions dictate, the site may be dewatered using well points or cut off trenches (with a minimum depth of three [3] to four [4] feet) to drawdown and maintain groundwater levels below the excavation bottom (as required). Deeper sumps or trenches may be required to adequately drawdown groundwater. Collected water in sumps or trenches should be conveyed offsite and discharged in accordance with applicable requirements or permits.

7.0 Additional Construction Considerations

7.1 Site Drainage

Positive drainage should be maintained around the site, preventing water to pond and otherwise saturate subgrade soils. Ponded water or saturation of subgrade soils adjacent to the embankment or constructed elements may encumber construction activities and may require reworking of previously placed embankment materials.

7.2 OSHA Soil Classification

Soils previously disturbed by construction or similar activities should be considered to be OSHA Classification – Type C soils. In accordance with OSHA guidelines the following soil classifications are provided for soils encountered at the site during our evaluation.

- Lean Clay (CL) — Type B Soil
- Silty Sand (SM) — Type C Soil
- Clayey Sand (SC) — Type C Soil

7.3 Construction Material Testing & Inspections

Recommendations provided herein are made assuming proper civil design of foundations and civil site work, as well the use of satisfactory construction materials and installation practices. It is recommended that client contract construction inspection and material testing services from a licensed and accredited laboratory who has an established history of working in the immediate vicinity of the site and is accustom to matters of local soil behavior and construction practices including but not limited to mass grading, compaction of fine and coarse grained soils and trenching. Onsite representation of the laboratory should have a working knowledge of the on-going construction and testing requirements as evident by ICC, NICET or Department of Transportation certifications, or subsequent education in Civil Engineering or Construction Science.

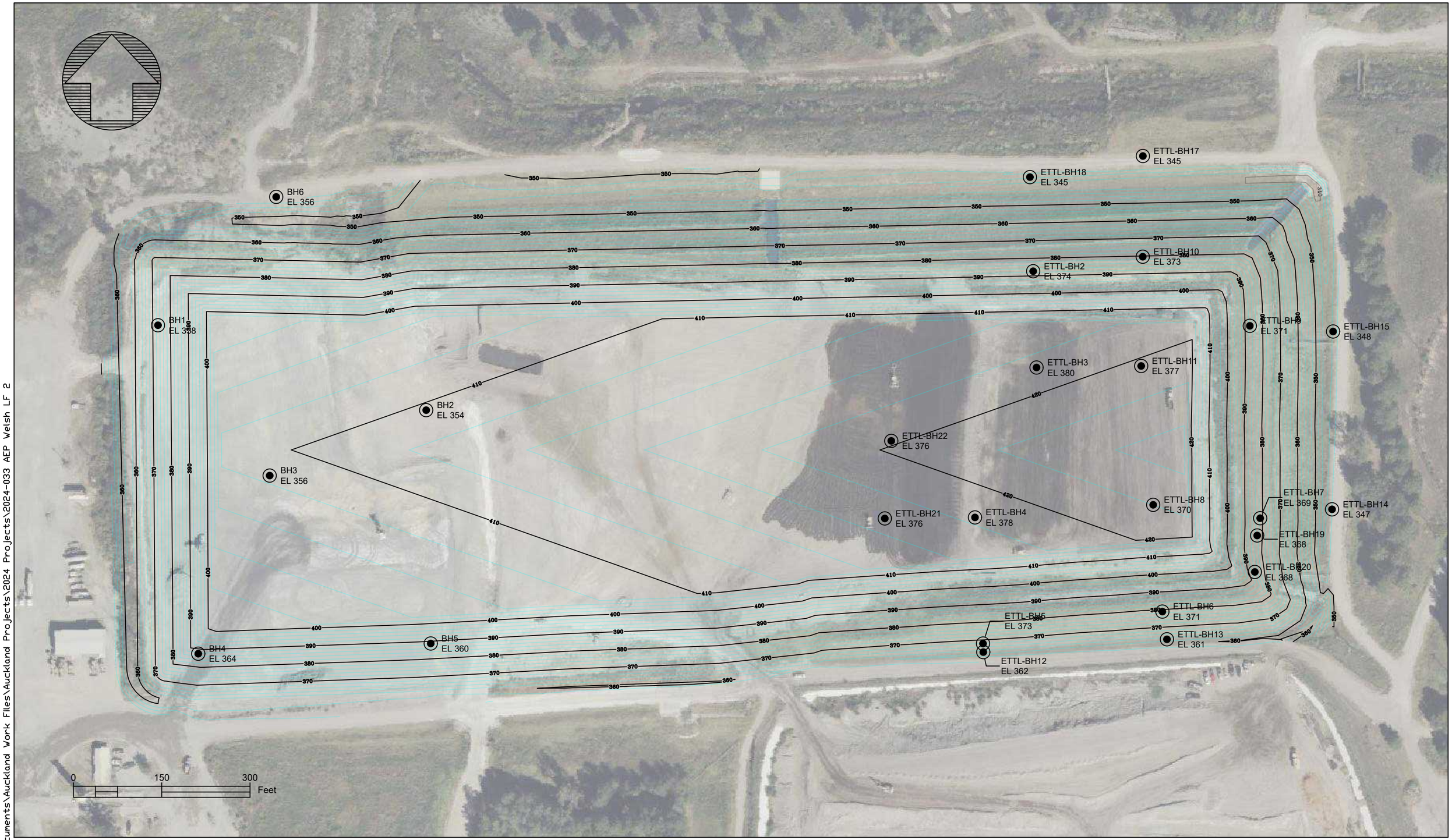
8.0 Report Limitations

This report has been prepared for the exclusive use of our client for the specific application to the project discussed and has been prepared in accordance with the generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. The analyses contained in the report are based on the data obtained from the soil borings performed within the project site and previous geotechnical data cited herein. This report does not reflect variations that may occur between borings or across the site. Soil borings do not necessarily reflect strata variations that may exist at other locations within the project site. This report does not reflect the potential variations that may occur in subsurface conditions and waste material across the site.

Landfill Vertical Expansion – Phase 2 Final Closure
Stability and Settlement Assessment
Welsh Power Plant
Auckland Project No. 2024-033

APPENDIX A

FIGURE 1 PLAN OF BORINGS AND BOREHOLE LOGS



C:\Users\John\Documents\Auckland Work Files\Auckland Projects\2024 Projects\2024-033 AEP Welsh LF 2

Auckland Consulting, LLC
PO Box 8155
Jacksonville, Texas 75766
TBPE Firm No. F-16721

Date	Revision

FIGURE 1: PLAN OF BORINGS
Welsh Power Plant - CCR Landfill Phase 2 Final Closure
Pittsburg, Texas

Project No.	2024-033
Drawn	J. Tayntor
Date	04/23/2025
Sheet No.	1

Auckland Consulting LLC

LOG OF BORING: BH1

Project Name: Welsh Power Plant - Landfill Phase 2 Stability Assessment

Project Location: Cason, Texas

Project No.: 2024-033

Drilling Contractor: C&S Lease

Logged by: S. Propes

Drill Date(s): 02/06/2025

Coordinates: N33.04879 W94.84937

Surface Elevation: 358 ft, MSL

Drilling Method: Hollow Stem Auger (HSA)

Groundwater Elevation (ft)	Depth (feet)	Sample Type	Graphic Log	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Compressive Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Dry Unit Weight (pcf)
	0			Brown and gray, Fly-Ash, mottled, comingled with silty sand	31								
					4								
	5			Medium Dense, gray, red, Clayey Sand (SC), motted	14								
						3.5		27	19	31	17	14	105
▽	10			- gray and reddish brown below 8 ft	15								
	15			Very Stiff, brown, gray, Fat Clay (CH), mottled, ferrous partings, laminated	16			93	25	59	25	34	
	20			- shaley below 18 ft	20								
	25			Very Stiff, gray, Lean Clay (CL), laminated, trace gypsum and silt	22			99	28	49	22	27	
	30				22								
	35			Very Dense, gray, dark gray, Clayey Sand (SC), laminated, few lignitic material	80/10								
	40			- with clay layers below 38 ft	45			45	18	25	17	8	
				Boring terminated at 40 feet.									
	45												
	50												
	55												
	60												
	65												

Additional Information/Comments:

Groundwater encounterd at 10 feet during drilling.

Auckland Consulting LLC

LOG OF BORING: BH2

Project Name: Welsh Power Plant - Landfill Phase 2 Stability Assessment

Project Location: Cason, Texas

Project No.: 2024-033

Drilling Contractor: C&S Lease

Logged by: S. Propes

Drill Date(s): 02/05/2025

Coordinates: N33.04835 W94.84790

Surface Elevation: 354 ft, MSL

Drilling Method: Hollow Stem Auger (HSA)

Groundwater Elevation (ft)	Depth (feet)	Sample Type	Graphic Log	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Compressive Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Dry Unit Weight (pcf)
	0			Brown and gray, Fly-Ash, mottled, comingled with clay	28								
					14								
	5			Medium Dense, reddish brown, gray, Clayey Sand (SC), mottled		3.5		36	17	33	16	17	
					16								
	10			Dense, brown, tan, Silty Sand (SM)	34			16	21	NL	NP	NP	
	15			Very Stiff, gray, brown, Fat Clay (CH), laminated, shaley	18			93	28	59	24	35	
					21								
	20												
	25				25			98	22	56	25	31	
					24								
▽	30												
	35			Hard, gray, Sandy Lean Clay (CL), laminated, shaley	50/6								
				- with lignitic material below 38 ft	52			53	16	27	17	10	
	40												
					49								
	45												
	50			Very Dense, gray, dark gray, Clayey Sand (SC), laminated, with layers of clay	76								
					82/10								
	55												
	60				50/5								
				Boring terminated at 60 feet.									
	65												

Additional Information/Comments:

Groundwater encounterd at 33 feet during drilling.

Auckland Consulting LLC

LOG OF BORING: BH3

Project Name: Welsh Power Plant - Landfill Phase 2 Stability Assessment

Project Location: Cason, Texas

Project No.: 2024-033

Drilling Contractor: C&S Lease

Logged by: S. Propes

Drill Date(s): 02/04/2025

Coordinates: N33.04807 W94.84878

Surface Elevation: 356 ft, MSL

Drilling Method: Hollow Stem Auger (HSA)

Groundwater Elevation (ft)	Depth (feet)	Sample Type	Graphic Log	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Compressive Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Dry Unit Weight (pcf)
	0			Brown and gray, Fly-Ash	50/4								
					9								
	5			Stiff, gray, reddish brown, Lean Clay with Sand (CL), mottled		N/A	3.5	70	19	40	17	23	108
					16								
	10			Medium Dense, brown, tan, Silty Sand (SM)	17								
▽	15			Stiff, gray, brown, Fat Clay (CH), mottled, laminated, with ferrous partings	12			91	26	60	24	36	
				- no sample from 18 to 20 ft		N/A							
	20			- very stiff, with layers of silt below 20 ft	21								
					21								
	25												
	30			- hard below 28 ft		4.5		99	23	53	22	31	100
	35			Dense, dark gray, Silty Clayey Sand (SC-SM), laminated, with layers of clay	47								
	40			- very dense below 38 ft	61			42	19	25	19	6	
	45			- dense below 43 ft	41								
	50			- very dense below 48 ft	89/11			34	22	21	15	6	
	55			Very Dense, gray, dark gray, Clayey Sand (SC), laminated, with layers of clay	78/11								
	60				50/3								
				Boring terminated at 60 feet.									
	65												

Additional Information/Comments:

Groundwater encounterd at 15 feet during drilling.

Auckland Consulting LLC

LOG OF BORING: BH4

Project Name: Welsh Power Plant - Landfill Phase 2 Stability Assessment

Project Location: Cason, Texas

Project No.: 2024-033

Drilling Contractor: C&S Lease

Logged by: S. Propes

Drill Date(s): 02/03/2025

Coordinates: N33.04725 W94.84921

Surface Elevation: 364 ft, MSL

Drilling Method: Hollow Stem Auger (HSA)

Groundwater Elevation (ft)	Depth (feet)	Sample Type	Graphic Log	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Compressive Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Dry Unit Weight (pcf)
	0			Brown and gray, Fly-Ash	28								
					22								
	5			Medium Dense, red, gray, Clayey Sand (SC), mottled, laminated	21			42	12	31	16	15	
				Medium Dense, reddish brown, Silty Clayey Sand (SC-SM), mottled	19			45	13	22	16	6	
	10				16								
				Very Stiff, gray, Sandy Lean Clay (CL), mottled, laminated, with silt layers	21								
▽	15												
					28			57	27	27	19	8	
	20												
				- stiff, tan below 23 ft	11								
	25												
				Hard, dark gray, Fat Clay (CH), mottled, laminated		4.5		99	24	57	26	31	
	30												
				Very Dense, gray, dark gray, Clayey Sand (SC), laminated, with layers of oxidized lignitic material	76/11								
	35												
				- with gravel below 38 ft	50			36	18	25	17	8	
	40			Boring terminated at 40 feet.									
	45												
	50												
	55												
	60												
	65												

Additional Information/Comments:

Groundwater encounterd at 18 feet during drilling.

Auckland Consulting LLC

LOG OF BORING: BH5

Project Name: Welsh Power Plant - Landfill Phase 2 Stability Assessment

Project Location: Cason, Texas

Project No.: 2024-033

Drilling Contractor: C&S Lease

Logged by: S. Propes

Drill Date(s): 02/04/2025

Coordinates: N33.04726 W94.84792

Surface Elevation: 360 ft, MSL

Drilling Method: Hollow Stem Auger (HSA)

Groundwater Elevation (ft)	Depth (feet)	Sample Type	Graphic Log	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Compressive Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Dry Unit Weight (pcf)
	0			Brown and gray, Fly-Ash	11								
					40								
	5			- comingled with sandy clay below 4 ft	11								
				Stiff, gray, tan, Fat Clay (CH), mottled, laminated		2.0		96	25	64	20	44	98
	10				10								
				Very Dense, tan, gray, Silty Sand (SM)	50								
	15												
	20			Hard, tan, white, Lean Clay with Sand (CL), mottled, laminated, trace silt	33			85	24	37	16	21	
▽				- very stiff with silt and sand below 23 ft	25								
	25												
				- hard below 28 ft	33								
	30												
				Very Stiff, gray, dark gray, Fat Clay (CH), mottled, laminated, with gypsum	19			93	30	58	27	31	
	35												
				-no sample from 38 to 40 ft		N/A							
	40			- hard, shaley below 40 ft	56								
				Boring terminated at 41.5 feet.									
	45												
	50												
	55												
	60												
	65												

Additional Information/Comments:

Groundwater encounterd at 25 feet during drilling.

Auckland Consulting LLC

LOG OF BORING: BH6

Project Name: Welsh Power Plant - Landfill Phase 2 Stability Assessment

Project Location: Cason, Texas

Project No.: 2024-033

Drilling Contractor: C&S Lease

Logged by: S. Propes

Drill Date(s): 02/07/2025

Coordinates: N33.04937 W94.84869

Surface Elevation: 356 ft, MSL

Drilling Method: Hollow Stem Auger (HSA)

Groundwater Elevation (ft)	Depth (feet)	Sample Type	Graphic Log	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Compressive Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Dry Unit Weight (pcf)
	0			Brown and tan, Fly-Ash	50/3								
					11								
	5				7								
					5								
				- with clay below 8 ft	3								
	10			Very Stiff, gray, tan, Lean Clay with Sand (CL), mottled, laminated									
	15					4.5	1.86	84	23	48	20	28	101
	20			Very Stiff, tan, brown, Fat Clay with Sand (CH), mottled, laminated, with ferrous partings	19			82	29	51	23	28	
	25			- hard below 23 ft		4.5		99	24	58	24	34	99
	30			- very stiff below 28 ft	24								
	35			Hard, gray, dark gray, Lean Clay (CL), mottled, laminated, trace gypsum	84/11			91	22	39	24	15	
	40				38								
				Boring terminated at 40 feet.									
	45												
	50												
	55												
	60												
	65												

Additional Information/Comments:

Groundwater encounterd at 6 feet during drilling.

Auckland Consulting LLC

Boring Log Terms and Symbols

Symbols and Sampler Types

 Thin-walled Tube (Shelby Tube)

 Standard Penetration Test (SPT)

 Auger Sample

 Texas Cone Penetration Test (TCP)

 Observed Static-Water Level

 Observed Free Water (Seepage)

Soil Consistency and Structure

Strength of Fine Grained Soils		
Consistency	**SPT (Blows/ft)**	**UCS (tsf)**
Very Soft	< 2	< 0.25
Soft	2 – 4	0.25 – 0.5
Medium Stiff	4 – 8	0.5 – 1.0
Stiff	8 – 15	1.0 – 2.0
Very Stiff	15 – 30	2.0 – 4.0
Hard	> 30	> 4.0

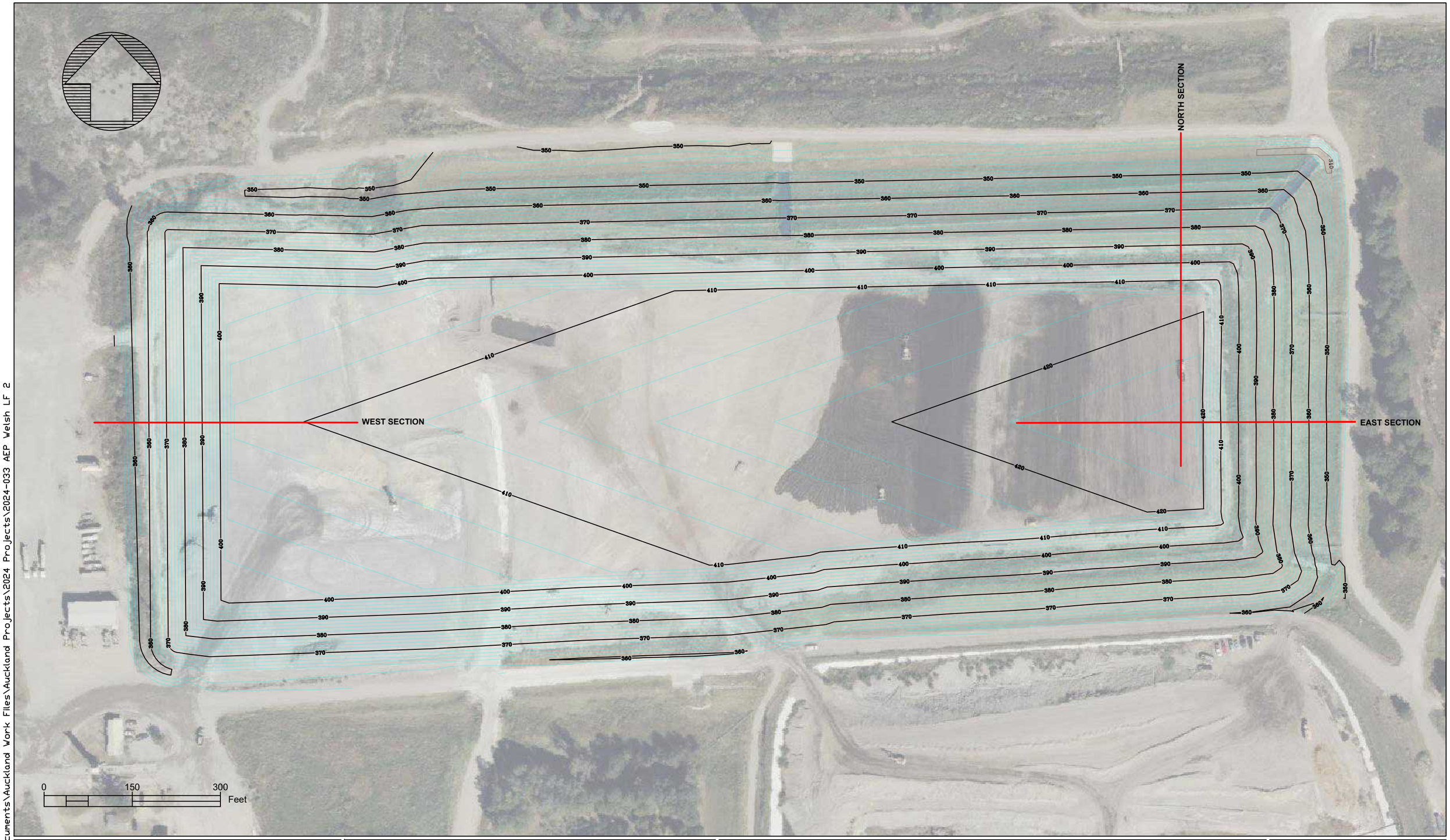
Density of Coarse Grained Soils		
Consistency	**SPT (Blows/ft)**	**TCP (Blows/ft)**
Very Loose	0 – 4	< 8
Loose	5 – 10	9 – 20
Medium Dense	11 – 30	21 – 60
Dense	31 – 50	61 -100
Very Dense	> 50	> 100

Soil Structure - Description	
Description	**Explanation**
Laminated	Alternating layers of varying material or color.
Slickensided	Fractured polished planes, little resistance to fracturing
Blocky	Cohesive soil that can be broken into small angular pieces.
Lensed	Inclusion of small pockets of different soils
Homogeneous	Same appearance and color throughout

Landfill Vertical Expansion – Phase 2 Final Closure
Stability and Settlement Assessment
Welsh Power Plant
Auckland Project No. 2024-033

APPENDIX B

SLOPE STABILITY SECTIONS AND MODEL OUTPUT



C:\Users\John\Documents\Auckland Work Files\Auckland Projects\2024 Projects\2024-033 AEP Welsh LF 2

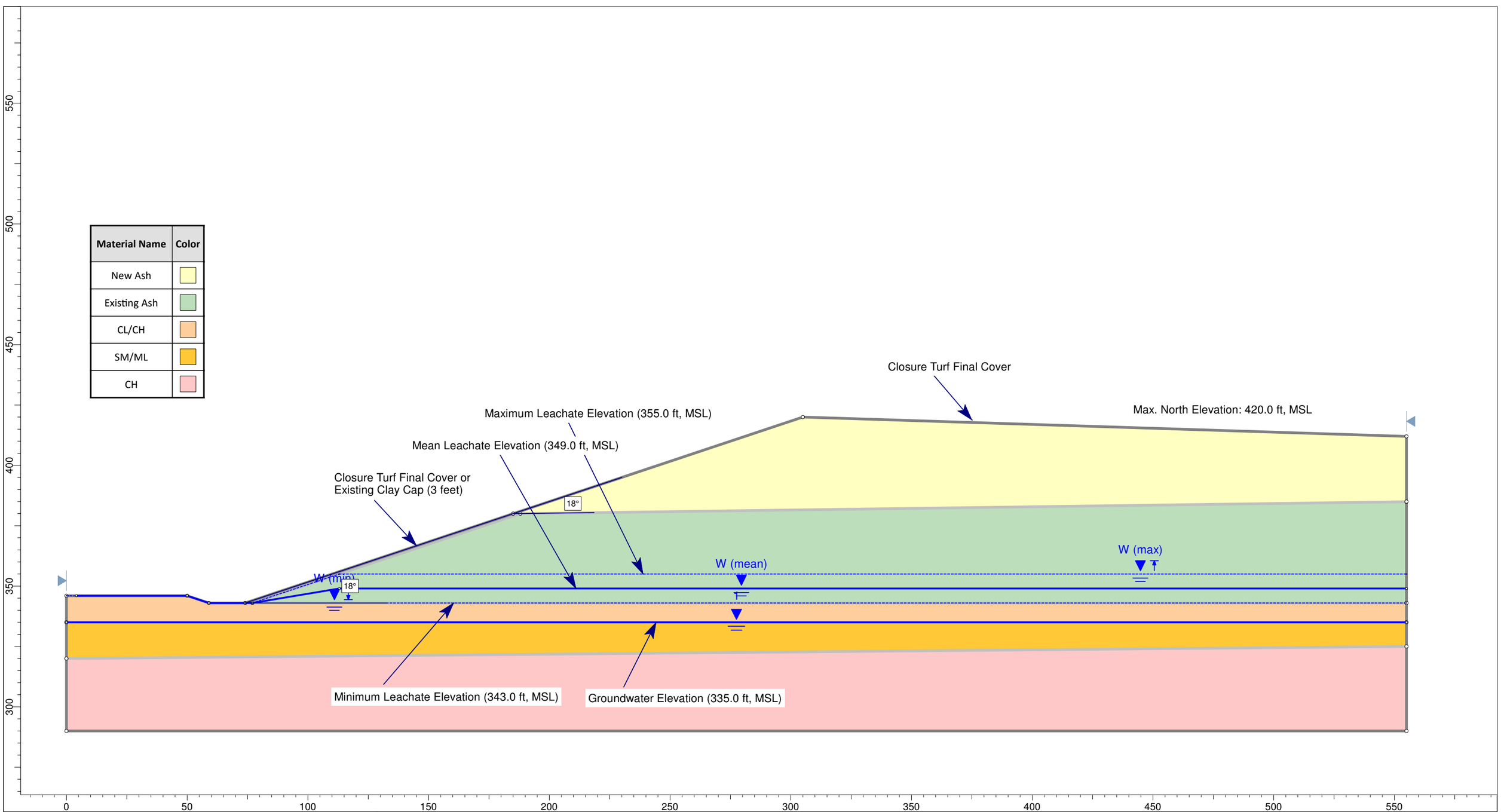
Auckland Consulting, LLC
PO Box 8155
Jacksonville, Texas 75766
TBPE Firm No. F-16721

Date	Revision

FIGURE 2: SLOPE STABILITY MODEL SECTIONS
Welsh Power Plant - CCR Landfill Phase 2 Final Closure
Pittsburg, Texas

Project No.	2024-033
Drawn	J. Tayntor
Date	04/16/2025
Sheet No.	1

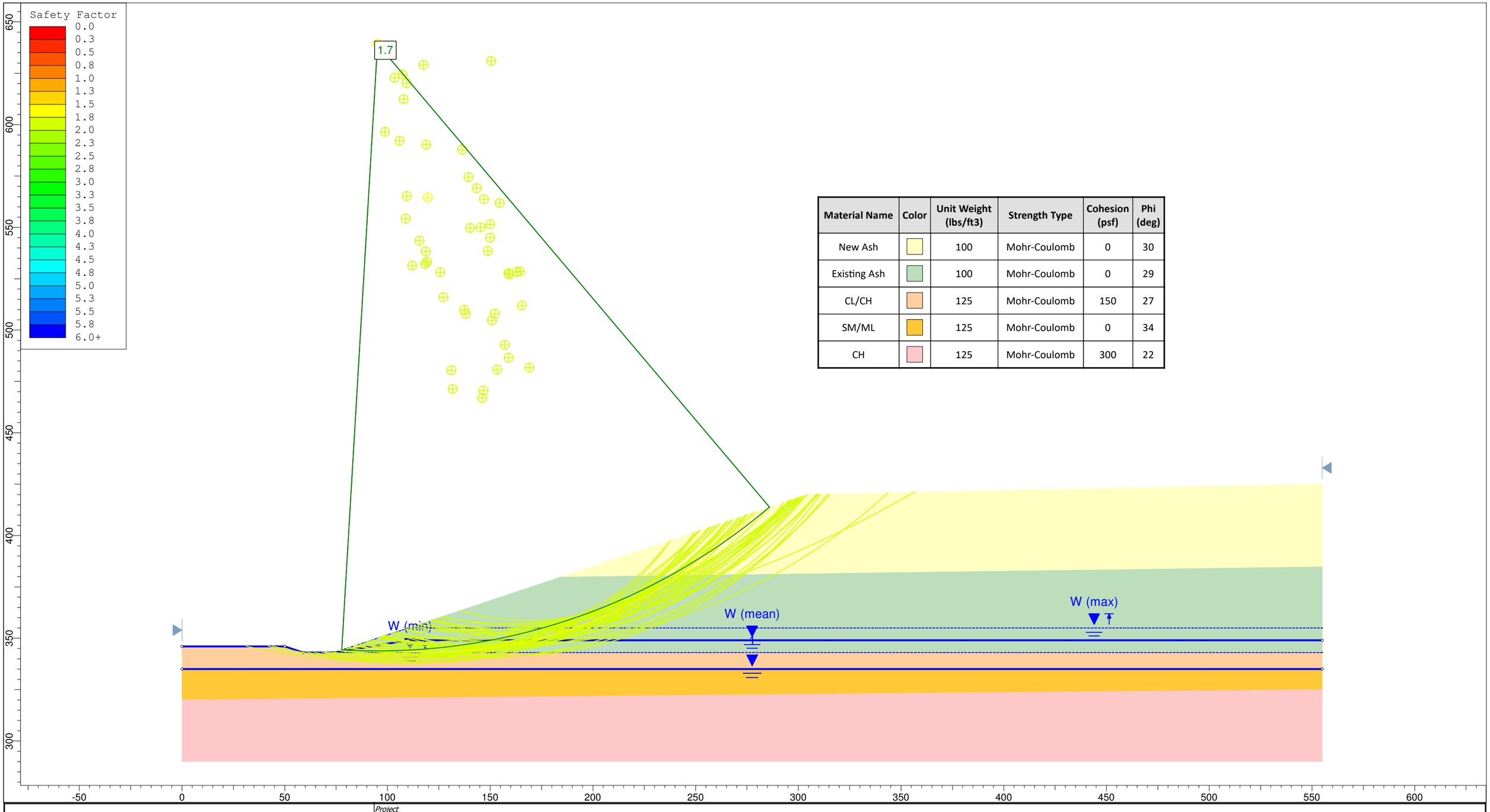
Material Name	Color
New Ash	
Existing Ash	
CL/CH	
SM/ML	
CH	



Auckland Consulting LLC

SLIDE 6.039

Project	Welsh Power Plant: CCR Landfill Phase 2 Final Closure				
Analysis Description	North Section: Model Geometry				
Drawn By	J. Tayntor	*Scale*	1:450	*Company*	Auckland Consulting, LLC
Date	04/04/2025			*File Name*	LF-North Slope_PHASE2_040425.slim

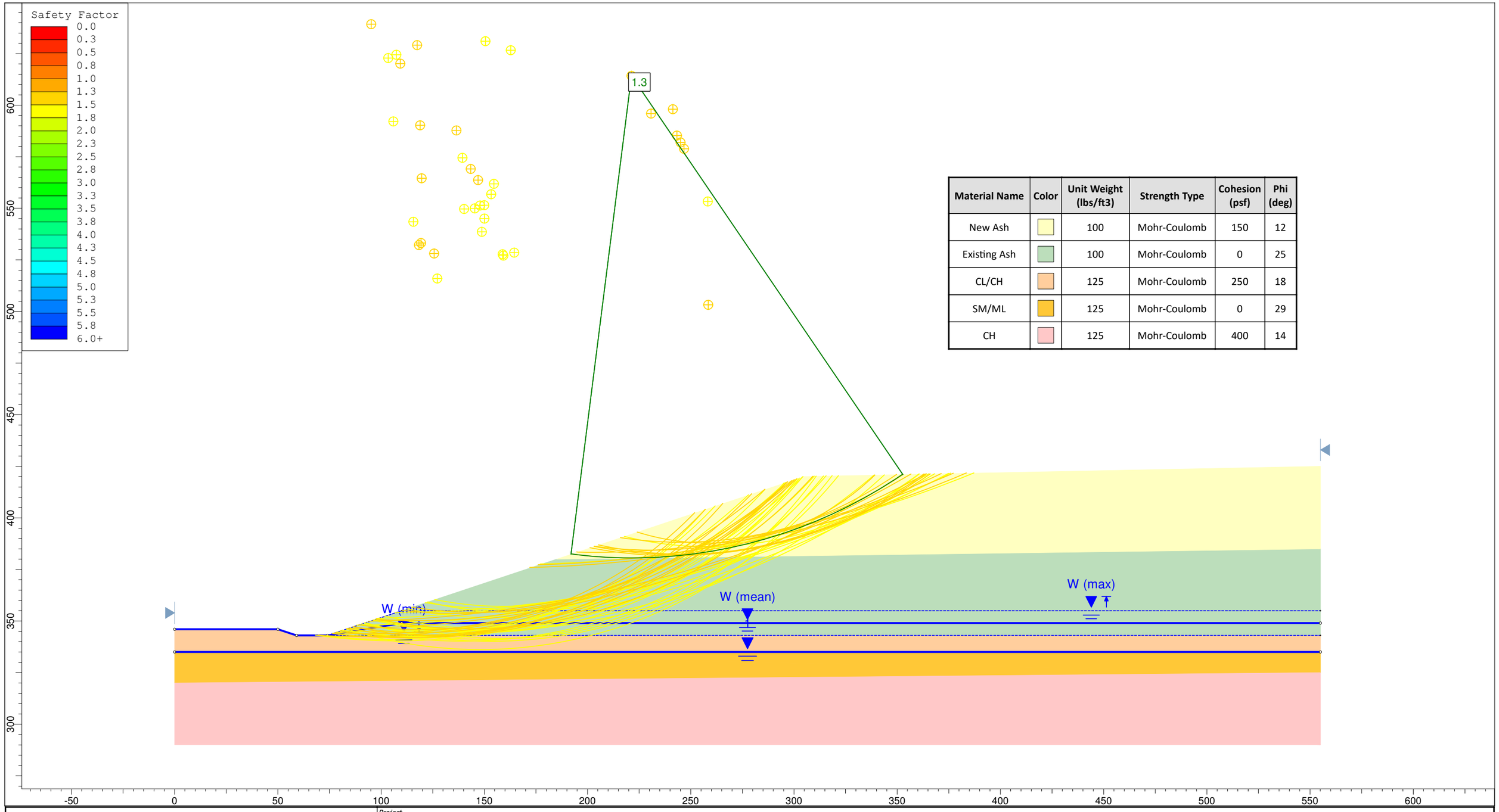


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	0	30
Existing Ash		100	Mohr-Coulomb	0	29
CL/CH		125	Mohr-Coulomb	150	27
SM/ML		125	Mohr-Coulomb	0	34
CH		125	Mohr-Coulomb	300	22

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Phase 2 Final Closure			
Analysis Description	North Section: End of Construction (Effective Stresses)			
Drawn By	J. Tayntor	*Scale*	1:525	*Company* Auckland Consulting, LLC
Date	07/11/2025			*File Name* LF-North Slope_EOC_PH2_0711225.slim

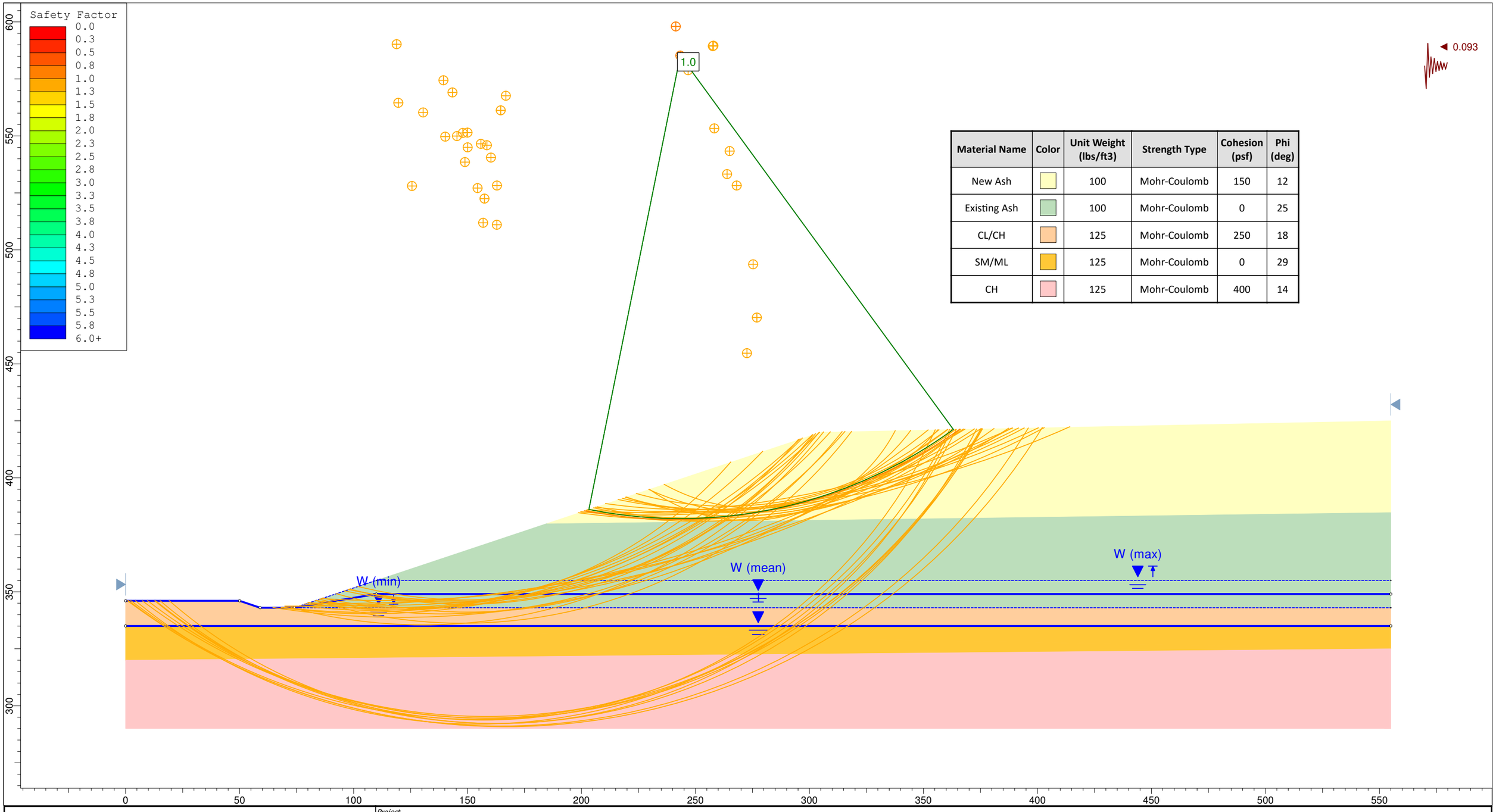


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	150	12
Existing Ash		100	Mohr-Coulomb	0	25
CL/CH		125	Mohr-Coulomb	250	18
SM/ML		125	Mohr-Coulomb	0	29
CH		125	Mohr-Coulomb	400	14

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Phase 2 Final Closure		
Analysis Description	North Section: End of Construction (Total Stresses)		
Drawn By J. Tayntor	*Scale* 1:525	*Company*	Auckland Consulting, LLC
Date 07/11/2025		*File Name*	LF-North Slope_EOC_TOTAL STRESS_PH2_071125.slim

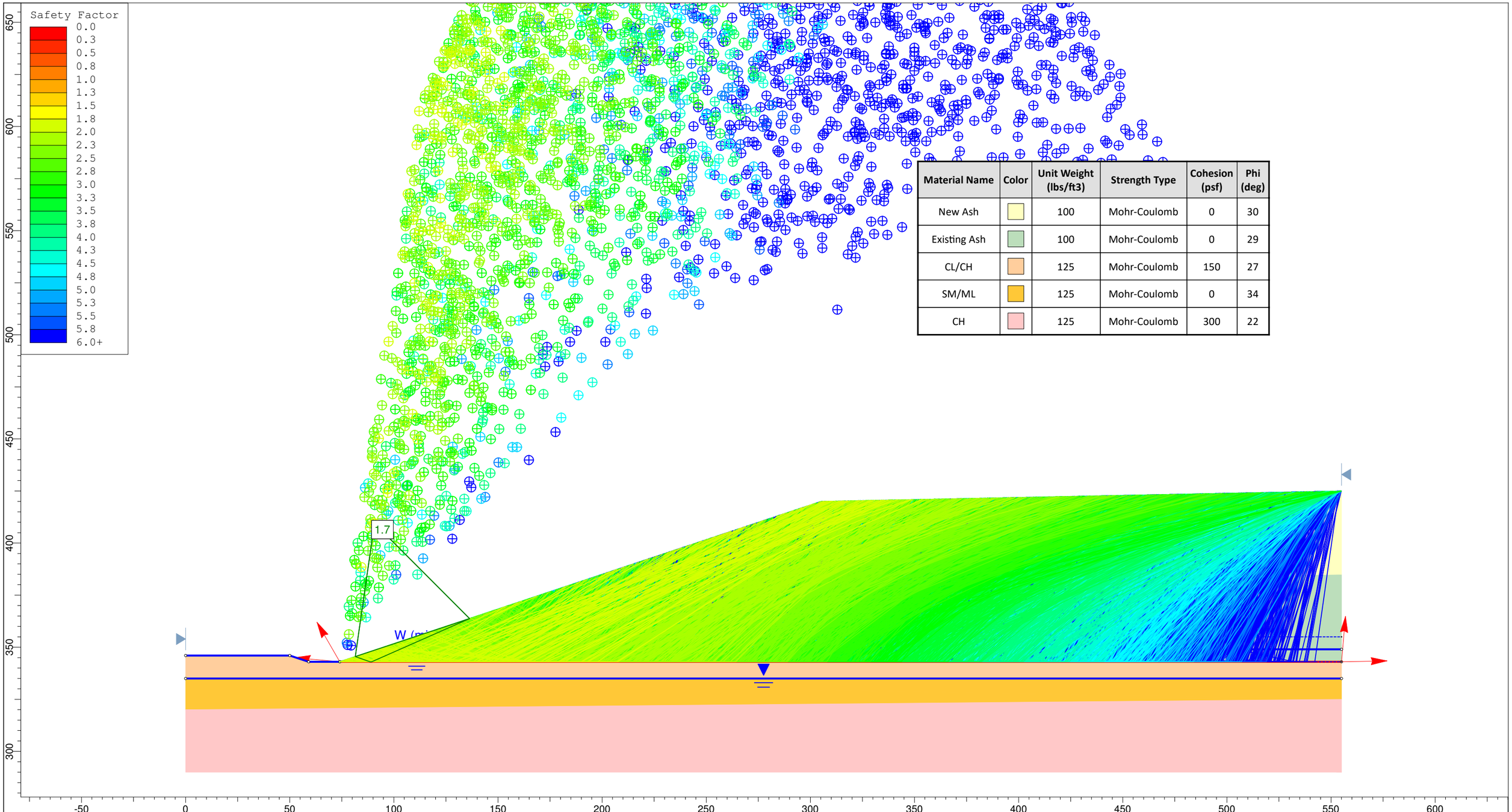


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	150	12
Existing Ash		100	Mohr-Coulomb	0	25
CL/CH		125	Mohr-Coulomb	250	18
SM/ML		125	Mohr-Coulomb	0	29
CH		125	Mohr-Coulomb	400	14

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Phase 2 Final Closure		
Analysis Description	North Section: End of Construction (Seismic Loading Conditions, Total Stresses)		
Drawn By	J. Tayntor	*Scale* 1:475	*Company* Auckland Consulting, LLC
Date	07/11/2025		*File Name* LF-North Slope_EOC_Seismic Loading _PH2_071125.slim



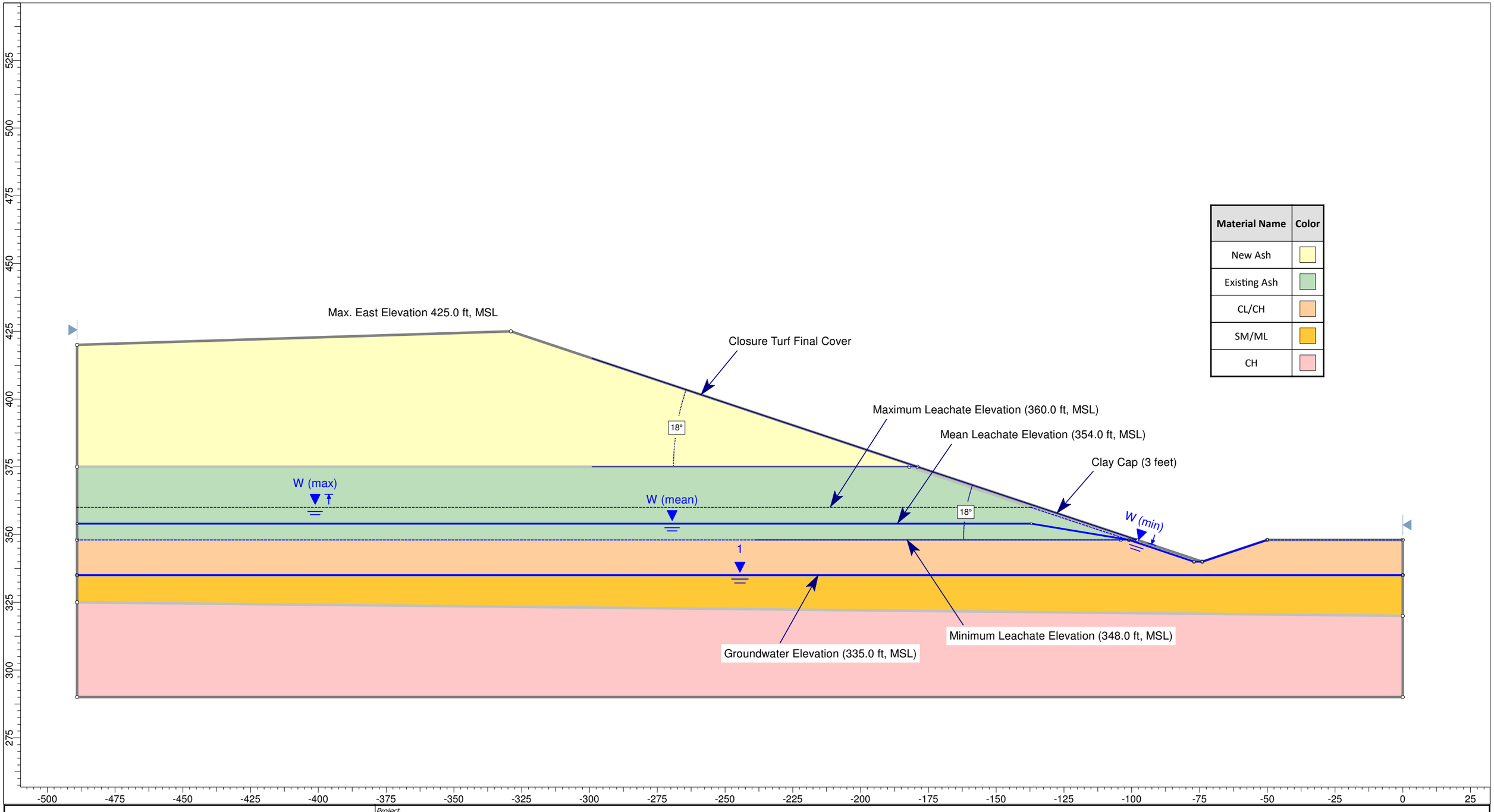
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	0	30
Existing Ash		100	Mohr-Coulomb	0	29
CL/CH		125	Mohr-Coulomb	150	27
SM/ML		125	Mohr-Coulomb	0	34
CH		125	Mohr-Coulomb	300	22

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Phase 2 Final Closure			
Analysis Description	North Section: End of Construction (Block Wedge Failure, Effective Stresses)			
Drawn By	J. Tayntor	*Scale*	1:526	*Company* Auckland Consulting, LLC
Date	07/11/2025			*File Name* LF-North Slope_EOC_Block_PH2_071125.slim

Material Name	Color
New Ash	
Existing Ash	
CL/CH	
SM/ML	
CH	



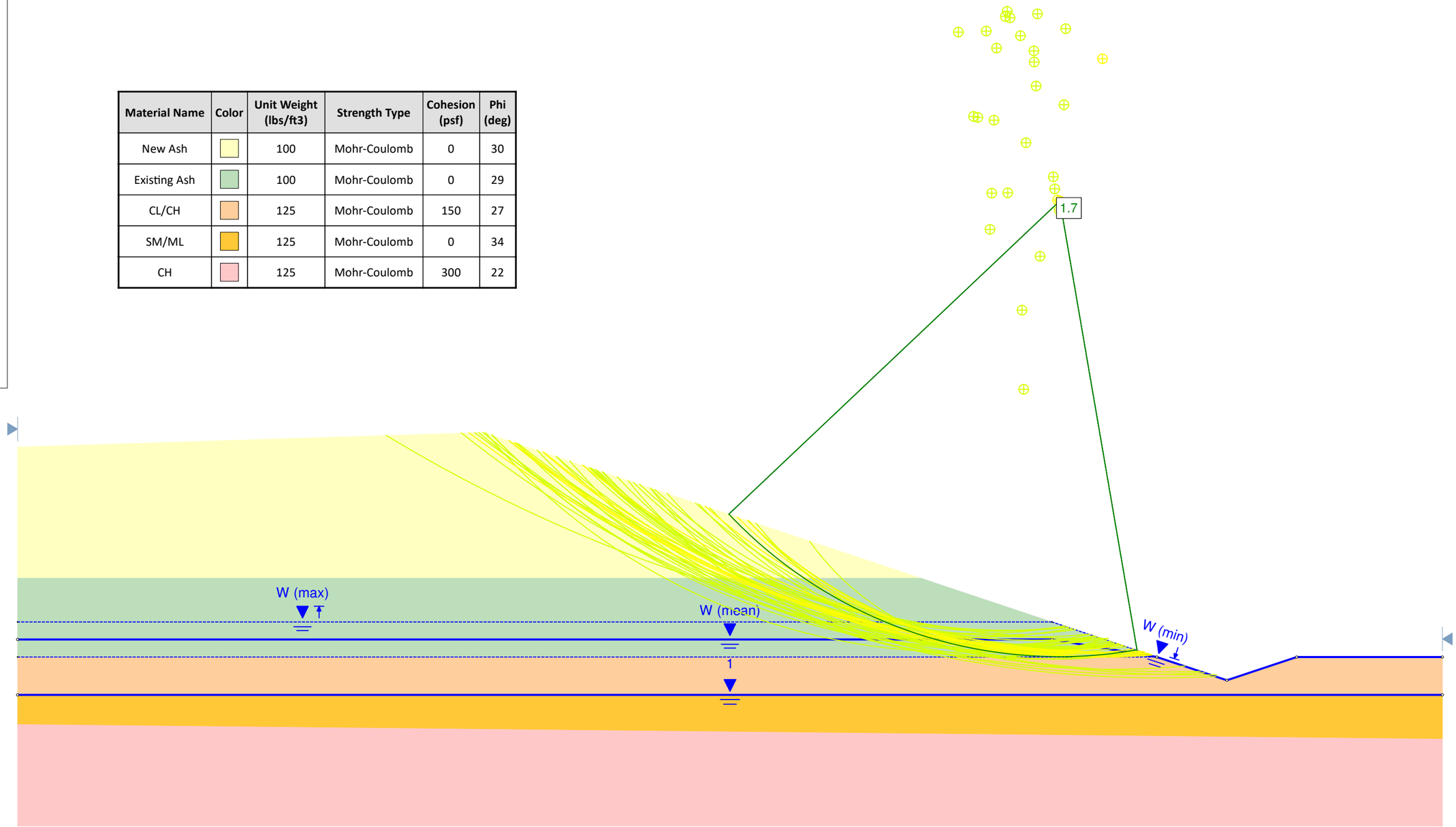
Auckland Consulting LLC

Project	Welsh Power Plant: CCR Landfill - Phase 2 Final Closure				
Analysis Description	East Section: Model Geometry				
Drawn By	J. Tayntor	Scale	1:399	Company	Auckland Consulting, LLC
Date	04/04/2025			File Name	LF-East Slope_Phase2_040425.slim

SLIDE 6.039

Safety Factor
0.0
0.3
0.5
0.8
1.0
1.3
1.5
1.8
2.0
2.3
2.5
2.8
3.0
3.3
3.5
3.8
4.0
4.3
4.5
4.8
5.0
5.3
5.5
5.8
6.0+

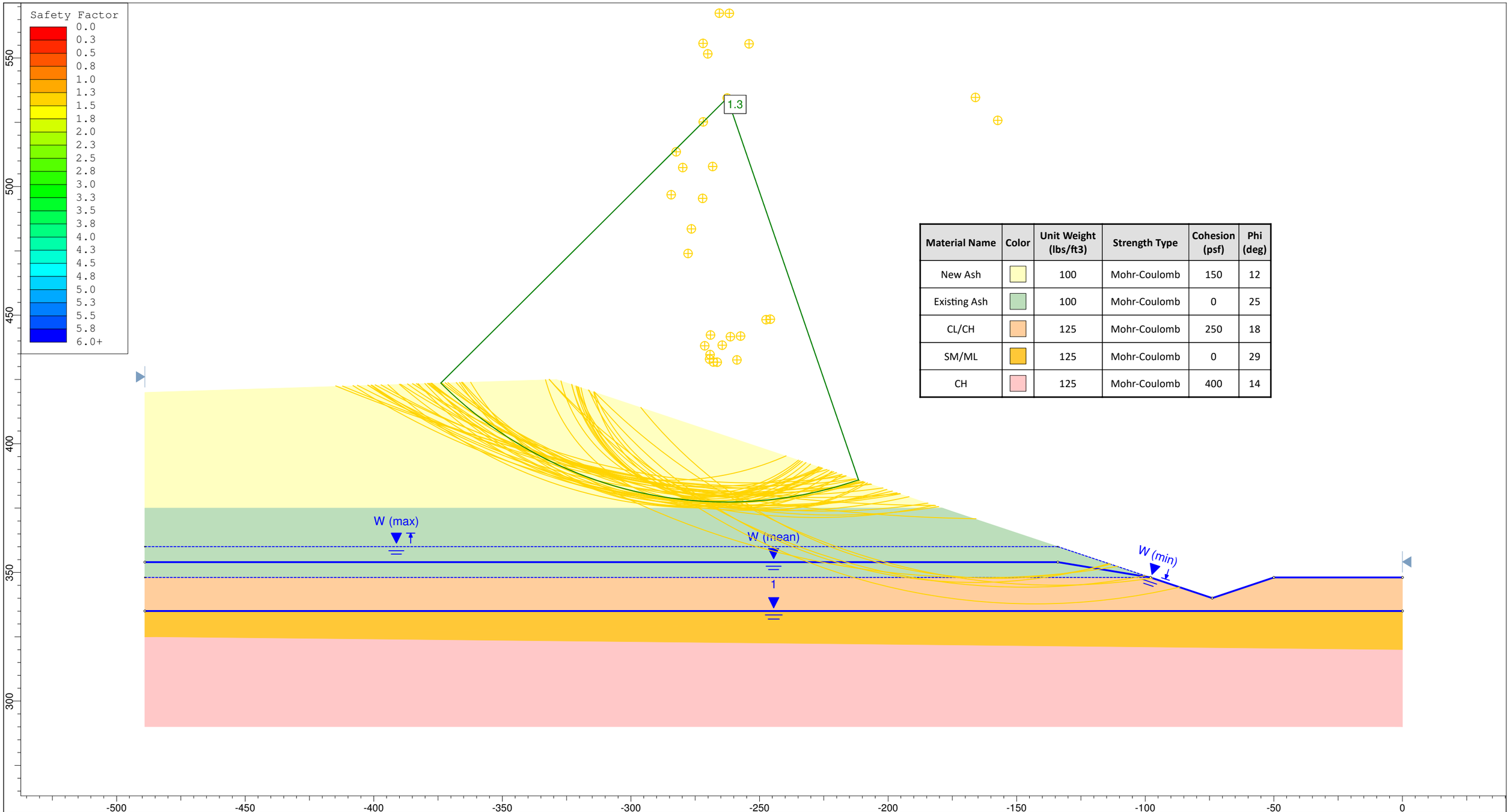
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	0	30
Existing Ash		100	Mohr-Coulomb	0	29
CL/CH		125	Mohr-Coulomb	150	27
SM/ML		125	Mohr-Coulomb	0	34
CH		125	Mohr-Coulomb	300	22



Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Phase 2 Final Closure			
Analysis Description	East Section: End of Construction (Effective Stresses)			
Drawn By	J. Tayntor	Scale	1:425	Company: Auckland Consulting, LLC
Date	07/11/2025			File Name: LF-East Slope EOC_ES_071125.slim

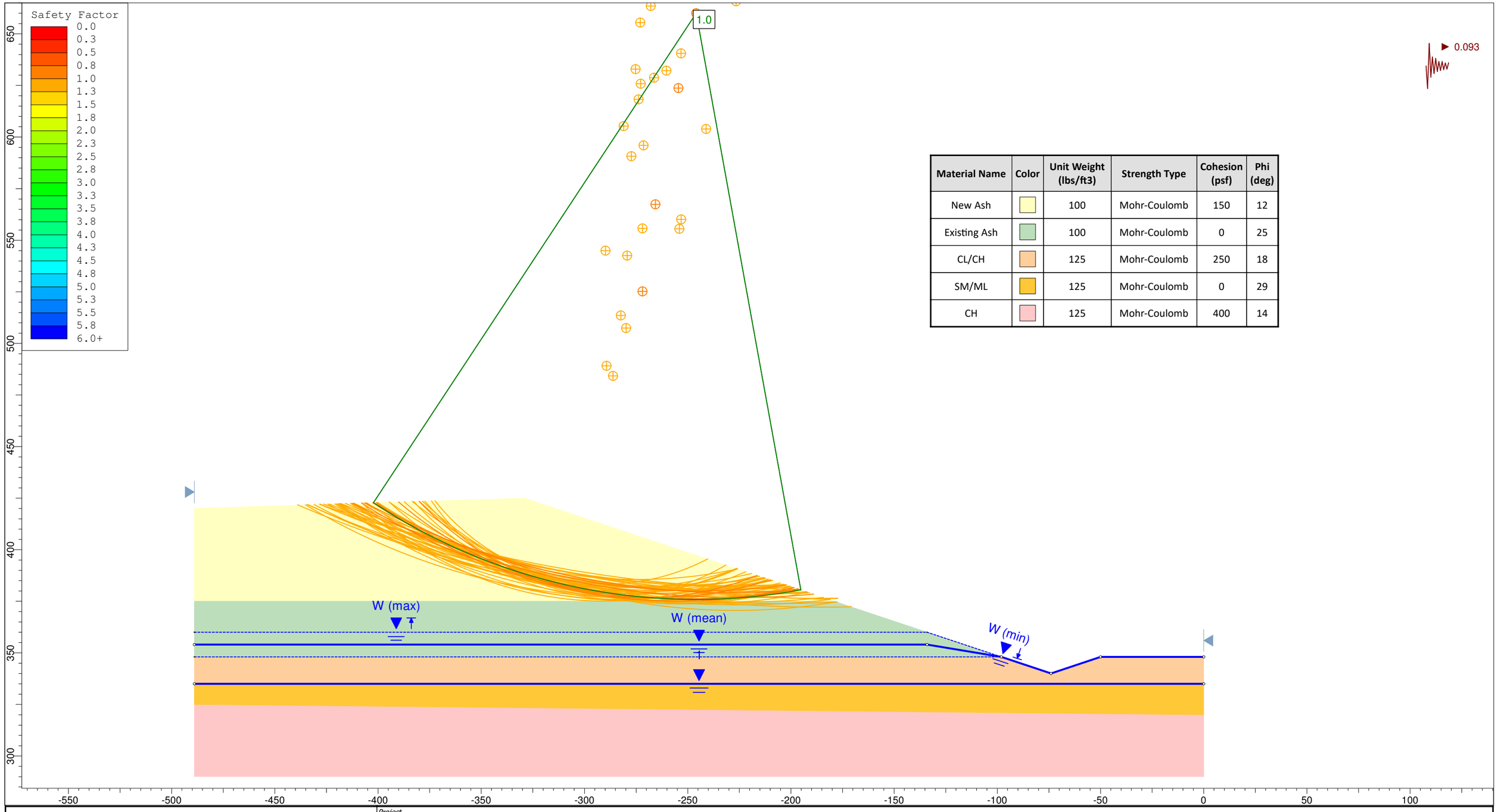


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	150	12
Existing Ash		100	Mohr-Coulomb	0	25
CL/CH		125	Mohr-Coulomb	250	18
SM/ML		125	Mohr-Coulomb	0	29
CH		125	Mohr-Coulomb	400	14

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Phase 2 Final Closure				
Analysis Description	East Section: End of Construction (Total Stresses)				
Drawn By	J. Tayntor	*Scale*	1:425	*Company*	Auckland Consulting, LLC
Date	07/11/2025			*File Name*	LF-East Slope EOC_PH2_TS_071125.slim

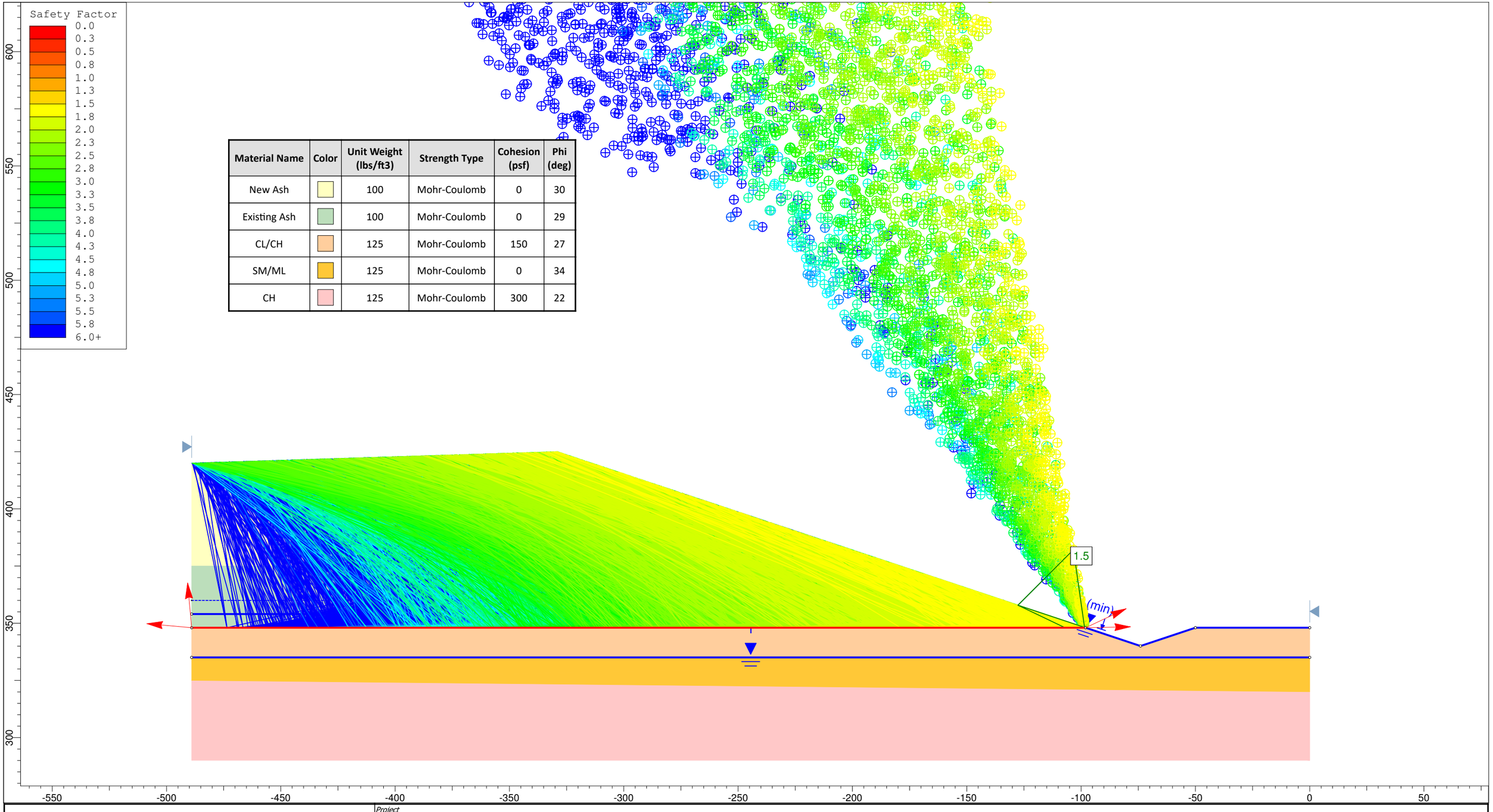


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	150	12
Existing Ash		100	Mohr-Coulomb	0	25
CL/CH		125	Mohr-Coulomb	250	18
SM/ML		125	Mohr-Coulomb	0	29
CH		125	Mohr-Coulomb	400	14

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Phase 2 Final Closure		
Analysis Description	East Section: End of Construction (Seismic Loading Conditions, Total Stresses)		
Drawn By	J. Tayntor	Scale 1:525	Company Auckland Consulting, LLC
Date	07/11/2025		File Name LF-East Slope EOC_PH2_Seismic_071125.slim



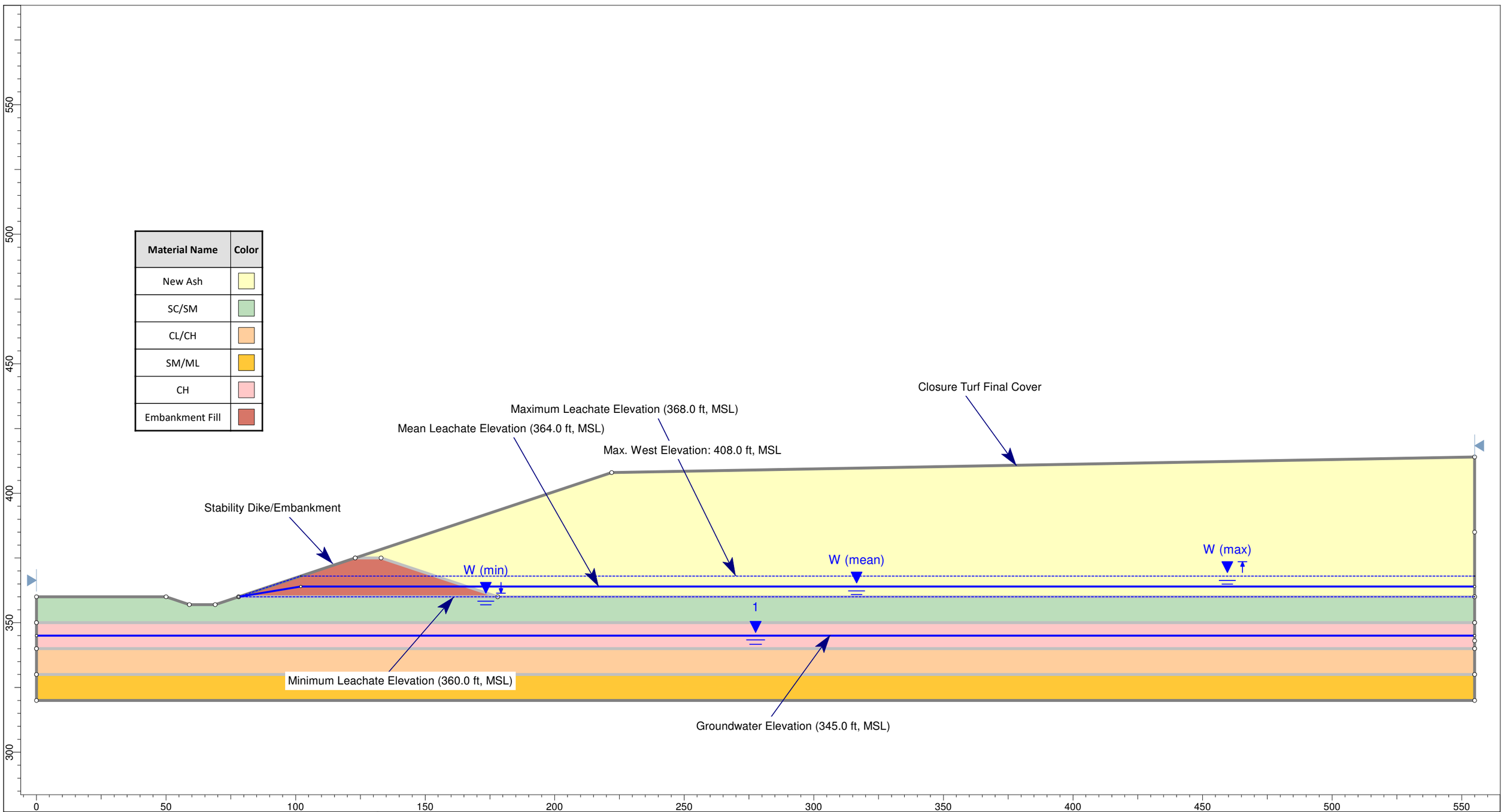
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	0	30
Existing Ash		100	Mohr-Coulomb	0	29
CL/CH		125	Mohr-Coulomb	150	27
SM/ML		125	Mohr-Coulomb	0	34
CH		125	Mohr-Coulomb	300	22

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Phase 2 Final Closure			
Analysis Description	East Section: End of Construction (Block Wedge Failure, Effective Stresses)			
Drawn By	J. Tayntor	*Scale*	1:473	*Company* Auckland Consulting, LLC
Date	07/11/2025			*File Name* LF-East Slope EOC_Block_ES_071125.slim

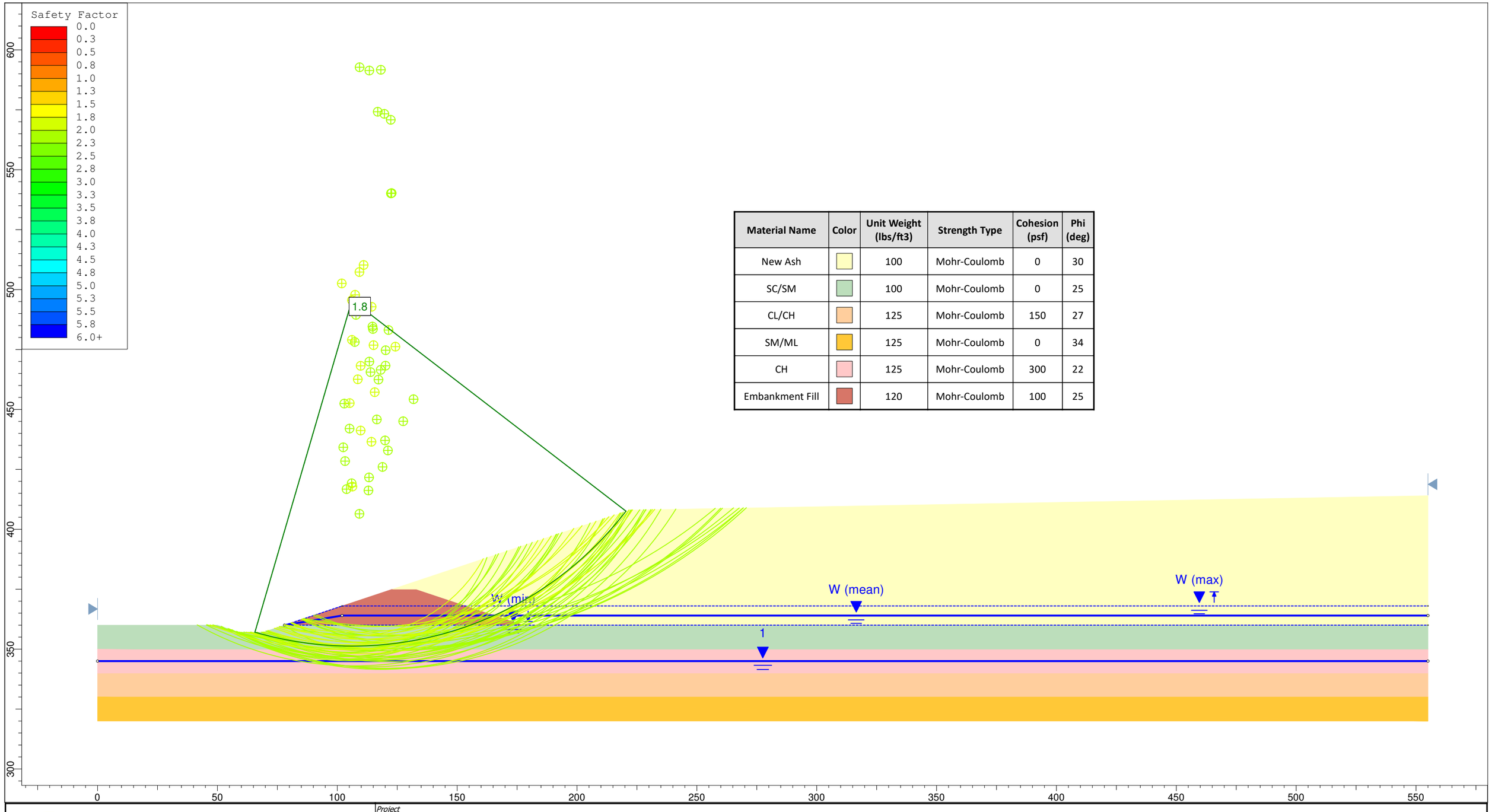
Material Name	Color
New Ash	
SC/SM	
CL/CH	
SM/ML	
CH	
Embankment Fill	



Auckland Consulting LLC

SLIDE 6.039

Project	Welsh Power Plant: CCR Landfill Phase 2 Final Closure				
Analysis Description	West Section: Model Geometry (with Stability Dike)				
Drawn By	J. Tayntor	*Scale*	1:420	*Company*	Auckland Consulting, LLC
Date	04/04/2025			*File Name*	LF-West Slope_SD_PHASE2_040425.slim

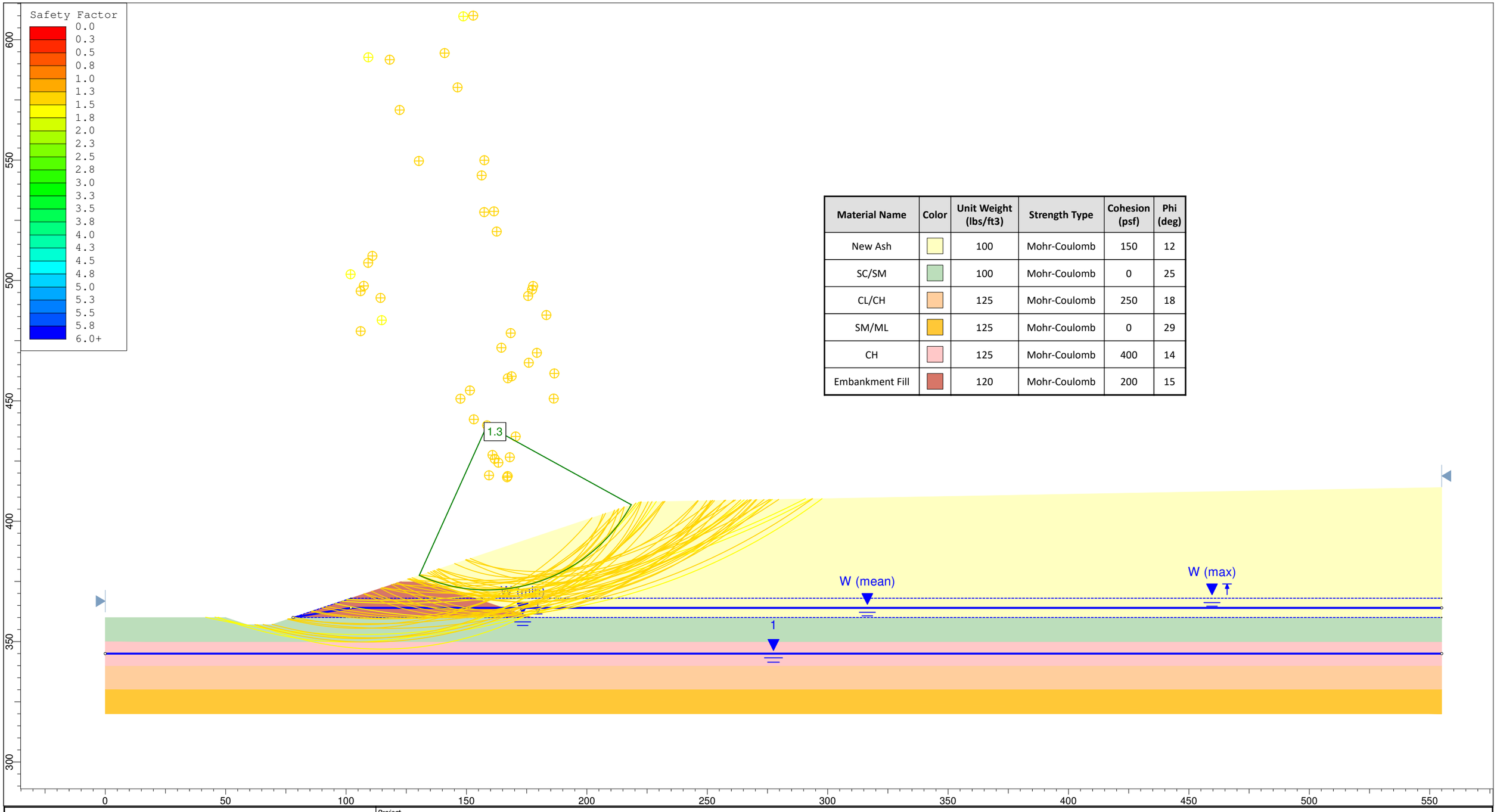


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	0	30
SC/SM		100	Mohr-Coulomb	0	25
CL/CH		125	Mohr-Coulomb	150	27
SM/ML		125	Mohr-Coulomb	0	34
CH		125	Mohr-Coulomb	300	22
Embankment Fill		120	Mohr-Coulomb	100	25

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Phase 2 Final Closure		
Analysis Description	West Section: End of Construction with Stability Dike (Effective Stresses)		
Drawn By J. Tayntor	*Scale* 1:450	*Company*	Auckland Consulting, LLC
Date 07/11/2025		*File Name*	LF-West Slope_EOC_SD-ES_PH2_071125.slim

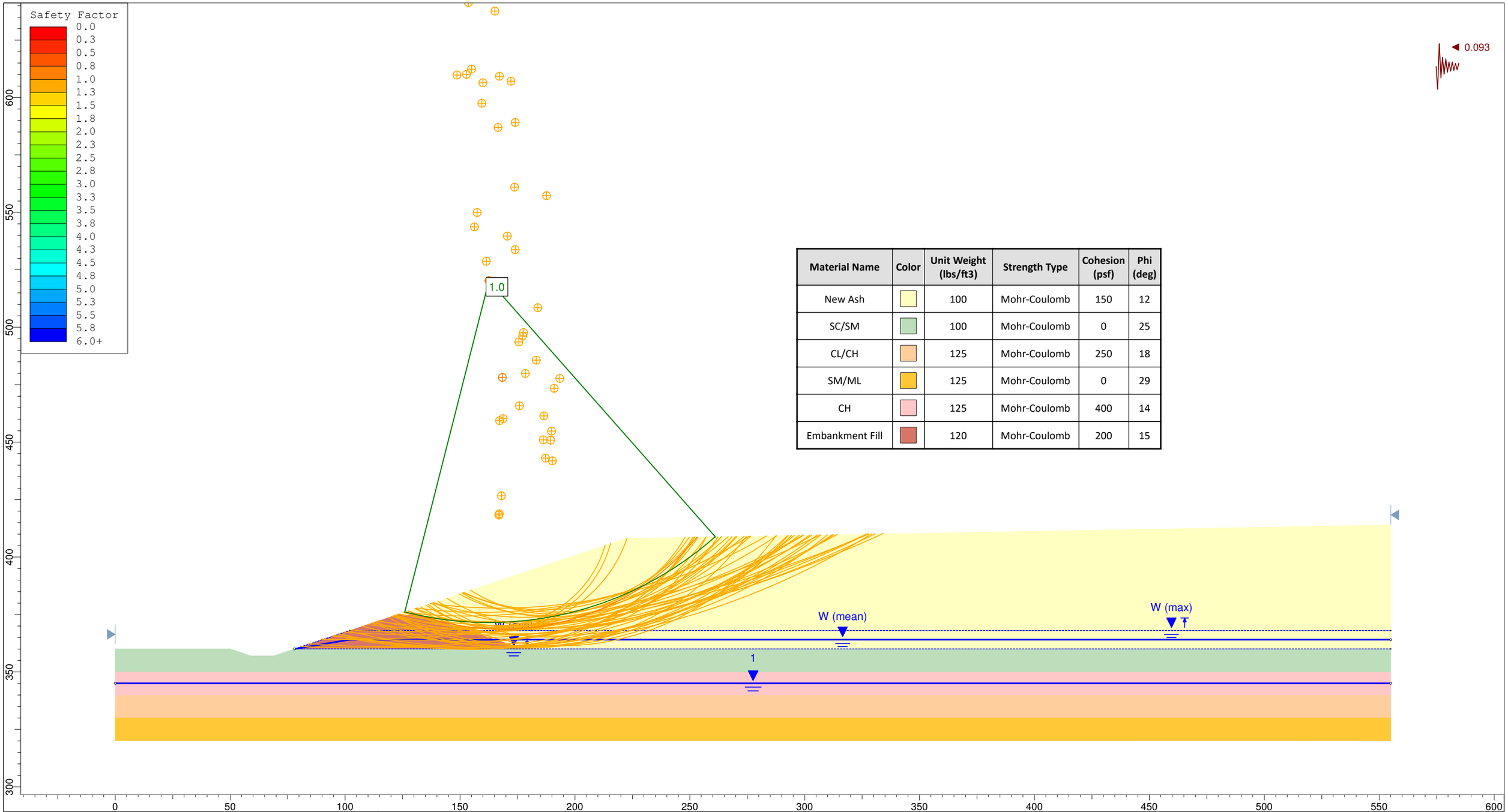


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	150	12
SC/SM		100	Mohr-Coulomb	0	25
CL/CH		125	Mohr-Coulomb	250	18
SM/ML		125	Mohr-Coulomb	0	29
CH		125	Mohr-Coulomb	400	14
Embankment Fill		120	Mohr-Coulomb	200	15

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Phase 2 Final Closure		
Analysis Description	West Section: End of Construction with Stability Dike (Total Stresses)		
Drawn By	J. Tayntor	*Scale* 1:450	*Company* Auckland Consulting, LLC
Date	07/11/2025		*File Name* LF-West Slope_EOC_SD-TS_PH2_071125.slim

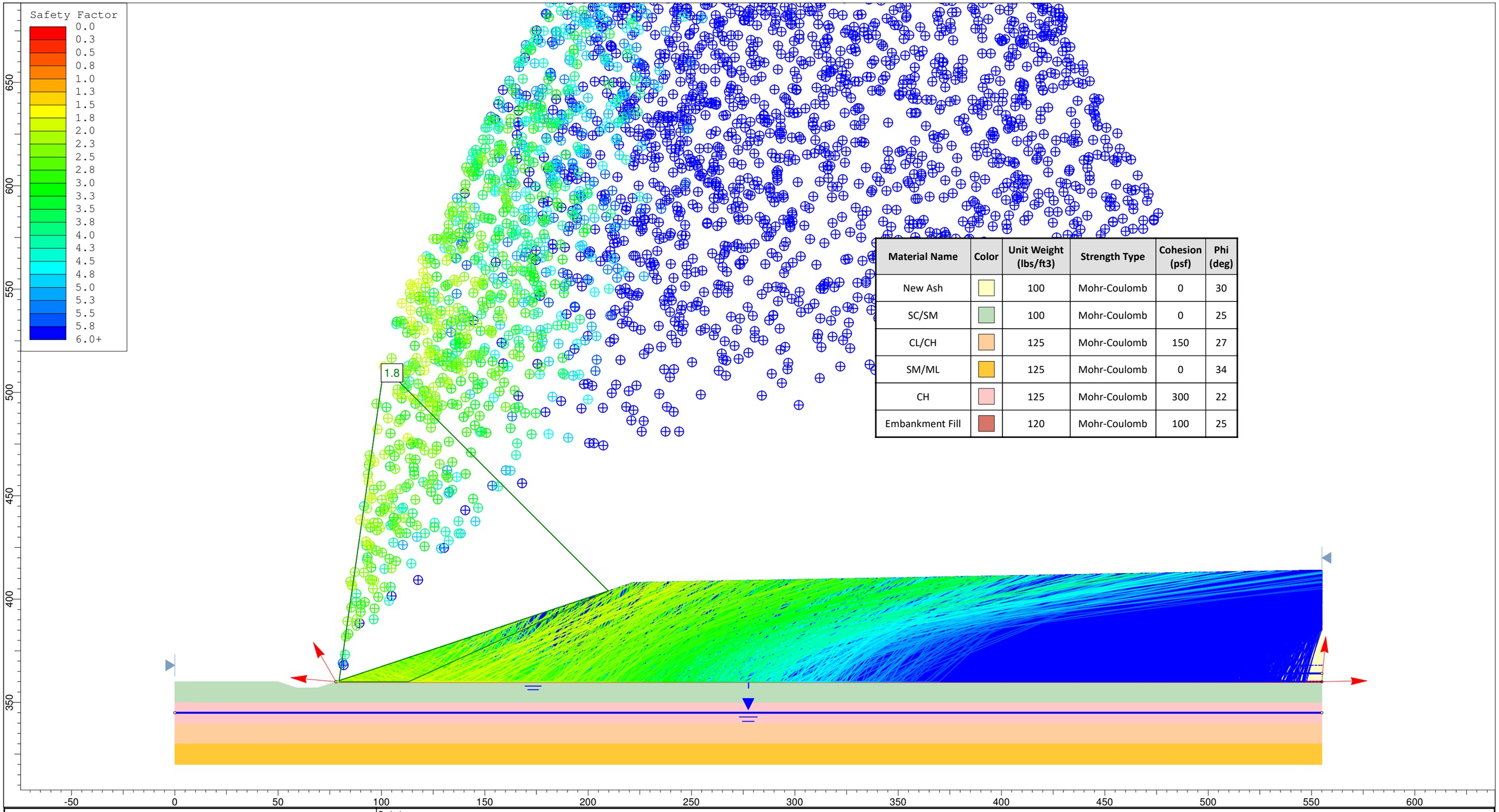


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	150	12
SC/SM		100	Mohr-Coulomb	0	25
CL/CH		125	Mohr-Coulomb	250	18
SM/ML		125	Mohr-Coulomb	0	29
CH		125	Mohr-Coulomb	400	14
Embankment Fill		120	Mohr-Coulomb	200	15

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Phase 2 Final Closure		
Analysis Description	West Section: End of Construction with Stability Dike (Seismic Loading Conditions, Total Stresses)		
Drawn By J. Tayntor	*Scale* 1:475	*Company*	Auckland Consulting, LLC
Date 07/11/2025		*File Name*	LF-West Slope_EOC_SD-Seismic_PH2_071125.slim



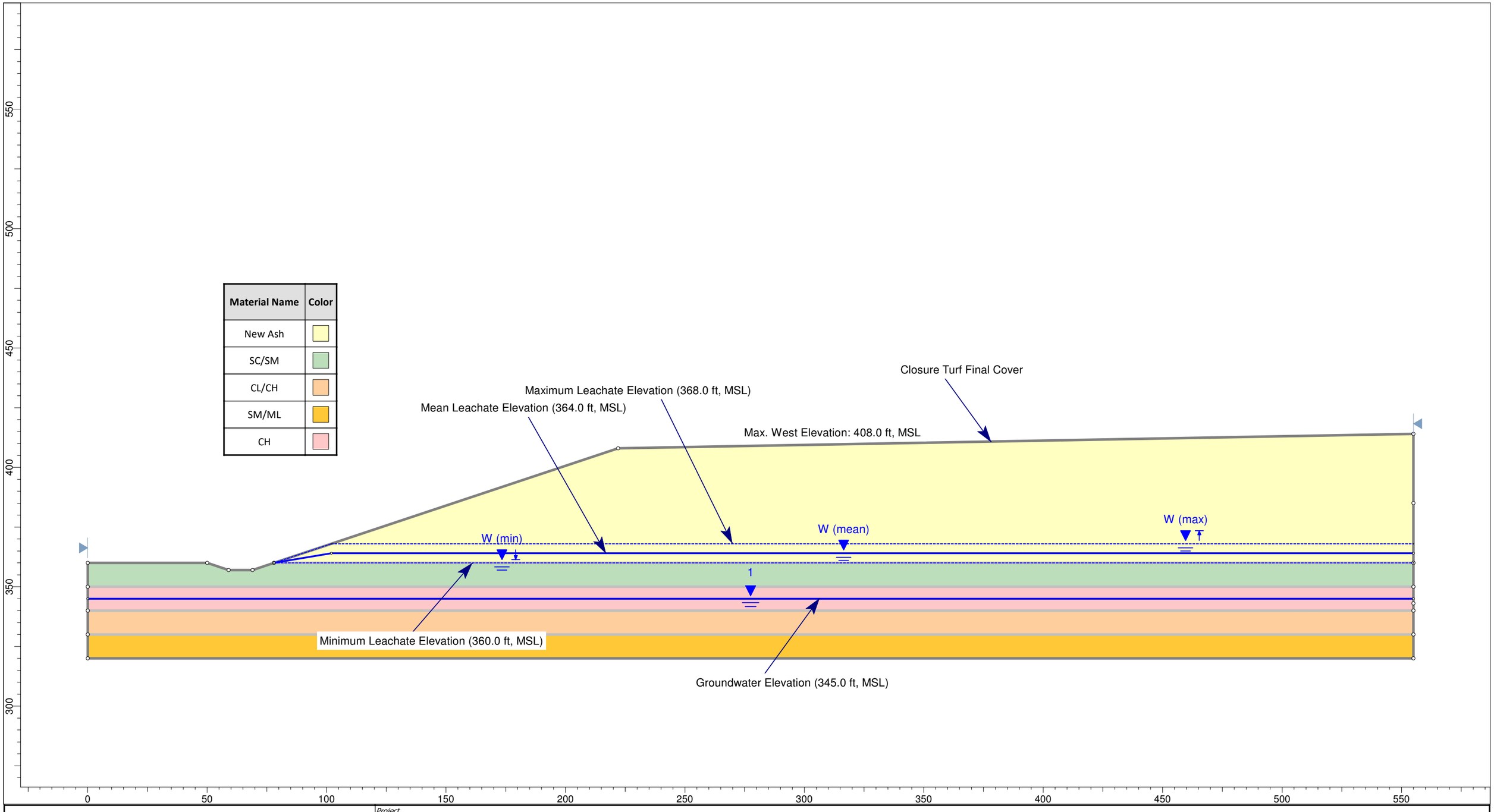
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	0	30
SC/SM		100	Mohr-Coulomb	0	25
CL/CH		125	Mohr-Coulomb	150	27
SM/ML		125	Mohr-Coulomb	0	34
CH		125	Mohr-Coulomb	300	22
Embankment Fill		120	Mohr-Coulomb	100	25

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Phase 2 Final Closure			
Analysis Description	West Section: End of Construction with Stability Dike (Block Wedge Failure, Effective Stresses)			
Drawn By	J. Tayntor	*Scale*	1:525	*Company* Auckland Consulting, LLC
Date	07/11/2025			*File Name* LF-West Slope_EOC_Block_SD-ES_PH2_071125.slim

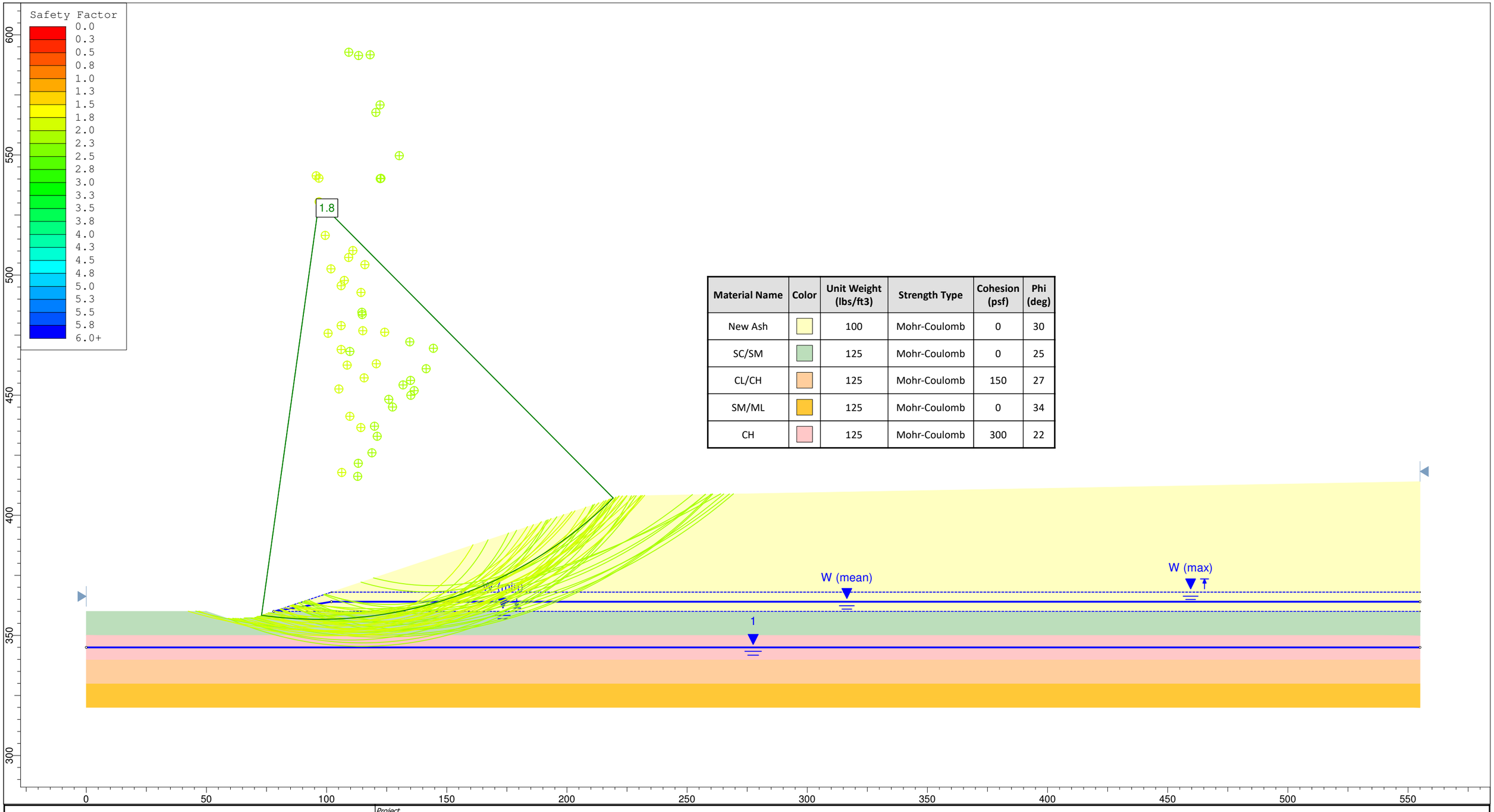
Material Name	Color
New Ash	
SC/SM	
CL/CH	
SM/ML	
CH	



Auckland Consulting LLC

SLIDE 6.039

Project	Welsh Power Plant: CCR Landfill Phase 2 Final Closure				
Analysis Description	West Section: Model Geometry (without Stability Dike)				
Drawn By	J. Tayntor	*Scale*	1:453	*Company*	Auckland Consulting, LLC
Date	04/04/2025			*File Name*	LF-West Slope_PHASE2_040425.slim

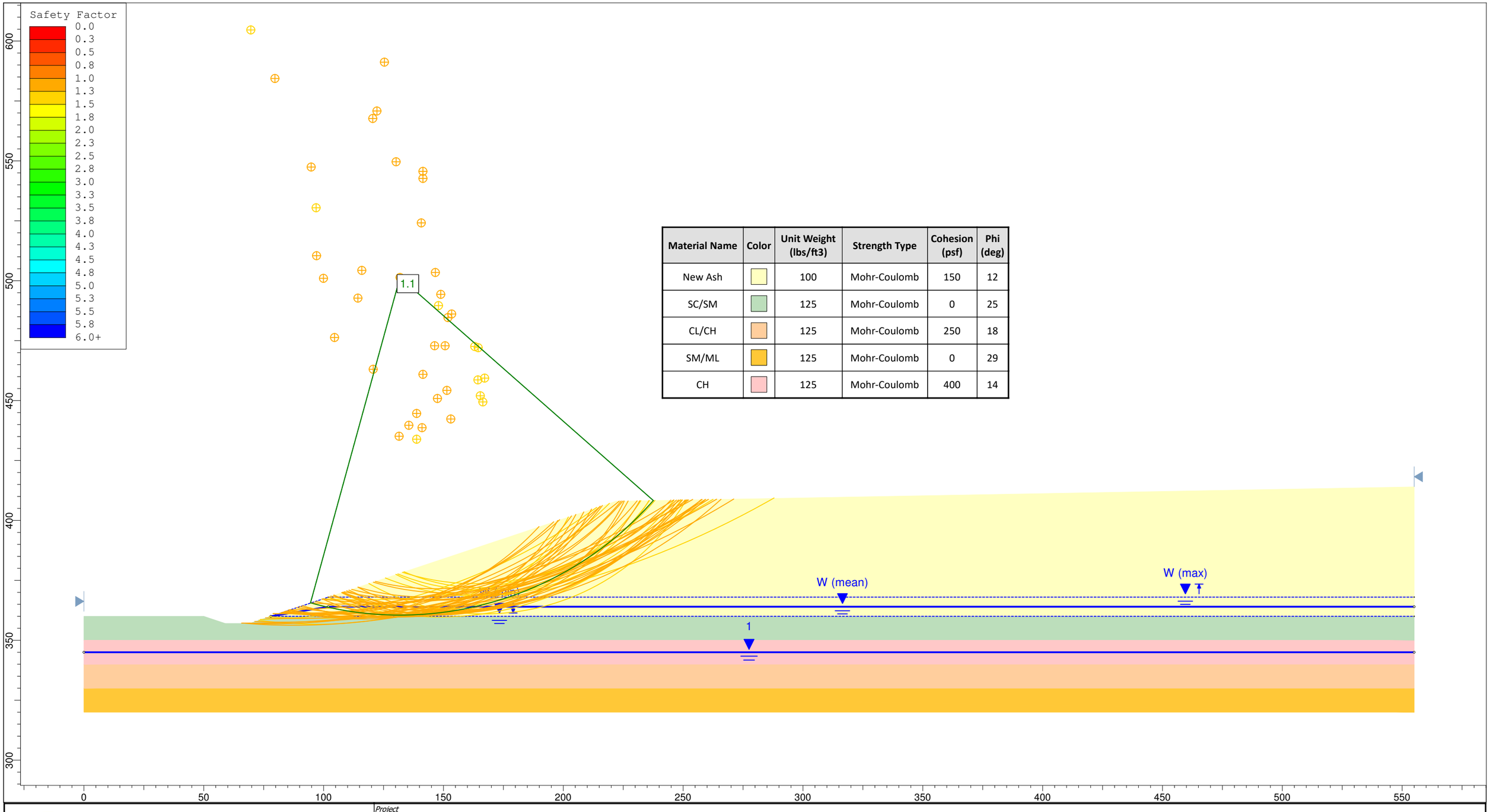


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	0	30
SC/SM		125	Mohr-Coulomb	0	25
CL/CH		125	Mohr-Coulomb	150	27
SM/ML		125	Mohr-Coulomb	0	34
CH		125	Mohr-Coulomb	300	22

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Phase 2 Final Closure		
Analysis Description	West Section: End of Construction without Stability Dike (Effective Stresses)		
Drawn By	J. Tayntor	*Scale* 1:450	*Company* Auckland Consulting, LLC
Date	07/11/2025		*File Name* LF-West Slope_EOC_ES_PH2_071125.slim

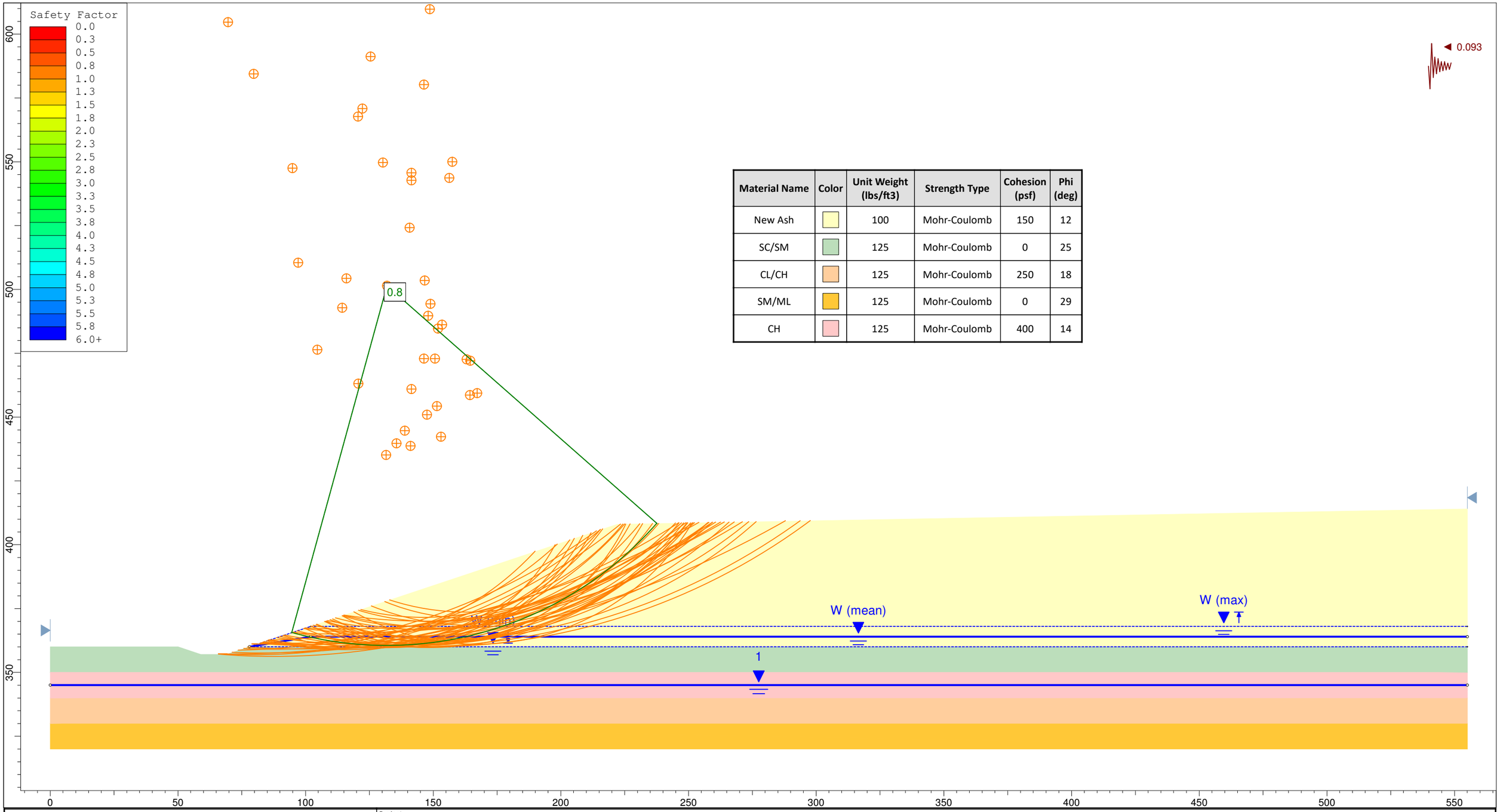


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	150	12
SC/SM		125	Mohr-Coulomb	0	25
CL/CH		125	Mohr-Coulomb	250	18
SM/ML		125	Mohr-Coulomb	0	29
CH		125	Mohr-Coulomb	400	14

Auckland Consulting LLC

SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Phase 2 Final Closure			
Analysis Description	West Section: End of Construction without Stability Dike (Total Stresses)			
Drawn By	J. Tayntor	*Scale*	1:450	*Company* Auckland Consulting, LLC
Date	07/11/2025			*File Name* LF-West Slope_EOC_TS_PH2_071125.slim

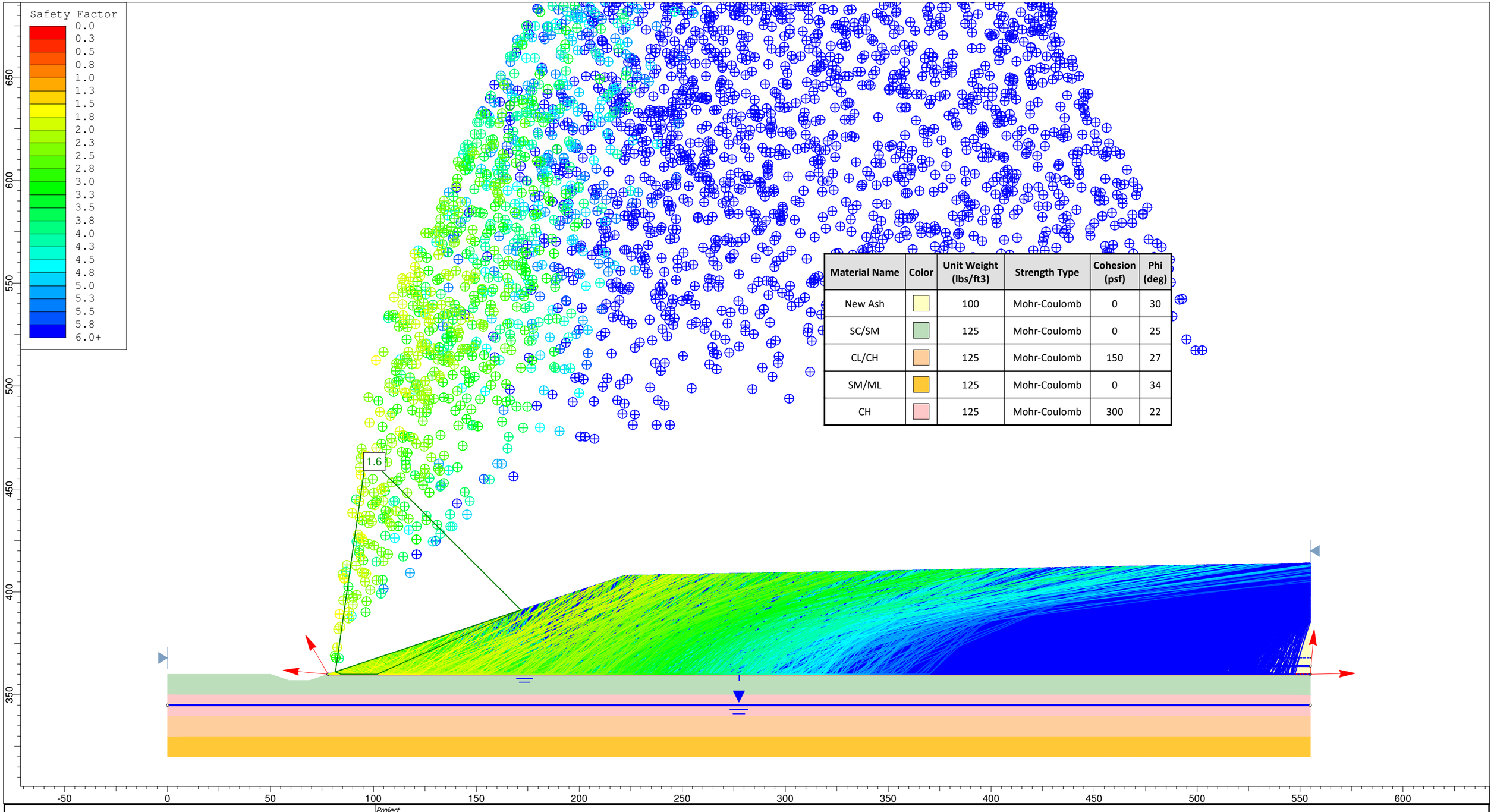


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	150	12
SC/SM		125	Mohr-Coulomb	0	25
CL/CH		125	Mohr-Coulomb	250	18
SM/ML		125	Mohr-Coulomb	0	29
CH		125	Mohr-Coulomb	400	14

Auckland Consulting LLC

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Project	Welsh Power Plant: CCR Landfill Phase 2 Final Closure		
Analysis Description	West Section: End of Construction without Stability Dike (Seismic Loading Conditions, Total Stresses)		
Drawn By J. Tayntor	*Scale* 1:425	*Company*	Auckland Consulting, LLC
Date 07/11/2025		*File Name*	LF-West Slope_EOC_Seismic_PH2_071125.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Ash		100	Mohr-Coulomb	0	30
SC/SM		125	Mohr-Coulomb	0	25
CL/CH		125	Mohr-Coulomb	150	27
SM/ML		125	Mohr-Coulomb	0	34
CH		125	Mohr-Coulomb	300	22

Auckland Consulting LLC

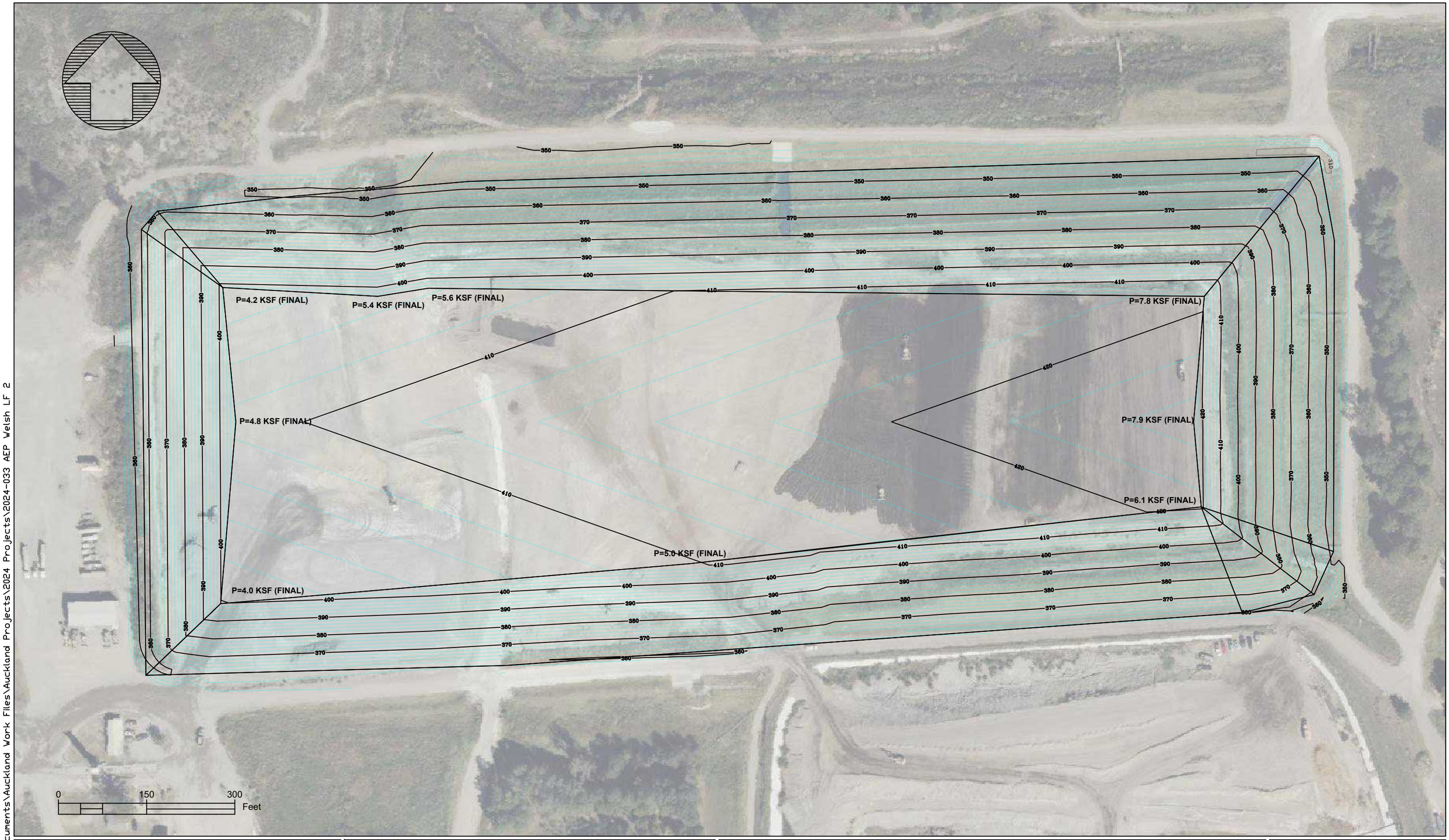
SLIDEINTERPRET 6.039

Project	Welsh Power Plant: CCR Landfill Phase 2 Final Closure			
Analysis Description	West Section: End of Construction without Stability Dike (Block Wedge Failure, Effective Stresses)			
Drawn By	J. Tayntor	*Scale*	1:525	*Company* Auckland Consulting, LLC
Date	07/11/2025			*File Name* LF-West Slope_EOC_Block_ES_PH2_071125.slim

Landfill Vertical Expansion – Phase 2 Final Closure
Stability and Settlement Assessment
Welsh Power Plant
Auckland Project No. 2024-033

APPENDIX C

SETTLEMENT ANALYSIS AND MODEL OUTPUT



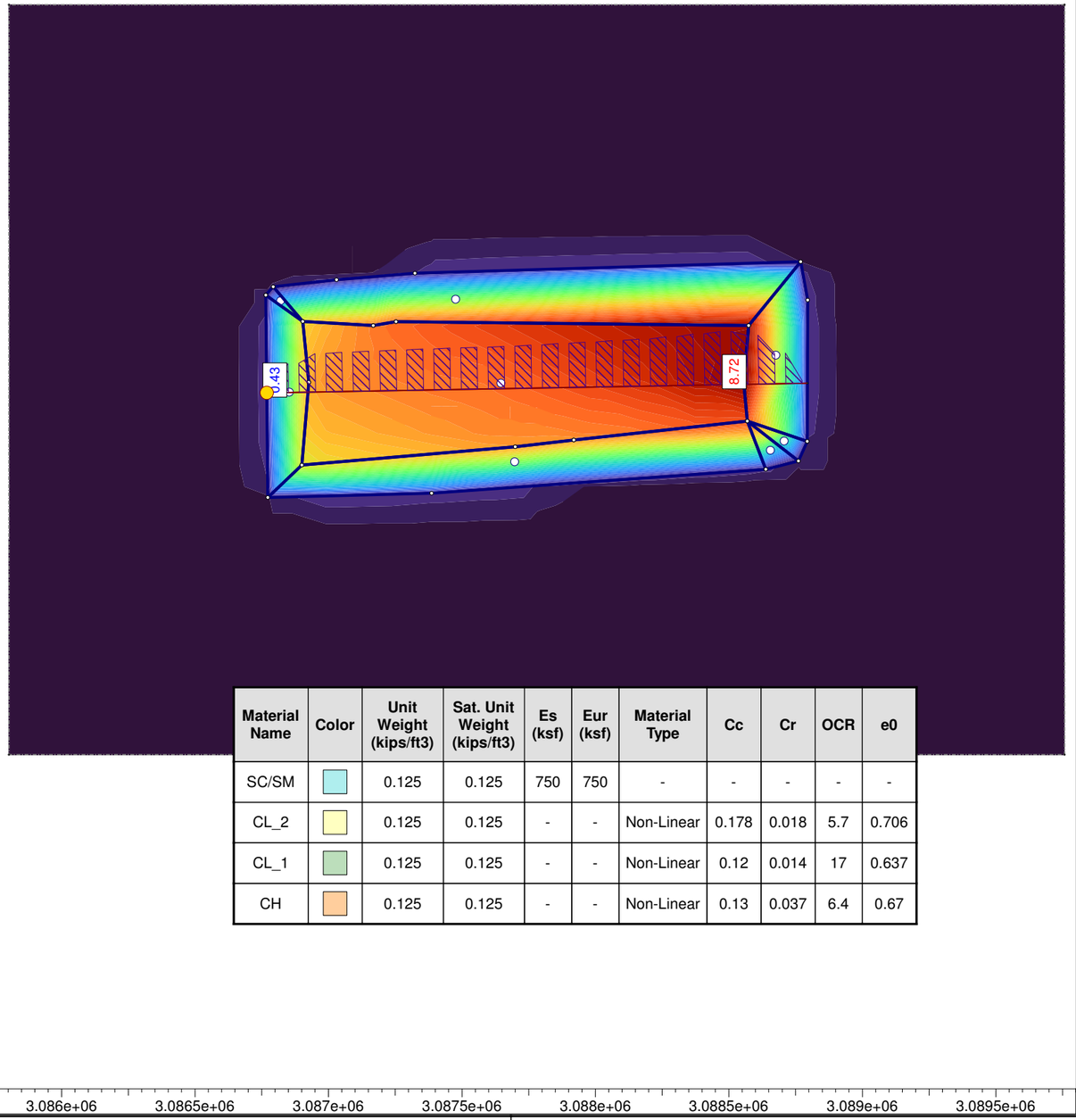
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Auckland Consulting, LLC
PO Box 8155
Jacksonville, Texas 75766
TBPE Firm No. F-16721

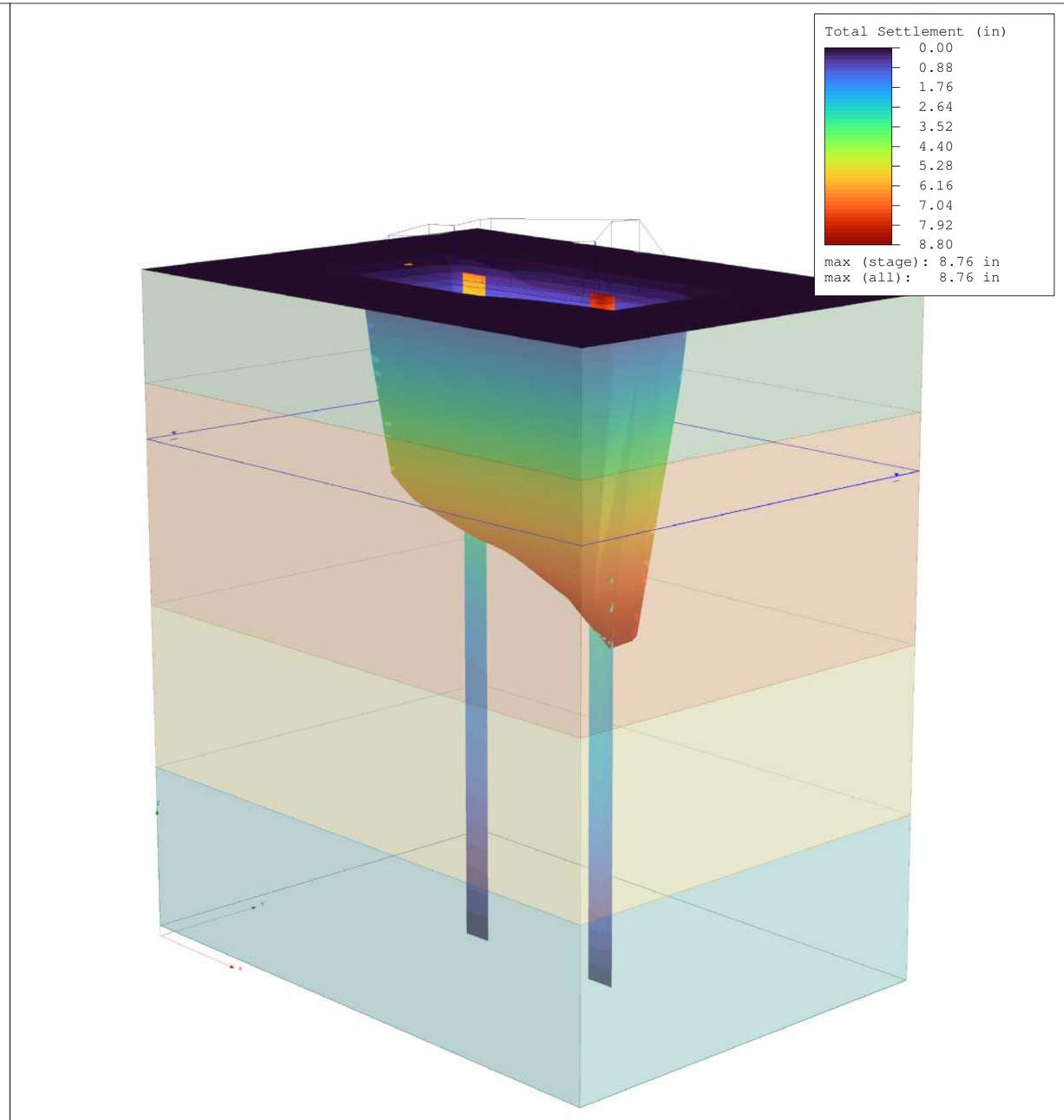
Date	Revision

FIGURE 3: SETTLE MODEL GEOMETRY AND LOADING CONDITIONS
Welsh Power Plant - CCR Landfill Phase 2 Final Closure
Pittsburg, Texas

Project No.	2024-033
Drawn	J. Tayntor
Date	04/16/2025
Sheet No.	1



Material Name	Color	Unit Weight (kips/ft3)	Sat. Unit Weight (kips/ft3)	Es (ksf)	Eur (ksf)	Material Type	Cc	Cr	OCR	e0
SC/SM		0.125	0.125	750	750	-	-	-	-	-
CL_2		0.125	0.125	-	-	Non-Linear	0.178	0.018	5.7	0.706
CL_1		0.125	0.125	-	-	Non-Linear	0.12	0.014	17	0.637
CH		0.125	0.125	-	-	Non-Linear	0.13	0.037	6.4	0.67



Auckland Consulting LLC

SETTLE3 5.022

Project	**Welsh Power Plant: CCR Landfill Phase 2 Final Closure**		
Analysis Description	Settlement Analysis - Foundation Soils		
Drawn By	J. Tayntor	*Company*	Auckland Consulting, LLC
Date	4/22/2025	*File Name*	024-033 LF Settle.s3z

Landfill Vertical Expansion – Phase 2 Final Closure
Stability and Settlement Assessment
Welsh Power Plant
Auckland Project No. 2024-033

APPENDIX D

SOIL LABORATORY RESULTS

Alpine Engineering Services, LLC
105 Tradesmen Drive, Suite B
Hutto, TX 78634
Tel: (512) 387-1287

Water Content, P-200. & Atterberg Limits (ASTM D2216, D1140, & D4318)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2
(PN: 2024-033)

Alpine Project No.: 2502078
Test Date: 02/21/25
Tested By: T.D. & T.V.

No.	Boring No.	Depth (ft)	WC (%)	No. 4 Sieve[1]	Fines (%)[2]	LL	PL	PI	USCS Classification
1	BH1	6-8	18.9	- -	27.1	31	17	14	- -
2	BH1	13-15	25.1	- -	93.2	59	25	34	Fat Clay (CH)
3	BH1	23-25	27.7	- -	98.5	49	22	27	Lean clay (CL)
4	BH1	38-40	18.3	- -	45.4	25	17	8	- -
5	BH2	4-6	17.2	- -	35.6	33	16	17	- -
6	BH2	8-10	21.3	- -	16.2	NL	NP	NP	- -
7	BH2	13-15	28.1	- -	92.6	59	24	35	Fat Clay (CH)
8	BH2	23-25	22.1	- -	98.1	56	25	31	Fat Clay (CH)
9	BH2	38-40	16.3	- -	52.5	27	17	10	- -
10	BH3	4-6	18.8	- -	70.0	40	17	23	- -
11	BH3	13-15	26.0	- -	91.2	60	24	36	Fat Clay (CH)
12	BH3	28-30	23.2	- -	99.7	53	22	31	Fat clay (CH)
13	BH3	38-40	18.7	- -	42.2	25	19	6	- -
14	BH3	48-50	22.4	- -	33.6	21	15	6	- -
15	BH4	4-6	12.0	- -	42.4	31	16	15	- -
16	BH4	6-8	12.9	- -	44.9	22	16	6	- -
17	BH4	18-20	26.8	- -	57.1	27	19	8	- -
18	BH4	28-30	23.8	- -	99.3	57	26	31	Fat Clay (CH)
19	BH4	38-40	18.1	- -	35.8	25	17	8	- -
20	BH5	6-8	25.4	- -	96.4	64	20	44	Fat Clay (CH)

[1] Percent passing No. 4 sieve per ASTM D6913.

[2] Percent passing No. 200 sieve per ASTM D1140.

Note: Soil was air dried and 3-point Liquid Limit procedure was used. NL = No Liquid Limit, NP = No Plastic Limit.

Cheng-Wei Chen, Ph.D. 03/08/25

Reviewed By / Date

The testing was performed in accordance with applicable industry standard. The results provided in this report do not constitute a professional opinion by Alpine Engineering Services, LLC (Alpine). This report may be used only by the Client and the registered design professional in charge.

Alpine Engineering Services, LLC
105 Tradesmen Drive, Suite B
Hutto, TX 78634
Tel: (512) 387-1287

Water Content, P-200. & Atterberg Limits (ASTM D2216, D1140, & D4318)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2
(PN: 2024-033)

Alpine Project No.: 2502078
Test Date: 02/21/25
Tested By: T.D. & T.V.

No.	Boring No.	Depth (ft)	WC (%)	No. 4 Sieve[1]	Fines (%)[2]	LL	PL	PI	USCS Classification
21	BH5	18-20	23.8	- -	84.9	37	16	21	- -
22	BH5	33-35	30.3	- -	93.0	58	27	31	Fat clay (CH)
23	BH6	13-15	23.2	- -	84.3	48	20	28	- -
24	BH6	18-20	28.7	- -	82.2	51	23	28	- -
25	BH6	23-25	23.6	- -	98.8	58	24	34	Fat clay (CH)
26	BH6	33-35	22.1	- -	90.6	39	24	15	Lean clay (CL)

[1] Percent passing No. 4 sieve per ASTM D6913.

[2] Percent passing No. 200 sieve per ASTM D1140.

Note: Soil was air dried and 3-point Liquid Limit procedure was used. NL = No Liquid Limit, NP = No Plastic Limit.

Cheng-Wei Chen, Ph.D. 03/08/25

Reviewed By / Date

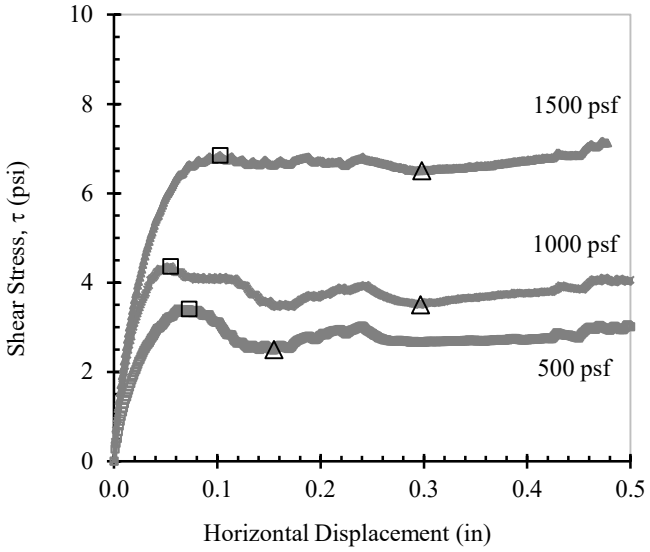
The testing was performed in accordance with applicable industry standard. The results provided in this report do not constitute a professional opinion by Alpine Engineering Services, LLC (Alpine). This report may be used only by the Client and the registered design professional in charge.

Alpine Engineering Services, LLC
105 Tradesmen Drive, Suite B
Hutto, TX 78634
Tel: (512) 387-1287

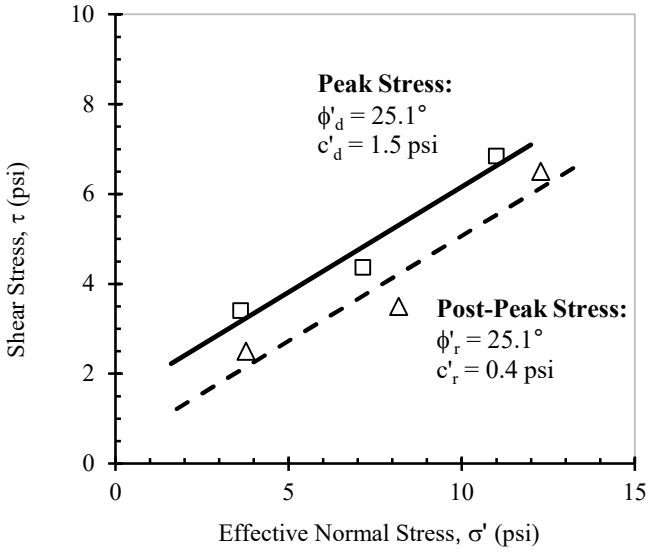
Direct Shear Consolidated Drained Test (ASTM D3080)

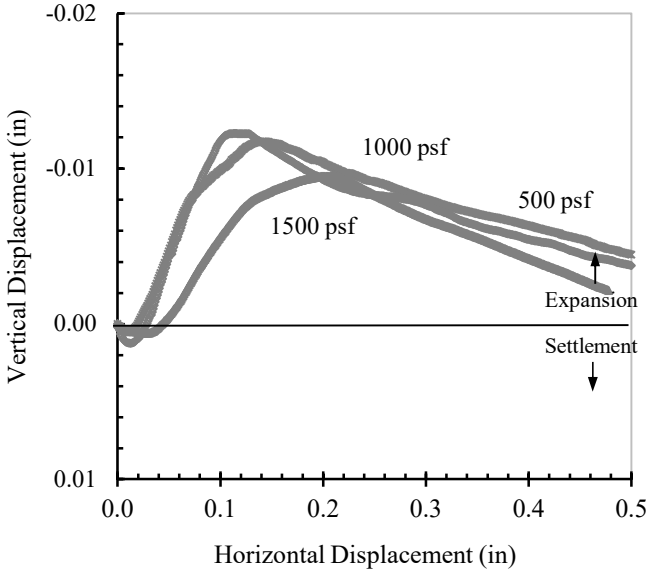
Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2 (PN: 2024-033)
Sample ID: BH1 (6-8 ft)

Alpine Project No.: 2502078
Test Date: 02/20/25
Tested By: T.D.
Method of Preparation: *Shelby Tube*



Note: Area Correction Has Been Applied





Specimen Number		1	2	3
Initial Condition	Diameter, in	2.51	2.50	2.50
	Height, in (before consol)	1.00	1.00	1.00
	Water Content, %	18.7	19.1	19.3
	Degree of Saturation, %	86.1	89.6	91.5
	Dry Unit Weight, pcf	105.7	106.5	106.9
	Void Ratio, e_0	0.58	0.57	0.57
After Consolidation	Height, in (prior to shear)	1.00	1.00	1.01
	Final Water Content, %	20.9	21.4	21.1
	Dry Unit Weight, pcf	105.8	106.3	105.7
	Void Ratio, e_f	0.58	0.57	0.58
Peak Normal Stress, σ' (psi)		3.6	7.1	11.0
Peak Shear Stress, τ (psi)		3.4	4.4	6.8
Displacement at Failure (in)		0.07	0.05	0.10
Displacement Rate (in/min)		0.00035		
Peak Strength Parameters	ϕ'_d, degree			**25.1**
	c'_d, psi			**1.5**
Post-Peak Strength Parameters	ϕ'_r, degree			**25.1**
	c'_r, psi			**0.4**

Note: The Shelby tube sample was extruded and provided by the client. Specimens were trimmed using a trimming turntable. The specific gravity of 2.68 was assumed.

Cheng-Wei Chen, Ph.D. 02/28/25
Reviewed By / Date

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Alpine Engineering Services, LLC
105 Tradesmen Drive, Suite B
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Tel: (512) 387-1287

Direct Shear Consolidated Drained Test
(ASTM D3080)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2
(PN: 2024-033)
Sample ID: BH1 (6-8 ft)

Alpine Project No.: 2502078
Test Date: 02/20/25
Tested By: T.D.
Method of Preparation: *Shelby Tube*





(1) Normal Load = 500 psf





(2) Normal Load = 1000 psf





(3) Normal Load = 1500 psf

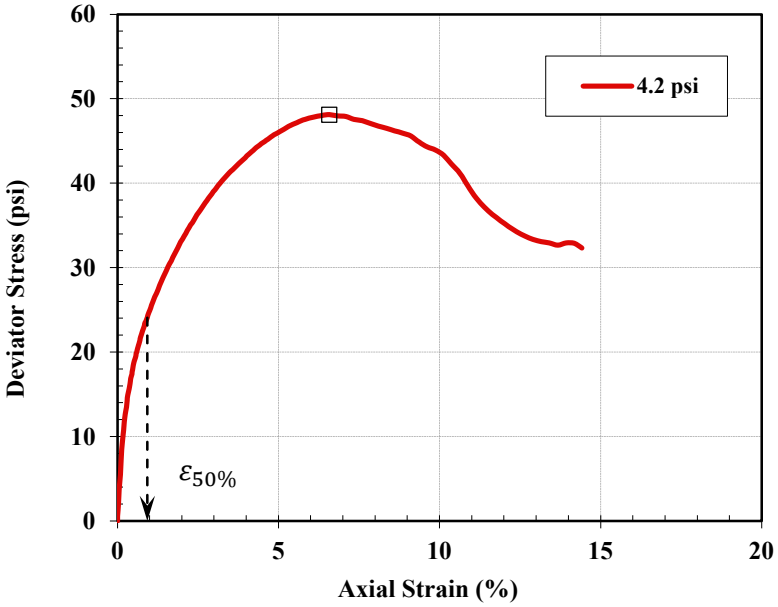
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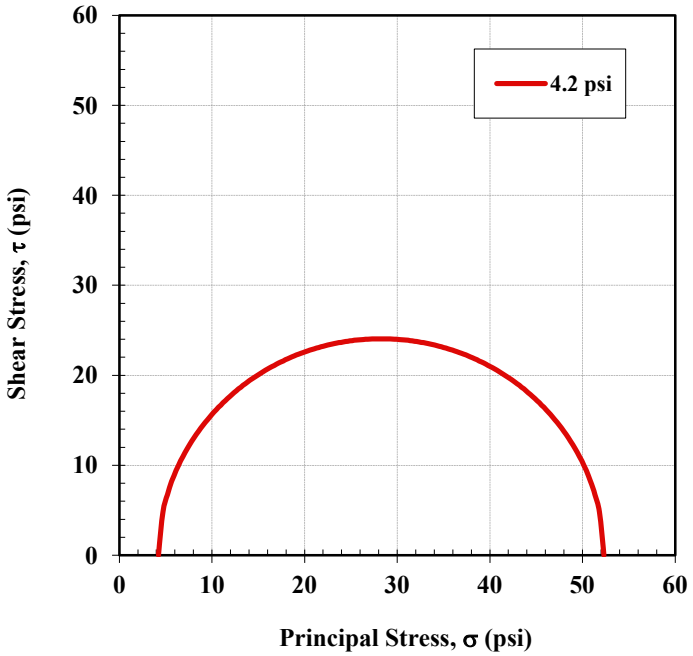
Alpine Engineering Services, LLC
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Tel: (512) 387-1287

Unconsolidated-Undrained Triaxial Compression (ASTM D2850)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2
(PN: 2024-033)
Sample ID: BH3 (4-6 ft)

Alpine Project No.: 2502078
Test Date: 02/25/25
Tested By: T.D.





Initial Conditions	
Confining Stress (psi)	4.2
Avg. Diameter (in)	2.82
Avg. Height, H_0 (in)	5.67
Avg. Water Content (%)	18.7
Total Unit Weight, γ_{total} (pcf)	128.8
Dry Unit Weight, γ_{dry} (pcf)	108.5
Degree of Saturation (%)	92.4
Void Ratio, e_0	0.54
Specific Gravity (Assumed)	2.68
Rate of Axial Strain, %/ min	1.0

Stresses at Failure	
Max, Deviator Stress, q_u (psi)	48.1
Axial Strain at Failure (%)	6.6
Axial Strain at 50% of q_u , $\varepsilon_{50\%}$	0.9

Total Stresses at Failure	
Major Principal Stress *Corrected*, σ_{1C} (psi)	52.3
Minor Principal Stress, σ_3 (psi)	4.2

Unconsolidated-Undrained Compressive Strength at Failure, σ_{1C} - σ_3 (tsf)	3.46

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whichever is obtained first.

Cheng-Wei Chen, Ph.D., 03/03/25

Reviewed By / Date

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Hutto, TX 78634
Tel: (512) 387-1287

Unconsolidated-Undrained Triaxial Compression (ASTM D2850)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2
(PN: 2024-033)
Sample ID: BH3 (4-6 ft)

Alpine Project No.: 2502078
Test Date: 02/25/25
Tested By: T.D.







(a) Confining Pressure = 4.2 psi

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Alpine Engineering Services, LLC
105 Tradesmen Drive, Suite B
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Tel: (512) 387-1287

One-Dimensional Consolidation of Soils (ASTM D2435)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2
(PN: 2024-033)
Sample ID: BH3 (28-30 ft)

Alpine Project No.: 2502078
Test Date: 02/19/25
Tested By: T.D.

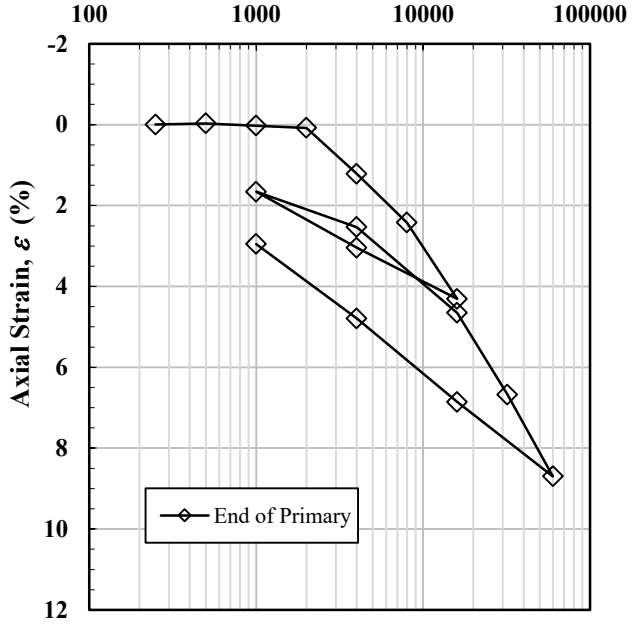
Soil Testing Properties		
Initial Condition	Initial Water Content, w_o (%)	23.2
	Specimen Height, H_o (in)	0.904
	Dry Unit Weight, γ_{do} (pcf)	100.2
	Void Ratio, e_o	0.670
	Degree of Saturation, S_o (%)	92.6
End of Testing Condition	Final Water Content, w_f (%)	24.1
	Specimen Height, H_f (in)	0.877
	Dry Unit Weight, γ_{df} (pcf)	103.3
	Void Ratio, e_f	0.620
Estimated Preconsolidation Stress, p'_c (psf)		5,100

Test Method: B
Specimen Diameter (in): 2.500
Specific Gravity, Gs (assumed): 2.68

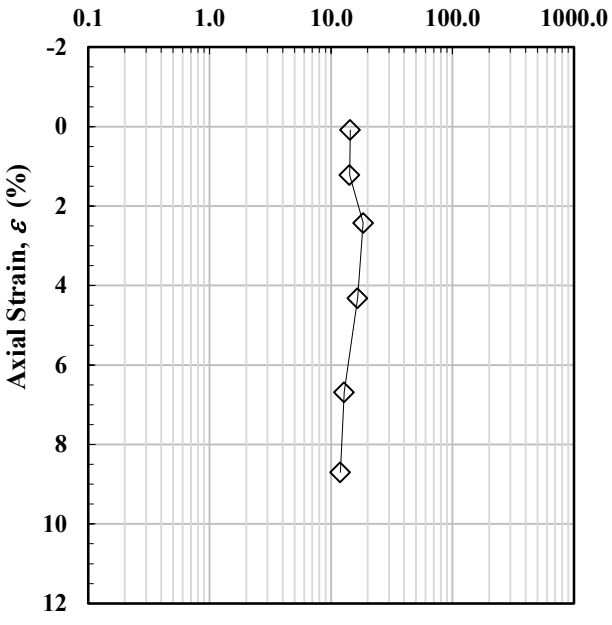
Note: Specimen was trimmed using a trimming turntable and a cutting shoe. Specimen was inundated with potable tap water during testing. The machine deflections were measured and included for the end-of-primary deformation results. Estimated preconsolidation pressure was determined by using the Casagrande construction technique.

Compression Index, C_c	0.130
Recompression Index, C_r (1st Rebound)	0.037
Recompression Index, C_r (2nd Rebound)	0.053

Axial Effective Stress, σ'_v (psf)



Coefficient of Consolidation, C_v (ft²/yr)



σ'_v (psf)	250	500	1000	2000	4000	8000	16000	4000	1000	4000
ε (%)	0.00	-0.03	0.02	0.08	1.22	2.42	4.31	3.04	1.66	2.53
e	0.670	0.670	0.669	0.669	0.650	0.629	0.598	0.619	0.642	0.628
C_v (ft²/yr)	- -	- -	- -	14.38	14.21	18.38	16.52	- -	- -	- -

σ'_v (psf)	16000	32000	60000	16000	4000	1000
ε (%)	4.65	6.68	8.70	6.86	4.79	2.95
e	0.592	0.558	0.525	0.555	0.590	0.620
C_v (ft²/yr)	13.51	12.81	11.92	- -	- -	- -

Cheng-Wei Chen, Ph.D. 03/05/25
Reviewed By / Date

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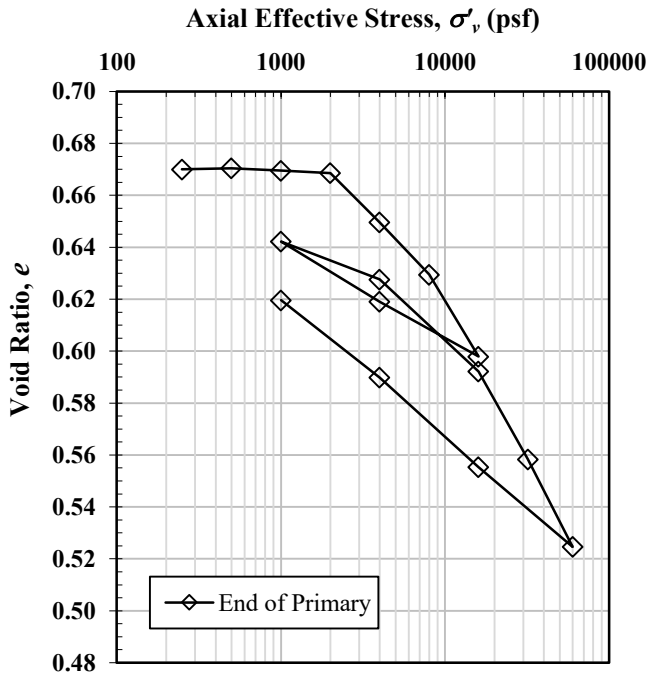
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Tel: (512) 387-1287

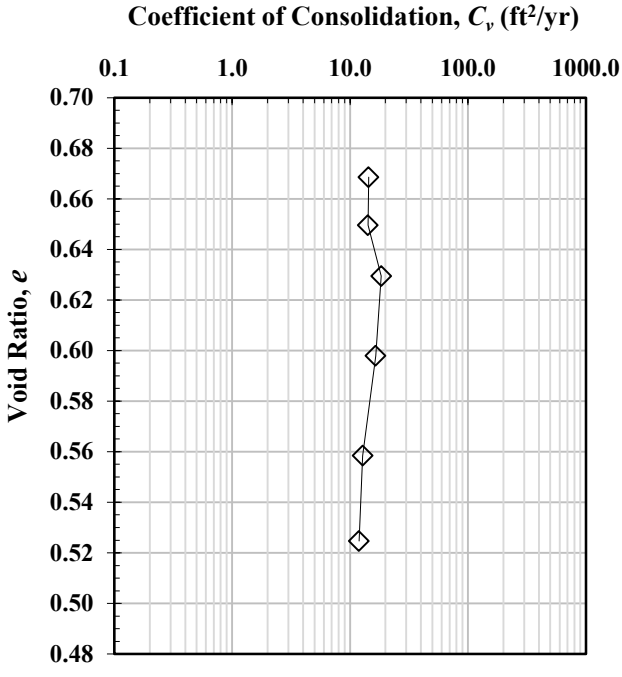
One-Dimensional Consolidation of Soils (ASTM D2435)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2 (PN: 2024-033)
Sample ID: BH3 (28-30 ft)

Alpine Project No.: 2502078
Test Date: 02/19/25
Tested By: T.D.

Test Method: B









(a) As-received





(b) After Test

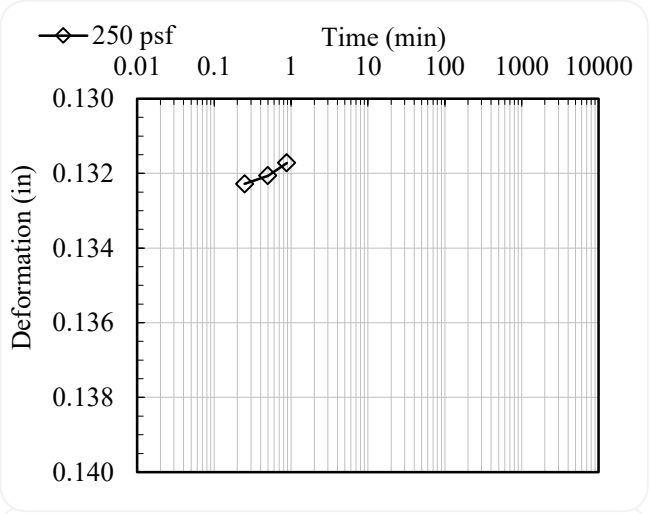
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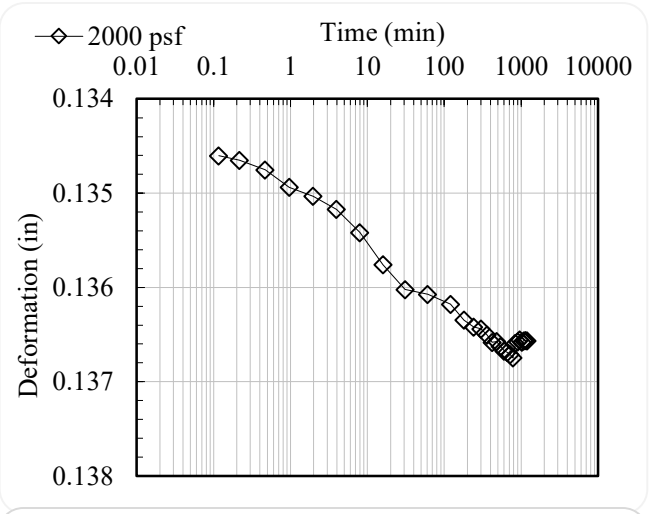
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Hutto, TX 78634
Tel: (512) 387-1287

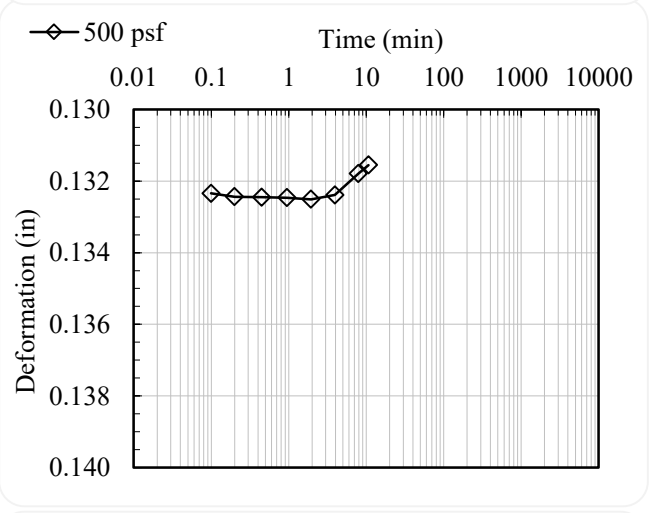
One-Dimensional Consolidation of Soils (ASTM D2435)

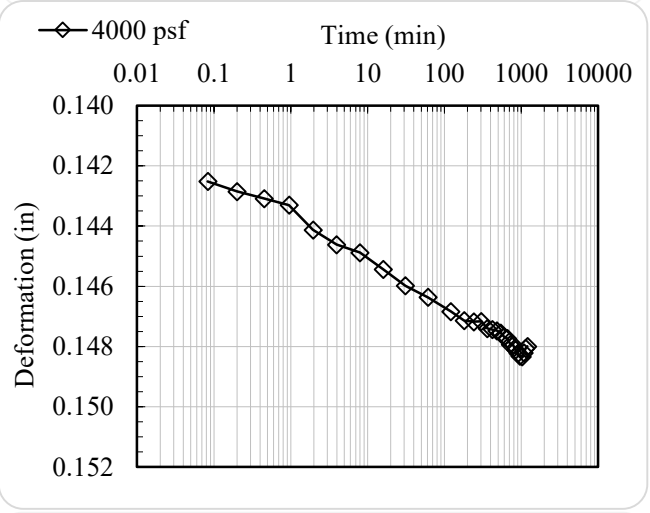
Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2
(PN: 2024-033)
Sample ID: BH3 (28-30 ft)

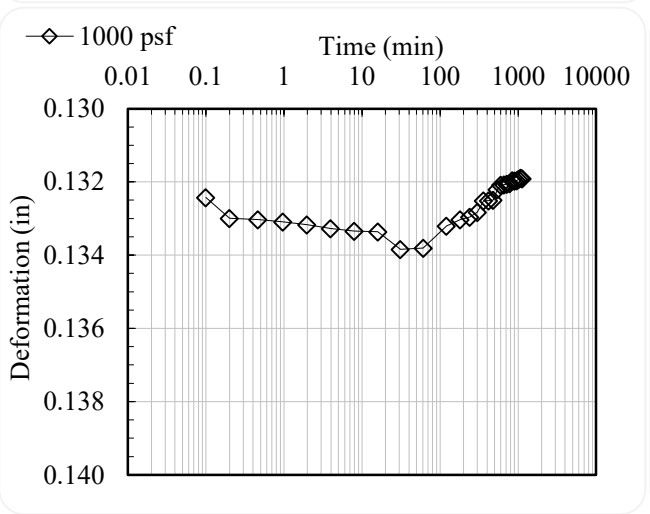
Alpine Project No.: 2502078
Test Date: 02/19/25
Tested By: T.D.

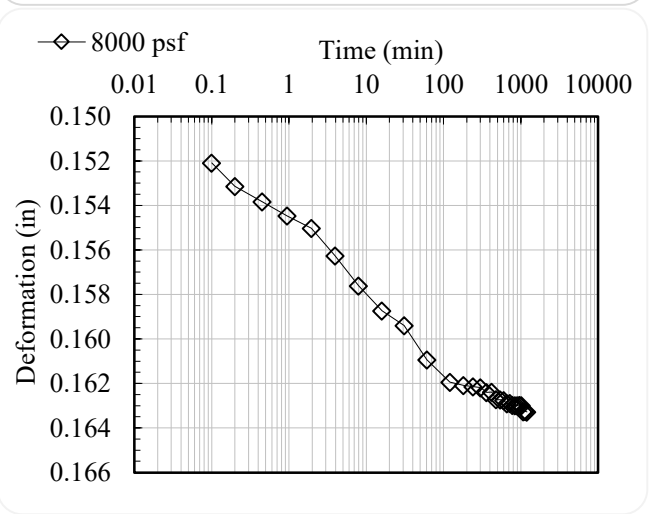












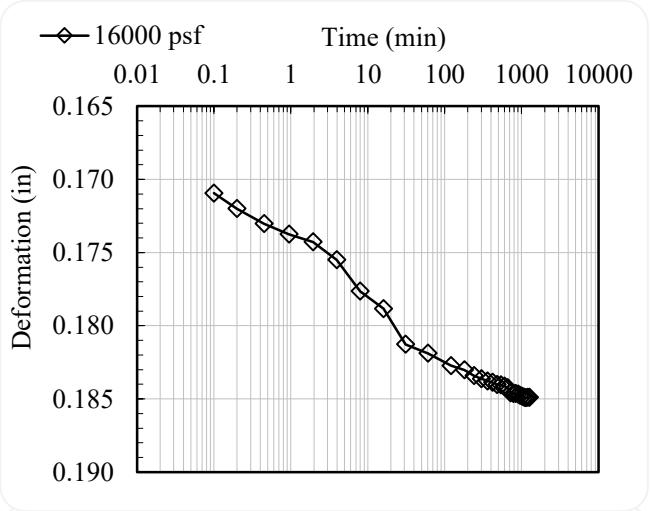
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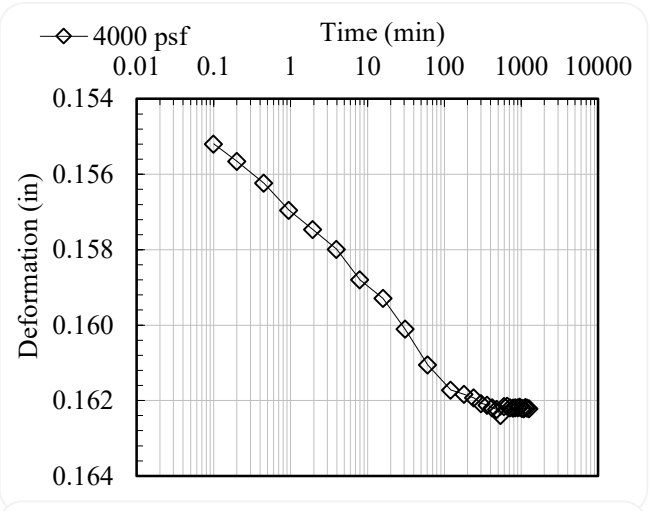
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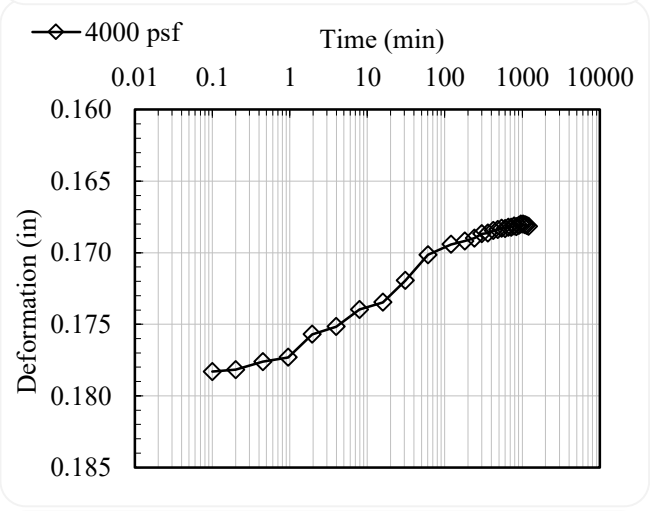
One-Dimensional Consolidation of Soils (ASTM D2435)

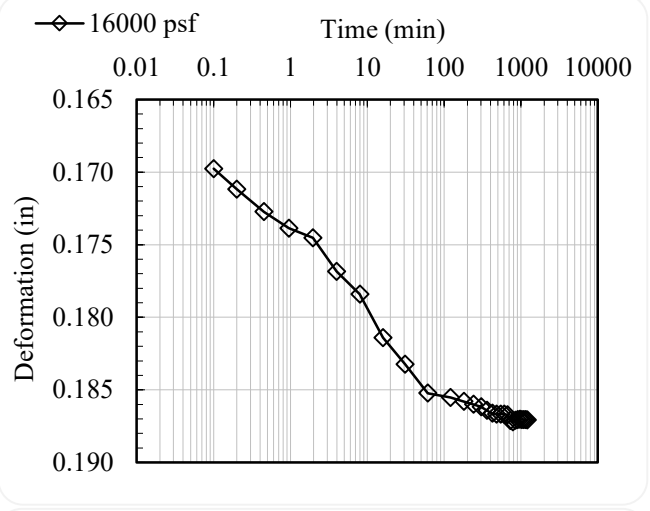
Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2
(PN: 2024-033)
Sample ID: BH3 (28-30 ft)

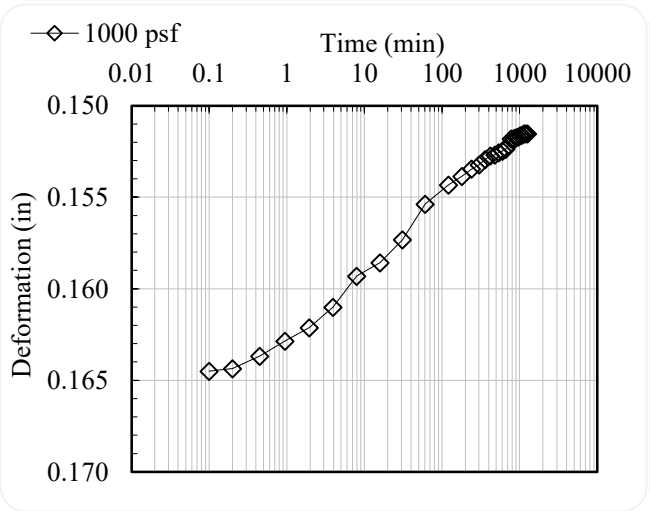
Alpine Project No.: 2502078
Test Date: 02/19/25
Tested By: T.D.

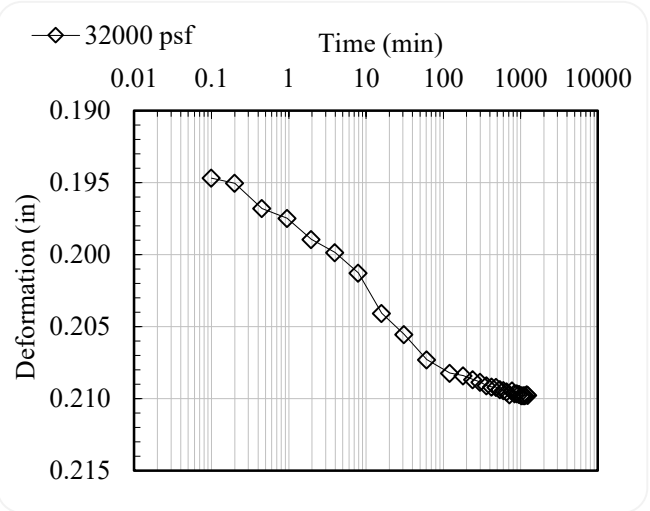












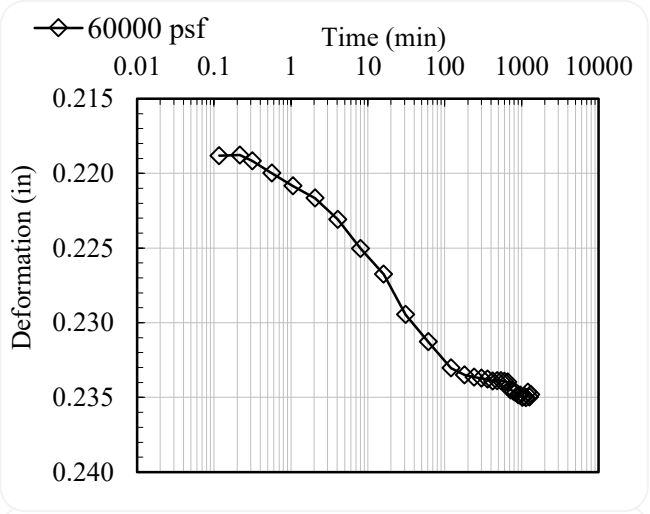
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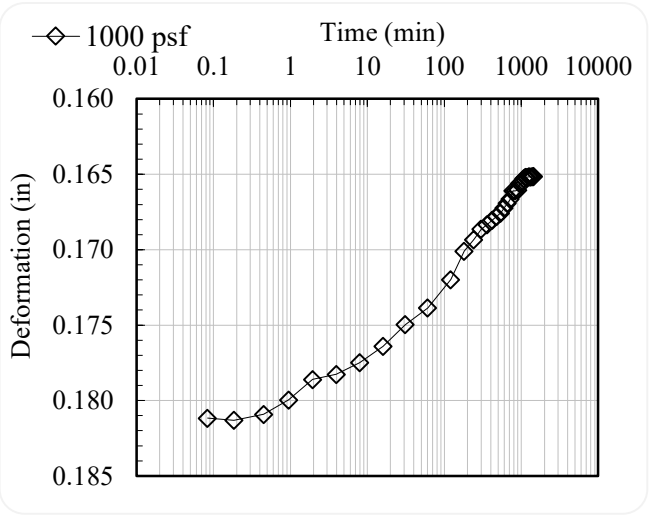
Alpine Engineering Services, LLC
105 Tradesmen Drive, Suite B
Hutto, TX 78634
Tel: (512) 387-1287

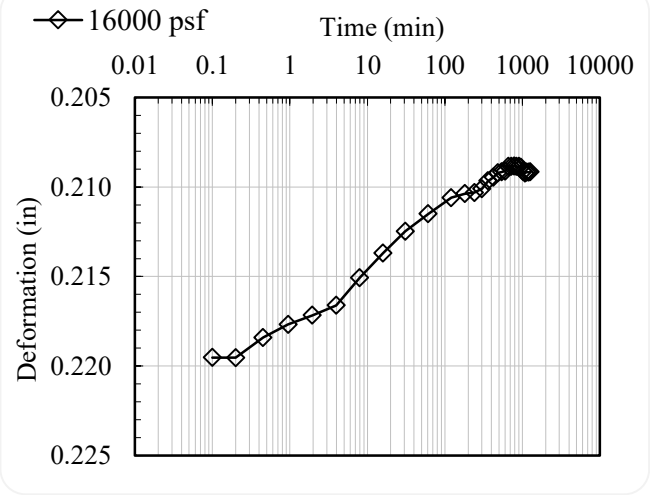
One-Dimensional Consolidation of Soils (ASTM D2435)

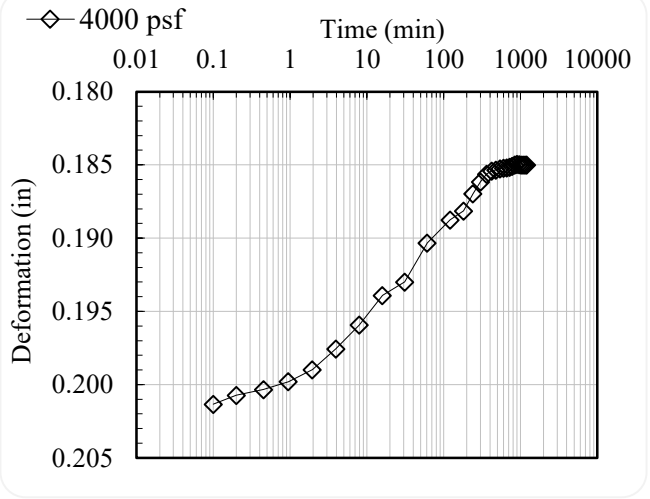
Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2 (PN: 2024-033)
Sample ID: BH3 (28-30 ft)

Alpine Project No.: 2502078
Test Date: 02/19/25
Tested By: T.D.









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Tel: (512) 387-1287

One-Dimensional Consolidation of Soils (ASTM D2435)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2
(PN: 2024-033)
Sample ID: BH5 (6-8 ft)

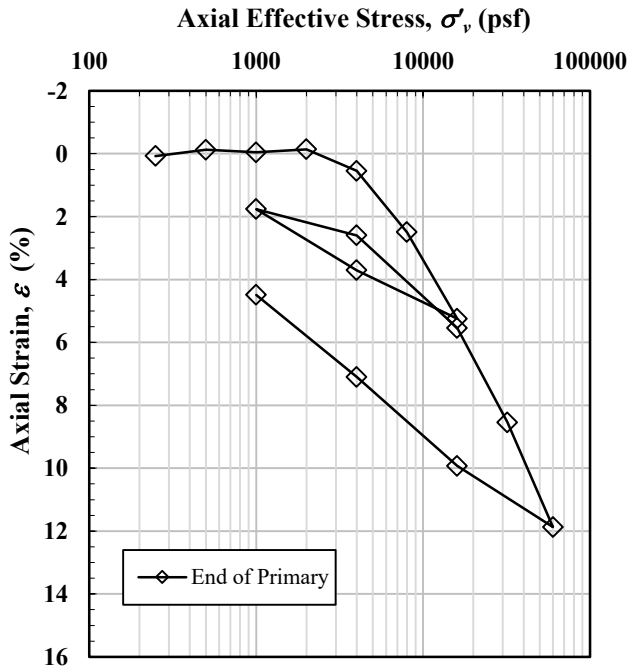
Alpine Project No.: 2502078
Test Date: 02/19/25
Tested By: T.D.

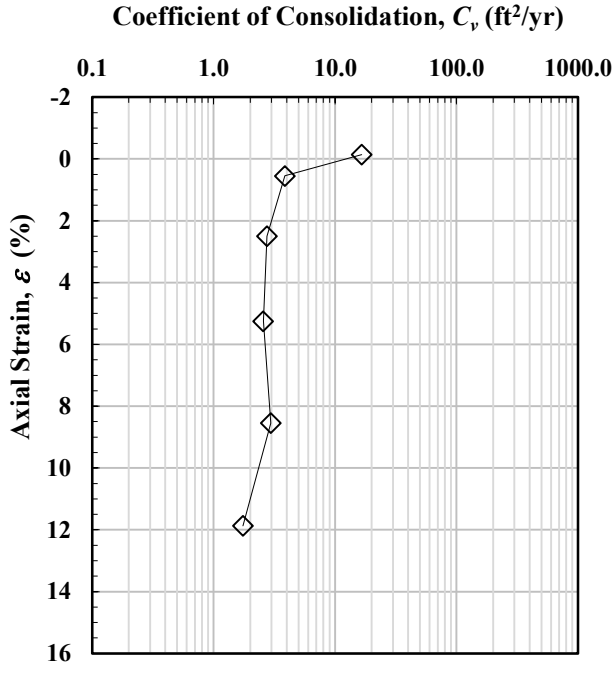
Soil Testing Properties		
Initial Condition	Initial Water Content, w_o (%)	25.6
	Specimen Height, H_o (in)	0.905
	Dry Unit Weight, γ_{do} (pcf)	98.0
	Void Ratio, e_o	0.707
	Degree of Saturation, S_o (%)	97.1
End of Testing Condition	Final Water Content, w_f (%)	23.7
	Specimen Height, H_f (in)	0.865
	Dry Unit Weight, γ_{df} (pcf)	102.6
	Void Ratio, e_f	0.630
Estimated Preconsolidation Stress, p'_c (psf)		5,800

Test Method: B
Specimen Diameter (in): 2.500
Specific Gravity, Gs (assumed): 2.68

Note: Specimen was trimmed using a trimming turntable and a cutting shoe. Specimen was inundated with potable tap water during testing. The machine deflections were measured and included for the end-of-primary deformation results. Estimated preconsolidation pressure was determined by using the Casagrande construction technique.

Compression Index, C_c 0.196
Recompression Index, C_r (1st Rebound) 0.049
Recompression Index, C_r (2nd Rebound) 0.071





σ'_v (psf)	250	500	1000	2000	4000	8000	16000	4000	1000	4000
ε (%)	0.07	-0.12	-0.04	-0.14	0.54	2.50	5.25	3.71	1.76	2.60
e	0.705	0.708	0.707	0.709	0.697	0.664	0.617	0.643	0.676	0.662
C_v (ft²/yr)	- -	- -	- -	16.58	3.86	2.75	2.57	- -	- -	- -

σ'_v (psf)	16000	32000	60000	16000	4000	1000
ε (%)	5.54	8.54	11.87	9.93	7.10	4.49
e	0.612	0.560	0.504	0.537	0.585	0.630
C_v (ft²/yr)	4.40	2.96	1.75	- -	- -	- -

Cheng-Wei Chen, Ph.D. 03/05/25
Reviewed By / Date

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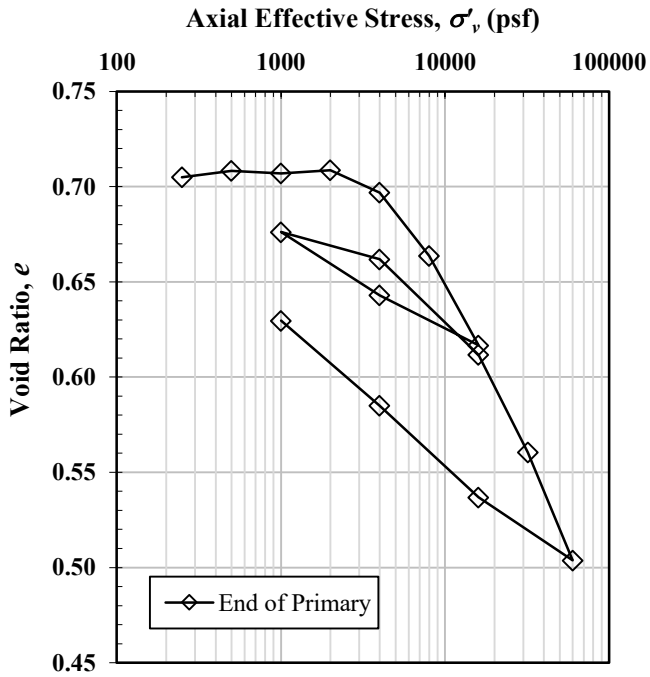
Alpine Engineering Services, LLC
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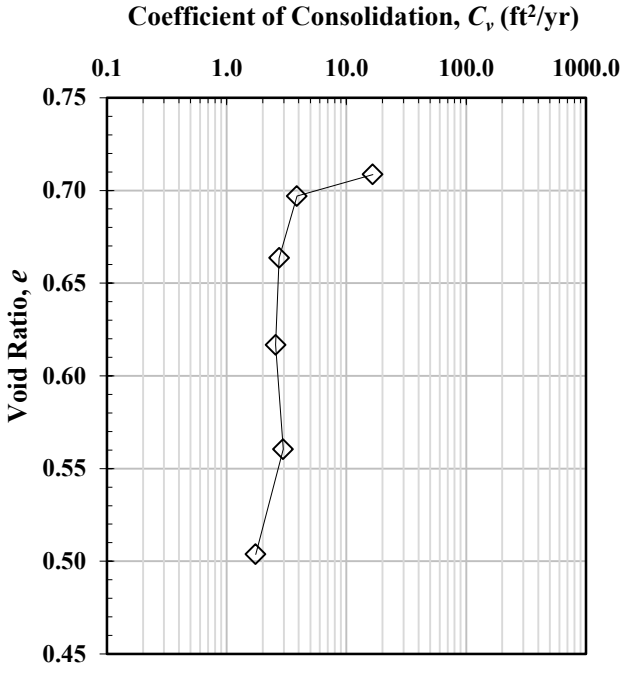
One-Dimensional Consolidation of Soils (ASTM D2435)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2 (PN: 2024-033)
Sample ID: BH5 (6-8 ft)

Alpine Project No.: 2502078
Test Date: 02/19/25
Tested By: T.D.

Test Method: B









(a) As-received





(b) After Test

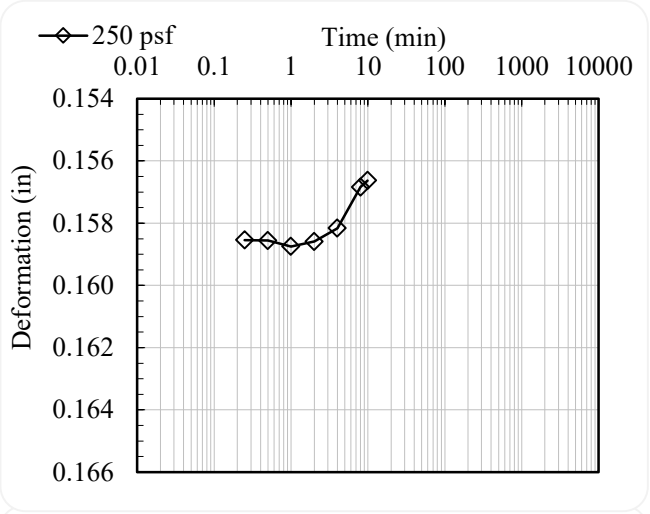
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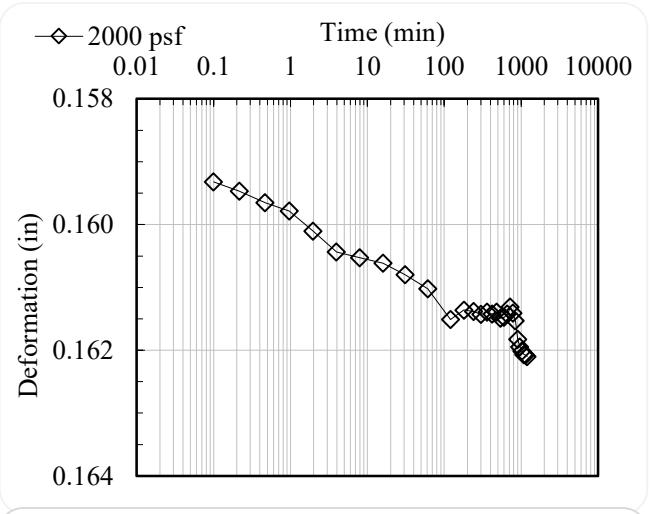
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Hutto, TX 78634
Tel: (512) 387-1287

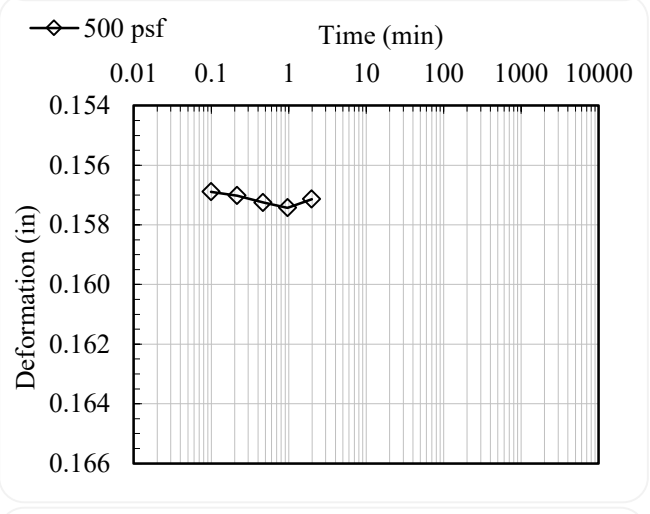
One-Dimensional Consolidation of Soils (ASTM D2435)

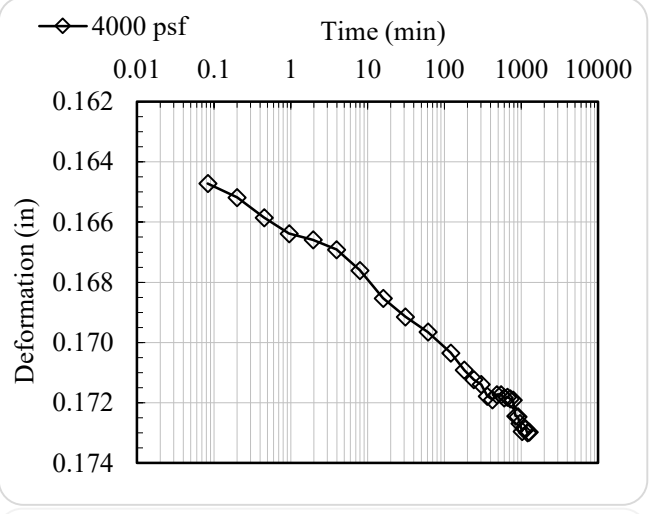
Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2
(PN: 2024-033)
Sample ID: BH5 (6-8 ft)

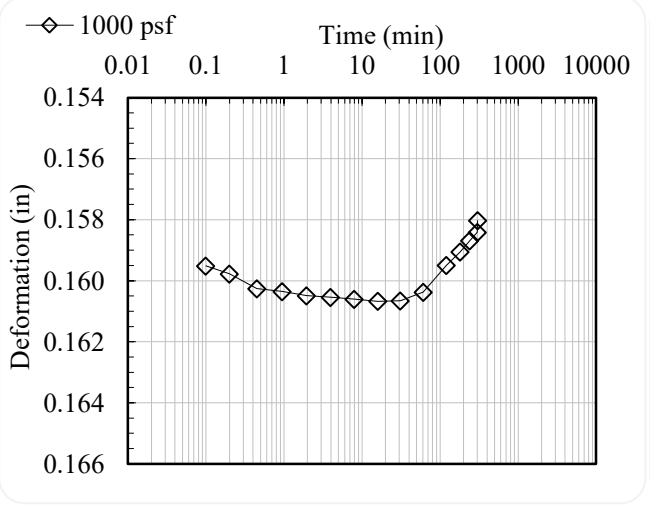
Alpine Project No.: 2502078
Test Date: 02/19/25
Tested By: T.D.

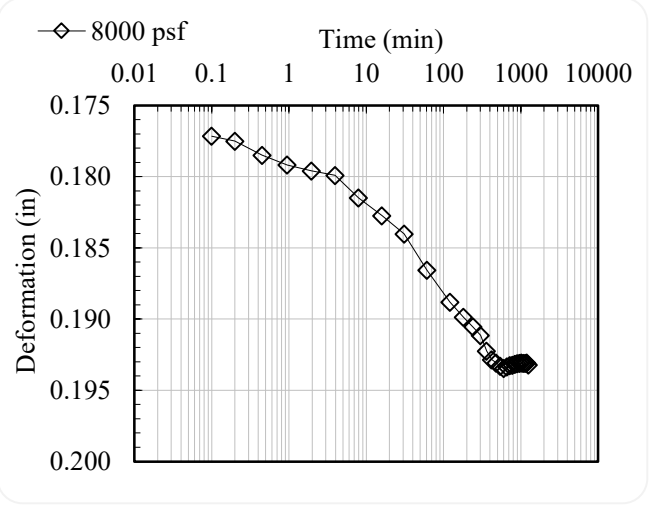












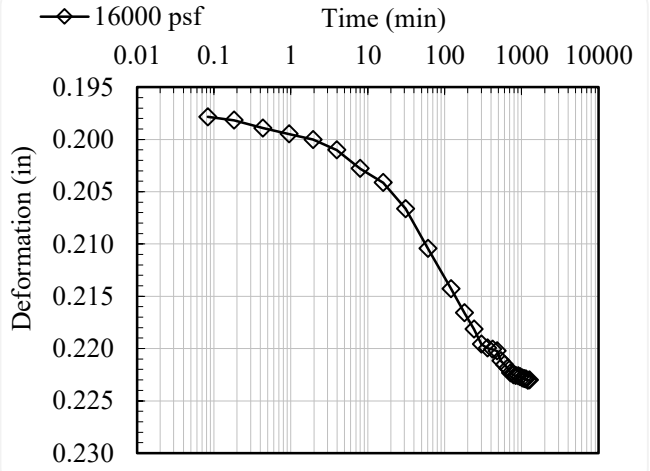
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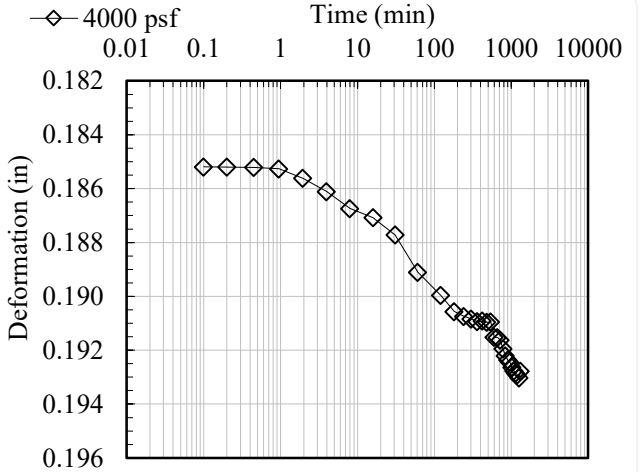
Alpine Engineering Services, LLC
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Hutto, TX 78634
Tel: (512) 387-1287

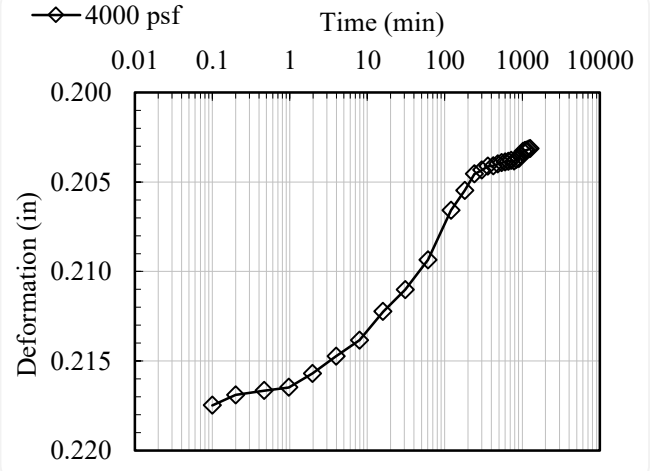
One-Dimensional Consolidation of Soils (ASTM D2435)

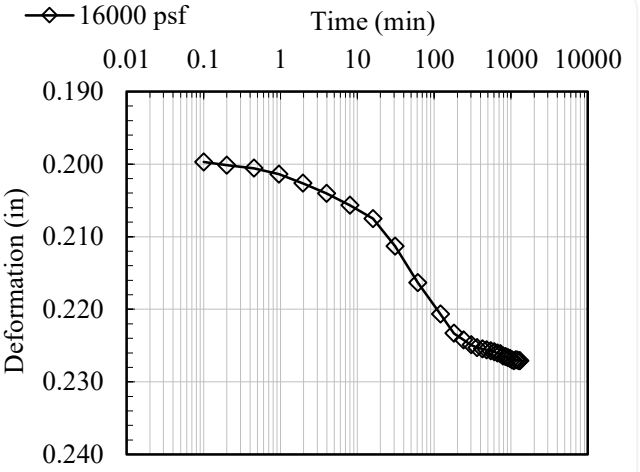
Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2
(PN: 2024-033)
Sample ID: BH5 (6-8 ft)

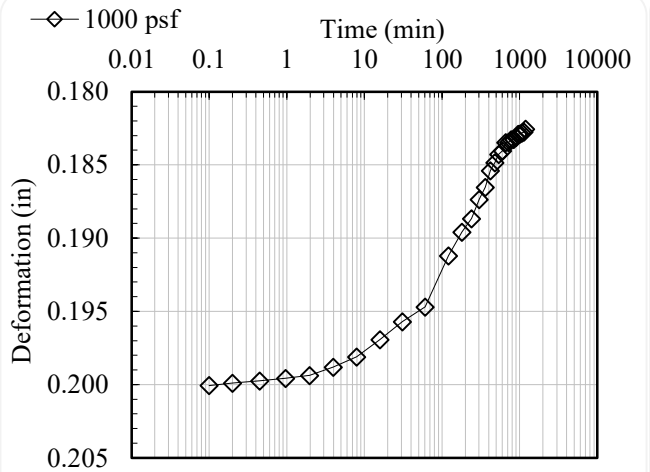
Alpine Project No.: 2502078
Test Date: 02/19/25
Tested By: T.D.

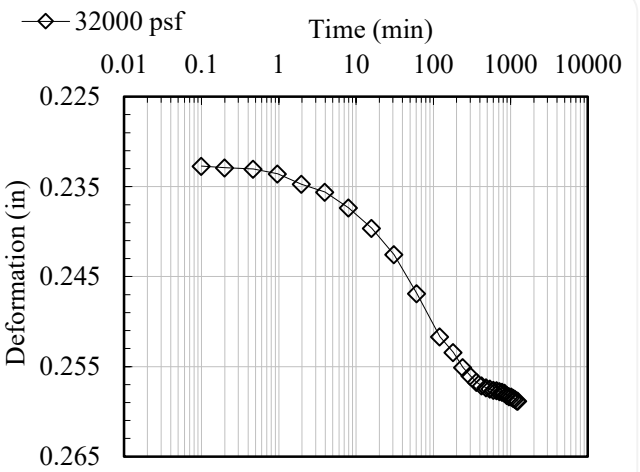












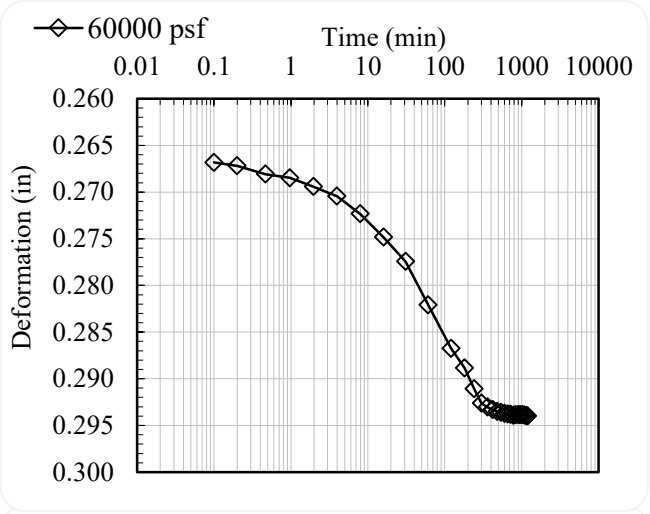
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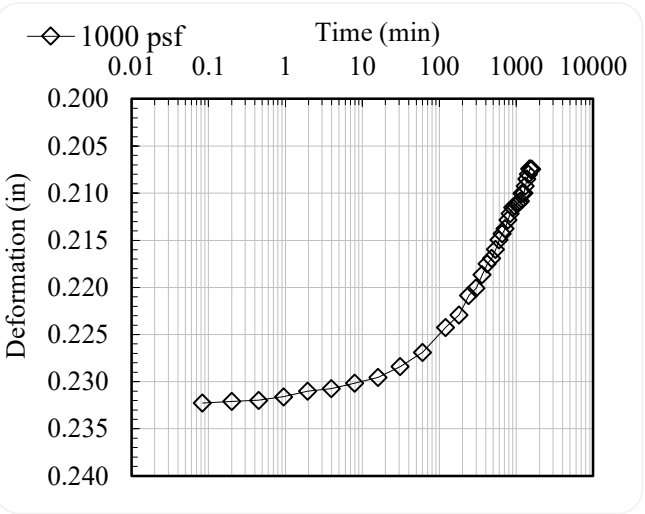
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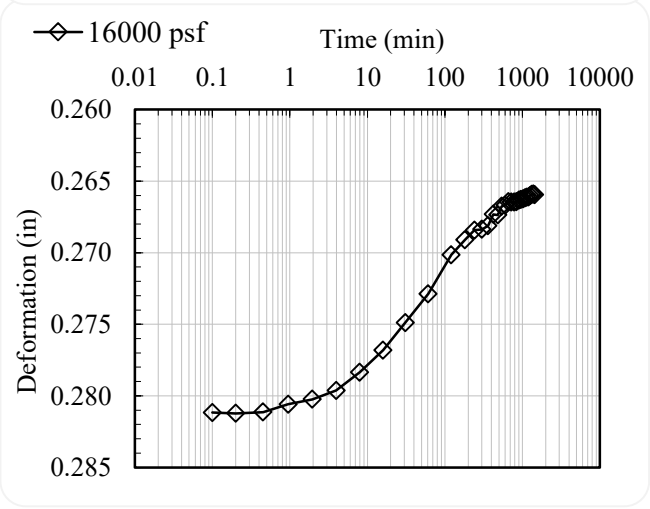
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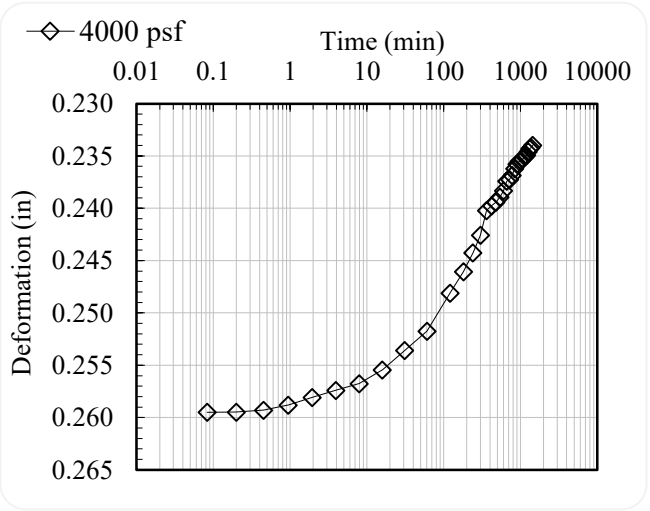
Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2
(PN: 2024-033)
Sample ID: BH5 (6-8 ft)

Alpine Project No.: 2502078
Test Date: 02/19/25
Tested By: T.D.









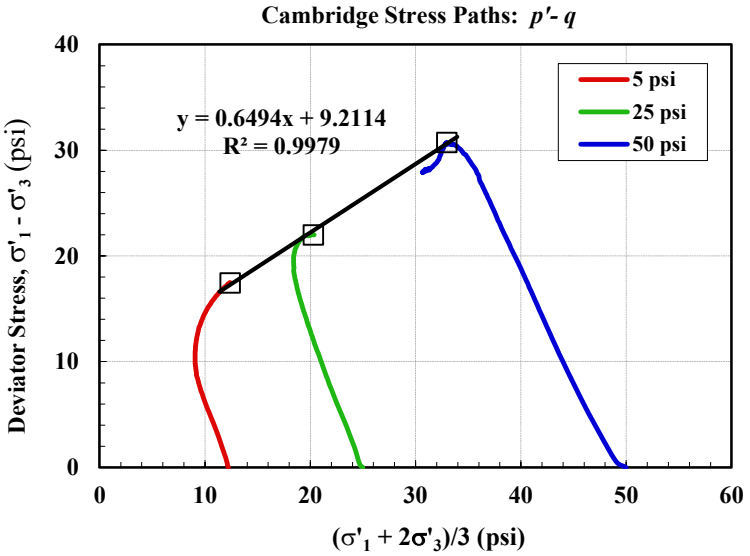
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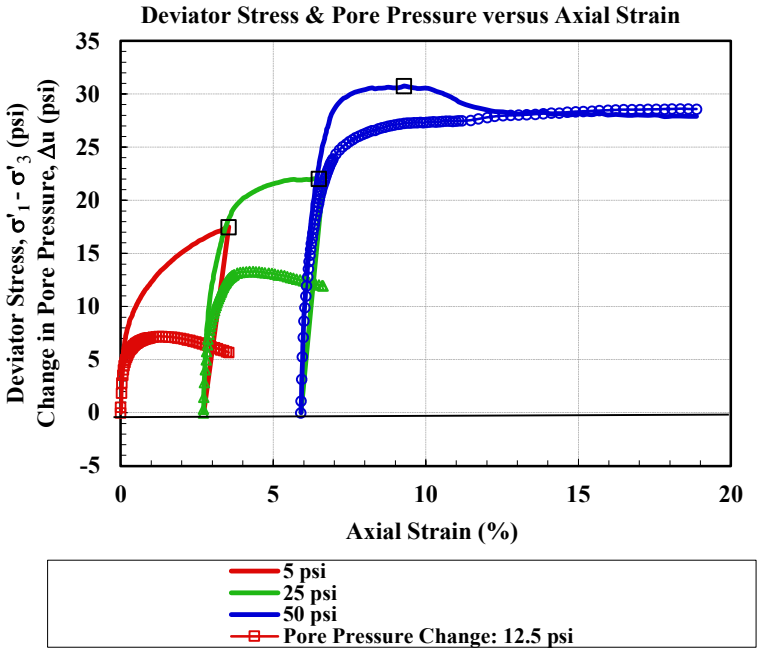
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Tel: (512) 387-1287

Multi-Stage CU Triaxial Compression on Single Specimen (ASTM D4767, Modified)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2 (PN: 2024-033)
Batch No.: BH5 (6-8 ft)

Alpine Project No.: 2502078
Test Date: 02/20/25
Tested By: T.D.





Note: Specimen was mounted in the triaxial cells using the back-pressure saturation method. Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whichever is obtained first.

Initial Conditions			
Eff. Consolidation Stress (psi)	5	25	50
Avg. Diameter (in)	2.80	2.80	2.80
Avg. Height (in)	5.67	5.52	5.35
Avg. Water Content, w_o (%)	28.7	- -	- -
Total Unit Weight, γ_T (pcf)	119.9	123.2	127.0
Dry Unit Weight, γ_d (pcf)	93.1	- -	- -
Void Ratio, e_0	0.80	- -	- -
Saturation, S_o (%)	96.7	- -	- -
Specific Gravity (assumed)	2.68	- -	- -
B-Coefficient	0.97	- -	- -

After Consolidation			
Cross-Sectional Area, A_c (in^2)	6.16	6.14	6.11
Void Ratio, e_c	0.78	0.77	0.76
Avg. Water Content, w_f (%)	- -	- -	29.9
Strain Rate	0.65 %/hr		

Peak Stresses at Failure			
Deviator Stress (psi)	17.5	22.0	30.8
Total Stresses at Failure			
σ_{1f} (psi)	29.7	47.0	80.7
σ_{3f} (psi)	12.2	25.0	50.0
Effective Stresses at Failure			
σ'_{1f} (psi)	24.1	35.0	53.5
σ'_{3f} (psi)	6.6	13.0	22.7

Total Stresses	
Friction Angle, ϕ (degree)	**8.9**
Cohesion, c (psi)	**5.5**
Effective Stresses	
Friction Angle, ϕ' (degree)	**17.0**
Cohesion, c' (psi)	**4.3**

Cheng-Wei Chen, Ph.D. 03/04/25
Reviewed By / Date

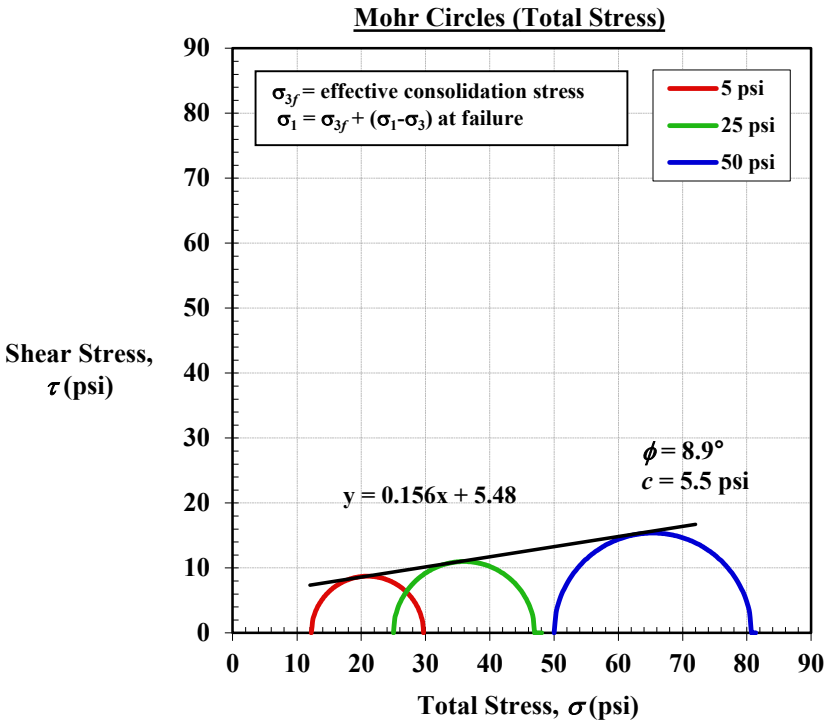
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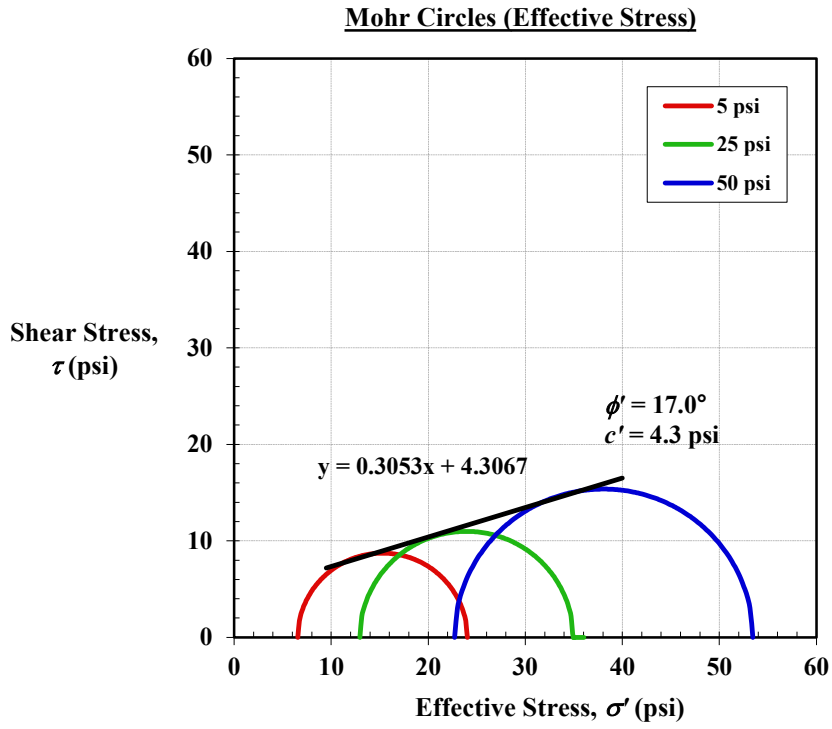
Alpine Engineering Services, LLC
105 Tradesmen Drive, Suite B
Hutto, TX 78634
Tel: (512) 387-1287

Multi-Stage CU Triaxial Compression on Single Specimen (ASTM D4767, Modified)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2 (PN: 2024-033)
Batch No.: BH5 (6-8 ft)

Alpine Project No.: 2502078
Test Date: 02/20/25
Tested By: T.D.





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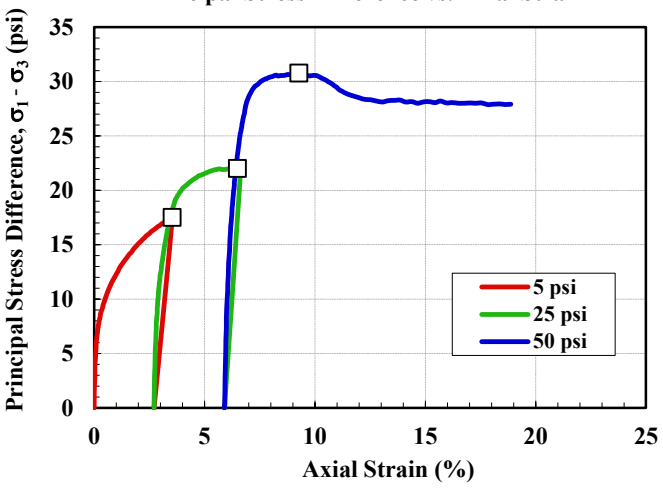
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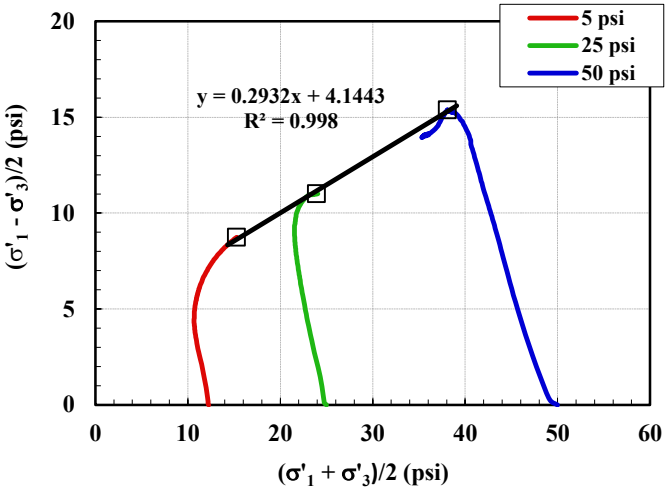
Multi-Stage CU Triaxial Compression on Single Specimen (ASTM D4767, Modified)

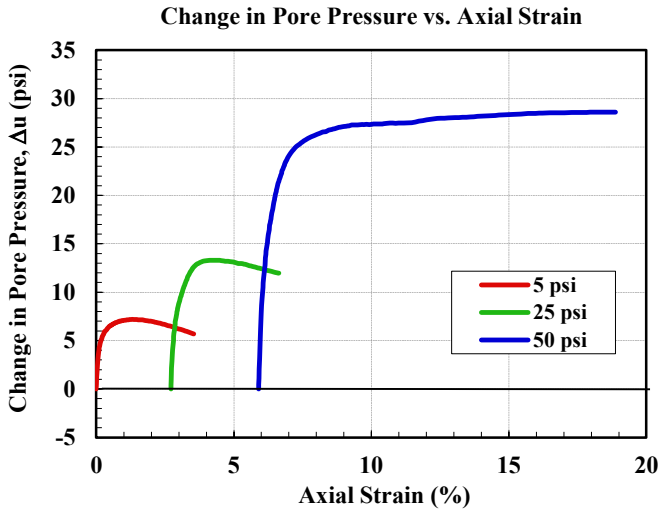
Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2 (PN: 2024-033)
Batch No.: BH5 (6-8 ft)

Alpine Project No.: 2502078
Test Date: 02/20/25
Tested By: T.D.

Effective Consolidation Stress, σ'_{3C} (psi)	During Saturation		End of Consolidation		
	Cell Pressure (psi)	Back Pressure (psi)	Cell Pressure (psi)	Back Pressure (psi)	Volume Change, ΔV_C (mL)
5	65	60	73	60	1.0
25	- -	- -	85	60	3.2
50	- -	- -	110	60	7.0









(a) As-Received



(b) After Test

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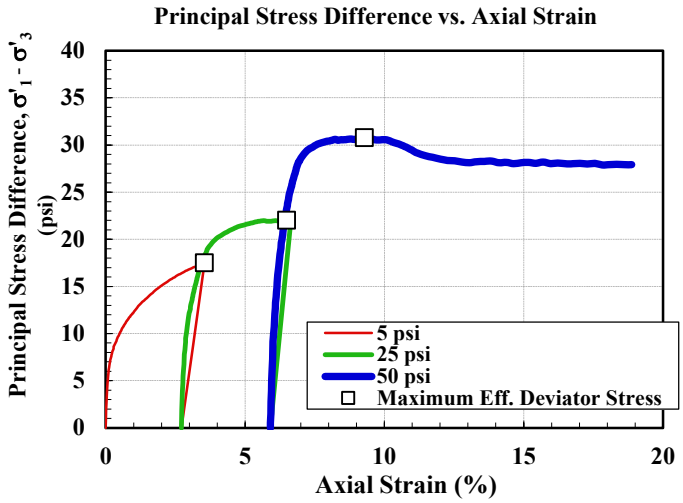
Alpine Engineering Services, LLC
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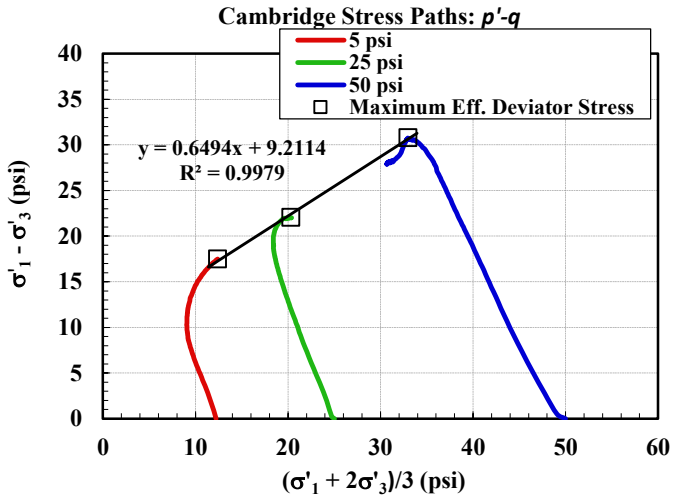
Consolidated Undrained Triaxial Compression Test (ASTM D4767)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2 (PN: 2024-033)
Batch No.: BH5 (6-8 ft)

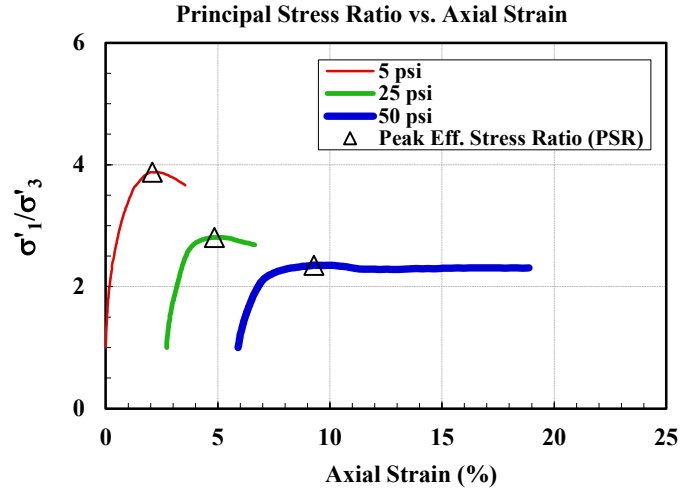
Alpine Project No.: 2502078
Test Date: 02/20/25
Tested By: T.D.

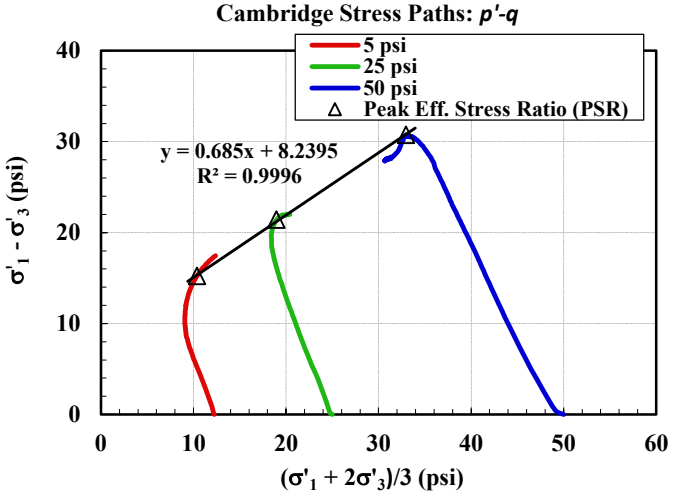
Failure Criteria	Friction Angle, ϕ' (degree)	Cohesion, c' (psi)
Maximum Eff. Deviator Stress	17.0	4.3





Failure Criteria	Friction Angle, ϕ' (degree)	Cohesion, c' (psi)
Peak Eff. Stress Ratio (PSR)	17.9	3.9





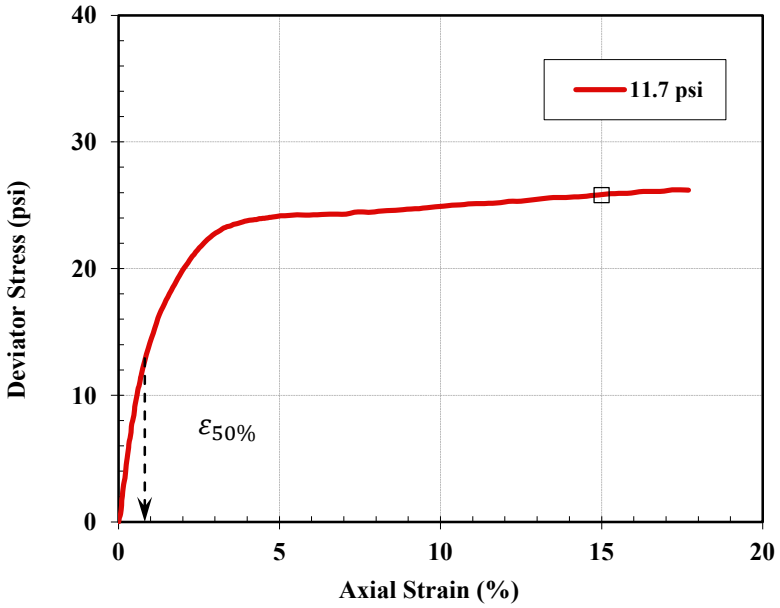
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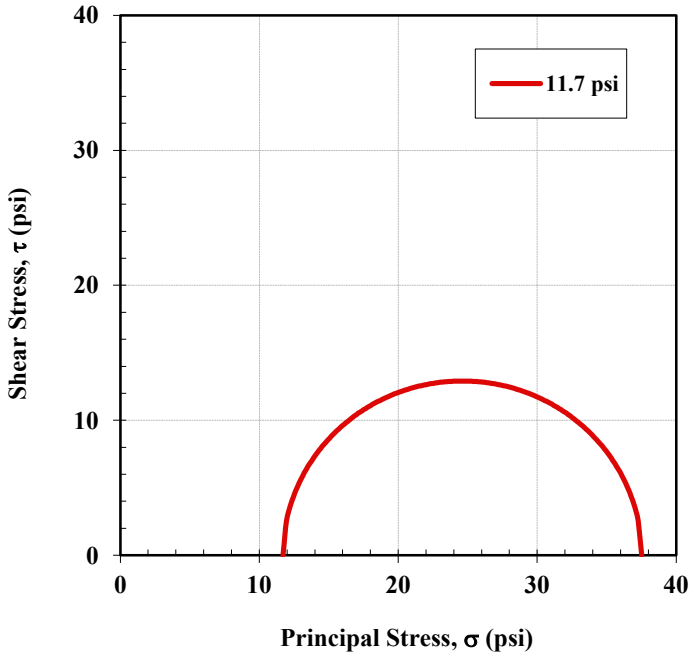
Alpine Engineering Services, LLC
105 Tradesmen Drive, Suite B
Hutto, TX 78634
Tel: (512) 387-1287

Unconsolidated-Undrained Triaxial Compression (ASTM D2850)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2
(PN: 2024-033)
Sample ID: BH6 (13-15 ft)

Alpine Project No.: 2502078
Test Date: 02/25/25
Tested By: T.D.





Initial Conditions	
Confining Stress (psi)	11.7
Avg. Diameter (in)	2.83
Avg. Height, H_0 (in)	5.67
Avg. Water Content (%)	24.0
Total Unit Weight, γ_{total} (pcf)	125.9
Dry Unit Weight, γ_{dry} (pcf)	101.5
Degree of Saturation (%)	99.3
Void Ratio, e_0	0.65
Specific Gravity (Assumed)	2.68
Rate of Axial Strain, %/ min	1.0

Stresses at Failure	
Max, Deviator Stress, q_u (psi)	25.8
Axial Strain at Failure (%)	15.0
Axial Strain at 50% of q_u , $\varepsilon_{50\%}$	0.8

Total Stresses at Failure	
Major Principal Stress *Corrected*, σ_{1C} (psi)	37.5
Minor Principal Stress, σ_3 (psi)	11.7
Unconsolidated-Undrained Compressive Strength at Failure, σ_{1C} - σ_3 (tsf)	1.86

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whichever is obtained first.

Cheng-Wei Chen, Ph.D., 03/03/25

Reviewed By / Date

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Tel: (512) 387-1287

Unconsolidated-Undrained Triaxial Compression (ASTM D2850)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2
(PN: 2024-033)
Sample ID: BH6 (13-15 ft)

Alpine Project No.: 2502078
Test Date: 02/25/25
Tested By: T.D.







(a) Confining Pressure = 11.7 psi

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One-Dimensional Consolidation of Soils (ASTM D2435)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2
(PN: 2024-033)
Sample ID: BH6 (23-25 ft)

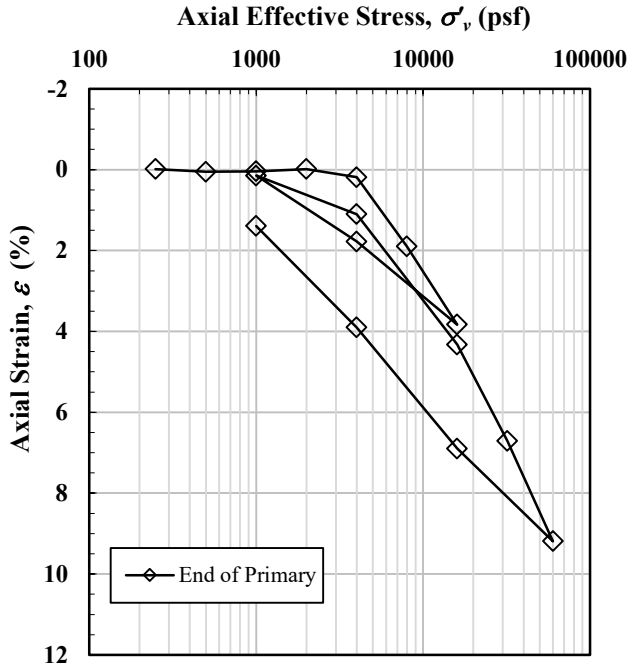
Alpine Project No.: 2502078
Test Date: 02/19/25
Tested By: T.D.

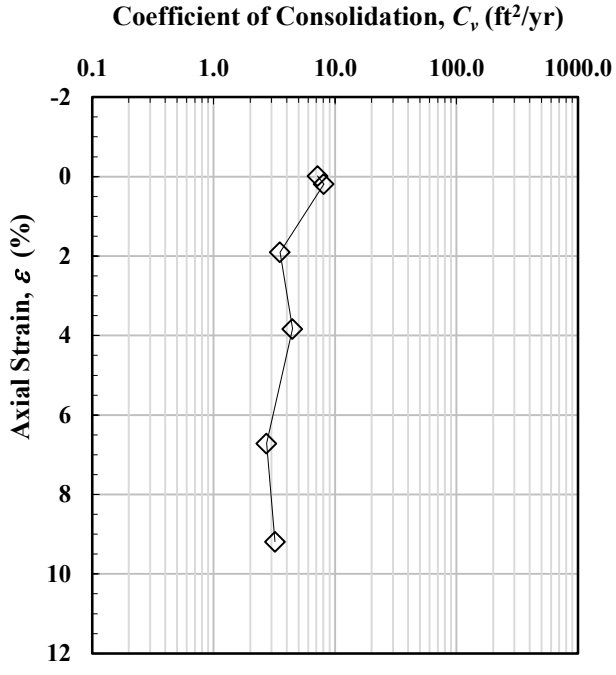
Soil Testing Properties		
Initial Condition	Initial Water Content, w_o (%)	24.0
	Specimen Height, H_o (in)	0.905
	Dry Unit Weight, γ_{do} (pcf)	99.4
	Void Ratio, e_o	0.684
	Degree of Saturation, S_o (%)	94.1
End of Testing Condition	Final Water Content, w_f (%)	26.9
	Specimen Height, H_f (in)	0.892
	Dry Unit Weight, γ_{df} (pcf)	100.8
	Void Ratio, e_f	0.660
Estimated Preconsolidation Stress, p'_c (psf)		6,800

Test Method: B
Specimen Diameter (in): 2.500
Specific Gravity, Gs (assumed): 2.68

Note: Specimen was trimmed using a trimming turntable and a cutting shoe. Specimen was inundated with potable tap water during testing. The machine deflections were measured and included for the end-of-primary deformation results. Estimated preconsolidation pressure was determined by using the Casagrande construction technique.

Compression Index, C_c 0.158
Recompression Index, C_r (1st Rebound) 0.052
Recompression Index, C_r (2nd Rebound) 0.074





σ'_v (psf)	250	500	1000	2000	4000	8000	16000	4000	1000	4000
ε (%)	-0.01	0.05	0.04	-0.01	0.19	1.90	3.83	1.78	0.15	1.10
e	0.684	0.682	0.683	0.684	0.680	0.651	0.619	0.653	0.681	0.665
C_v (ft²/yr)	- -	- -	- -	7.18	8.08	3.52	4.45	- -	- -	- -

σ'_v (psf)	16000	32000	60000	16000	4000	1000
ε (%)	4.32	6.71	9.19	6.90	3.90	1.39
e	0.611	0.570	0.529	0.567	0.618	0.660
C_v (ft²/yr)	2.28	2.73	3.20	- -	- -	- -

Cheng-Wei Chen, Ph.D. 03/05/25
Reviewed By / Date

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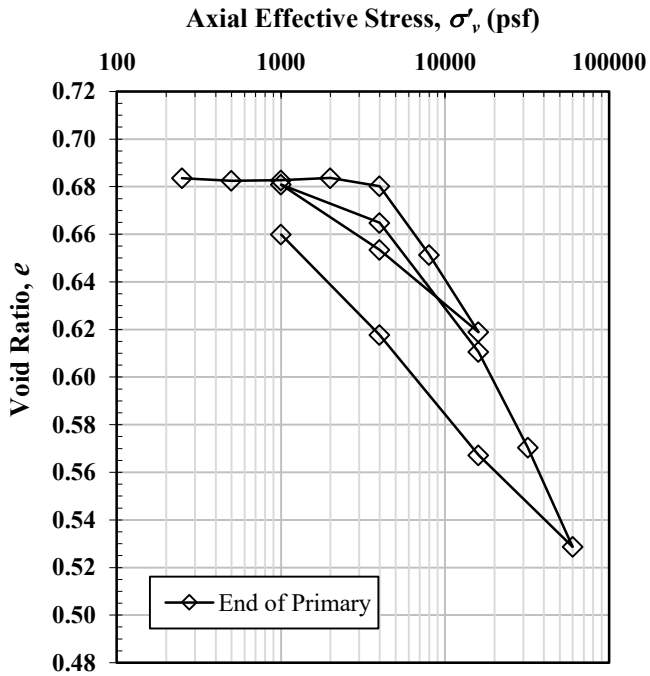
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Hutto, TX 78634
Tel: (512) 387-1287

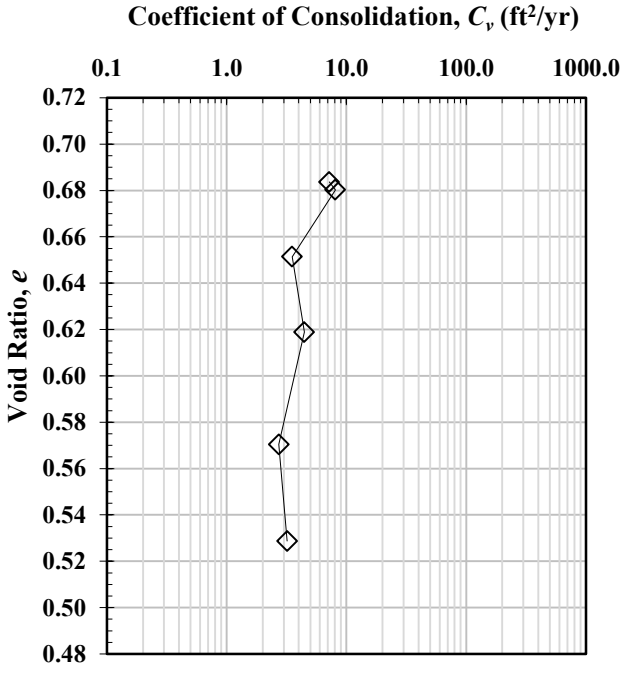
One-Dimensional Consolidation of Soils (ASTM D2435)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2 (PN: 2024-033)
Sample ID: BH6 (23-25 ft)

Alpine Project No.: 2502078
Test Date: 02/19/25
Tested By: T.D.

Test Method: B









(a) As-received





(b) After Test

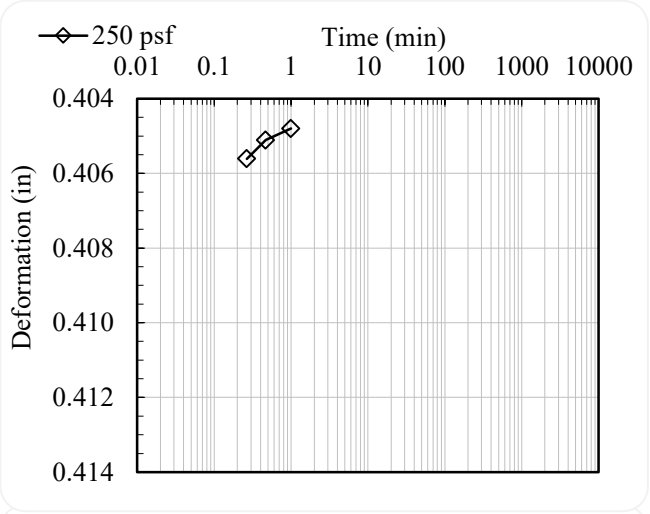
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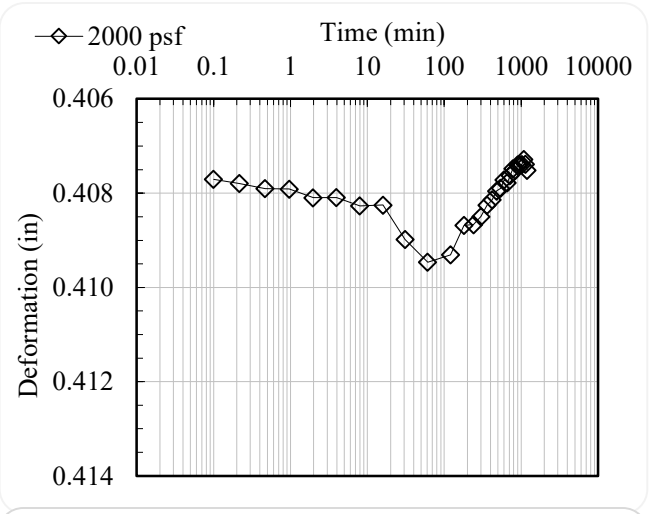
Alpine Engineering Services, LLC
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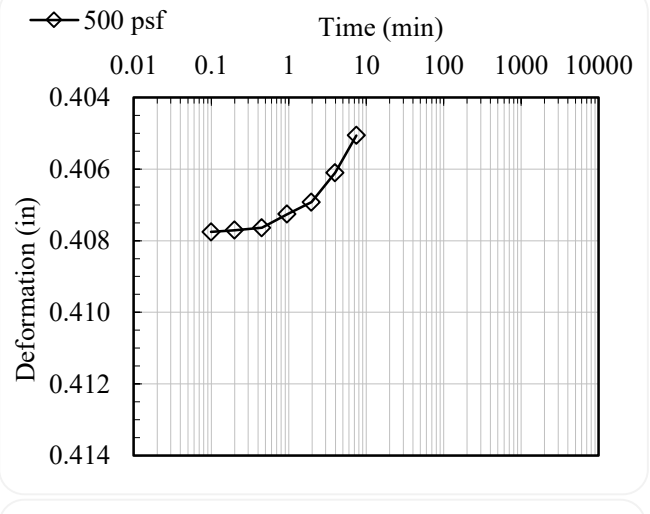
One-Dimensional Consolidation of Soils (ASTM D2435)

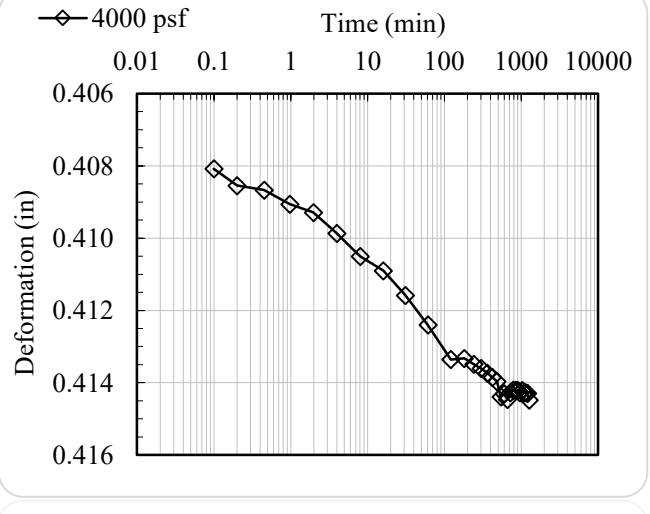
Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2
(PN: 2024-033)
Sample ID: BH6 (23-25 ft)

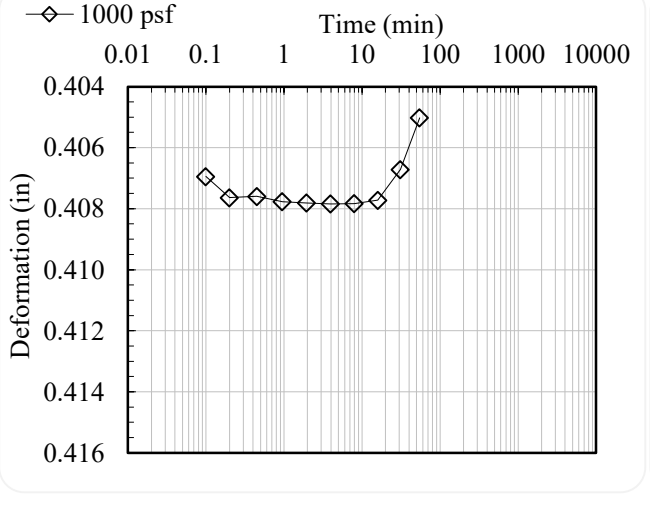
Alpine Project No.: 2502078
Test Date: 02/19/25
Tested By: T.D.

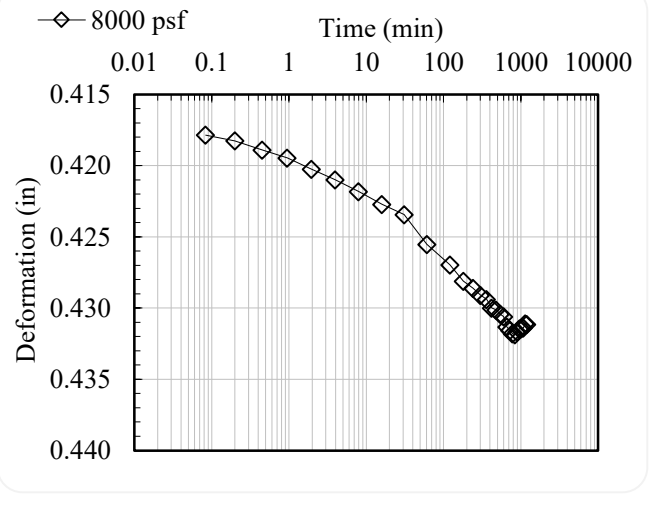












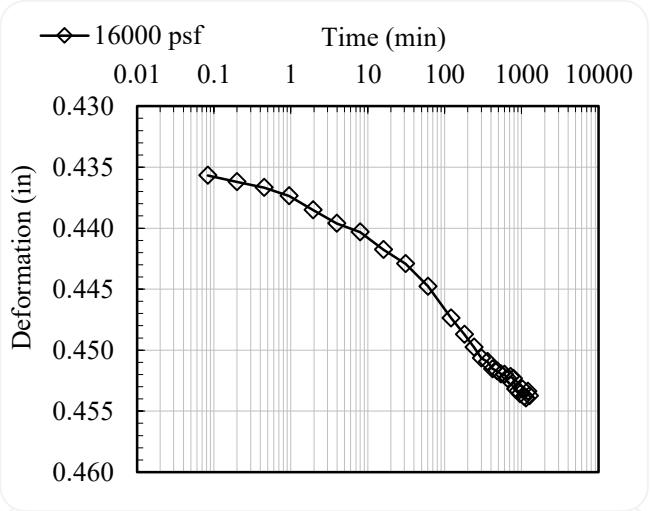
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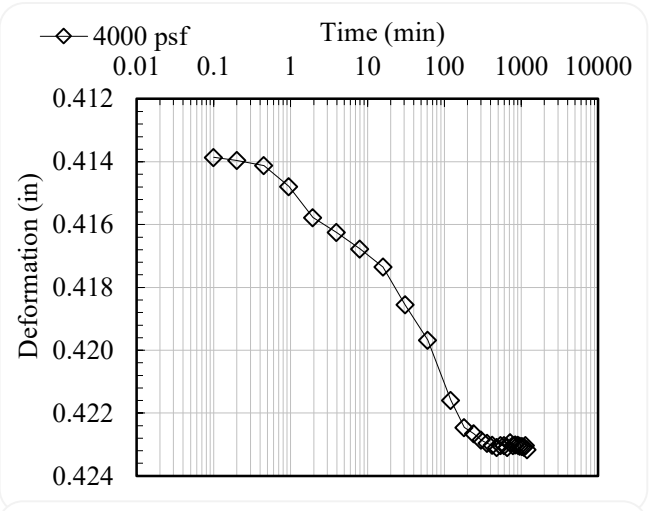
Alpine Engineering Services, LLC
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Tel: (512) 387-1287

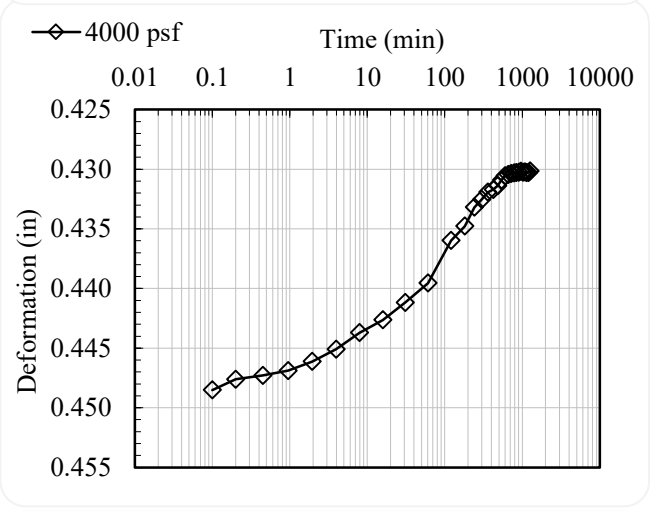
One-Dimensional Consolidation of Soils (ASTM D2435)

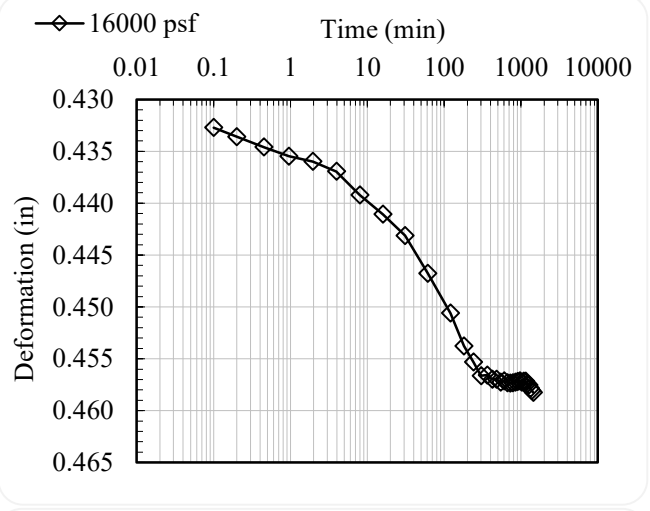
Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2
(PN: 2024-033)
Sample ID: BH6 (23-25 ft)

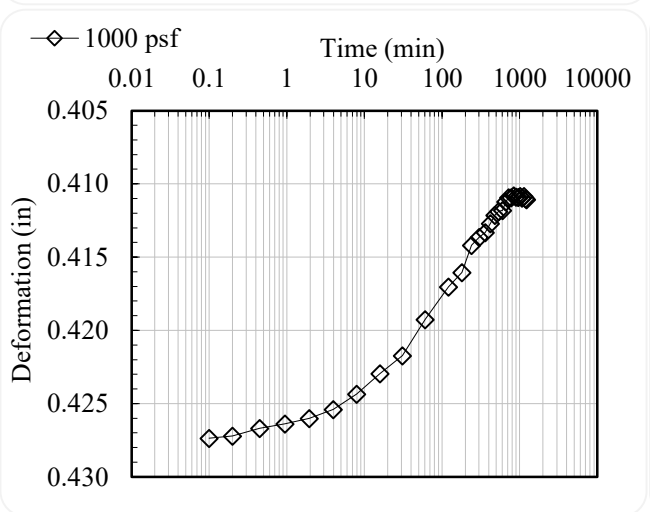
Alpine Project No.: 2502078
Test Date: 02/19/25
Tested By: T.D.

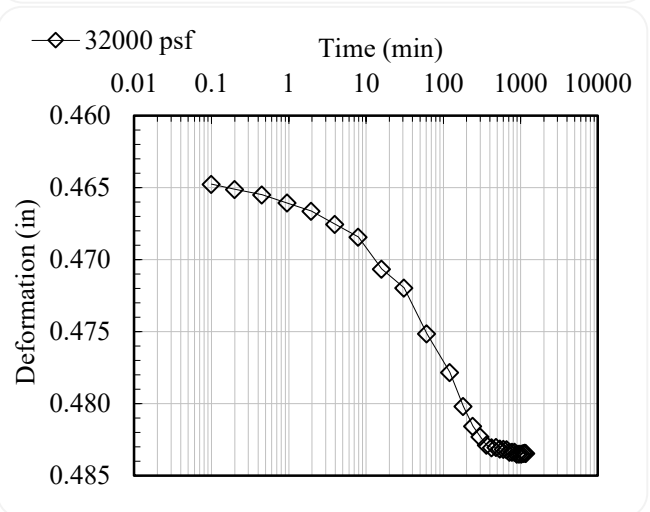












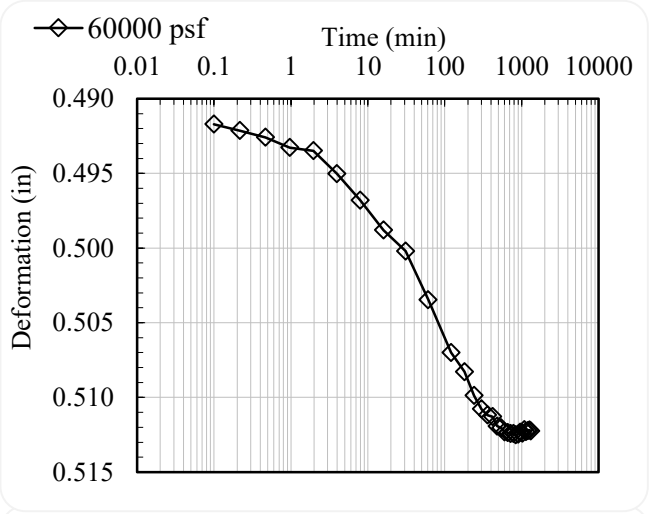
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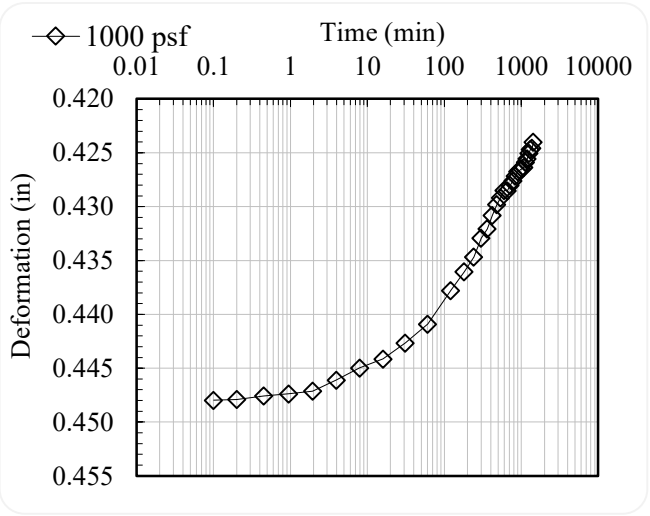
Alpine Engineering Services, LLC
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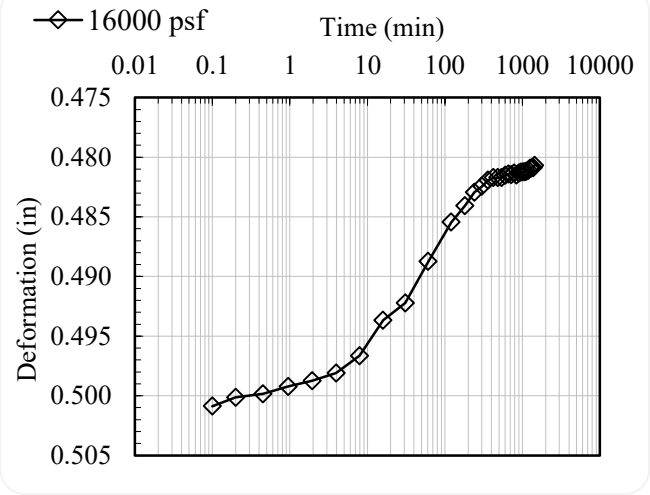
One-Dimensional Consolidation of Soils (ASTM D2435)

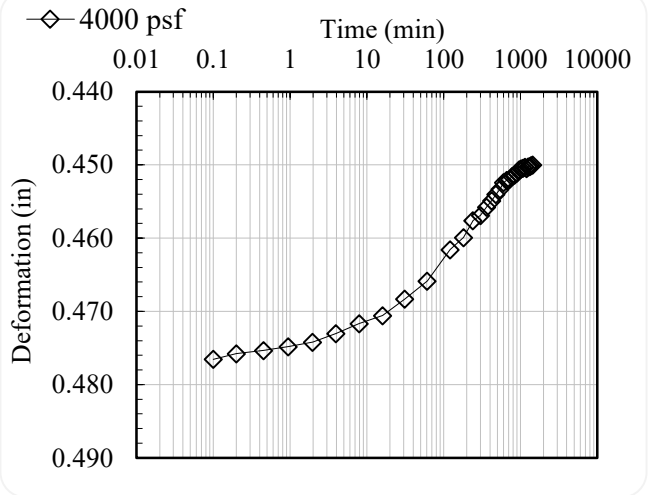
Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2
(PN: 2024-033)
Sample ID: BH6 (23-25 ft)

Alpine Project No.: 2502078
Test Date: 02/19/25
Tested By: T.D.









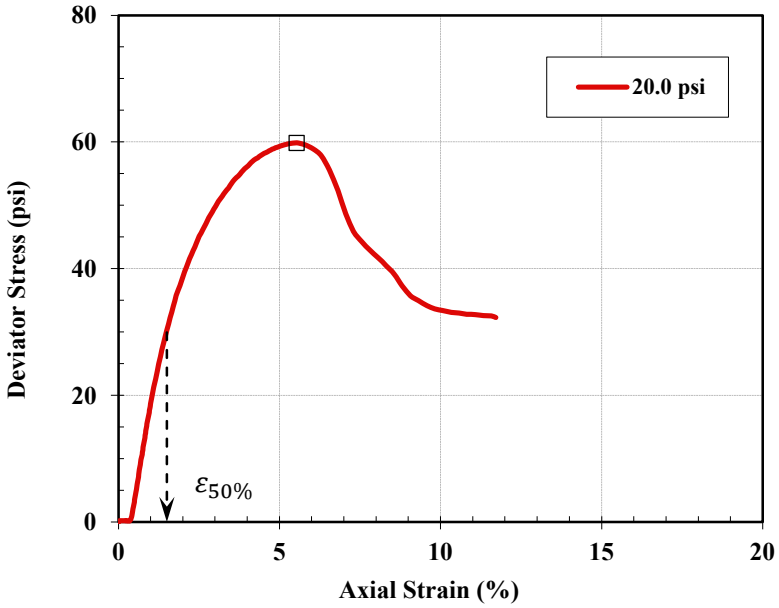
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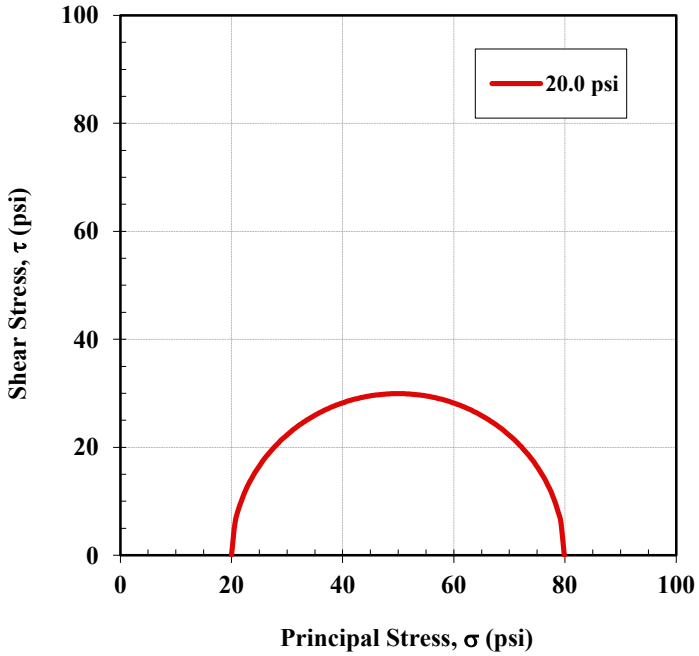
Alpine Engineering Services, LLC
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Tel: (512) 387-1287

Unconsolidated-Undrained Triaxial Compression (ASTM D2850)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2
(PN: 2024-033)
Sample ID: BH6 (23-25 ft)

Alpine Project No.: 2502078
Test Date: 02/19/25
Tested By: T.D.





Initial Conditions	
Confining Stress (psi)	20.0
Avg. Diameter (in)	2.79
Avg. Height, H_0 (in)	5.61
Avg. Water Content (%)	23.9
Total Unit Weight, γ_{total} (pcf)	127.0
Dry Unit Weight, γ_{dry} (pcf)	102.5
Degree of Saturation (%)	100
Void Ratio, e_0	0.63
Specific Gravity (Assumed)	2.68
Rate of Axial Strain, %/ min	0.3

Stresses at Failure	
Max, Deviator Stress, q_u (psi)	59.9
Axial Strain at Failure (%)	5.5
Axial Strain at 50% of q_u , $\varepsilon_{50\%}$	1.5

Total Stresses at Failure	
Major Principal Stress *Corrected*, σ_{1C} (psi)	79.9
Minor Principal Stress, σ_3 (psi)	20.0
Unconsolidated-Undrained Compressive Strength at Failure, σ_{1C} - σ_3 (tsf)	4.31

Note: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whichever is obtained first.

Cheng-Wei Chen, Ph.D., 03/03/25

Reviewed By / Date

The testing was performed in accordance with applicable industry standard. The results provided in this report do not constitute a professional opinion by Alpine Engineering Services, LLC (Alpine). This report may be used only by the Client and the registered design professional in charge.

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Tel: (512) 387-1287

Unconsolidated-Undrained Triaxial Compression (ASTM D2850)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2
(PN: 2024-033)
Sample ID: BH6 (23-25 ft)

Alpine Project No.: 2502078
Test Date: 02/19/25
Tested By: T.D.







(a) Confining Pressure = 20.0 psi

The testing was performed in accordance with applicable industry standard. The results provided in this report do not constitute a professional opinion by Alpine Engineering Services, LLC (Alpine). This report may be used only by the Client and the registered design professional in charge.

Landfill Vertical Expansion – Phase 2 Final Closure
Stability and Settlement Assessment
Welsh Power Plant
Auckland Project No. 2024-033

APPENDIX E

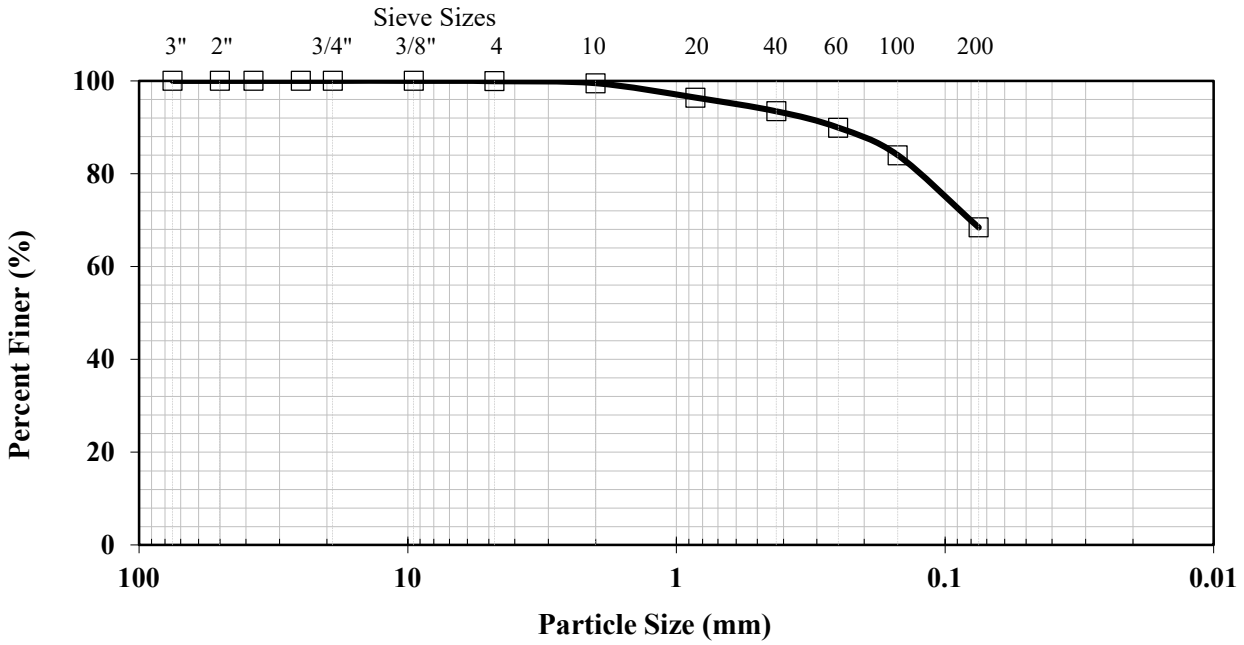
LABORATORY RESULTS – ASH MATERIAL

Alpine Engineering Services, LLC
105 Tradesmen Drive, Suite B
Hutto, TX 78634
Tel: (512) 387-1287

Particle Size Analysis for Soils (ASTM D6913)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2 (PN: 2054-033)
Sample ID: Combined Bulk (LF1-LF3)

Alpine Project No.: 2502078
Test Date: 05/29/25
Tested By: T.D.



Sieve Analysis	
Sieve Size	Percentage Passing (%)
3 in.	100.0
2 in.	100.0
1.5 in.	100.0
1 in.	100.0
3/4 in.	100.0
3/8 in.	100.0
No. 4 (4.75 mm)	99.9
No. 10 (2.0 mm)	99.5
No. 20 (850 µm)	96.4
No. 40 (425 µm)	93.4
No. 60 (250 µm)	89.9
No. 100 (150 µm)	83.9
No. 200 (75 µm)	68.4

Note: Soil classifies as sandy silt (ML) in accordance with ASTM D2487.

Atterberg Limits (ASTM D4318)	
Liquid Limit	35
Plastic Limit	33
Plastic Index	2
Note: Specimen was air dried, 3-pt Liquid Limit procedure was used.	

D60 (mm)	- -
D30 (mm)	- -
D10 (mm)	- -

Coeff. of Uniformity, Cu : - -
Coeff. of Curvature, Cc : - -

Cheng-Wei Chen, Ph.D. 06/05/25
Reviewed By / Date

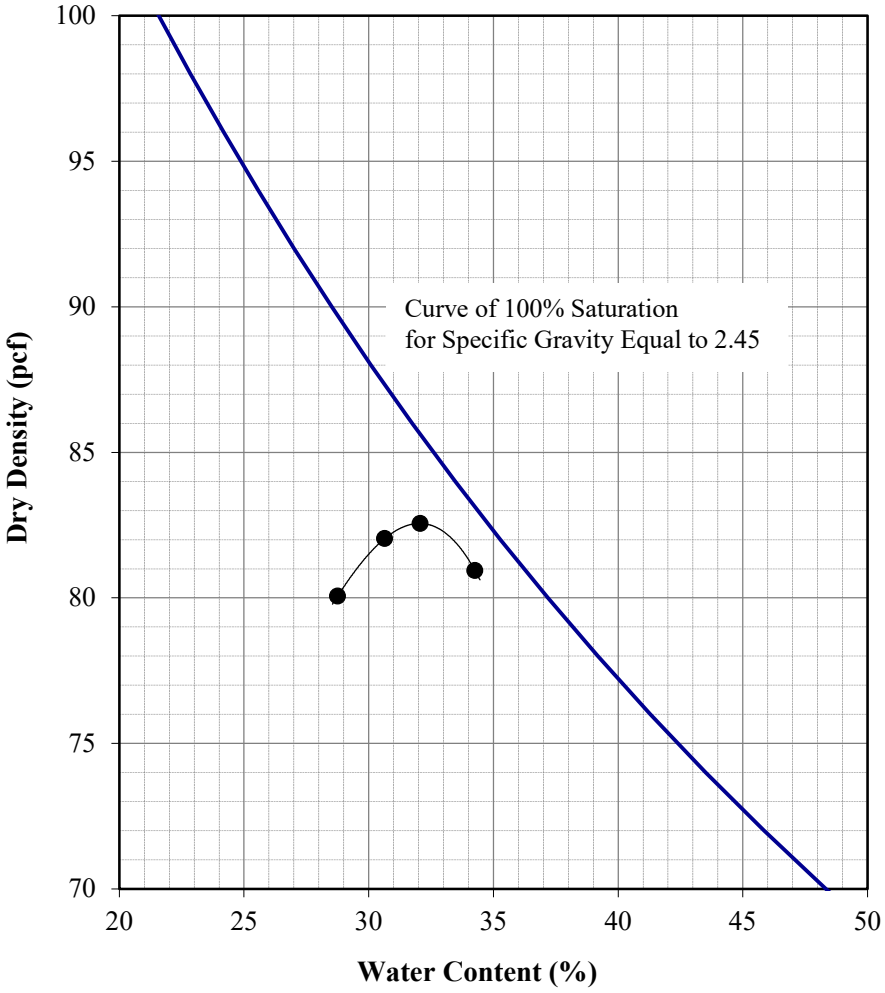
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Alpine Engineering Services, LLC
105 Tradesmen Drive, Suite B
Hutto, TX 78634
Tel: (512) 387-1287

Moisture-Density Compaction Test (Standard Proctor - ASTM D698)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2 (PN: 2054-033)
Sample ID: Combined Bulk (LF1-LF3)

Alpine Project No.: 2502078
Test Date: 06/02/25
Tested By: C.M.



Method Used: A
Preparation Method Used: Air Dry
% Fractions Retained: 0.2%
Rammer: Mechanical
Calibrated On: 06/05/24

Water Content (%)	Dry Density (pcf)
34.3	80.9
32.1	82.6
30.6	82.0
28.7	80.1

% Passing #200	68.4
Liquid Limit	35
Plasticity Index	2
USCS	ML

Material Description: Dark brown sandy silt

Laboratory Compacted Samples	
Maximum Dry Density, $\gamma_{d,max}$ (pcf)	**82.6**
Optimum Water Content, w_{opt} (%)	**32.1**

Cheng-Wei Chen, Ph.D. 06/05/25
Reviewed By / Date

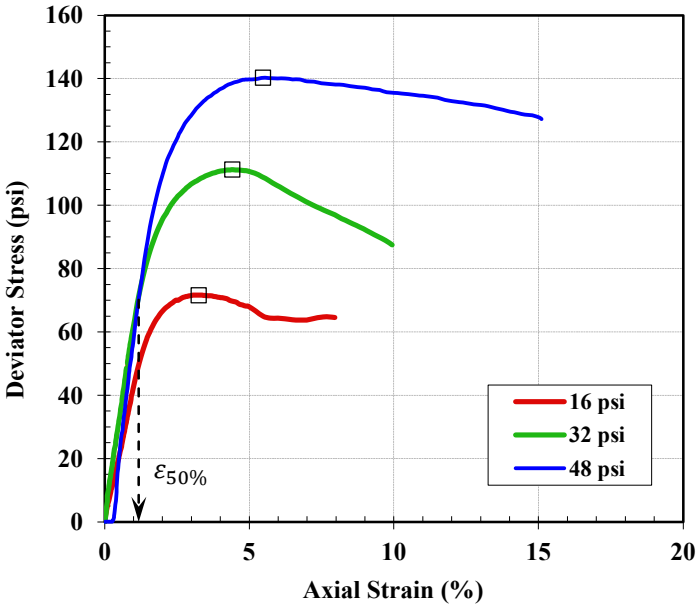
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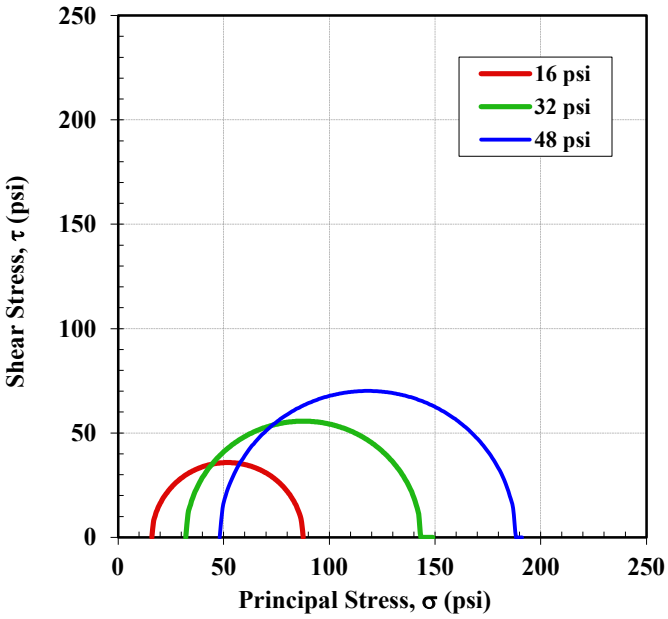
Alpine Engineering Services, LLC
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Hutto, TX 78634
Tel: (512) 387-1287

Unconsolidated-Undrained Triaxial Compression (ASTM D2850)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2
(PN: 2024-033)
Sample ID: Combined Bulk (LF1-LF3)

Alpine Project No.: 2502078
Test Date: 06/18/25
Tested By: T.D.





Initial Conditions			
Confining Stress (psi)	16.0	32.0	48.0
Avg. Diameter (in)	2.88	2.88	2.88
Avg. Height, H_0 (in)	5.77	5.77	5.71
Avg. Water Content (%)	32.2	32.1	32.2
Total Unit Weight, γ_{total} (pcf)	103.7	103.7	103.8
Dry Unit Weight, γ_{dry} (pcf)	78.4	78.4	78.5
Degree of Saturation (%)	94.2	94.2	94.5
Void Ratio, e_0	0.75	0.75	0.75
Specific Gravity (Assumed)	2.20		
Rate of Axial Strain, %/ min	0.3		

Stresses at Failure			
Max, Deviator Stress, q_u (psi)	71.6	111.3	140.3
Axial Strain at Failure (%)	3.3	4.4	5.4
Axial Strain at 50% of q_u , $\varepsilon_{50\%}$	0.8	0.9	1.2

Total Stresses at Failure			
Major Principal Stress *Corrected*, σ_{1C} (psi)	87.6	143.3	188.3
Minor Principal Stress, σ_3 (psi)	16.0	32.0	48.0
Unconsolidated-Undrained Compressive Strength at Failure, σ_{1C} - σ_3 (tsf)	5.16	8.01	10.10

Note 1: Testing specimens were remolded to a target dry unit weight of 95 % standard Proctor at 2 % above of optimum water content or 93.0 pcf dry unit weight at a water content of 24.9 %.

Note 2: Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whichever is obtained first.

Cheng-Wei Chen, Ph.D. 06/20/25

Reviewed By / Date

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Alpine Engineering Services, LLC
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Hutto, TX 78634
Tel: (512) 387-1287

Unconsolidated-Undrained Triaxial Compression (ASTM D2850)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2 (PN: 2024-033)
Sample ID: Combined Bulk (LF1-LF3)

Alpine Project No.: 2502078
Test Date: 06/18/25
Tested By: T.D.



(a) Confining Pressure = 16 psi



(b) Confining Pressure = 32 psi



(c) Confining Pressure = 48 psi

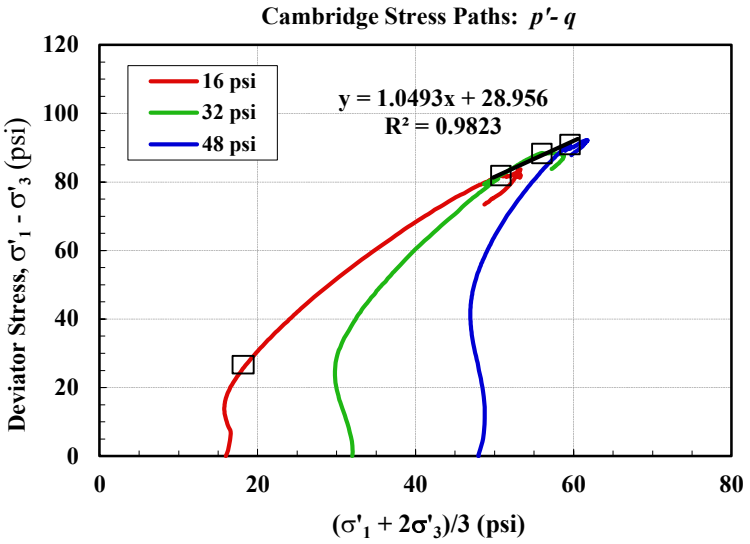
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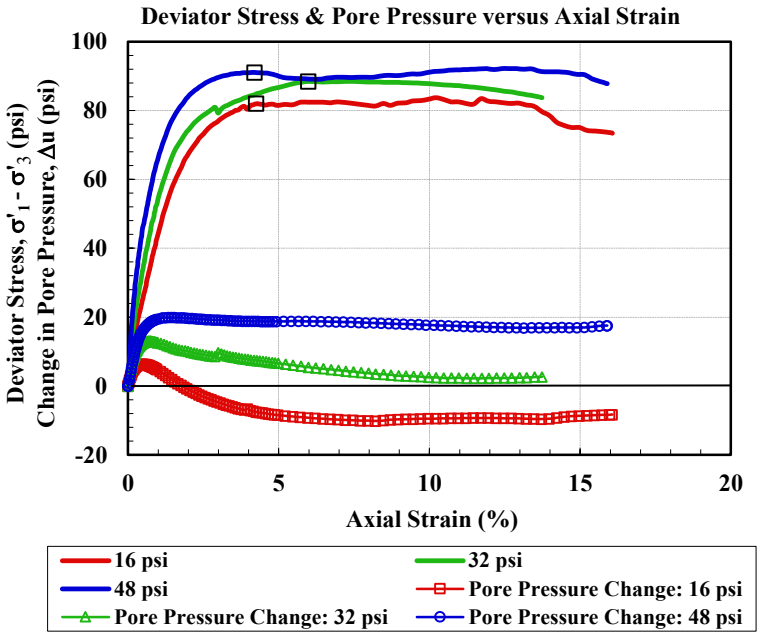
Alpine Engineering Services, LLC
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Hutto, TX 78634
Tel: (512) 387-1287

Consolidated Undrained Triaxial Compression Test (ASTM D4767)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2 (PN: 2024-033)
Sample ID: Combined Bulk (LF1-LF3)

Alpine Project No.: 2502078
Test Date: 6/12/25
Tested By: T.D.





Initial Conditions			
Eff. Consolidation Stress (psi)	16	32	48
Avg. Diameter (in)	2.87	2.87	2.87
Avg. Height (in)	5.78	5.77	5.77
Avg. Water Content, w_o (%)	32.2	32.2	32.1
Total Unit Weight, γ_T (pcf)	103.9	103.9	103.7
Dry Unit Weight, γ_d (pcf)	78.6	78.6	78.5
Void Ratio, e_0	0.75	0.75	0.75
Saturation, S_o (%)	94.7	94.6	94.2
Specific Gravity (assumed)	2.20	2.20	2.20
B-Coefficient	0.97	0.96	0.96

After Consolidation			
Cross-Sectional Area, A_c (in^2)	6.48	6.46	6.44
Void Ratio, e_c	0.74	0.73	0.73
Saturation, S_c (%)	99.9	99.9	99.9
Avg. Water Content, w_f (%)	41.3	41.3	41.0
Strain Rate	0.6 %/hr		

Peak Stresses at Failure			
Deviator Stress (psi)	82.0	88.4	91.0
Total Stresses at Failure			
σ_{1f} (psi)	98.0	120.4	139.0
σ_{3f} (psi)	16.0	32.0	48.0
Effective Stresses at Failure			
σ'_{1f} (psi)	105.5	114.9	120.2
σ'_{3f} (psi)	23.5	26.5	29.2

Total Stresses	
Friction Angle, ϕ (degree)	**9.0**
Cohesion, c (psi)	**32.2**
Effective Stresses	
Friction Angle, ϕ' (degree)	**26.5**
Cohesion, c' (psi)	**13.8**

Note 1: Testing specimens remolded to 95% compaction at optimum water content (ASTM D698), or 78.5 pcf dry unit weight at 32.1 % water content.

Note 2: Specimens were mounted in the triaxial cells using the back-pressure saturation method. Failure was determined at the maximum deviator stress or deviator stress at 15 % axial strain, whichever is obtained first.

Cheng-Wei Chen, Ph.D. 06/20/25

Reviewed By / Date

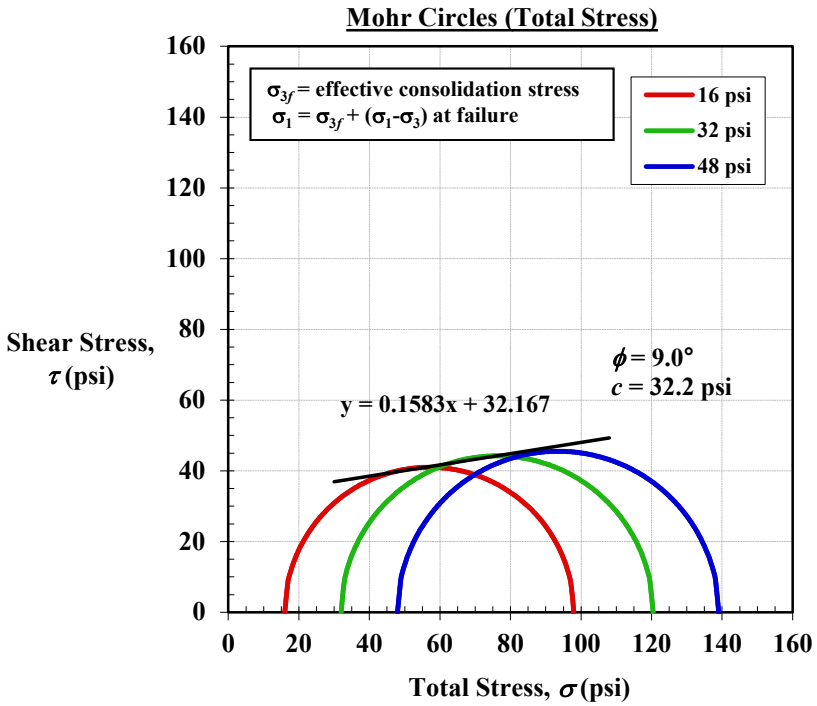
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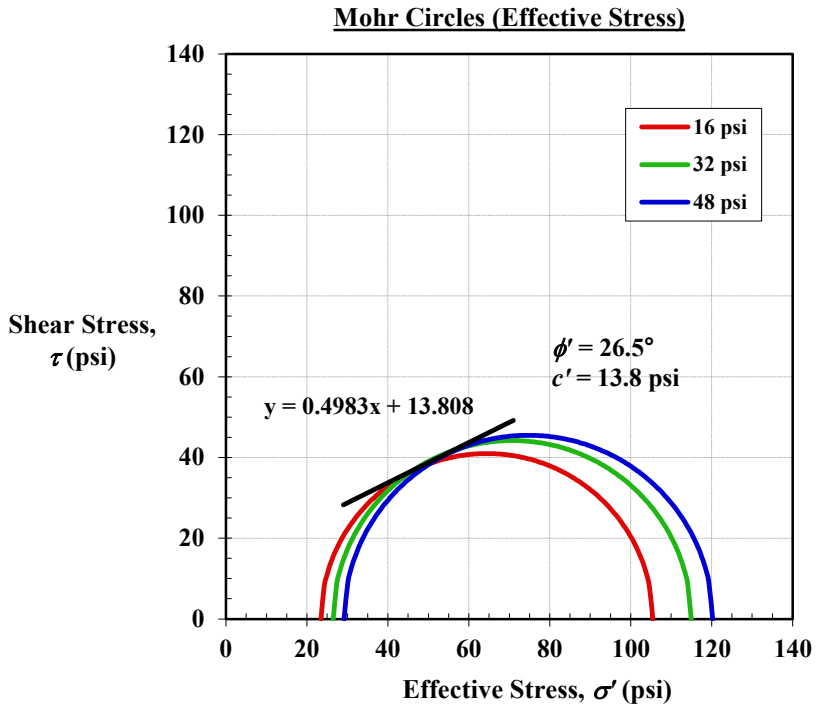
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Hutto, TX 78634
Tel: (512) 387-1287

Consolidated Undrained Triaxial Compression Test (ASTM D4767)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2 (PN: 2024-033)
Sample ID: Combined Bulk (LF1-LF3)

Alpine Project No.: 2502078
Test Date: 6/12/25
Tested By: T.D.





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Consolidated Undrained Triaxial Compression Test (ASTM D4767)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2 (PN: 2024-033)
Sample ID: Combined Bulk (LF1-LF3)

Alpine Project No.: 2502078
Test Date: 6/12/25
Tested By: T.D.

Effective Consolidation Stress, σ'_{3C} (psi)	During Saturation		End of Consolidation			
	Cell Pressure (psi)	Back Pressure (psi)	Cell Pressure (psi)	Back Pressure (psi)	Volume Change, ΔV_C (mL)	t_{50} [(1)] (min)
16	65	60	76	60	1.7	1
32	65	60	92	60	4.5	1.8
48	65	60	108	60	6.8	10.6

(1): t_{50} was determined from isotropic consolidation results (volume change vs. log-time plot) at target effective consolidation stress.

σ'_{3C} = 16 psi

Final Water Content (%)	
No.	w_f (%)
1 (Top)	41.0
2	41.5
3	41.6
4 (Bottom)	41.1





σ'_{3C} = 32 psi

Final Water Content (%)	
No.	w_f (%)
1 (Top)	40.9
2	41.6
3	41.6
4 (Bottom)	41.1





σ'_{3C} = 48 psi

Final Water Content (%)	
No.	w_f (%)
1 (Top)	40.9
2	41.2
3	40.4
4 (Bottom)	41.4





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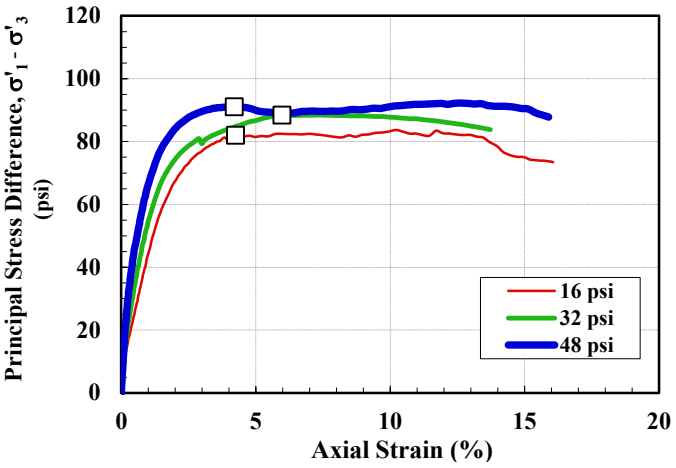
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Consolidated Undrained Triaxial Compression Test (ASTM D4767)

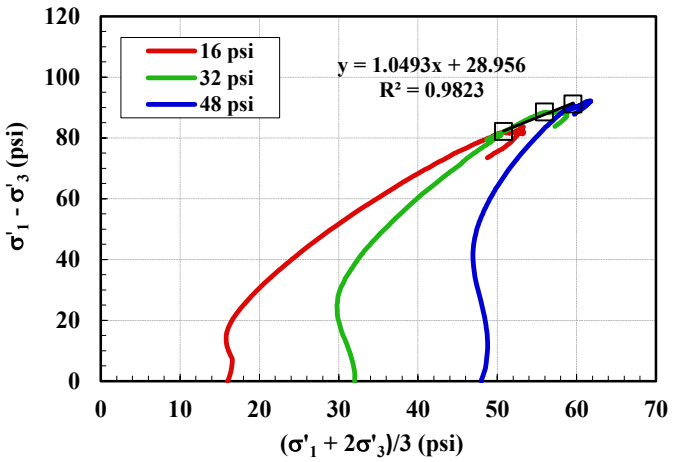
Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2 (PN: 2024-033)
Sample ID: Combined Bulk (LF1-LF3)

Alpine Project No.: 2502078
Test Date: 6/12/25
Tested By: T.D.

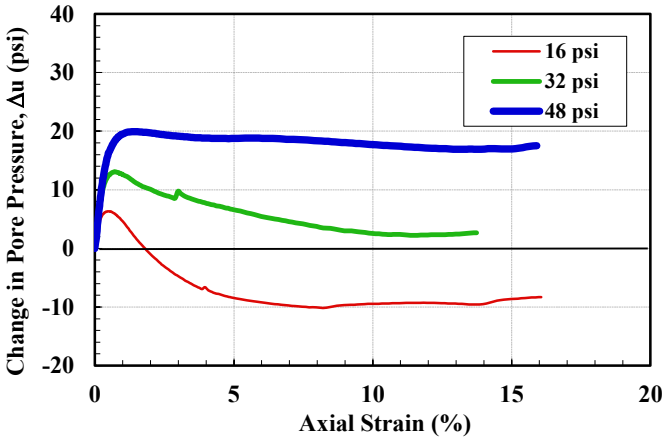
Principal Stress Difference vs. Axial Strain



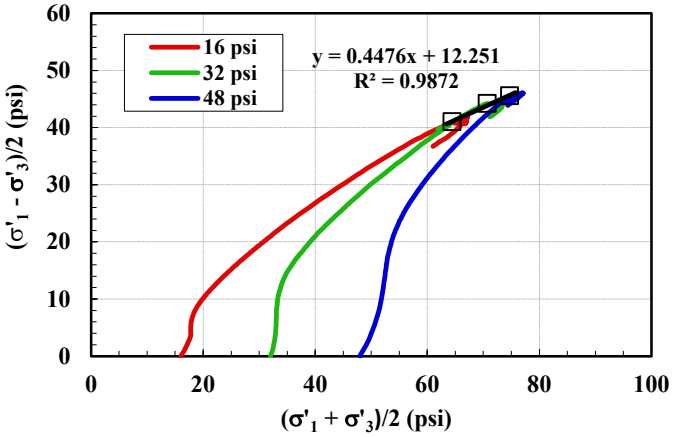
Cambridge Stress Paths: *p'-q*



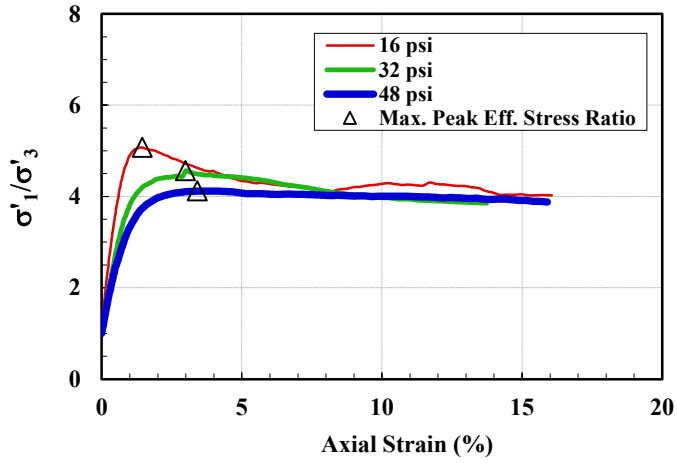
Change in Pore Pressure vs. Axial Strain



MIT Stress Paths



Principal Stress Ratio vs. Axial Strain



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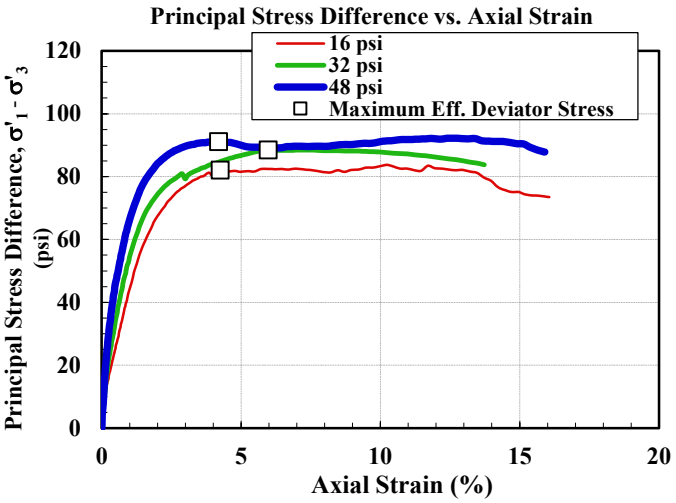
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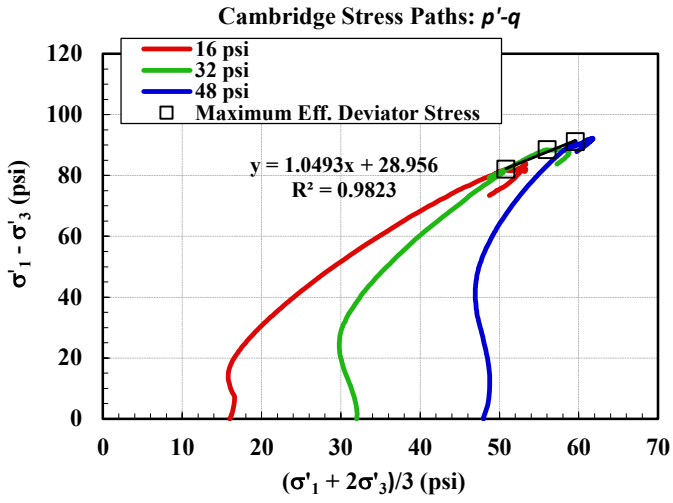
Consolidated Undrained Triaxial Compression Test (ASTM D4767)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2 (PN: 2024-033)
Sample ID: Combined Bulk (LF1-LF3)

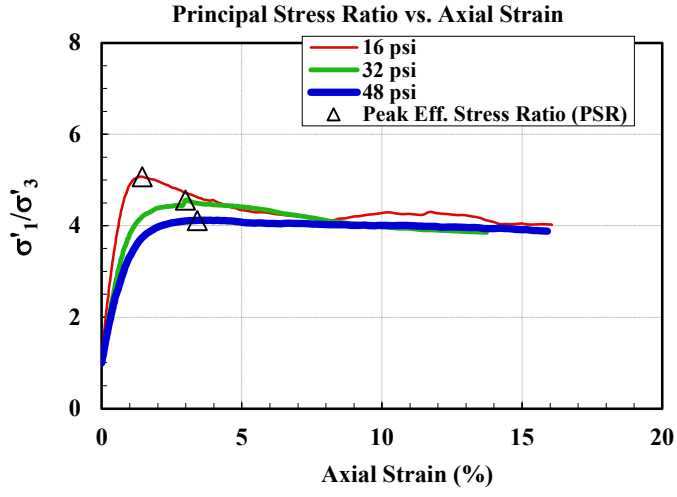
Alpine Project No.: 2502078
Test Date: 6/12/25
Tested By: T.D.

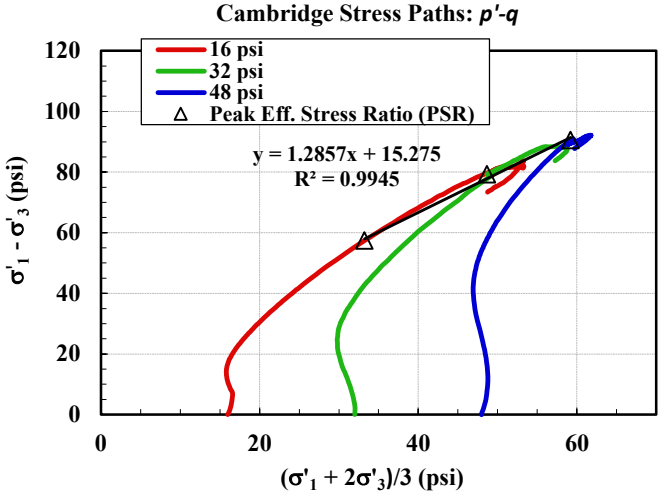
Failure Criteria	Friction Angle, ϕ' (degree)	Cohesion, c' (psi)
Maximum Eff. Deviator Stress	26.5	13.8





Failure Criteria	Friction Angle, ϕ' (degree)	Cohesion, c' (psi)
Peak Eff. Stress Ratio (PSR)	32.0	7.4





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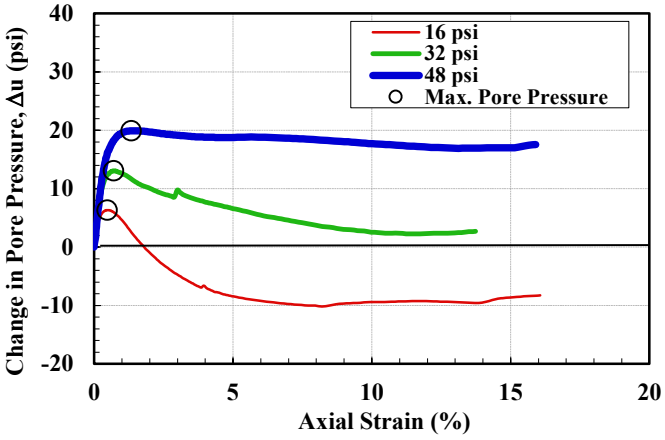
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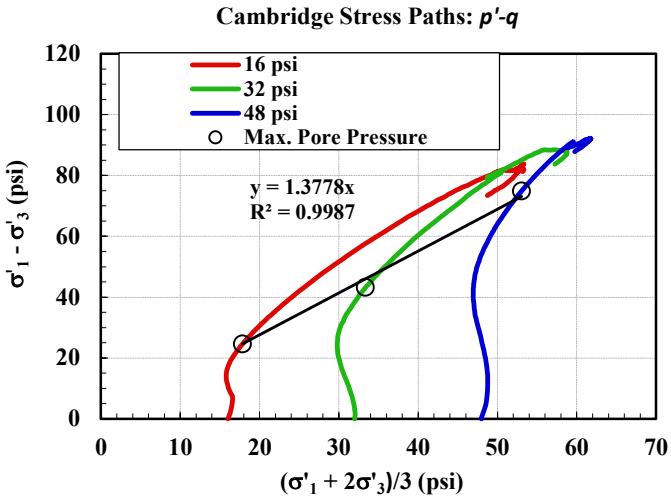
Consolidated Undrained Triaxial Compression Test (ASTM D4767)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2 (PN: 2024-033)
Sample ID: Combined Bulk (LF1-LF3)

Alpine Project No.: 2502078
Test Date: 6/12/25
Tested By: T.D.

Failure Criteria	Friction Angle, ϕ' (degree)	Cohesion, c' (psi)
Maximum Pore Pressure	34.1	0





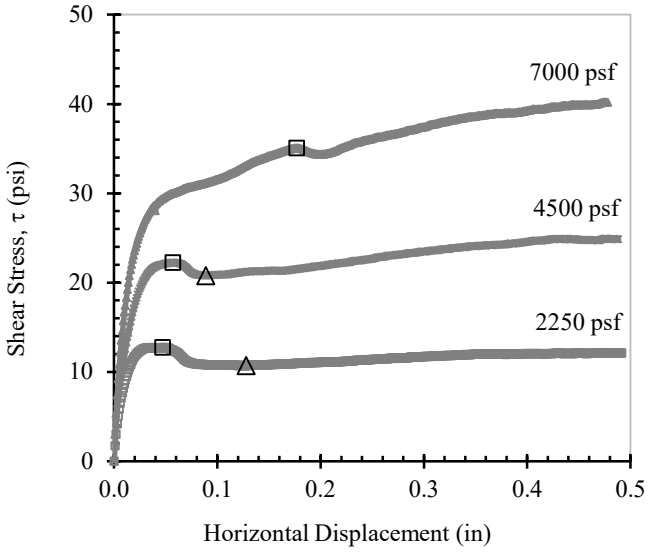
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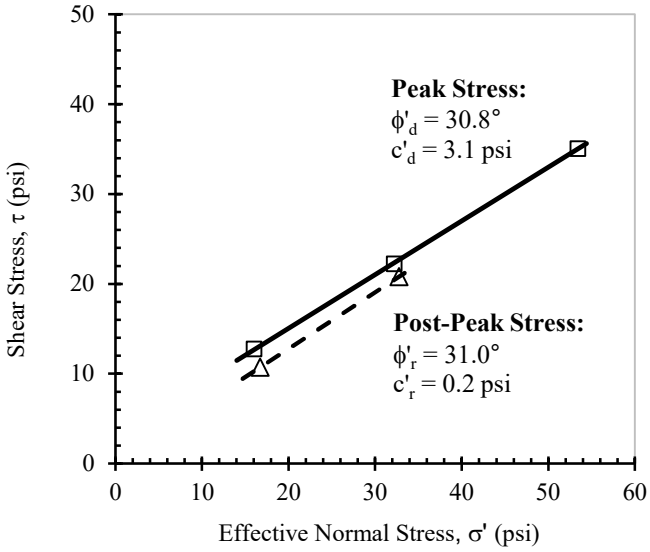
Direct Shear Consolidated Drained Test (ASTM D3080)

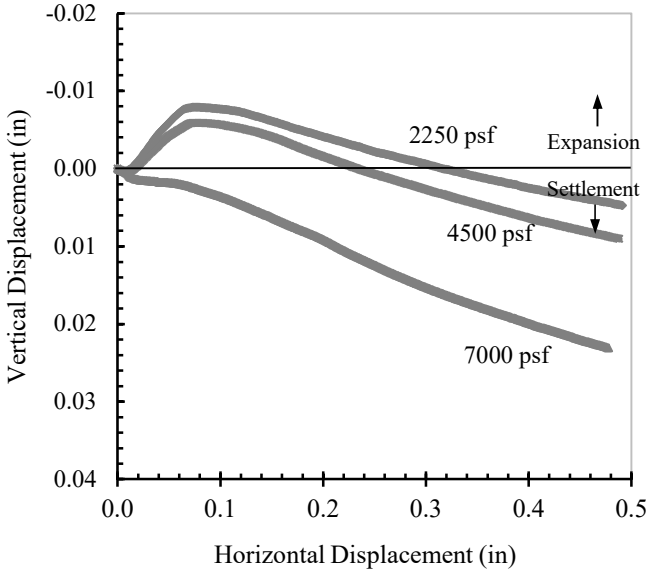
Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2 (PN: 2024-033)
Sample ID: Combined Bulk (LF1-LF3)

Alpine Project No.: 2502078
Test Date: 06/16/25
Tested By: T.D.
Method of Preparation: *Remolded*



Note: Area Correction Has Been Applied





Specimen Number		1	2	3
Initial Condition	Diameter, in	2.51	2.50	2.50
	Height, in (before consol)	1.00	1.00	1.00
	Water Content, %	32.1	32.2	32.3
	Degree of Saturation, %	93.2	94.1	94.2
	Dry Unit Weight, pcf	78.1	78.4	78.4
	Void Ratio, e_0	0.76	0.75	0.75
After Consolidation	Height, in (prior to shear)	1.00	1.00	1.01
	Final Water Content, %	45.3	43.8	42.3
	Dry Unit Weight, pcf	78.1	78.3	77.4
	Void Ratio, e_f	0.76	0.75	0.77
Peak Normal Stress, σ' (psi)		16.0	32.2	53.4
Peak Shear Stress, τ (psi)		12.7	22.2	35.1
Displacement at Failure (in)		0.05	0.06	0.18
Displacement Rate (in/min)		0.0003		
Peak Strength Parameters	ϕ'_d, degree			**30.8**
	c'_d, psi			**3.1**
Post-Peak Strength Parameters	ϕ'_r, degree			**31.0**
	c'_r, psi			**0.2**

Note: Specimen remolded to 95% compaction at the optimum water content (ASTM D698), or 78.5 pcf dry unit weight at 32.1 % water content. The specific gravity of 2.20 was assumed.

Cheng-Wei Chen, Ph.D. 06/20/25
Reviewed By / Date

The testing was performed in accordance with applicable industry standard. The results provided in this report do not constitute a professional opinion by Alpine Engineering Services, LLC (Alpine). This report may be used only by the Client and the registered design professional in charge.

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Direct Shear Consolidated Drained Test (ASTM D3080)

Client: Auckland Consulting, LLC
Project Name: AEP Welsh LF Phase 2 (PN: 2024-033)
Sample ID: Combined Bulk (LF1-LF3)

Alpine Project No.: 2502078
Test Date: 06/16/25
Tested By: T.D.
Method of Preparation: *Remolded*





(1) Normal Load = 2250 psf





(2) Normal Load = 4500 psf





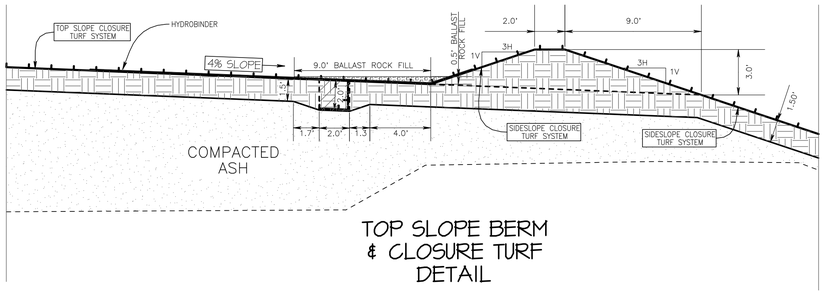
(3) Normal Load = 7000 psf

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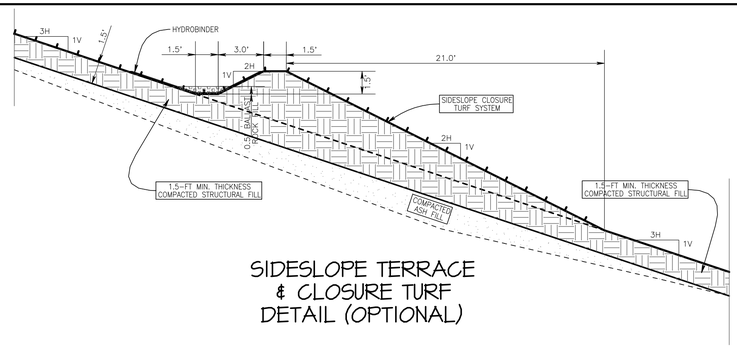
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Stability and Settlement Assessment
Welsh Power Plant
Auckland Project No. 2024-033

APPENDIX F

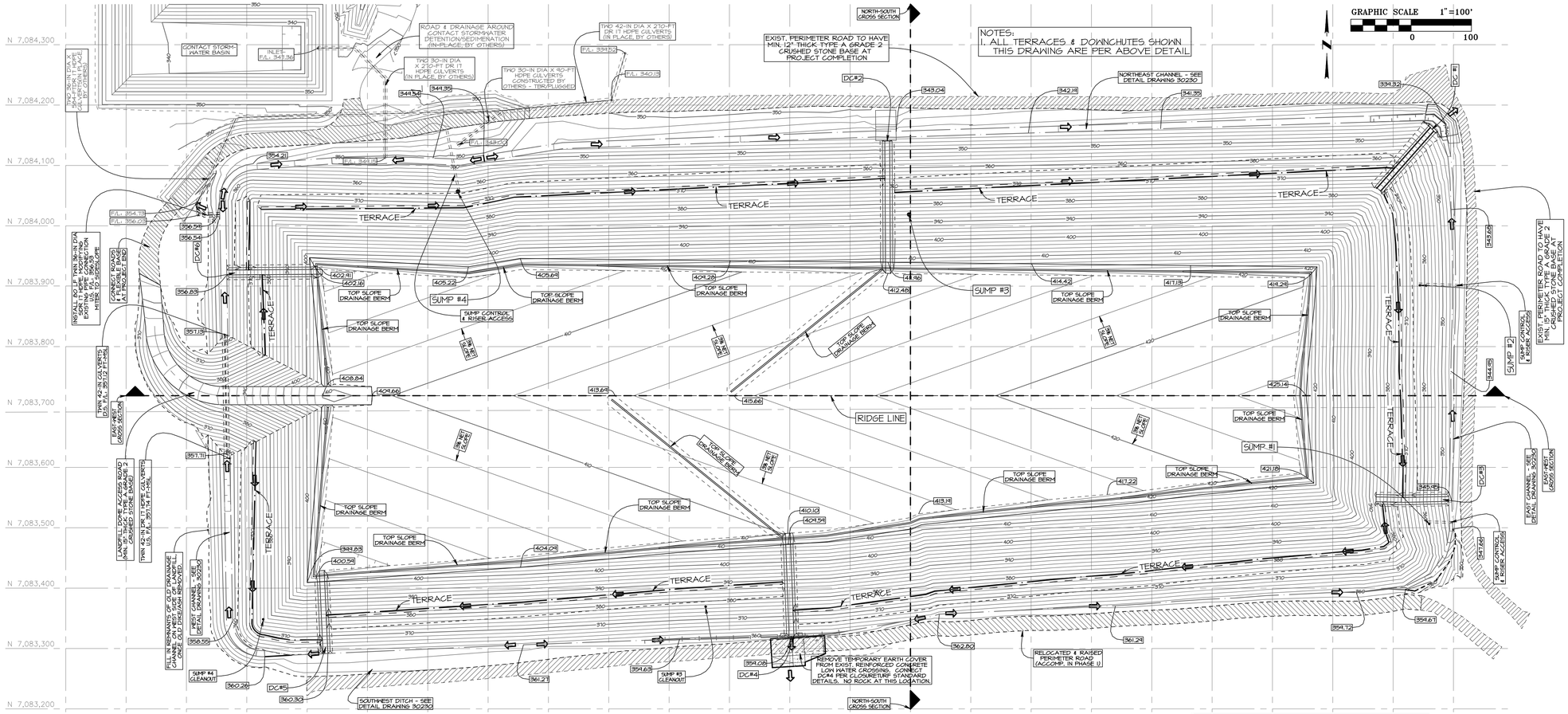
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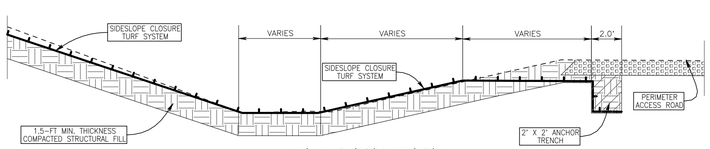


TOP SLOPE BERM & CLOSURE TURF DETAIL



SIDESLOPE TERRACE & CLOSURE TURF DETAIL (OPTIONAL)



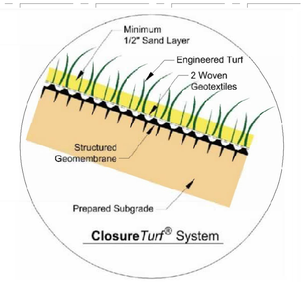


CLOSURE TURF TERMINATION DETAIL

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CLOSURE TURF SYSTEM REQUIREMENTS:
1. ALL STRUCTURED GEOMEMBRANES SHALL BE MINIMUM 50 MIL.
2. THE STRUCTURED GEOMEMBRANE FOR ALL SLOPES LESS THAN 3H:1V (SIDESLOPE CLOSURE TURF SYSTEM) SHALL BE THE MICRODRAIN SYSTEM.
3. THE STRUCTURED GEOMEMBRANE FOR ALL SLOPES EQUAL TO OR STEEPER THAN 3H:1V (SIDESLOPE CLOSURE TURF SYSTEM) SHALL BE THE SUPER GRIPNET SYSTEM.



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REVISIONS

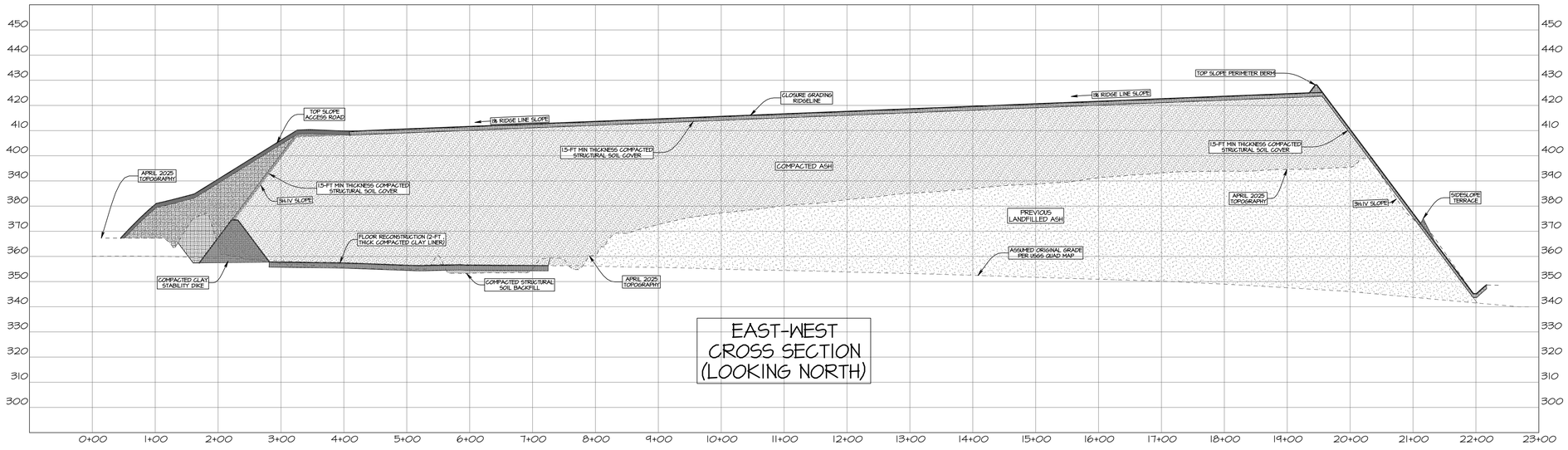
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FINAL CLOSURE COVER SYSTEM GRADING PLAN

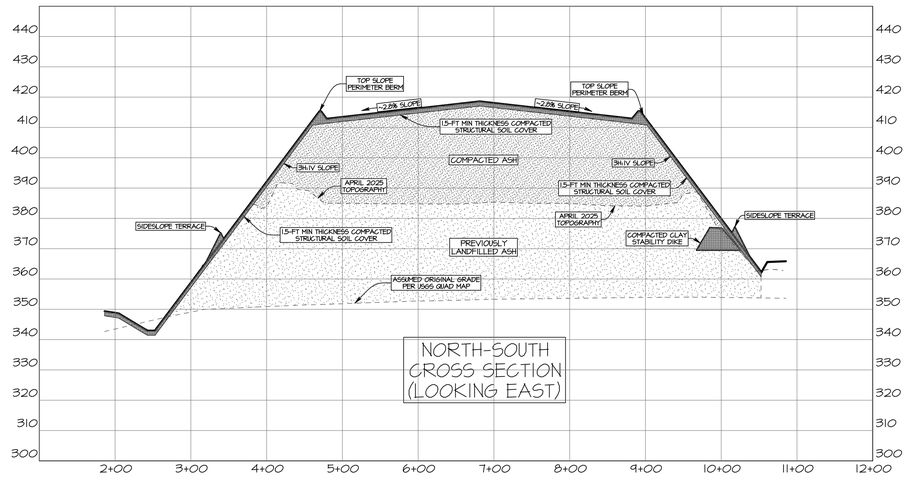
WELSH ASH LANDFILL PHASE 2 CONSTRUCTION

Drawing Date: 6/16/2025
Project Number: 237008
Sheet Number: 300225

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Mon Jun 16, 2025 10:05AM



EAST-WEST
CROSS SECTION
(LOOKING NORTH)



NORTH-SOUTH
GROSS SECTION
(LOOKING EAST)



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NO.	DESCRIPTION	APPR.
1	REVISED GRADING PLAN, CROSS SECTIONS FOR TCEQ SUBMITTAL	
DATE		
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TYPICAL CROSS SECTIONS

WELSH ASH LANDFILL PHASE 2 CONSTRUCTION

Drawing Date: 6/16/2025
Project Number: 237008
Sheet Number: 300226

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Geotechnical Investigation

AEP-Southwestern Electric Power Company

Phase 1 Landfill Seepage Evaluation and Vertical Expansion
Pittsburg, Texas

Submitted to

AEP-Southwestern Electric Power Company
Pittsburg, Texas

Prepared by

ETTL Engineers & Consultants Inc.
Tyler, Texas

April 2015

Table 5.0.1 – Soil Laboratory Testing Procedures		
Test	**Test Method**	**Number of Tests**
Drained Conditions		
Unconsolidated-Undrained Triaxial Compression Test for Cohesive Soils	ASTM D 2850	4
Consolidated-Undrained Triaxial Compression Test for Cohesive Soils	ASTM D 4767	5

The above laboratory tests were performed in general accordance with applicable ASTM, U.S. Army Corps of Engineers procedures, and/or generally accepted practice. It should be noted that reference to ASTM or other standard procedures does not imply that all cross-referenced procedures in ASTM or other standards have been used, or that all ASTM or other procedures used have been followed exactly. Only those ASTM or other standard procedures and/or portions of procedures, which, in the professional judgment of the geotechnical engineer of record for this report, are applicable, appropriate, and necessary for this particular project, have been used or followed. Details regarding these tests are included on the logs (APPENDIX A) and in the Laboratory Test Reports of APPENDIX B.

5.1 Test Specimen Preparation

Because of the relative difficulty of obtaining intact, undisturbed samples of the ash, strength tests were conducted on remolded specimens. The specimens were prepared with care to avoid over-compaction. That is, the specimens were compacted such that they did not exceed the confining stress to be used in the test (except for native clays which were assumed to be used in construction of the cap and which were molded to approximately 95% of ASTM D698). Thus shear strength parameters for remolded specimens represent the properties of normally consolidated ash, which is a conservatively realistic way to represent them. Only that portion of the sample finer than the #10 sieve was used to remold strength specimens. In some cases some of this material contained cemented particles.

Specimens for permeability were molded to approximately 95% ASTM D698 as predicted by correlations with index properties.

6.0 LANDFILL AND FOUNDATION STRATIGRAPHY & PROPERTIES

Detailed on the boring logs are the specific types and depths of the various ash and soil strata encountered.

6.1 Regional Geology

The landfill is situated over an outcrop of the Queen City Sand. Characteristic lithologies of this formation are light gray to brownish gray, fine- to medium-grained quartz sand and gray to brown clay, occasionally silty and slightly lignitic. Ironstone concretions, sometimes occurring as ledges, are common within the formation. In outcrop, the Queen City weathers to a mottled red and white color.

It is possible that the fat clay encountered at elevations ranging approximately from 320 to 330 beneath the subject area is the top of the Reklaw formation. The Reklaw Formation includes, from top down, Marquez and Newby Members which are not separately mapped. The Marquez Member, is comprised of clay and silt, carbonaceous, lentils of glauconitic clay ironstone, brownish black, reddish brown; and weathers light brown to light gray.

6.2 Foundation Soil Stratigraphy

The native soil profile beneath the landfill consists generally of 5' to 15' of lean clay (CL) and/or fat clay (CH) that is generally soft to medium stiff directly beneath the landfill and medium stiff to very stiff otherwise, overlying a varying thickness of very dense silty sand (SM) / sandy silt (ML), which is underlain by a basal hard fat clay (CH).

6.3 Landfill Ash Deposits

The ash currently varies in thickness generally from 25' to 33'. It characterized by a large range of grain size distributions and classifies generally as very loose to medium dense silty sand (SM), clayey sand (SC), silt (ML) and elastic silt (MH). Localized zones can be cemented. We have identified basically four types of ash, designated as follows, including estimated % of total landfill contents (based on the ratio of the sum of the thicknesses of each type from each boring to the sum of the total ash thickness from each boring):

- Economizer ash, Dark Brown and Grayish Brown (visual appearance of small glass beads) (SM, SC) – 44%
- Bottom ash, black (MH) – 10%
- Ash mixture, dark gray and dark brown (MH, sandy ML/MH) – 13%
- Fly ash, Light brown and grayish brown, some cementing (SM, SC, sandy ML/MH) – 33%

The location of each of the 4 types in the landfill is random. There is no regular layering. It was generally quite common for the upper 10' – 15' to be denser (or perhaps stronger due to some cementing) than the remaining ash below the estimated perched water level. The predicted engineering properties of each of the ashes are listed on the logs and/or TABLE 6.5.1 – ENGINEERING PROPERTIES in Section 6.5 of this report.

6.4 Seismic Design

Due to the relatively low ground acceleration potential of the area, seismicity is not generally a concern. However, an initial screening analysis was performed.

6.4.1 GROUND MOTION PARAMETERS

The source of seismic data is the U S Geological Survey website, utilizing the *NEHRP Recommended Seismic Provisions*, FEMA P-750, 2009 Edition:

http://earthquake.usgs.gov/designmaps/us/application.php
http://geohazards.usgs.gov/eqprob/2009/index.php

Based on the soil stratigraphy in the surficial 100', the site is categorized as Class D. The site

coordinates used for reference are: 33.04776 N, 94.84488 W. The assumed risk category is Category I, II, III (non-essential facilities).

With the above information as input, the website computed applicable seismic parameters, a report of which is included in APPENDIX E. In summary the salient parameters for this analysis for a return period of 2,500 years (probability of 2% in 50 years) are:

- Peak Ground Acceleration (Free Field) - PGA = 0.093g
- Spectral Acceleration (short period, 0.2 second) – S_{Ms} = 0.197g
- Spectral Acceleration (long period, 1.0 second) – S_{M1} = 0.161g
- Site Coefficient F_a = 1.6
- Site Coefficient F_v = 2.4
- Site Coefficient F_{PGA} = 1.6

In keeping with recommendations of the MSHA Engineering and Design Manual (cited below), section **7.7.3.7 Simplified Design Ground Motion for Areas of Low Seismic Hazard**, the maximum credible earthquake for the site is determined by generating an earthquake probability map with a return period $\geq$ 10,000 years (a somewhat arbitrary return period to satisfy a "very low probability of occurrence" criterion which would be conservative for this type of facility) for earthquakes within 50km of a given site. This map is included in APPENDIX E. This simplified approach to determining the maximum credible earthquake applies only to areas of low seismic hazard such as characterize much of the central and eastern US (as well as this site). Based on this analysis:

- Maximum Credible Earthquake Magnitude, M_w = 5.5 (generally recognized minimum for design—The probability map in APPENDIX E indicates an even lower probability than 1:10,000 years for this EQ)

In addition for liquefaction screening analysis, the MSHA Manual recommends that the Free Field, Site-Adjusted PGA (2,500 year return interval) be multiplied by 1.5 to obtain the PGA corresponding to the maximum credible earthquake:

- PGA for Liquefaction Screening Analysis (Maximum Credible Earthquake within 50km) = 0.093g x 1.5 = 0.14g

6.4.2 LIQUEFACTION SCREENING ANALYSIS

Per the *FEDERAL GUIDELINES FOR DAM SAFETY, Earthquake Analyses and Design of Dams (*FEMA 65*),* FEMA 2005, Section I.E.1, a basic seismic study was conducted to assess the potential for liquefaction. In general, very loose, granular material below a groundwater table indicates susceptibility. However, except for an isolated pocket or two detected in our borings, all of the ash is either too fine (-#200 > 35%) or is above the perched water, or is cemented, indicating that the majority is not susceptible to liquefaction. In addition, the fact that possibly susceptible zones are in isolated pockets indicates that the risk of detrimental deformation or failure due to liquefaction is very low. However, an analysis was performed in the event that a given zone could possibly be typical of an extensive pocket (although the borings gave no indication of this).

TABLE 6.5.1 - REPRESENTATIVE ENGINEERING PROPERTIES

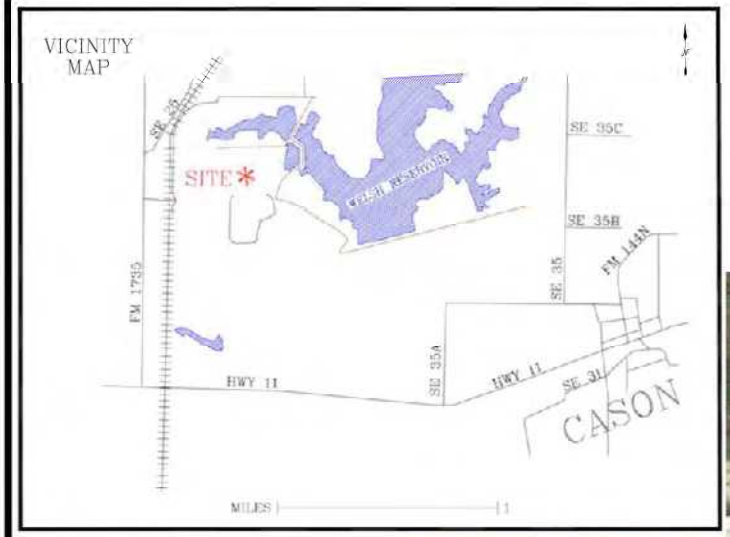
Stratum Color Classification(s)	Peak / Post Peak Shear Strength				Unconsolidated Undrained (UU) c (psf)[19] /Confining Pressure (psi)	Hydraulic Conductivity (cm/sec)	Range of Plasticity Index	Range of % Passing No. 200 Sieve	Predicted Range Dry Unit Wt. (pcf)	Predicted Range Moist Unit Wt. (pcf)	Saturated Unit Wt. (pcf) / MC (%)
	Effective (Drained)		Total (Undrained)								
	c' (psf)	ϕ'	c (psf)	ϕ							
Economizer Ash Dk. Br., Grayish Br. SM, SC	171 / 72	39.4 / 37.6	NA	NA	NA	2.95E-04[3]	NP - 12	25 - 50	78 – 83 (82)[17]	---	111[10]/34
Bottom Ash Black MH	801 / NA	37.7 / NA	NT	NT	NT	8.03E-07	19 - 42	96 - 100	35 – 45[6] (41)[17]	---	85[6]-88[10]/104
Ash Mixture Dk. Gray, Dk. Brown MH, Sandy ML / MH	130	43.7	1,140	18.5	2,120/10[4] 2,780/20[4] 4,030/40[4]	NT	NP – 15 (10)[17]	62 – 96 (89)[17]	33 - 37[6] (42)[17]	---	85[6]-83[10]/99
Fly Ash Lt. Br. / Grayish Br. SM, SC, Sand ML / MH	431 / 386	40.9 / 37.1	NT	NT	NT	NT	NP - 5	36 – 82[11]	39 – 95[6,7] (77)[17]	---	85[6]-109[10]/41
Predicted Composite Ash Properties for Design	387[8]	35.3[8]	580[9]	25.4[9]	1,190[18]	---	---	---	71	85 - 100[14]	96 - 105[14]
Upper Native Clay Red, Lt. Br & Lt. Gray SC, Sandy CL / CH[15][16]	NT	NT	NT	NT	1,400/21[2] 1,500/18[2] 2,400/24[2] 2,100/21[2]	9.66E-08(CL) 1.13E-08(CH) 1.40E-08(CL)	9 - 50	39 - 95	99 - 110	123 – 131	130[5]
Remolded Upper Clay Reddish Br & Lt. Gray CH w/ Sand[1]	345	26.3	446	16.1	1,580/10[4] 1,980/20[4]	1.59E-07[1]	42	78	96	119	128
Remolded Upper Clay Reddish Br & Lt. Brown Sandy CL[1]	0	35.8	230	23.5	1,580/10[4] 3,100/20[4]	2.32E-05[1]	11	62.6	109 - 111	127 - 130	130
Upper Native Clay Reddish Br & Lt. Gray CH[16]	187	32.6	360	18.2	2,090/10[4] 3,430/40[4]	NT	38	85.8	98 - 103	124 - 127	130
Lower Native Clay Dark Brown CH[16]	101	31.1	446	16.3	1,440/10[4] 2,750/40[4]	NT	35 - 42	90 - 99	100 - 105	120 - 125	130[5]

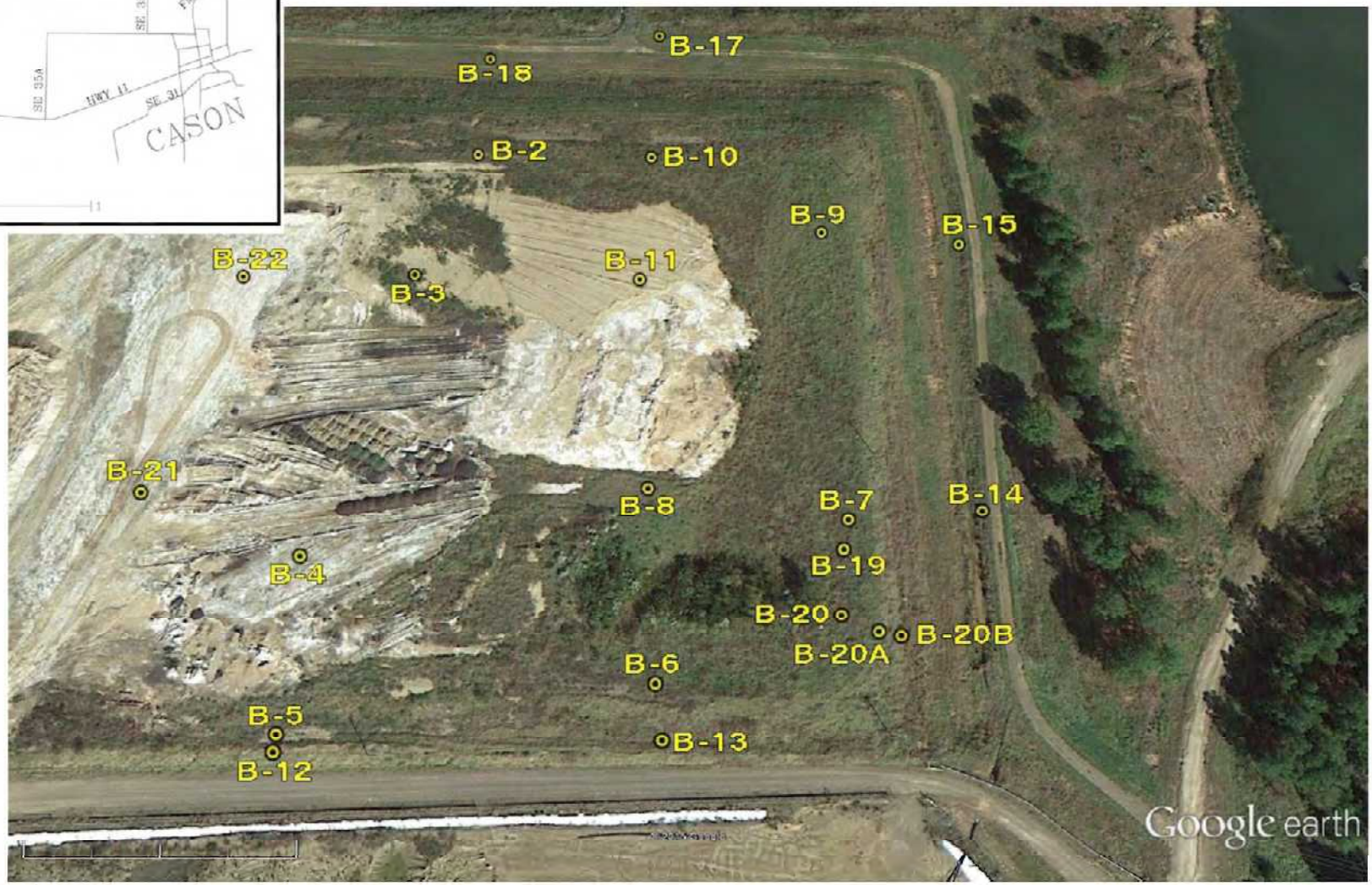
Stratum Color Classification(s)	Peak / Post Peak Shear Strength[1]				Unconsolidated Undrained c (psf) /Confining Pressure (psi)	Hydraulic Conductivity (cm/sec)	Range of Plasticity Index	Range of % Passing No. 200 Sieve	Predicted Range Dry Unit Wt. (pcf)	Predicted Range Moist Unit Wt. (pcf)	Saturated Unit Wt. (pcf)
	Effective (Drained)		Total (Undrained)								
	c' (psf)	ϕ'	c (psf)	ϕ							
Interbedded Layer Light Brown SM, SP-SM	0.0	34(5)	NA	NA	NA	NT	NP	21 - 46	90 - 95	110 - 115	130(5)
Interbedded Layer Light Gray ML, Sandy ML	0.0	32(5)	NA	NA	NA	NT	NP - 3	50 - 87	90 -95	110 - 115	130(5)

NT = Not tested
NP = Non-Plastic
NA = Not Applicable

(1) Samples Remolded at 95% predicted Maximum Dry Density
(2) Peak Unconsolidated/Undrained Triaxial Compression at insitu moisture content.
(3) Predicted by Beyer's Equation
(4) Shear strength from Unconsolidated/Undrained Triaxial Compression for saturated specimens at 10, 20 & 40 psi confining pressure.
(5) Predicted Values
(6) Measured from Trimmed SPT Samples
(7) Upper range is cemented fly ash
(8) Calculated weighted average of the four ash components based on their percentage of the overall landfill contents, using post peak data points from each test. Power curve fit variables a = 2.7619 and b = 0.8534. This normally consolidated representation of strength is believed conservative for the new ash to be placed with some nominal compaction.
(9) Crude estimate of c = 1.5 * c' and tan(ϕ) = 0.5 * tan(ϕ')
(10) Measured from direct shear or permeability specimens consolidated to approximately 10 psi
(11) Affected by cemented particles in sample. Uncemented material is finer
(12) Shear strength properties are based on tests on the portion of sample finer than #10 sieve, but which contains some cemented particles. Does not reflect cemented strength which is likely to be significantly higher.
(13) The post-peak values of this ash were used to represent the lower bound strength. Power curve fit variables a = 1.398 and b = 0.9303
(14) Lighter weights are, in some cases, conservative for stability analyses
(15) Fully softened strength (drained) is predicted (Re: aforementioned paper by Dr. Gregory) to be characterized by the equation (%Clay size fraction = 42% by hydrometer testing of CH constituent):
Drained fully softened shear strength = 0.8672*(eff normal stress)^0.9326.
(16) Shear strength measured on trimmed Shelby tube specimens
(17) Properties of test specimens
(18) Calculated from CU parameters at 1284 psf preconsolidation pressure (i.e. @ base of level 1 ash, i.e. beneath 26' of ash submerged in 18' of water)
(19) Lower bound UU values estimated from lowest test value of undrained shear strength * .85.

APPENDIX A





feet 600

ETTL ENGINEERS & CONSULTANTS MAIN OFFICE 1717 East Erwin Tyler, Texas 75702 (903) 595-4421	PHASE I FLY ASH STORAGE AREA EMBANKMENT SEEPAGE & VERTICAL EXPANSION INVESTIGATION WELSH POWER STATION CASON, TEXAS	PLATE 1 - PLAN OF BORINGS		APPROVED BY:
		JOB.NO.: G4207-14		DRAWN BY: A.K.B.
		DATE: NOV. 2014	SCALE: AS SHOWN	

LOG OF BORING B-2

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX
PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/8/14
SURFACE ELEVATION 373.8

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	ML	ASH (SILT WITH GRAVEL(ML)) medium dense; light grayish brown; with coarse-grained sand and lightly cemented gravel pieces; dry	N=13					46				59	+40 Sieve=27% +4 Sieve=16%
5	SM	ASH (SILTY SAND(SM)) medium dense; dark brown and light brown; with coarse-grained sand and lightly cemented gravel pieces --loose; moist	N=29 N=18 N=9					40				40	+40 Sieve=19% +4 Sieve=2%
10													
15	MH	ASH (ELASTIC SILT(MH)) very loose; black; with fine-grained sand and lightly cemented gravel pieces; saturated	N=0					200	134	92	42	100	+40 Sieve=0% +4 Sieve=0%
20	SM	ASH (SILTY SAND(SM)) very loose; dark brown; with coarse-grained sand and lightly cemented gravel pieces; moist	N=1										
25		--loose; dark brown and light brown; with coarse-grained sand and lightly cemented gravel pieces; moist	N=7					91				61	+40 Sieve=11% +4 Sieve=1%
30	CL	SANDY LEAN CLAY(CL) medium stiff; dark brown and black; with fine-grained sand and cemented gravel pieces; saturated	N=6					18	30	15	15	63	+40 Sieve=1% +4 Sieve=0%

Egc @ 28-43' & Er @ 43-60'

Water Level Est.: Measured: Perched:

Water Observations: Water level @ 13'.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04890°, W94.84451°
Driller: Tommy Cook
Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-2 (cont.)

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX

PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/8/14

SURFACE ELEVATION 373.8

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)	ATTERBERG LIMITS(%) PLASTIC LIMIT (PL)	ATTERBERG LIMITS(%) PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35		SC			CLAYEY SAND(SC) dense; light brown, light gray and reddish brown; moist; with fine-grained sand; mottled	P=3.5 P=2.75	110	1.39	4.3	21	18 16	30	15	15	39	+40 Sieve=0% +4 Sieve=0%
40		SM			SILTY SAND(SM) very dense; light brown, yellowish brown and light gray; moist; mottled; with fine-grained sand	N=78					21				24	+40 Sieve=0% +4 Sieve=0%
45		CH	Eqc @ 28-43' & Er @ 43-60'		FAT CLAY(CH) very stiff; dark brown and light brown; moist; with sand seams; laminated	N=27					25	62	26	36	96	+40 Sieve=2% +4 Sieve=0%
50					--dark brown with light gray; moist; with silt seams	P=4.0	98				24					
55					--hard; dark brown; moist	N=37										
60					Bottom of Boring @ 60'											

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

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Water level @ 13'.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04890°, W94.84451°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-3

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: D-50
PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/24/14
SURFACE ELEVATION 380.5

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. #)
0		SM			ASH (SILTY SAND(SM)) medium dense; grayish brown; with lightly cemented gravel pieces; moist	N=11										
5																
		MH			ASH (SANDY ELASTIC SILT(MH)) loose; dark brown; with lightly cemented gravel pieces; wet	N=8					73	61	57	4	70	+40 Sieve=9% +4 Sieve=0%
10						N=9										
15			Eqc @ 23-40'													
		MH			ASH (ELASTIC SILT(MH)) very loose; grayish brown and light brown; lightly cemented; moist	N=4					135	104	99	5	91	+40 Sieve=2% +4 Sieve=0%
20																
		CL			SANDY LEAN CLAY(CL) soft; reddish brown and light brown; moist; mottled	N=6										
25																
					--very stiff; light gray and reddish brown; moist; blocky; mottled; with ferric partings	N=16										
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 @ 8' while drilling. Water level @ 15' and open upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04845°, W94.84451°
Driller: Tommy Cook
Logger: O.Sanderson

LOG OF BORING B-3 (cont.)

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: D-50
PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/24/14
SURFACE ELEVATION 380.5

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(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35		ML	Eqc @ 23-40'	SILT(ML) dense; light gray; moist	N=42					27	29	26	3	87	+40 Sieve=0% +4 Sieve=0%
40		SP SM		POORLY GRADED SAND WITH SILT(SP-SM) very dense; light grayish brown	N=50/4.5"										
				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 @ 8' while drilling. Water level @ 15' and open upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04845°, W94.84451°
Driller: Tommy Cook
Logger: O.Sanderson

LOG OF BORING B-4

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

DRILL RIG: B-61 HDX

PROJECT NO.: G4207-146

BORING TYPE: Hollow Stem Auger

DATE 10/8/14

SURFACE ELEVATION 377.6

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. #)
0		SM			ASH (SILTY SAND(SM)) very dense; dark brown with light brown; with coarse-grained sand, and lightly cemented gravel pieces; dry	N=54										
5					--medium dense	N=31										
10																
13		MH			ASH (ELASTIC SILT WITH SAND(MH)) very loose; light brown; with black ash seams; wet	N=0	39				106 119	81	76	5	82	+40 Sieve=10% +4 Sieve=1%
15			Eqc @ 28-40'													
20		MH			ASH (ELASTIC SILT(MH)) very loose; black and dark gray; wet	N=0	35				139					
25		MH			ASH (GRAVELLY ELASTIC SILT WITH SAND(MH)) very loose; black and dark gray with light brown; with lightly cemented gravel pieces; wet	N=0					100	113	92	21	66	+40 Sieve=30% +4 Sieve=25%
28		CL			LEAN CLAY(CL) very stiff; grayish brown and reddish brown; mottled; moist	N=25					27	44	22	22	95	+40 Sieve=1% +4 Sieve=0%
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)

Water Level Est.: ▽ Measured: ▼ Perched: ⊻

Water Observations: Water level @ 13' and open upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04776°, W94.84488°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-4 (cont.)

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX
PROJECT NO.: G4207-146
BORING TYPE: Hollow Stem Auger

DATE 10/8/14
SURFACE ELEVATION 377.6

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. #)
35		CH	Eqc @ 28-40'		FAT CLAY(CH) stiff; dark brown; moist; laminated; with sand seams	N=14					25	64	28	36	99	+40 Sieve=0% +4 Sieve=0%
40					--gray and yellowish brown; moist; mottled	P=3.0 P=4.5+	99	2.35	3.8	24	24					
					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 @ 13' and open upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04776°, W94.84488°
Driller: Tommy Cook
Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-5

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX

PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/8/14

SURFACE ELEVATION 372.9

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	ATTERBERG LIMITS(%) PLASTIC LIMIT (PL)	ATTERBERG LIMITS(%) PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	GM	ASH (SILTY GRAVEL WITH SAND(GM)) very loose; light brown and dark brown; with lightly cemented gravel pieces and coarse-grained sand; moist	N=3					45				28	+40 Sieve=56% +4 Sieve=43%
5			N=0										
10													
15	CL	--black; saturated SANDY LEAN CLAY WITH GRAVEL(CL) stiff; light brown, gray and reddish brown; moist; mottled; with medium-grained sand	N=10					41	26	17	9	54	+40 Sieve=23% +4 Sieve=22%
20		--very stiff	N=18										
25	CH	FAT CLAY WITH SAND(CH) very stiff; light gray and reddish brown; moist; mottled	N=18					26	60	22	38	78	+40 Sieve=0% +4 Sieve=0%
30		--with sand pockets; mottled; moist Bottom of Boring @ 30'	P=2.25	100				25					

Ecp @ 16-30'

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

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 13' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
Hole terminated @ 30' due to water loss.

GPS Coordinates: N33.04717°, W94.84486°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-6

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX

PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/10/14

SURFACE ELEVATION 370.8

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)	ATTERBERG LIMITS(%) PLASTIC LIMIT (PL)	ATTERBERG LIMITS(%) PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0		SM			ASH (SILTY SAND(SM)) loose; dark brown and light brown; with coarse-grained sand and lightly cemented gravel pieces; moist	N=10										
5																
10				▽		N=7					58				39	+40 Sieve=17% +4 Sieve=3%
		MH	Eqc @ 23.5-53' & Er @ 53-60'		ASH (ELASTIC SILT(MH)) very loose; black and dark gray; wet	N=3	45				99					
15					--wet	N=0					129	96	92	4	96	+40 Sieve=1% +4 Sieve=0%
20																
		CH			FAT CLAY WITH SAND(CH) stiff; gray and reddish brown; moist; mottled	N=9										
25											29	54	18	36	72	+40 Sieve=10% +4 Sieve=5%
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

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 10' 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: N33.04729°, W94.84386°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-6 (cont.)

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX

PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/10/14

SURFACE ELEVATION 370.8

DEPTH (ft)	SAMPLES	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. #)
35	SM		SILTY SAND(SM) very dense; light brown, gray and reddish brown; mottled; moist	N=62					26	25	22	3	25	+40 Sieve=3% +4 Sieve=0%
40	ML		SANDY SILT(ML) very dense; light gray; moist; saturated	N=50/5"					26				56	+40 Sieve=0% +4 Sieve=0%
45			--with clay seams	N=57										
50	ML		SILT WITH SAND(ML) very dense; light gray; moist	N=93					25				76	+40 Sieve=0% +4 Sieve=0%
55	CH		FAT CLAY(CH) very stiff; dark brown; with silt seams; moist	N=27	103				28	72	24	48	95	+40 Sieve=0% +4 Sieve=0%
60			Bottom of Boring @ 60'											

GEOLOGIC UNIT: Eqc @ 23.5-53' & Er @ 53-60'

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

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 10' 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: N33.04729°, W94.84386°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-7

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

DRILL RIG: B-61 HDX

PROJECT NO.: G4207-146

BORING TYPE: Rotary Wash/Flight Auger

DATE 10/10/14

SURFACE ELEVATION 368.8

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	ML	ASH (SANDY SILT(ML)) loose; dark brown; with lightly cemented gravel pieces; moist	N=10					20				53	+40 Sieve=10% +4 Sieve=5%
5		--very loose; wet	N=0	33				>>159					
10	SM	ASH (SILTY SAND(SM)) very loose; dark brown; with coarse-grained sand; wet	N=2					97				40	+40 Sieve=9% +4 Sieve=2%
15	MH	ASH (SANDY ELASTIC SILT(MH)) very loose; grayish brown; moist	N=4	37				>>127					
20		--cemented ash seam	Tx=50/2"										
25	CL	SANDY LEAN CLAY(CL) brown with red and light gray; wet	Tx=10/6"										
30		--very stiff; light gray, reddish brown and light brown; moist; mottled	P=3.0										

SAMPLES | GEOLOGIC UNIT | WATER LEVEL

Eqc @ 23.5-43' & Er @ 43-60'

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

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 8' 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: N33.04771°, W94.84330°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-7 (cont.)

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas **DRILL RIG:** B-61 HDX

PROJECT NO.: G4207-146 **BORING TYPE:** Rotary Wash/Flight Auger

DATE 10/10/14

SURFACE ELEVATION 368.8

ETTL ENGINEERS & CONSULTANTS

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Tyler, Texas 75702
(903) 595-4421

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(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35				--light grayish brown and yellowish brown; laminated with silt; with fine-grained sand	N=25					26	43	17	26	68	+40 Sieve=0% +4 Sieve=0%
40		SM		SILTY SAND(SM) very dense; light gray; with coarse-grained sand; moist	N=83					28				38	+40 Sieve=0% +4 Sieve=0%
45		CH	Eqc @ 23.5-43' & Er @ 43-60'	FAT CLAY(CH) hard; dark brown with light gray; with silt seams; moist	N=37					26	62	20	42	92	+40 Sieve=1% +4 Sieve=0%
50					P=4.5+										
55					P=4.5+										
60				Bottom of Boring @ 60'	P=4.5+										

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

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 8' 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: N33.04771°, W94.84330°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-8

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas **DRILL RIG:** D-50

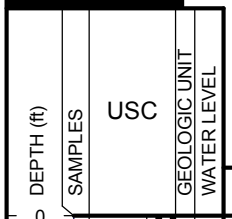
PROJECT NO.: G4207-146 **BORING TYPE:** Hollow Stem Auger

DATE 10/24/14

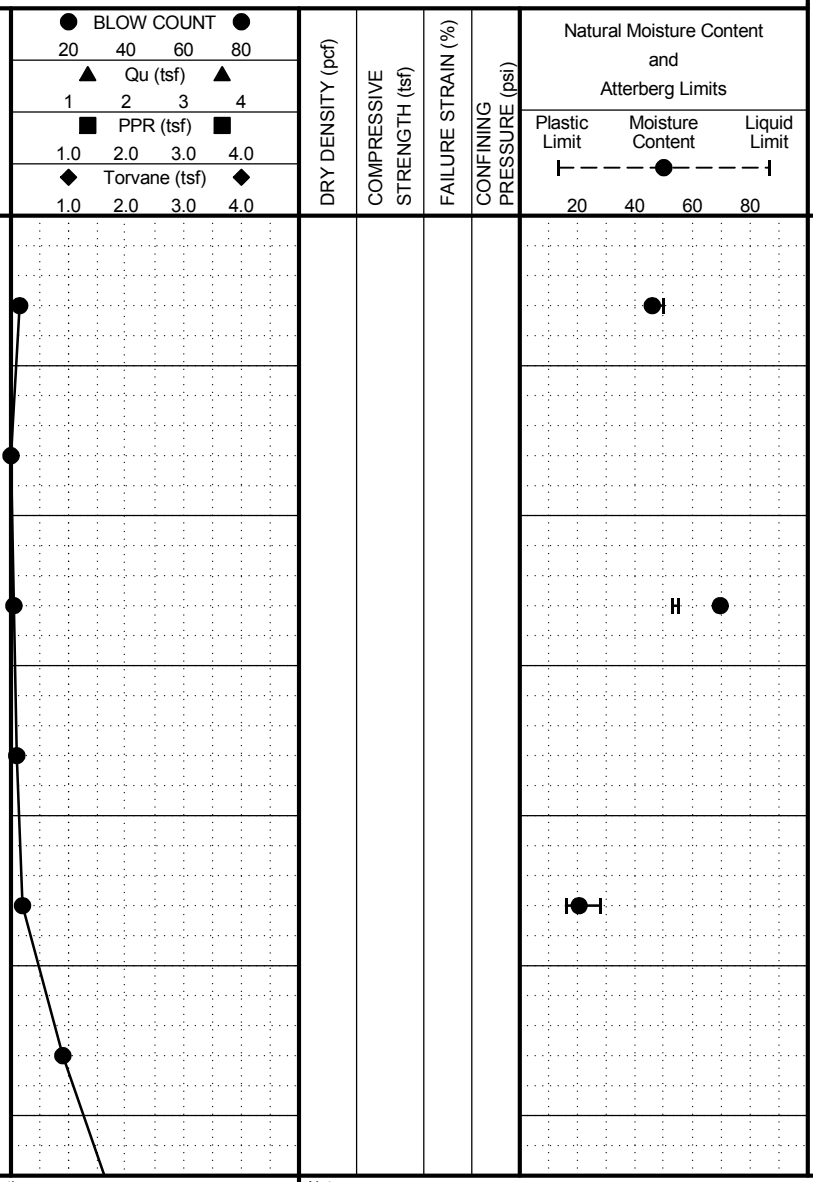
SURFACE ELEVATION 370.0

ETTL ENGINEERS & CONSULTANTS

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Tyler, Texas 75702
(903) 595-4421



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. #)
ASH (SANDY ELASTIC SILT(MH)) very loose; grayish brown; with lightly cemented gravel pieces; moist	N=3					46	50	46	4	60	+40 Sieve=19% +4 Sieve=4%
ASH (SANDY ELASTIC SILT(MH)) very loose; dark brown; with lightly cemented gravel pieces; wet	N=0										
	N=1					70	55	53	2	68	+40 Sieve=10% +4 Sieve=1%
ASH (ELASTIC SILT(MH)) very loose; dark grayish brown; moist	N=2										
SANDY LEAN CLAY(CL) soft; reddish brown and light brown; wet; mottled	N=4					21	28	16	12	63	+40 Sieve=6% +4 Sieve=4%
--very stiff; light grayish brown and reddish brown; moist; layered; with ferric partings	N=18										



Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 6' while drilling. Water level @ 18' 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: N33.04779°, W94.84389°

Driller: Tommy Cook

Logger: O.Sanderson

LOG OF BORING B-8 (cont.)

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
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PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: D-50

PROJECT NO.: G4207-146
BORING TYPE: Hollow Stem Auger

DATE 10/24/14

SURFACE ELEVATION 370.0

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT / WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	Natural Moisture Content and Atterberg Limits	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35		ML	Eqc @ 23-40'	SILT(ML) dense; light gray; moist; with clay seams	N=36											
40		SP SM		POORLY GRADED SAND WITH SILT(SP-SM) very dense; light gray; moist	N=50/4"											
				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 @ 6' while drilling. Water level @ 18' 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: N33.04779°, W94.84389°
Driller: Tommy Cook
Logger: O.Sanderson

LOG OF BORING B-9

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX
PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/9/14
SURFACE ELEVATION 371.0

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	SM	ASH (SILTY SAND(SM)) loose; dark brown and light brown; with coarse-grained sand and lightly cemented gravel pieces; moist	N=10					22				44	+40 Sieve=12% +4 Sieve=1%
5													
8	MH	ASH (SANDY ELASTIC SILT(MH)) very loose; black and dark gray; saturated	N=0					90	61	61	NP	62	+40 Sieve=3% +4 Sieve=0%
10													
15		--with coarse-grained sand and lightly cemented gravel pieces; moist	N=2										
20		--gray and light gray --light brown; cemented layer from 20' to 25'	N=50/3"	96				21					
25			Tx=50/1.5" Tx=50/0"					36					
28	CH	FAT CLAY WITH SAND(CH) stiff; light gray and reddish brown; mottled; moist	P=1.75	106	1.52	13.4	18	26 21	70	20	50	83	+40 Sieve=1% +4 Sieve=0%
30													

Eqc @ 28-43' & Er @ 43-60'

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.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04861°, W94.84332°
Driller: Tommy Cook
Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-9 (cont.)

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX

PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/9/14

SURFACE ELEVATION 371.0

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. #)
35		CL			SANDY LEAN CLAY(CL) hard; light brown, reddish brown and light gray; moist; mottled	N=65										
40		SM			SILTY SAND(SM) very dense; light brown and gray; moist; with coarse-grained sand	N=60					26				46	+40 Sieve=0% +4 Sieve=0%
45		CH	Eqc @ 28-43' & Er @ 43-60'		FAT CLAY(CH) very stiff; dark brown and gray; with silt seams; moist	N=29										
50						P=4.5+					19	54	19	35	98	+40 Sieve=0% +4 Sieve=0%
55						P=4.5+										
60					Bottom of Boring @ 60'	P=4.5+										

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

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 8' 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: N33.04861°, W94.84332°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-10

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX
PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/8/14
SURFACE ELEVATION 373.2

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	SC	ASH (CLAYEY SAND(SC)) loose; dark brown and light brown; with coarse-grained sand and lightly cemented gravel pieces; moist	N=7					24	31	19	12	41	+40 Sieve=21% +4 Sieve=11%
5			N=3										
10	MH	ASH (ELASTIC SILT(MH)) very loose; black; moist	N=0										
15		--wet											
20	SM	ASH (SILTY SAND WITH GRAVEL(SM)) very dense; light brown and dark brown; with lightly cemented gravel pieces and coarse-grained sand; moist; cemented layer from 17.5' to 21'	N=50/1"					56				14	+40 Sieve=71% +4 Sieve=28%
25		--cemented layer from 23' to 27'	N=50/4"										
30	CL	SANDY LEAN CLAY(CL) medium stiff; grayish brown and yellowish brown; saturated; mottled	N=4					19	23	14	9	57	+40 Sieve=1% +4 Sieve=0%

GEOLOGIC UNIT: Eqc @ 27-43' & Er @ 43-60'
WATER LEVEL: ▽

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)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 13' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04895°, W94.84390°
Driller: Tommy Cook
Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-10 (cont.)

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas **DRILL RIG:** B-61 HDX

PROJECT NO.: G4207-146 **BORING TYPE:** Rotary Wash/Flight Auger

DATE 10/8/14

SURFACE ELEVATION 373.2

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

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(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35						P=1.25 P=1.0	107	2.10	6.1	21	22					
40		SC			CLAYEY SAND(SC) medium dense; reddish brown and grayish brown; moist; mottled	N=23					22	25	17	8	27	+40 Sieve=3% +4 Sieve=0%
45		CH	Eqc @ 27-43' & Er @ 43-60'		FAT CLAY(CH) very stiff; dark brown with light gray; with silt seams; moist	N=18					25	64	24	40	90	+40 Sieve=7% +4 Sieve=0%
50					--hard	P=4.5+										
55						P=4.5+										
60					Bottom of Boring @ 60'											

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 @ 13' 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: N33.04895°, W94.84390°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-11

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas **DRILL RIG:** D-50

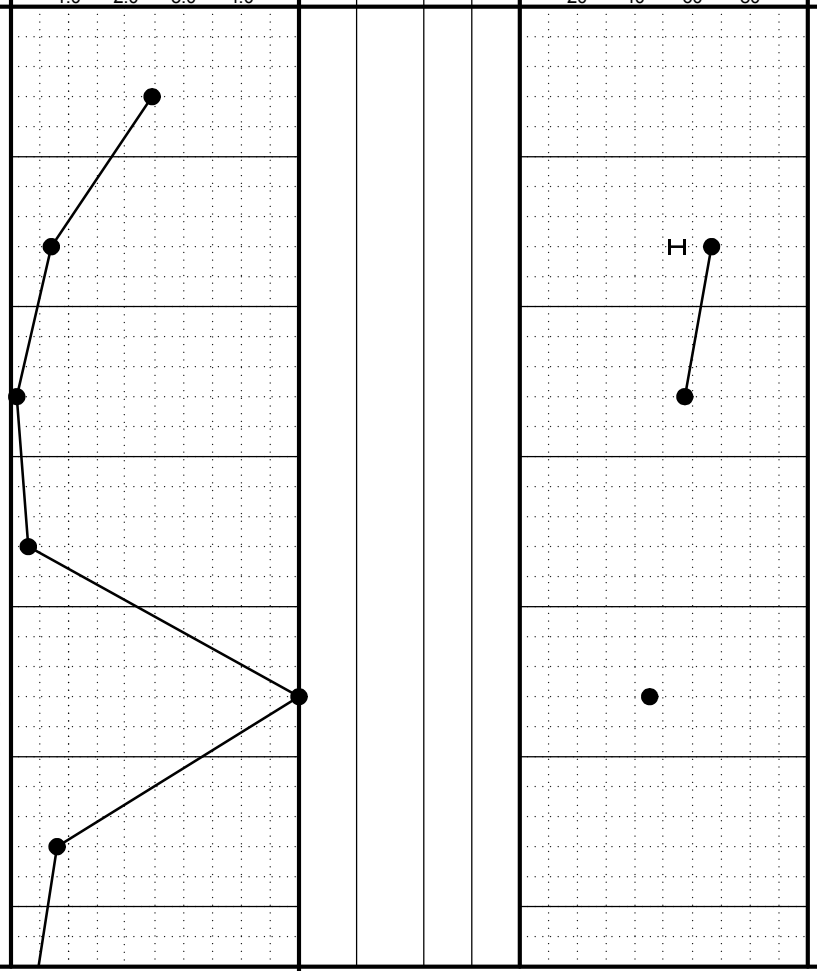
PROJECT NO.: G4207-146 **BORING TYPE:** Rotary Wash/Flight Auger

DATE 10/24/14

SURFACE ELEVATION 376.6

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	MH	<u>ASH (SANDY ELASTIC SILT</u>(MH)) very dense; light brownish gray; lightly cemented; moist	N=49						
5		--medium dense	N=14	67	57	52	5	66	+40 Sieve=10% +4 Sieve=1%
10	SM	<u>ASH (SILTY SAND</u>(SM)) very loose; black; with coarse-grained sand and lightly cemented gravel pieces; moist	N=2	57				22	+40 Sieve=43% +4 Sieve=1%
15	MH	<u>ASH (ELASTIC SILT</u>(MH)) loose; black; wet	N=6						
20	SM	<u>ASH (SILTY SAND</u>(SM)) very dense; grayish brown; moist; with coarse-grained sand and lightly cemented gravel pieces	N=50/3.5"	45				28	+40 Sieve=58% +4 Sieve=13%
25	ML	<u>ASH (SILT</u>(ML)) medium dense; light grayish brown and black; moist; lightly cemented	N=16						
30									

Eqc @ 33-40'



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 13' 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: N33.04844°, W94.84393°

Driller: Tommy Cook

Logger: O.Sanderson

LOG OF BORING B-11 (cont.)

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas **DRILL RIG:** D-50

PROJECT NO.: G4207-146 **BORING TYPE:** Rotary Wash/Flight Auger

DATE 10/24/14

SURFACE ELEVATION 376.6

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT / WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	Natural Moisture Content and Atterberg Limits	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35		CL	Eqc @ 33-40'	SANDY LEAN CLAY(CL) medium stiff;light brown and reddish brown; moist; mottled	N=8						18	27	16	11	54	+40 Sieve=2% +4 Sieve=0%
40		SM		SILTY SAND(SM) dense; light brown; moist	N=51											
				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 @ 13' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04844°, W94.84393°

Driller: Tommy Cook

Logger: O.Sanderson

LOG OF BORING B-12

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas **DRILL RIG:**

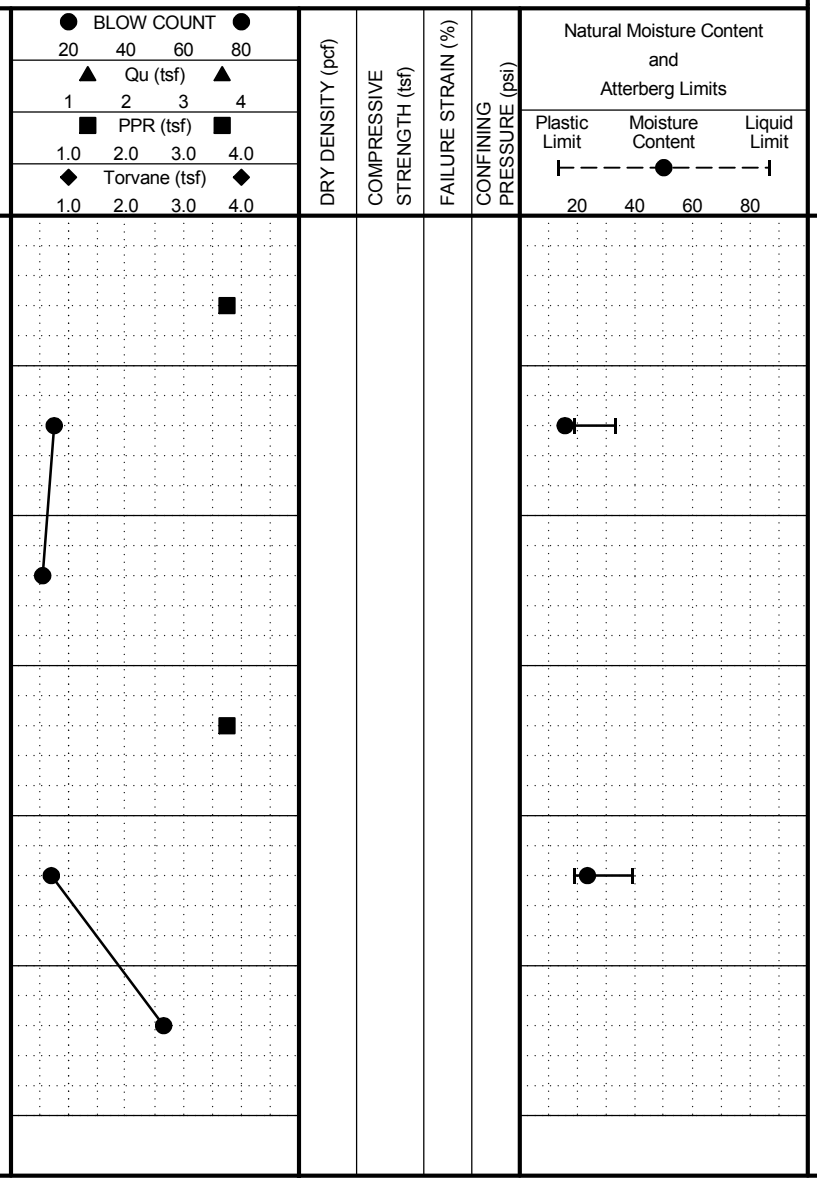
PROJECT NO.: G4207-146 **BORING TYPE:** Flight Auger

DATE 10/15/14

SURFACE ELEVATION 361.7

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	LEAN CLAY WITH SAND(CL) stiff; light gray and reddish brown; moist; mottled	P=3.75						
5	CL	SANDY LEAN CLAY(CL) stiff; light brown, light gray and reddish brown; moist; mottled	N=15	16	33	19	14	58	+40 Sieve=1% +4 Sieve=0%
10		--grayish brown and brown; moist	N=11						
15	CH	FAT CLAY WITH SAND(CH) stiff; light gray and reddish brown; moist; mottled; with ferric seams	P=3.75						
20	CL	LEAN CLAY(CL) stiff; light gray and brownish gray; moist; layered with silt	N=14	24	39	19	20	93	+40 Sieve=1% +4 Sieve=0%
25	ML	SILT WITH SAND(ML) very dense; light brown and yellowish brown; moist; with clay seams	N=53						
30		Bottom of Boring @ 30'							

Geologic Unit: Eqc



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Water level @ 27' and open upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04713°, W94.84486°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

LOG OF BORING B-13

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas **DRILL RIG:**

PROJECT NO.: G4207-146 **BORING TYPE:** Flight Auger

DATE 10/15/14

SURFACE ELEVATION 361.4

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. #)
0		CL			LEAN CLAY WITH SAND(CL) medium stiff; reddish brown with light gray; moist	N=7					20	45	17	28	76	+40 Sieve=1% +4 Sieve=0%
5		CL			SANDY LEAN CLAY(CL) very stiff; light brown, gray and reddish brown; moist; mottled	P=4.0										
10		SC			CLAYEY SAND(SC) medium dense; grayish brown; moist	N=11										
		CH	Eqc		FAT CLAY WITH SAND(CH) medium stiff; reddish brown and light gray; moist; mottled											
15						N=8					22	54	20	34	79	+40 Sieve=1% +4 Sieve=0%
20		CL			LEAN CLAY(CL) very stiff; light gray and grayish brown; moist; layered with silt	N=21										
25		ML		▼	SILT WITH SAND(ML) very dense; light gray and yellowish brown; wet; with clay seams	N=50/5"					24				80	+40 Sieve=0% +4 Sieve=0%
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)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Water level @ 28' 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: N33.047160°, W94.84384°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

LOG OF BORING B-14

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas **DRILL RIG:**

PROJECT NO.: G4207-146 **BORING TYPE:** Flight Auger

DATE 10/14/14

SURFACE ELEVATION 347.2

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	SANDY LEAN CLAY(CL) medium stiff; yellowish brown with reddish brown; dry; with clay seams	N=9						
5	ML	SANDY SILT(ML) medium dense; grayish brown; moist; with clay seams	N=11	108	17	17	NP	68	+40 Sieve=1% +4 Sieve=1%
10	CL	SANDY LEAN CLAY(CL) very stiff; light gray and gray; moist	P=4.0						
15		--light gray and grayish brown; moist; layered with silt	N=34	26	40	16	24	67	+40 Sieve=1% +4 Sieve=0%
20	SP SM	POORLY GRADED SAND WITH SILT(SP-SM) medium dense; yellowish brown, light gray and reddish brown; wet	N=27	25				10	+40 Sieve=0% +4 Sieve=0%
25	CL	LEAN CLAY(CL) very stiff; dark brown; moist; with silt partings	N=26						
30		Bottom of Boring @ 30'							

GEOLOGIC UNIT: Eqc @ 0-28' & Er @ 28-30'

WATER LEVEL

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

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Water level @ 17' and caved to 23' upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04774°, W94.84290°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

LOG OF BORING B-15

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG:

PROJECT NO.: G4207-146
BORING TYPE: Flight Auger

DATE 10/14/14

SURFACE ELEVATION 348.2

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. #)
0		CH														
					FAT CLAY(CH) stiff; reddish brown and light gray; moist; mottled	N=10										
5																
					--very stiff; light gray, grayish brown and reddish brown; moist; layered	P=3.75					24	59	21	38	85	+40 Sieve=0% +4 Sieve=0%
10																
		SM			SILTY SAND(SM) very dense; light brown; dry	N=59					7				12	+40 Sieve=0% +4 Sieve=0%
15																
					--medium dense; wet	N=21										
20																
					--very dense	N=56										
25																
		CL			LEAN CLAY(CL) hard; dark brown; moist; with silt partings	P=4.5					25	45	22	23	92	+40 Sieve=0% +4 Sieve=0%
30					Bottom of Boring @ 30'											

Eqc @ 0-28' & Er @ 28-30'

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

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Water level @ 17' and caved to 19' upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04857°, W94.84286°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

LOG OF BORING B-17

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas **DRILL RIG:**

PROJECT NO.: G4207-146 **BORING TYPE:** Flight Auger

DATE 10/14/14

SURFACE ELEVATION 344.8

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

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(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0		CL		SANDY LEAN CLAY(CL) medium stiff; brown and gray	N=7					13	27	15	12	60	+40 Sieve=1% +4 Sieve=0%
5				--stiff; grayish brown and reddish brown; moist; mottled	N=12										
10		CH	Eqc @ 0-18' & Er @ 18-30'	FAT CLAY(CH) medium stiff; light gray and gray with yellowish brown; moist; layered	P=2.25										
15				--stiff; grayish brown; moist; ferric and silt partings	P=3.5					23	56	22	34	87	+40 Sieve=9% +4 Sieve=2%
20				--dark gray; moist	N=13										
25		CL		LEAN CLAY(CL) stiff; dark brown; moist	N=21										
30				Bottom of Boring @ 30'											

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (20 40 60 80)

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: N33.04942°, W94.84388°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

LOG OF BORING B-18

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas **DRILL RIG:**

PROJECT NO.: G4207-146 **BORING TYPE:** Flight Auger

DATE 10/14/14

SURFACE ELEVATION 345.0

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL ML	SANDY SILTY CLAY(CL-ML) very stiff; light brown; moist	N=7					10	23	17	6	51	+40 Sieve=1% +4 Sieve=0%
5													
10	CL	SANDY LEAN CLAY(CL) very stiff; light brown and light gray; moist	N=16										
15	CH	FAT CLAY(CH) very stiff; grayish brown; moist; with silt partings	N=17					28	55	20	35	95	+40 Sieve=3% +4 Sieve=1%
			P=4.0										
20													
25	CL	LEAN CLAY(CL) very stiff; dark brown and light brown; moist; with clay stone partings; slickensided	N=20										
			N=16										
30		Bottom of Boring @ 30'											

Eqc @ 0-13' & Er @ 13-30'

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

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: N33.04931°, W94.84451°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

LOG OF BORING B-19

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

PROJECT NO.: G4207-146

DRILL RIG:

BORING TYPE: Flight Auger

DATE 10/15/14

SURFACE ELEVATION 368.4

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(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0		SM			ASH (SILTY SAND(SM)) very loose; dark brown; with coarse-grained sand and lightly cemented gravel pieces; dry	N=4					32				28	+40 Sieve=33% +4 Sieve=9%
5					--loose; black; with coarse-grained sand and lightly cemented gravel pieces; dry	N=5										
10				▽	--saturated @ 12'											
		ML			ASH (SANDY SILT(ML)) very loose; grayish brown; lightly cemented	N=2					92				62	+40 Sieve=5% +4 Sieve=0%
15						N=3										
20					Bottom of Boring @ 20'											

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)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 12' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04763°, W94.84332°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

LOG OF BORING B-20

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG:

PROJECT NO.: G4207-146
BORING TYPE: Flight Auger

DATE 10/15/14

SURFACE ELEVATION 368.4

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. #)
0		SM			ASH (SILTY SAND(SM)) loose; dark brown; dry; lightly cemented gravel pieces	N=9					26				33	+40 Sieve=32% +4 Sieve=13%
5					--with clay seams	N=10										
10		SM			ASH (SILTY SAND(SM)) very loose; grayish brown; with lightly cemented gravel pieces; wet	N=1					92				50	+40 Sieve=7% +4 Sieve=0%
15		MH			ASH (ELASTIC SILT(MH)) very loose; gray and black; wet	N=1										
20					Bottom of Boring @ 20'											

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)

Water Level Est.: ▽ Measured: ▼ Perched: ⧩

Water Observations: Water level @ 12' and caved to 14' upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.04746°, W94.84334°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

LOG OF BORING B-20A

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

DRILL RIG:

PROJECT NO.: G4207-146

BORING TYPE: Hand Auger

DATE 12/12/14

SURFACE ELEVATION 365.1

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION
0		SC			ASH (CLAYEY SAND(SC)) dark brown; moist; with coarse-grained sand and sand mix
		SM			SILTY SAND(SM) yellowish brown
		GP GM			POORLY GRADED GRAVEL WITH SILT AND SAND(GP-GM) black; dry; with lignite gravel
		MH			ASH (SANDY ELASTIC SILT(MH)) dark brown; moist; with sand mix and roots
5		MH		▽	ASH (ELASTIC SILT(MH)) black; wet
		ML			ASH (SANDY SILT(ML)) grayish brown; wet; with coarse-grained sand; with sand mix
		SM			SILTY SAND(SM) grayish brown; wet; with coarse-grained sand and poorly graded gravel
10					Bottom of Boring @ 10'

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	PLASTIC LIMIT	PLASTICITY INDEX
LL	PL	PI

MINUS #200 SIEVE (%)

OTHER TESTS PERFORMED (Page Ref. #)

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 are approximate

GPS Coordinates: N33.047419°, W94.843238°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-20B

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG:

PROJECT NO.: G4207-146
BORING TYPE: Hand Auger

DATE 12/12/14

SURFACE ELEVATION 359.2

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION
0		MH			ASH (ELASTIC SILT(MH)) black; wet; with organics
		SM			SILTY SAND(SM) brown; wet; with coarse-grained sand and gravel
		SM			SILTY SAND(SM) grayish brown; wet; with fine-grained sand and lignite pieces
5		MH			ASH (ELASTIC SILT(MH)) dark gray; wet; with sand mix
		ML			ASH (SANDY SILT(ML)) grayish brown; wet; with sand mix
		MH			ASH (ELASTIC SILT(MH)) grayish brown; wet; with clay mix
		MH			ASH (ELASTIC SILT(MH)) dark gray; wet
10					Bottom of Boring @ 10'

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	PLASTIC LIMIT	PLASTICITY INDEX
LL	PL	PI

MINUS #200 SIEVE (%)

OTHER TESTS PERFORMED (Page Ref. #)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 0' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates are approximate

GPS Coordinates: N33.047409°, W94.843177°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-21

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas **DRILL RIG:**

PROJECT NO.: G4207-146 **BORING TYPE:** Flight Auger

DATE 10/15/14

SURFACE ELEVATION 376.2

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)	ATTERBERG LIMITS(%) PLASTIC LIMIT (PL)	ATTERBERG LIMITS(%) PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0		SM			ASH (SILTY SAND(SM)) very loose; light brown; with lightly cemented gravel pieces; dry	N=4					36				39	+40 Sieve=13% +4 Sieve=1%
5		MH			ASH (ELASTIC SILT(MH)) very loose; grayish brown; lightly cemented; dry	N=4										
10					--with cemented seams	Tx=50/0.5" Tx=50/0.5"										
15			Eqc @ 28-30'	▽	--grayish brown; wet	N=1					132	109	93	16	89	+40 Sieve=5% +4 Sieve=0%
20		SM		▼	ASH (SILTY SAND WITH GRAVEL(SM)) very dense; grayish brown; wet	N=50/4"					52				26	+40 Sieve=63% +4 Sieve=23%
25		CL			SANDY LEAN CLAY(CL) very stiff; light gray and reddish brown; moist; mottled	N=18										
30					Bottom of Boring @ 30'											

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 17' while drilling.Water level @ 20' and caved to 24' 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: N33.04777°, W94.84538°

Driller: Lewis Drilling, Inc.

Logger: O.Sanderson

LOG OF BORING B-22

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas

DRILL RIG: B-61 HDX

PROJECT NO.: G4207-146

BORING TYPE: Rotary Wash/Flight Auger

DATE 10/7/14

SURFACE ELEVATION 376.4

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	SM	ASH (SILTY SAND(SM)) dense; light grayish brown; with coarse-grained sand and lightly cemented gravel pieces; dry	N=50/5"	35				44	+40 Sieve=40% +4 Sieve=9%
		--medium dense; dark brown with light brown	N=15						
5		--loose	N=8	29				43	+40 Sieve=32% +4 Sieve=13%
			N=5						
10									
			N=0						
15	MH	ASH (ELASTIC SILT WITH SAND(MH)) very loose; light brown and dark brown; with lean clay, fine-grained sand and lightly cemented gravel pieces; wet		103	87	76	11	80	+40 Sieve=9% +4 Sieve=1%
	SM	ASH (SILTY SAND(SM)) very loose; light grayish brown; with coarse-grained sand and lightly cemented gravel pieces; wet	N=0						
20									
			N=3	54				36	+40 Sieve=40% +4 Sieve=12%
25									
	CL	SANDY LEAN CLAY(CL) stiff; reddish brown and light gray; wet; mottled	P=1.5						
30									

GEOLOGIC UNIT: Eqc @ 28-53' & Er @ 53-60'

WATER LEVEL

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

Water Level Est.: Measured: Perched:

Water Observations: Water level @ 14'.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.048131°, W94.845329°

Driller: Tommy Cook

Logger: B.Hobbs/O.Sanderson

LOG OF BORING B-22 (cont.)

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Phase 1 Fly Ash Storage Area Embankment Seepage & Vertical Expansion Invest.
Welsh Power Station - Cason, Texas
DRILL RIG: B-61 HDX

PROJECT NO.: G4207-146
BORING TYPE: Rotary Wash/Flight Auger

DATE 10/7/14

SURFACE ELEVATION 376.4

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35		--light gray, yellowish brown and reddish brown; moist; with fine-grained sand; mottled	P=3.75					23	43	18	25	50	+40 Sieve=14% +4 Sieve=9%
	SM	SILTY SAND(SM) medium dense; light brown and yellowish brown; moist; with fine-grained sand											
		--loose; light gray and light brown; moist; with fine-grained sand	P=1.0										
40													
			N=9					27				21	+40 Sieve=1% +4 Sieve=0%
45													
		--yellowish brown; moist; with fine-grained sand	N=6										
50													
	CH	FAT CLAY(CH) stiff; dark brown, light brown and light gray; moist; mottled	P=1.5										
55													
			P=4.0										
60		Bottom of Boring @ 60'											

Eqc @ 28-53' & Er @ 53-60'

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 @ 14'.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

GPS Coordinates: N33.048131°, W94.845329°
Driller: Tommy Cook
Logger: B.Hobbs/O.Sanderson

KEY TO SOIL CLASSIFICATIONS AND SYMBOLS

UNIFIED SOIL CLASSIFICATION SYSTEM [m]

Major Divisions		Letter	Symbol	Color	Name
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW		Red	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP			Poorly-graded gravels or gravel-sand mixtures, little or no fines
		GM		Yellow	Silty gravels, gravel-sand-clay mixtures.
		GC			Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW		Red	Well-graded sands or gravelly sands, little or no fines
		SP			Poorly-graded sands or gravelly sands, little or no fines
		SM		Yellow	Silty sands, sand-silt mixtures
		SC			Clayey sands, sand-clay mixtures
FINED GRAINED SOILS	SILTS AND CLAYS LL < 50	ML		Green	Inorganic silts and very fine sands, rock flour, fine sandy silts, gravelly silts or silts with slight plasticity
		CL			Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		OL			Organic silts and organic silt-clays of low plasticity.
	SILTS AND CLAYS LL > 50	MH		Blue	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH			Inorganic clays of high plasticity, fat clays
		OH			Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS		Pt		Orange	Peat and other highly organic soils

TERMS CHARACTERIZING SOIL STRUCTURE

SLICKENSIDED-having inclined planes of weakness that are slick and glossy in appearance

FISSURED-containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical

LAMINATED (VARVED)-composed of thin layers of varying color and texture, usually grading from sand or silt at the bottom to clay at the top

CRUMBLY-cohesive soils which break into small blacks or crumbs on drying.

CALCAREOUS-containing appreciable quantities of calcium carbonate, generally nodular.

WELL GRADED-having wide range in grain sizes and substantial amounts of all inermediate particle sizes.

POORLY GRADED-predominantly of one grain size (uniformly graded) or having a range of sizes with some intermediate size missing (gap or skip graded).

SYMBOLS FOR TEST DATA

M/C = 15 - Natural moisture content in percent

δ = 95 - - Dry unit weight in lbs/cu ft.

Qu = 1.23 - Unconfined compression strength in tons/sq. ft.

Qc = 1.68 (21 psi) - Confined compression strength at indicated lateral pressure.

51-21-30 - Liquid limit, Plastic limit and Plasticity index.

30% FINER - Percent finer than No. 200 mesh sieve.

30 B/F - Blows per foot, standard penetration test.

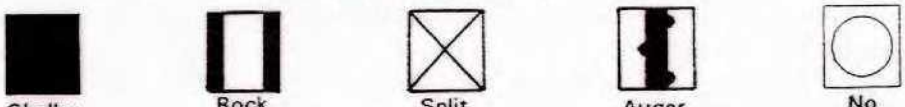
▼ - Ground water table.

TERMS DESCRIBING CONSISTENCY OF SOIL (2)

COARSE GRAINED SOILS		FINE GRAINED SOIL		
DESCRIPTIVE TERM	NO. BLOWS/FT. STANDARD PEN. TEST	DESCRIPTIVE TERMS	NO. BLOWS/FT. STANDARD PEN. TEST	UNCONFINED COMPRESSION TONS PER SQ.FT.
Very loose	0-4	Very Soft	< 2	< 0.25.
Loose	4-10	Soft	2 - 4	0.25 - 0.50
Medium Dense	10-30	Medium Stiff	4 - 8	0.50 - 1.00
Dense	30-50	Stiff	8 - 15	1.00 - 2.00
Very Dense	over 50	Very Stiff	15 - 30	2.00 - 4.00
		Hard	over 30	over 4.00

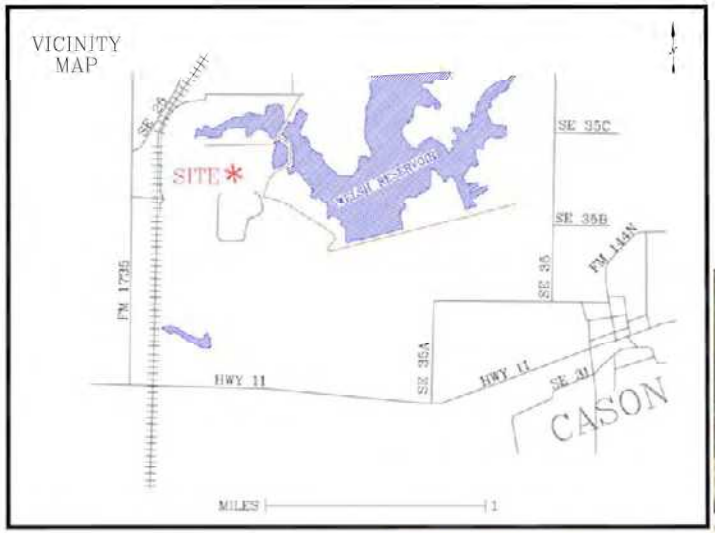
Field classification for "Consistency" is determined with a 0.25" diam. penetrometer.

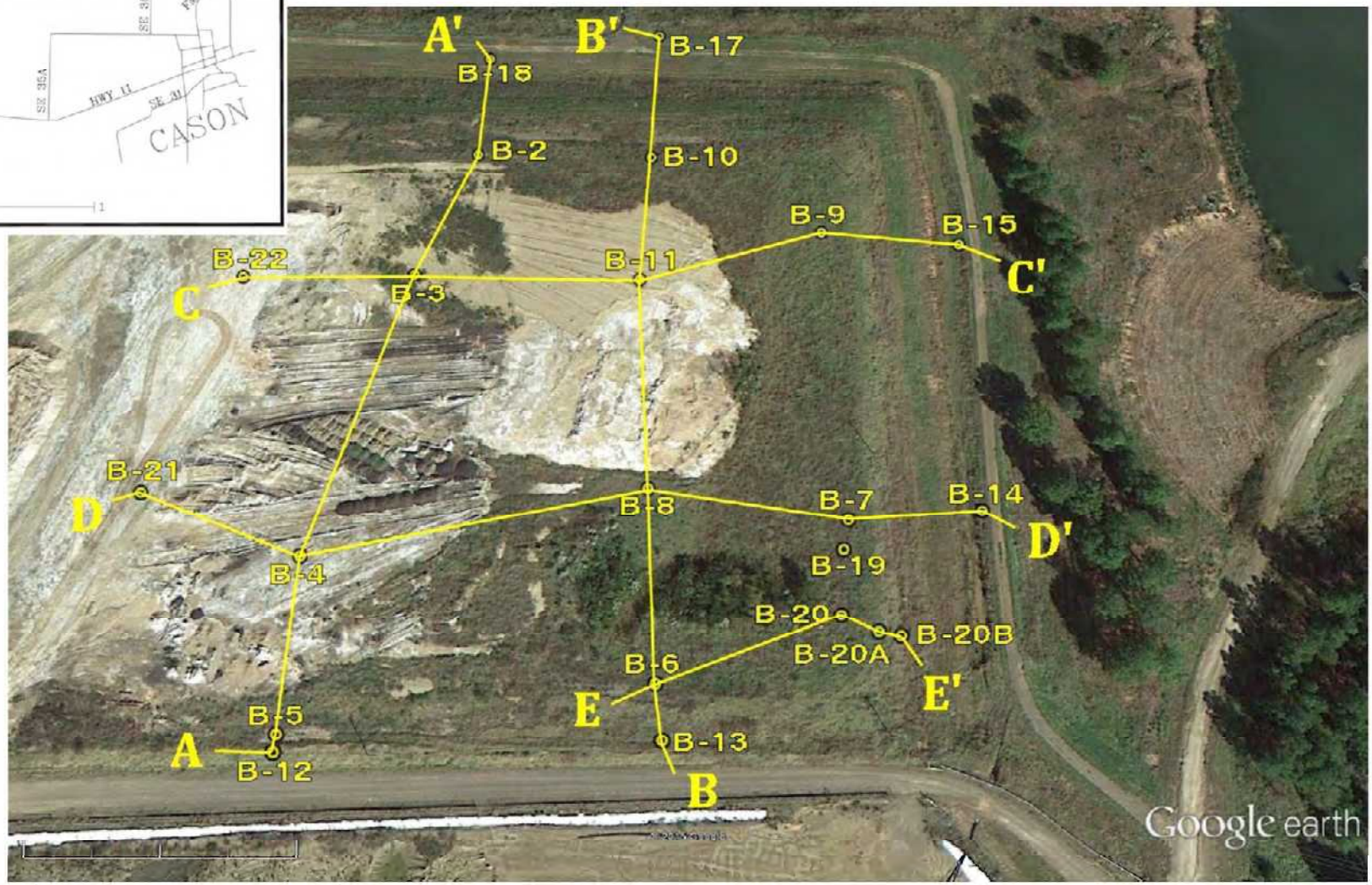
SAMPLER TYPES



Shelby Tube | Rock Core | Split Spoon | Auger | No Recovery

1 - From Waterways Experiment Station Technical Memorandum No. 3-367
2 - From "Soil Mechanics in Engineering Practice" by Terzeghi and Pock

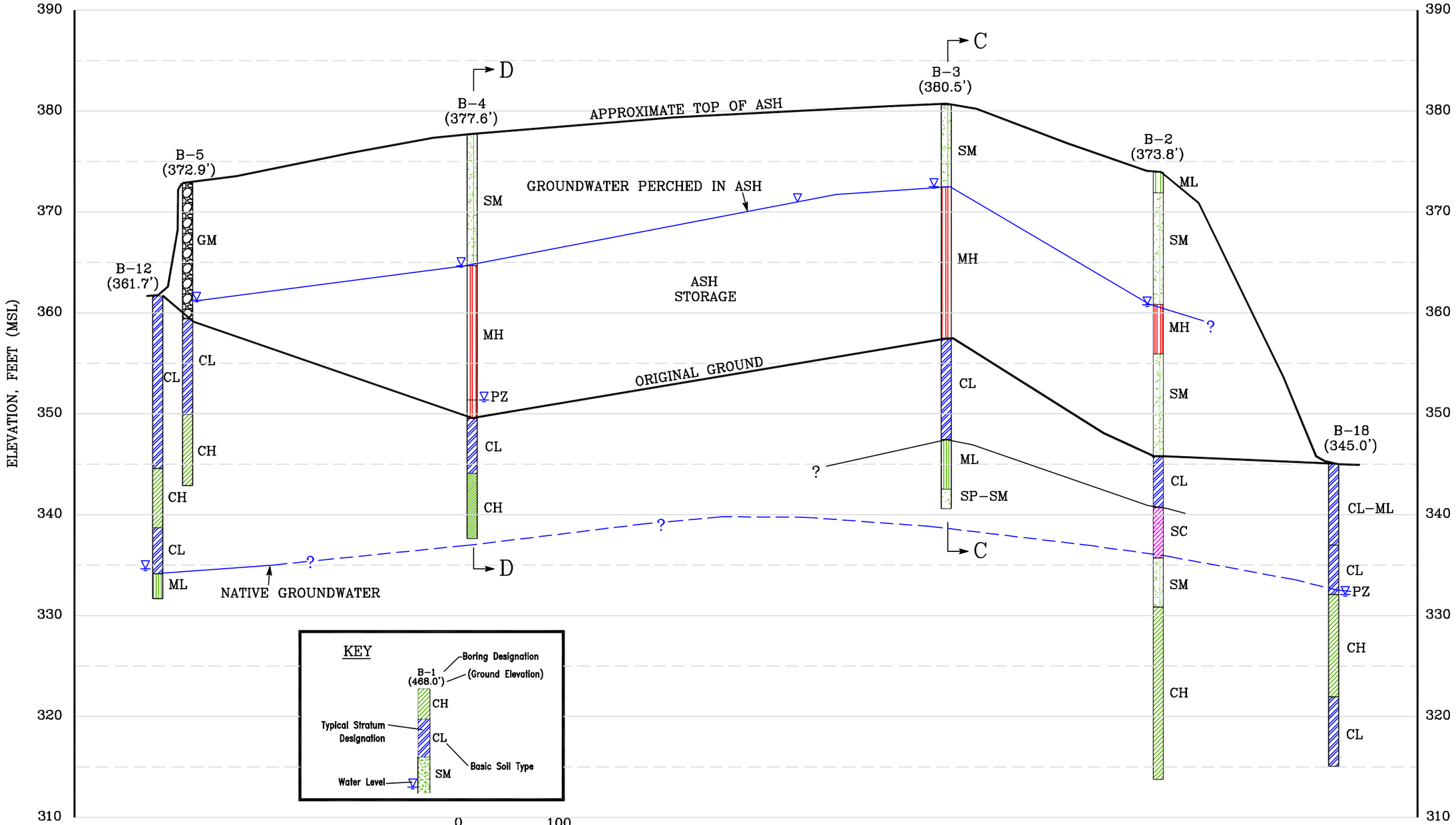




feet 600

ETTL ENGINEERS & CONSULTANTS MAIN OFFICE 1717 East Erwin Tyler, Texas 75702 (903) 595-4421	PHASE I FLY ASH STORAGE AREA EMBANKMENT SEEPAGE & VERTICAL EXPANSION INVESTIGATION WELSH POWER STATION CASON, TEXAS	KEY TO GEOLOGICAL PROFILES		APPROVED BY:
		JOB.NO.: G4207-14		DRAWN BY: A.K.B.
		DATE: NOV. 2014	SCALE: AS SHOWN	

GEOLOGIC PROFILE A–A'



KEY

HORIZONTAL SCALE = 0 50 100 FEET

VERTICAL SCALE = 0 5 10 FEET

ETTL ENGINEERS & CONSULTANTS MAIN OFFICE 1717 Edst Erwin Tyler, Texas 75702 (903) 595–4421	PHASE I FLY STORAGE AREA EMBANKMENT SEEPAGE & VERTICAL EXPANSION INVESTIGATION WELSH POWER STATION CASON, TEXAS	GEOLOGICAL PROFILE A–A' JOB No.: G4207–14 DATE: DEC. 2014 / SCALE: AS SHOWN	APPROVED BY: DRAWN BY: A.K.B.

GEOLOGIC PROFILE B–B'

B

B'

C

D

B–13 (361.4')

B–6 (370.8')

B–8 (370.0')

B–11 (376.6')

B–10 (373.2')

B–17 (344.8')

APPROXIMATE TOP OF ASH

GROUNDWATER PERCHED IN ASH

ASH STORAGE

ORIGINAL GROUND

NATIVE GROUNDWATER

ELEVATION, FEET (MSL)

380
370
360
350
340
330
320
310

KEY

Boring Designation

B–1 (488.0') (Ground Elevation)

Typical Stratum Designation

Basic Soil Type

Water Level

HORIZONTAL SCALE = 0 50 100 FEET

VERTICAL SCALE = 0 5 10 FEET

ETTL ENGINEERS & CONSULTANTS MAIN OFFICE 1717 Edst Erwin Tyler, Texas 75702 (903) 595–4421	PHASE I FLY STORAGE AREA EMBANKMENT SEEPAGE & VERTICAL EXPANSION INVESTIGATION WELSH POWER STATION CASON, TEXAS	GEOLOGICAL PROFILE B–B'		APPROVED BY:
		JOB No.: G4207–14		DRAWN BY: A.K.B.
		DATE: DEC. 2014	SCALE: AS SHOWN	

GEOLOGIC PROFILE C–C'

C

C'

ELEVATION, FEET (MSL)

390
380
370
360
350
340
330
320
310

A

B

B-22 (376.4')

B-3 (380.5')

B-11 (376.6')

B-9 (371.0')

B-15 (348.2')

APPROXIMATE TOP OF ASH

GROUNDWATER PERCHED IN ASH

ASH STORAGE

ORIGINAL GROUND

NATIVE GROUNDWATER

?

PZ

SM
MH
CL
ML
SP-SM
SC
CH

KEY

Boring Designation
B-1 (468.0') (Ground Elevation)
Typical Stratum Designation
Basic Soil Type
Water Level

HORIZONTAL SCALE = 0 50 100 FEET

VERTICAL SCALE = 0 5 10 FEET

ETTL ENGINEERS & CONSULTANTS MAIN OFFICE 1717 Edst Erwin Tyler, Texas 75702 (903) 595-4421	PHASE I FLY STORAGE AREA EMBANKMENT SEEPAGE & VERTICAL EXPANSION INVESTIGATION WELSH POWER STATION CASON, TEXAS	GEOLOGICAL PROFILE C–C'		APPROVED BY:
		JOB No.: G4207-14		DRAWN BY: A.K.B.
		DATE: DEC. 2014	SCALE: AS SHOWN	

GEOLOGIC PROFILE D–D'

D

D'

A

A

B

B

B–21
(376.2')

B–4
(377.6')

B–8
(370.0')

B–7
(368.8')

B–14
(347.2')

APPROXIMATE TOP OF ASH

GROUNDWATER PERCHED IN ASH

ASH
STORAGE

ORIGINAL GROUND

NATIVE GROUNDWATER

SM

MH

SM

CL

SM

MH

PZ

CL

CH

CL

PZ

ML

SP–SM

MH

ML

PZ

CL

SM

CH

CL

ML

CL

SP–SM

CL

?

?

?

?

?

?

?

ELEVATION, FEET (MSL)

380
370
360
350
340
330
320
310
300

KEY

Boring Designation

B–1
(466.0')

(Ground Elevation)

CH

Typical Stratum Designation

CL

Basic Soil Type

SM

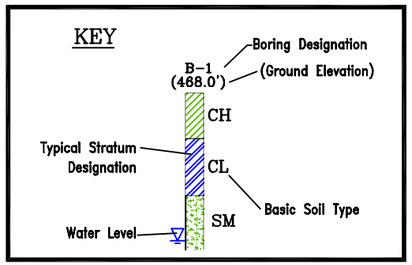
Water Level

HORIZONTAL SCALE = 0 50 100 FEET

VERTICAL SCALE = 0 5 10 FEET

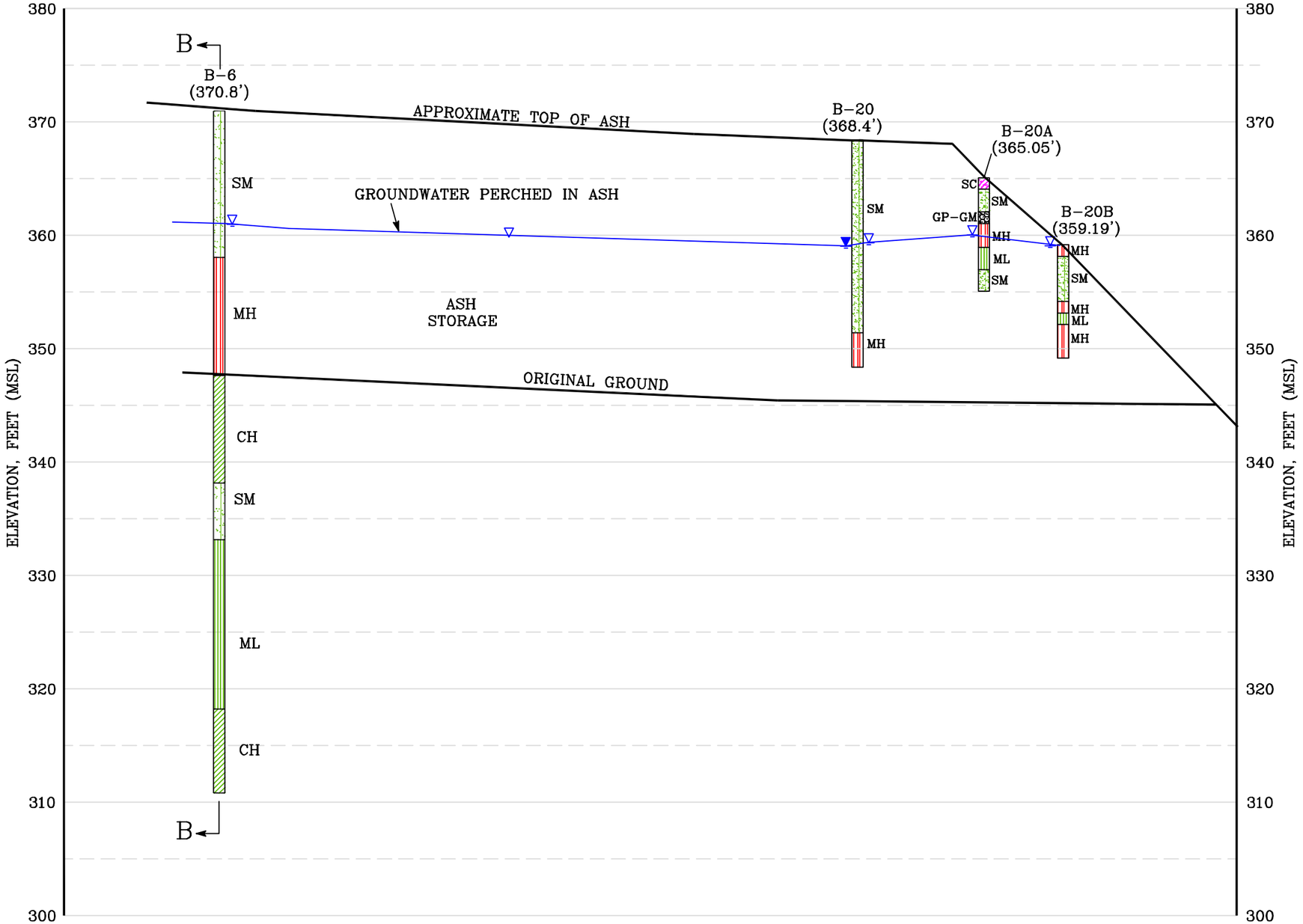
ETTL ENGINEERS & CONSULTANTS MAIN OFFICE 1717 Edst Erwin Tyler, Texas 75702 (903) 595–4421	PHASE I FLY STORAGE AREA EMBANKMENT SEEPAGE & VERTICAL EXPANSION INVESTIGATION WELSH POWER STATION CASON, TEXAS	GEOLOGICAL PROFILE D–D'		APPROVED BY:
		JOB No.: G4207–14		DRAWN BY: A.K.B.
		DATE: DEC. 2014	SCALE: AS SHOWN	

GEOLOGIC PROFILE E–E'

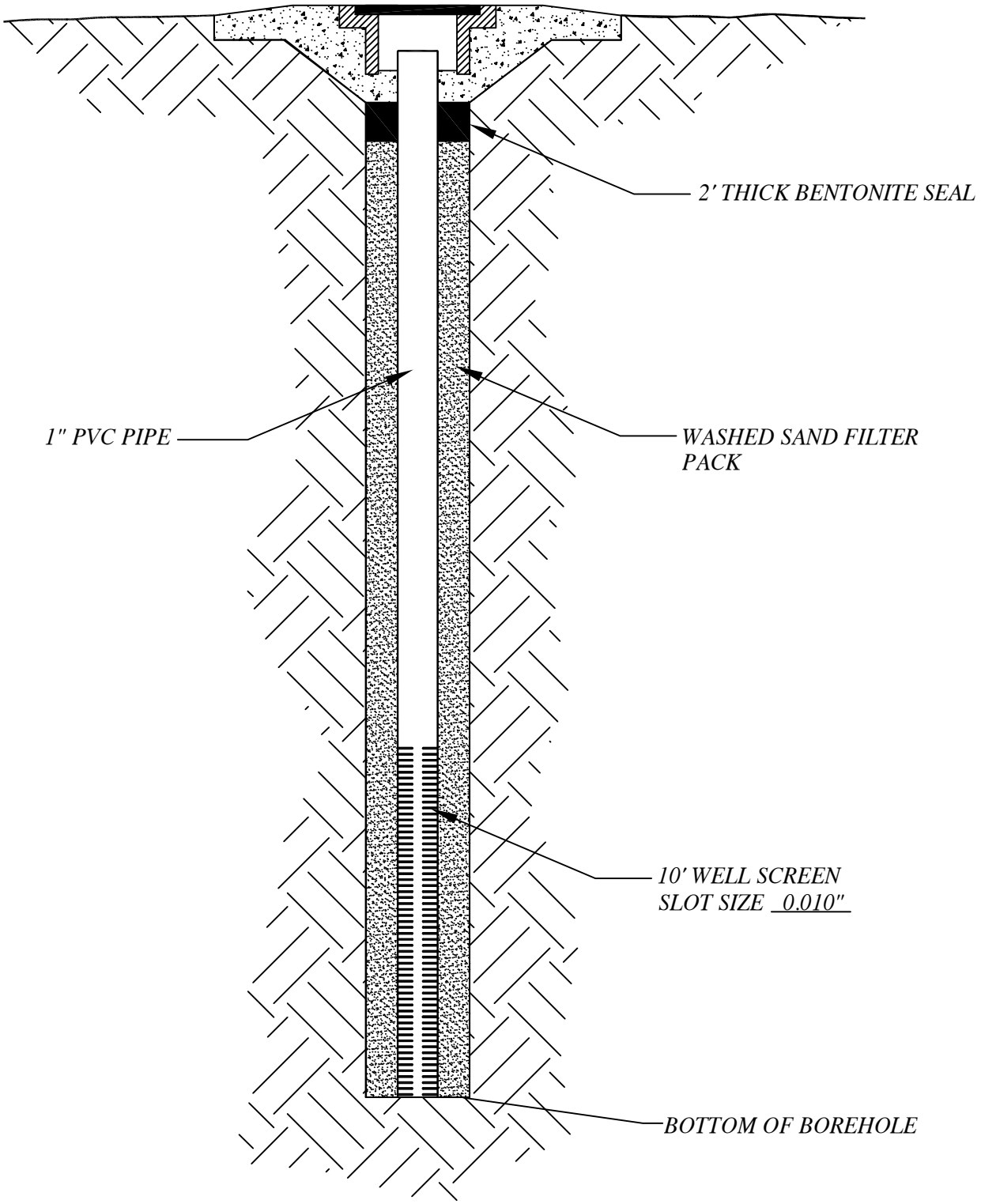








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		JOB No.: G4207–14		DRAWN BY: A.K.B.
		DATE: DEC. 2014	SCALE: AS SHOWN	



ETTL ENGINEERS & CONSULTANTS
MAIN OFFICE
1717 East Erwin Tyler, Texas 75702
Phone: (903) 595-4421
Texas Registered Engineering Firm #F3208

WHITEHOUSE LAKE DAM
(LAKE TYLER)
TX00245

TYPICAL OPEN STANDPIPE PIEZOMETER (OSP) DETAIL

JOB No.: G3763-12

DATE: NOV. 2012

SCALE: N.T.S.

APPROVED BY:

DRAWN BY: K.C.R

APPENDIX B – Laboratory Testing

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

LABORATORY INDEX TEST DATA SUMMARY SHEET

PROJECT: Phase 1 Ash Storage Embankment Investigaiton
JOB NUMBER: G 4207-14
LOCATION: Welsh Power Plant: Cason, Texas
CLEINT: AEP, Welsh Power Plant
PROJECT MANAGER: Steve Richards

Boring No.	Depth (ft.)	Soil Class	Description of Sample	USCS Classification	Atterberg Limits			Moisture Content (%)	Minus #200 Sieve (%)	+ # 40 Sieve (%)	+ # 4 Sieve (%)	Compression Tests					Swell Tests				Sample No.
					LL	PL	PI					Dry Density (pcf)	Moisture Content (%)	Compressive Strength (tsf)	Failure Strain (%)	Confining Pressure (psi)	Moisture Content Before Test (%)	Moisture Content, After Test(%)	Free Swell (%)	Restraining Pressure (psf)	
B-1	1-3	SM		Silty sand	0	0	0	34.5	43.7	39.9	8.7										
B-1	5-7	SM		Silty sand	0	0	0	29.2	43.1	31.5	12.7										
B-1	13-15	MH		Elastic Silt with Sand	87	76	11	102.8	80.0	8.5	1.3										
B-1	23-25	SM		Silty sand	0	0	0	54.1	35.8	39.8	12.1										
B-1	33-35	CL		Sandy Lean Clay	43	18	25	22.9	50.1	13.5	9.1										
B-1	43-45	SM		Silty sand	0	0	0	26.6	20.9	0.6	0.0										
B-2	1-3	ML		Sandy Silt with Gravel	0	0	0	46.2	58.6	27.1	15.7										
B-2	8-10	SM		Silty sand	0	0	0	39.8	40.3	18.8	1.6										
B-2	13-15	MH		Elastic Silt	134	92	42	199.6	99.7	0.0	0.0										
B-2	23-25	ML		Sandy Silt	0	0	0	91.3	60.5	11.3	1.3										
B-2	28-30	CL		Sandy Lean Clay	30	15	15	17.8	62.9	0.7	0.0										
B-2	33-35	SC		Clayey sand	30	15	15	17.9	38.8	0.3	0.0										
B-2	38-40	SM		Silty sand	0	0	0	21.2	23.6	0.1	0.0										
B-2	43-45	CH		Fat Clay	62	26	36	25.4	96.2	1.7	0.0										
B-4	13-15	MH		Elastic Silt with Sand	81	76	5	106.4	82.1	9.6	0.7										
B-4	23-25	MH		Gravelly Elastic Silt	113	92	21	100.1	65.6	30.3	25.0										
B-4	28-30	CL		Lean Clay	44	22	22	27.4	95.1	0.6	0.0										
B-4	33-35	CH		Fat Clay	64	28	36	25.1	98.6	0.2	0.0										

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

LABORATORY INDEX TEST DATA SUMMARY SHEET

PROJECT: Phase 1 Ash Storage Embankment Investigaiton
JOB NUMBER: G 4207-14
LOCATION: Welsh Power Plant: Cason, Texas
CLEINT: AEP, Welsh Power Plant
PROJECT MANAGER: Steve Richards

Boring No.	Depth (ft.)	Soil Class	Description of Sample	USCS Classification	Atterberg Limits			Moisture Content (%)	Minus #200 Sieve (%)	+ # 40 Sieve (%)	+ # 4 Sieve (%)	Compression Tests					Swell Tests				Sample No.
					LL	PL	PI					Dry Density (pcf)	Moisture Content (%)	Compressive Strength (tsf)	Failure Strain (%)	Confining Pressure (psi)	Moisture Content Before Test (%)	Moisture Content, After Test(%)	Free Swell (%)	Restraining Pressure (psf)	
B-3	8-10	MH		Sandy Elastic Silt	61	57	4	73.4	69.7	8.6	0.6										
B-3	18-20	MH		Elastic Silt	104	99	5	135.1	91.3	1.5	0.0										
B-3	33-35	ML		Silt	29	26	3	26.8	87.4	0.0	0.0										
B-8	3-5	MH		Sandy Elastic Silt	50	46	4	46.0	60.1	18.9	3.8										
B-8	13-15	MH		Sandy Elastic Silt	55	53	2	69.6	67.6	9.6	1.4										
B-8	23-25	CL		Sandy Lean Clay	28	16	12	20.6	63.2	6.0	3.8										
B-11	8-10	MH		Sandy Elastic Silt	57	52	5	66.6	66.0	9.8	0.5										
B-11	13-15	SM		Silty sand	0	0	0	57.3	22.0	42.6	1.4										
B-11	23-25	SM		Silty sand	0	0	0	45.1	28.0	57.6	13.1										
B-11	33-35	CL		Sandy Lean Clay	27	16	11	17.8	54.2	1.6	0.1										
B-12	7-9	CL		Sandy Lean Clay	33	19	14	15.7	58.3	0.9	0.4										
B-12	22-44	CL		Lean Clay	39	19	20	23.5	93.3	0.7	0.0										

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

LABORATORY INDEX TEST DATA SUMMARY SHEET

PROJECT: Phase 1 Ash Storage Embankment Investigaiton
JOB NUMBER: G 4207-14
LOCATION: Welsh Power Plant: Cason, Texas
CLEINT: AEP, Welsh Power Plant
PROJECT MANAGER: Steve Richards

Boring No.	Depth (ft.)	Soil Class	Description of Sample	USCS Classification	Atterberg Limits			Moisture Content (%)	Minus #200 Sieve (%)	+ # 40 Sieve (%)	+ # 4 Sieve (%)	Compression Tests					Swell Tests				Sample No.
					LL	PL	PI					Dry Density (pcf)	Moisture Content (%)	Compressive Strength (tsf)	Failure Strain (%)	Confining Pressure (psi)	Moisture Content Before Test (%)	Moisture Content, After Test(%)	Free Swell (%)	Restraining Pressure (psf)	
B-5	3-5	GM		Silty gravel with sand	0	0	0	45.3	27.9	56.1	43.1										
B-5	13-15	CL		Sandy Lean Clay with Gravel	26	17	9	41.3	53.6	23.2	22.0										
B-5	23-25	CH		Fat Clay with Sand	60	22	38	25.8	78.0	0.2	0.0										
B-6	8-10	SM		Silty sand	0	0	0	57.5	39.1	17.1	3.3										
B-6	18-20	MH		Elastic Silt	96	92	4	128.9	96.1	0.5	0.0										
B-6	28-30	CH		Fat Clay with Sand	54	18	36	28.6	72.0	9.7	4.6										
B-6	33-55	SM		Silty sand	25	22	3	25.9	24.9	2.9	0.4										
B-6	38-40	ML		Sandy Silt	0	0	0	25.8	56.3	0.0	0.0										
B-6	48-50	ML		Silt with Sand	0	0	0	25.2	76.4	0.0	0.0										
B-6	53-55	CH		Fat Clay	72	24	48	27.5	94.6	0.1	0.0										
B-7	3-5	ML		Sandy Silt	0	0	0	20.0	52.9	10.4	5.3										
B-7	13-15	SM		Silty sand	0	0	0	97.1	39.7	9.1	2.1										
B-7	33-35	CL		Sandy Lean Clay	43	17	26	25.9	67.6	0.4	0.0										
B-7	38-40	SM		Silty sand	0	0	0	28.3	37.7	0.3	0.0										
B-7	43-45	CH		Fat Clay	62	20	42	26.1	91.5	0.9	0.0										

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GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

LABORATORY INDEX TEST DATA SUMMARY SHEET

PROJECT: Phase 1 Ash Storage Embankment Investigaiton
JOB NUMBER: G 4207-14
LOCATION: Welsh Power Plant: Cason, Texas
CLEINT: AEP, Welsh Power Plant
PROJECT MANAGER: Steve Richards

Boring No.	Depth (ft.)	Soil Class	Description of Sample	USCS Classification	Atterberg Limits			Moisture Content (%)	Minus #200 Sieve (%)	+ # 40 Sieve (%)	+ # 4 Sieve (%)	Compression Tests					Swell Tests				Sample No.
					LL	PL	PI					Dry Density (pcf)	Moisture Content (%)	Compressive Strength (tsf)	Failure Strain (%)	Confining Pressure (psi)	Moisture Content Before Test (%)	Moisture Content, After Test(%)	Free Swell (%)	Restraining Pressure (psf)	
B-9	3-5	SM		Silty sand	0	0	0	21.7	43.5	11.5	1.3										
B-9	8-10	MH		Sandy Elastic Silt	61	61	0	90.2	62.4	2.5	0.0										
B-9	23-25	GP		Poorly graded gravel with sand	0	0	0	36.0	1.3	97.3	56.1										
B-9	28-30	CH		Fat Clay with Sand	70	20	50	26.0	83.1	1.3	0.4										
B-9	38-40	SM		Silty sand	0	0	0	26.3	45.5	0.0	0.0										
B-9	48-50	CH		Fat Clay	54	19	35	19.0	98.0	0.2	0.0										
B-10	3-5	SC		Clayey sand	31	19	12	24.3	40.5	21.1	11.4										
B-10	18-20	SM		Silty sand with gravel	0	0	0	56.4	13.7	71.0	28.2										
B-10	28-30	CL		Sandy Lean Clay	23	14	9	19.4	57.4	0.9	0.3										
B-10	38-40	SC		Clayey sand	25	17	8	22.1	27.3	2.5	0.3										
B-10	43-45	CH		Fat Clay	64	24	40	25.0	89.6	6.9	0.0										

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

LABORATORY INDEX TEST DATA SUMMARY SHEET

PROJECT: Phase 1 Ash Storage Embankment Investigaiton
JOB NUMBER: G 4207-14
LOCATION: Welsh Power Plant: Cason, Texas
CLEINT: AEP, Welsh Power Plant
PROJECT MANAGER: Steve Richards

Boring No.	Depth (ft.)	Soil Class	Description of Sample	USCS Classification	Atterberg Limits			Moisture Content (%)	Minus #200 Sieve (%)	+ # 40 Sieve (%)	+ # 4 Sieve (%)	Compression Tests					Swell Tests				Sample No.
					LL	PL	PI					Dry Density (pcf)	Moisture Content (%)	Compressive Strength (tsf)	Failure Strain (%)	Confining Pressure (psi)	Moisture Content Before Test (%)	Moisture Content, After Test(%)	Free Swell (%)	Restraining Pressure (psf)	
B-13	3-5	CL		Lean Clay with Sand	45	17	28	19.8	75.9	0.8	0.0										
B-13	17-19	CH		Fat Clay with Sand	54	20	34	21.6	79.1	0.8	0.0										
B-13	27-29	ML		Silt with Sand	0	0	0	24.2	79.5	0.2	0.0										
B-14	8-10	ML		Sandy Silt	17	17	0	108.3	67.5	1.3	1.3										
B-14	18-20	CL		Sandy Lean Clay	40	16	24	25.7	67.1	0.5	0.0										
B-14	23-25	SP-SM		Poorly graded sand with silt	0	0	0	25.1	10.2	0.0	0.0										
B-15	8-10	CH		Fat Clay	59	21	38	23.7	85.3	0.4	0.0										
B-15	13-15	SM		Silty sand	0	0	0	7.1	12.4	0.0	0.0										
B-15	28-30	CL		Lean Clay	45	22	23	25.3	92.2	0.3	0.0										
B-17	3-5	CL		Sandy Lean Clay	27	15	12	12.9	59.8	1.0	0.0										
B-17	18-20	CH		Fat Clay	56	22	34	23.4	86.9	9.3	1.5										
B-18	3-5	CL-ML		Sandy Silty Clay	23	17	6	10.4	51.4	0.9	0.3										
B-18	13-15	CH		Fat Clay	55	20	35	28.0	94.8	2.8	0.5										
B-19	3-5	SM		Silty sand	0	0	0	31.7	28.1	33.1	9.3										
B-19	13-15	ML		Sandy Silt	0	0	0	92.0	61.8	4.5	0.2										
B-20	3-5	SM		Silty sand	0	0	0	26.0	33.1	31.5	12.7										
B-20	13-15	SM		Silty sand	0	0	0	91.8	49.9	6.7	0.3										
B-21	3-5	SM		Silty sand	0	0	0	36.4	38.7	13.3	0.8										
B-21	18-20	MH		Elastic Silt	109	93	16	132.0	89.1	5.0	0.0										
B-21	23-25	SM		Silty sand with gravel	0	0	0	52.3	26.4	63.2	23.3										

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GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

LABORATORY INDEX TEST DATA SUMMARY SHEET, COMPOSITE SAMPLES USED IN STRENGHT TESTING

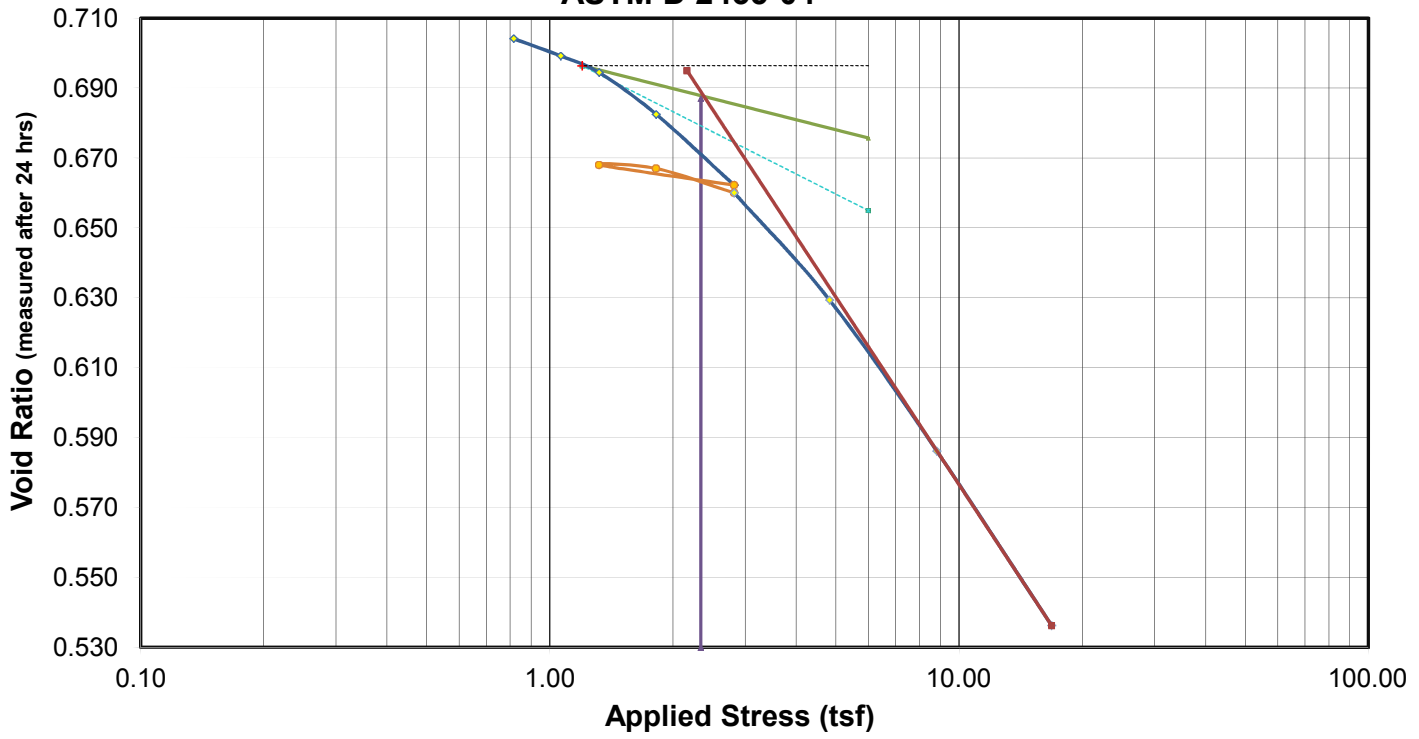
PROJECT: Phase 1 Ash Storage Embankment Investigaiton
JOB NUMBER: G 4207-14
LOCATION: Welsh Power Plant: Cason, Texas
CLEINT: AEP, Welsh Power Plant
PROJECT MANAGER: Steve Richards

Boring No.	Depth (ft.)	Soil Class	Description of Sample	USCS Classification	Atterberg Limits			Moisture Content (%)	Minus #200 Sieve (%)	+ # 40 Sieve (%)	+ # 4 Sieve (%)	Compression Tests					Swell Tests				Sample No.
					LL	PL	PI					Dry Density (pcf)	Moisture Content (%)	Compressive Strength (tsf)	Failure Strain (%)	Confining Pressure (psi)	Moisture Content Before Test (%)	Moisture Content, After Test(%)	Free Swell (%)	Restraining Pressure (psf)	
Dam Embankment	Sandy CL	CL		Sandy Lean Clay	29	18	11	12.1	62.6	0.6	0.0										#1
Dam Embankment	Fat Clay	CH		Fat Clay with Sand	62	20	42	22.0	78.0	1.9	0.0										#2
Dark Gray Ash	CU	MH		Elastic Silt	97	87	10	0.0	89.2	0.0	0.0										
Black Ash	DS/Consol.	MH		Elastic Silt	100	81	19		100.0												
B-11	18-20	MH		Elastic Silt	124	107	17		97.4												

One-Dimensional Consolidation

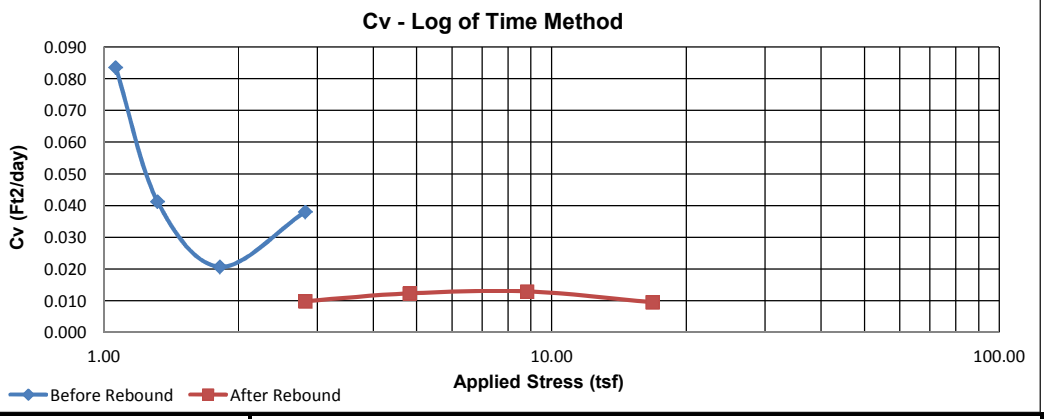
Consolidation Test Report

ASTM D 2435-04



C_c	e_o	C_r (0.82sf - 1.06tsf)	Preconsolidation Pressure (tsf)	C_r (rebound)
0.178	0.706	0.043	2.34	0.018

Applied Load (tsf)	Void Ratio (e)	Cv (ft^2/day)
0.00	0.706	-
0.82	0.704	-
1.06	0.699	0.084
1.32	0.694	0.041
1.82	0.682	0.021
2.82	0.662	0.038
1.32	0.668	0.027
1.82	0.667	Not Cal.
2.82	0.660	0.010
4.82	0.629	0.012
8.82	0.586	0.013
16.81	0.536	0.010
Estimated OCR		
1.1		



Sample and Test Data

Boring:	B-2	Depth:	48'-50'	
Material Description:		Dark Brown Fat with Light Gray Clay, (CH)		
LL	PL	PI	-200%	Assumed S.G.
N/T	N/T	N/T	N/T	2.680
Initial MC	Final MC	Initial Dry Unit Weight (lb/ft^3):		97.9
23.5%	21.6%	Final Dry Unit Weight (lb/ft^3):		108.7
Initial Sat. %	Final Sat. %	Test method:		B
89.3%	100.0%	Condition:		Inundated
Initial e	Final e	Consolidometer		
0.706	0.536	Soil Test		G 268
Molding:	Trimmed undisturbed Shelby tube sample			

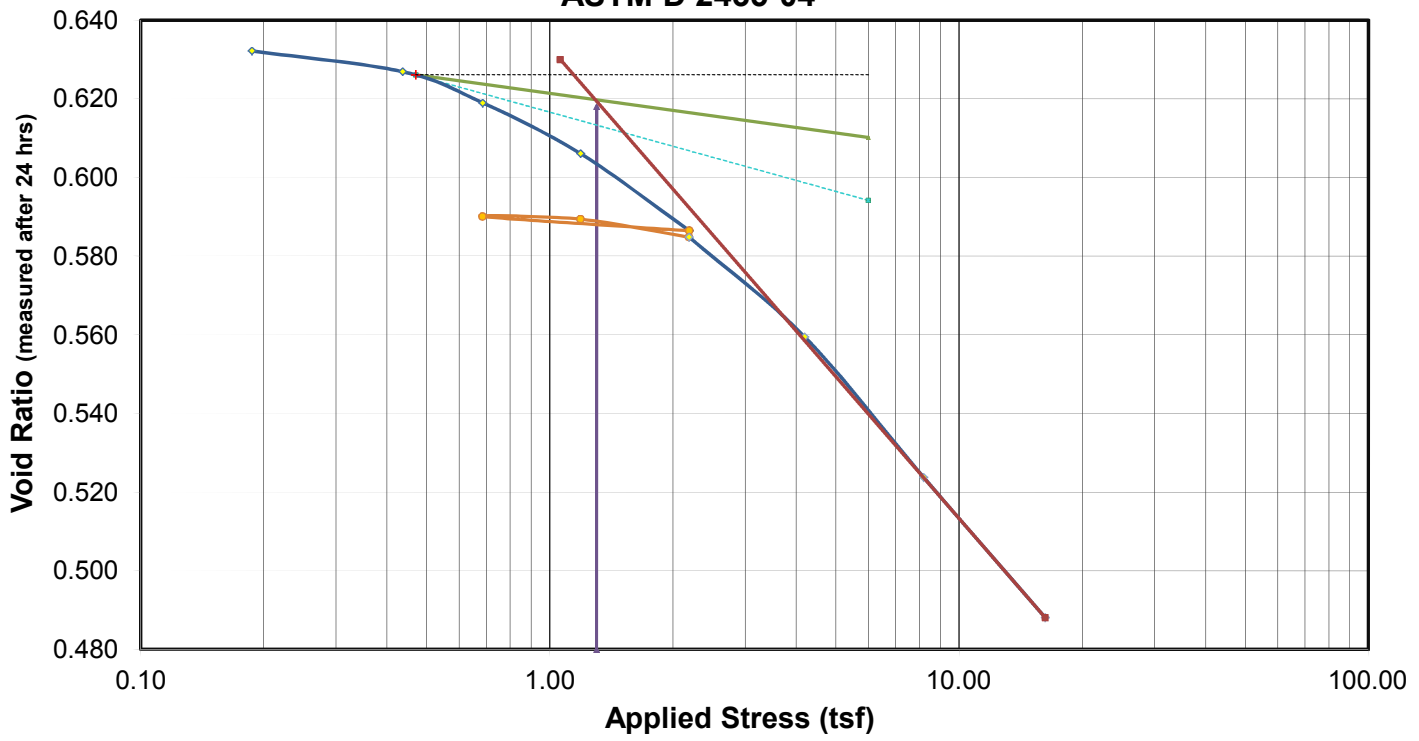
Project Information

Project:	Phase 1 Ash Stroage Embankment Investigation		
Location:	Cason,Texas		
Job Number:	G 4207-14		
Client:	AEP, Welsh power Plant		
Technician:	Owen Sanderson	Date:	1-Dec-14

Main Office: 1717 East Erwin Street Tyler, Texas 75702 Phone: 903-595-4421 Fax: 903-595-6113
Longview Branch: 707 West Cotton Street Longview, TX 75604-5505 Phone: 903-758-0915 Fax: 903-758-8245
Texarkana Branch: 210 Beech Street Texarkana, Arkansas 71854 Phone: 870-772-0013 Fax: 870-216-2413
Arlington Branch: 2000 E. Randol Mill Rd. Suite 613 Arlington, TX 76011 Phone: 817-962-0048 Fax: 817-962-0025

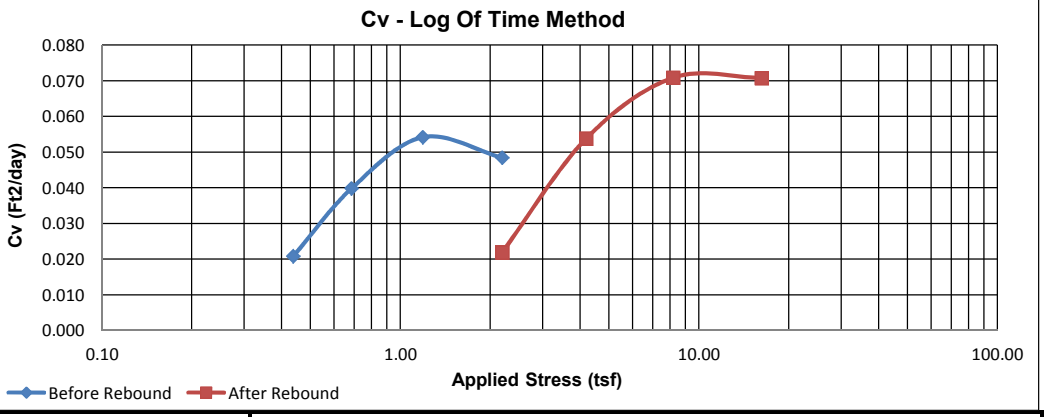
Consolidation Test Report

ASTM D 2435-04



C_c	e_o	C_r (0.19tsf - 0.44tsf)	Preconsolidation Pressure (tsf)	C_r (rebound)
0.120	0.637	0.014	1.30	0.007

Applied Load (tsf)	Void Ratio (e)	Cv (ft^2/day)
0.00	0.637	-
0.19	0.632	-
0.44	0.627	0.021
0.69	0.619	0.040
1.19	0.606	0.054
2.19	0.586	0.048
0.69	0.590	0.036
1.19	0.589	Not Cal.
2.19	0.585	0.022
4.19	0.559	0.054
8.19	0.524	0.071
16.21	0.488	0.071
Estimated OCR		
0.9		



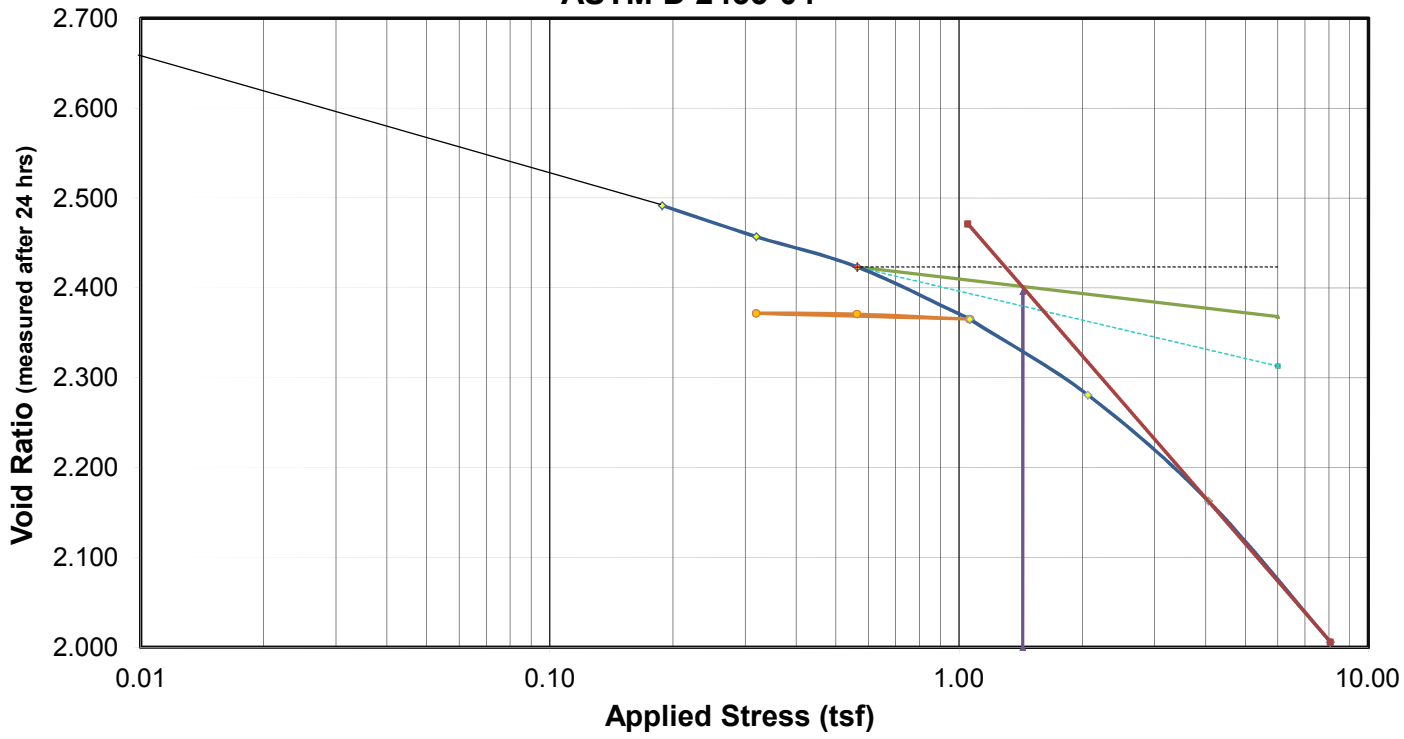
Sample and Test Data				
Boring:	B-9	Depth:	28'-30'	
Material Description:	Reddish Brown & Light Gray Fat Clay with sand, (CH)			
LL	PL	PI	-200%	Assumed S.G.
70	20	50	83.1	2.680
Initial MC	Final MC	Initial Dry Unit Weight (lb/ft^3):		102.0
23.0%	18.6%	Final Dry Unit Weight (lb/ft^3):		112.2
Initial Sat. %	Final Sat. %	Test method:		B
96.8%	100.0%	Condition:		Inundated
Initial e	Final e	Consolidometer		
0.637	0.488	Soil Test		G 270
Molding:	Trimmed undisturbed Shelby tube sample			

Project Information			
Project:	Phase 1 Ash Stroage Embankment Investigation		
Location:	Carson,Texas		
Job Number:	G 4207-14		
Client:	AEP, Welsh power Plant		
Technician:	Owen Sanderson	Date:	1-Dec-14

Main Office: 1717 East Erwin Street Tyler, Texas 75702 Phone: 903-595-4421 Fax: 903-595-6113
Longview Branch: 707 West Cotton Street Longview, TX 75604-5505 Phone: 903-758-0915 Fax: 903-758-8245
Texarkana Branch: 210 Beech Street Texarkana, Arkansas 71854 Phone: 870-772-0013 Fax: 870-216-2413
Arlington Branch: 2000 E. Randol Mill Rd. Suite 613 Arlington, TX 76011 Phone: 817-962-0048 Fax: 817-962-0025

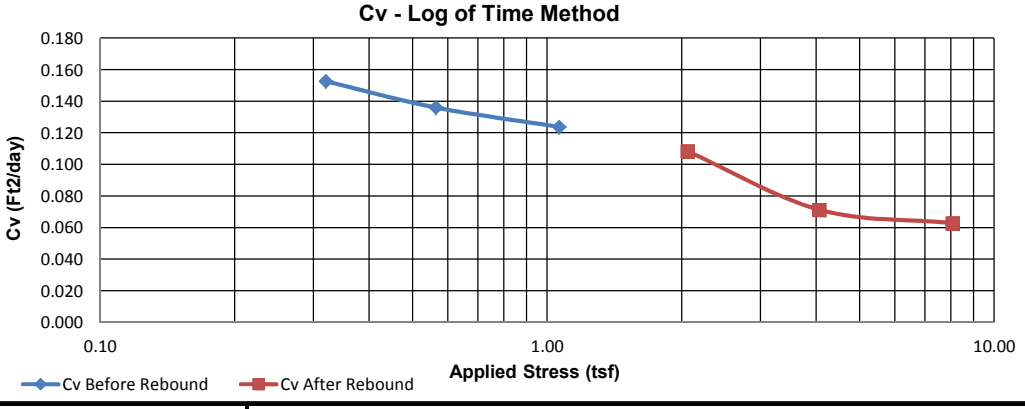
Consolidation Test Report

ASTM D 2435-04



C_c	e_o	C_r (0.063sf - 0.188tsf)	Preconsolidation Pressure (tsf)	C_r (rebound)
0.526	2.512	0.151	1.43	0.012

Applied Load (tsf)	Void Ratio (e)	Cv (ft^2/day)
0.010	2.512	-
0.063	2.497	-
0.188	2.492	Not Cal.
0.320	2.457	0.153
0.564	2.423	0.136
1.06	2.365	0.124
0.32	2.372	Not Cal.
0.56	2.371	Not Cal.
1.06	2.365	Not Cal.
2.06	2.281	0.108
4.06	2.163	0.071
8.07	2.006	0.063
Estimated OCR		
2.1		



Sample and Test Data

Boring:	B-6	Depth:	13'-20'	
Material Description:				
LL	PL	PI	-200%	Measured S.G.
100	81	19	100	2.320
Initial MC	Final MC	Initial Dry Unit Weight (lb/ft^3):		41.2
110.9%	89.4%	Final Dry Unit Weight (lb/ft^3):		48.1
Initial Sat. %	Final Sat. %	Test method:		B
100%	100%	Condition:		Inundated
Initial e	Final e	Consolidometer		
2.512	2.006	Soil Test		G 264

Project Information

Project:	Phase 1 Ash Stroage Embankment Investigation		
Location:	Cason,Texas		
Job Number:	G 4207-14		
Client:	AEP, Welsh power Plant		
Technician:	Owen Sanderson	Date:	1-Dec-14

Notes;

Sample pre-consolidated to a normal load of 9.5 psi = 0.684 tsf. Sample disturbance during placement in the cutting ring.

Main Office: 1717 East Erwin Street Tyler, Texas 75702 Phone: 903-595-4421 Fax: 903-595-6113

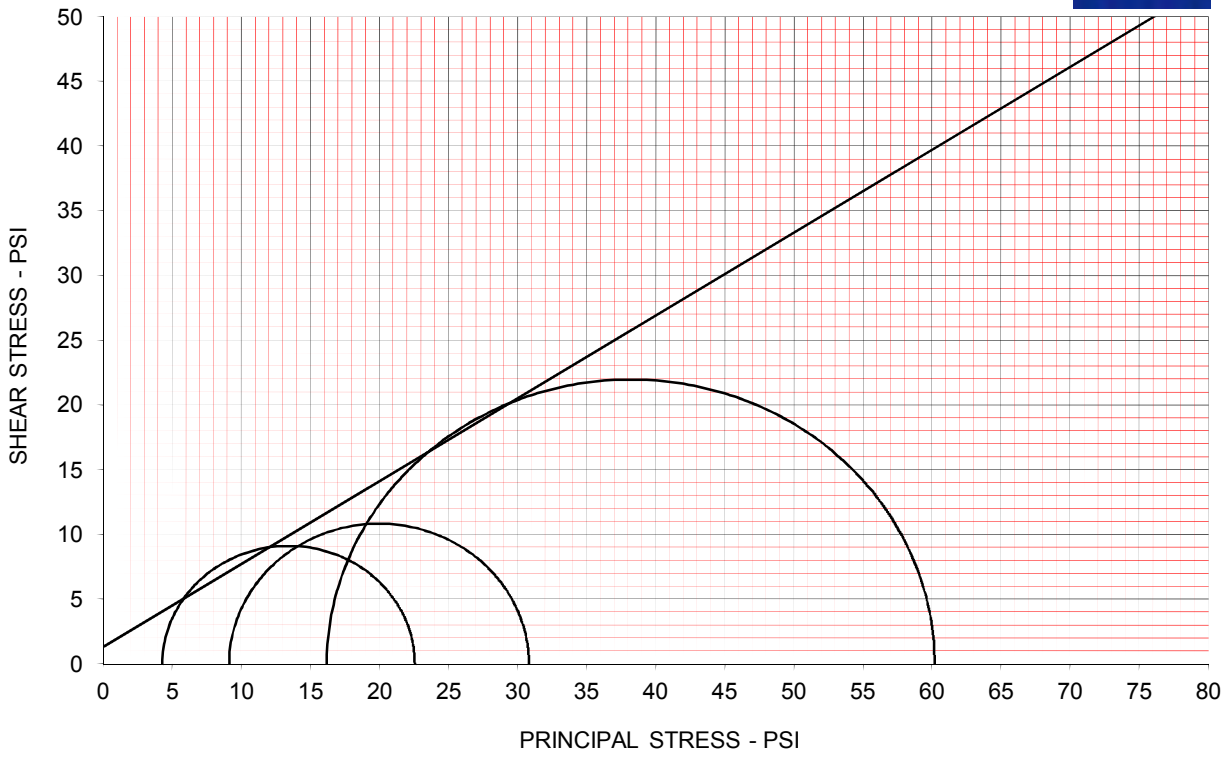
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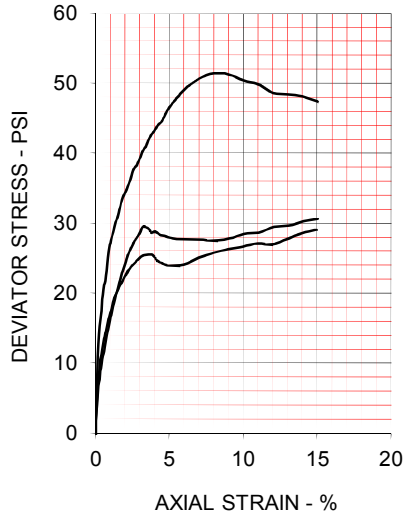
Consolidated Undrained Triaxial Compression

ASTM D4767 - CU TRIAXIAL SHEAR TEST REPORT



GREGORY GEOTECHNICAL SOFTWARE

EFFECTIVE STRESS PARAMETERS	ϕ ' = 32.6 deg	c' = 1.3 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	22.8	24.4	26.5	
Dry Density - pcf	103.4	97.6	97.7	
Diameter - inches	1.43	1.44	1.45	
Height - inches	3.18	3.26	3.18	
AT TEST				
Final Moisture - %	24.2	26.7	25.7	
Dry Density - pcf	104.5	100.1	102.6	
Calculated Diameter (in.)	1.43	1.42	1.43	
Height - inches	3.17	3.22	3.10	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	18.26	21.69	43.98	
Total Pore Pressure - psi	65.7	70.9	83.8	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.2	1.8	4.2	
σ_1' Failure - psi	22.53	30.79	60.15	
σ_3' Failure - psi	4.27	9.10	16.17	

TEST DESCRIPTION

TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: Undistrubed Shelby Tube, Trimmed
DESCRIPTION: Light Gray & Redd. Brown Fat Clay, (CH)
SAMPLE LOCATION: B-5 28'-30'
ASSUMED SPECIFIC GRAVITY: 2.67
LL: 58 PI: 38 %-200: 85.8 % Clay Fraction: 42.4
REMARKS: Calculated at peak Pore Pressure

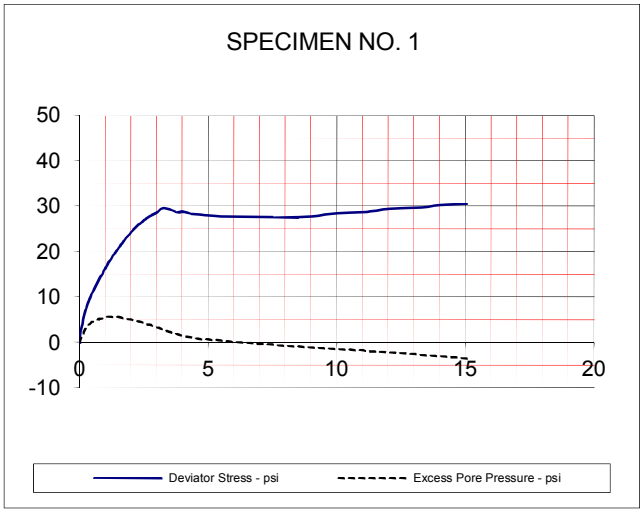
PROJECT INFORMATION

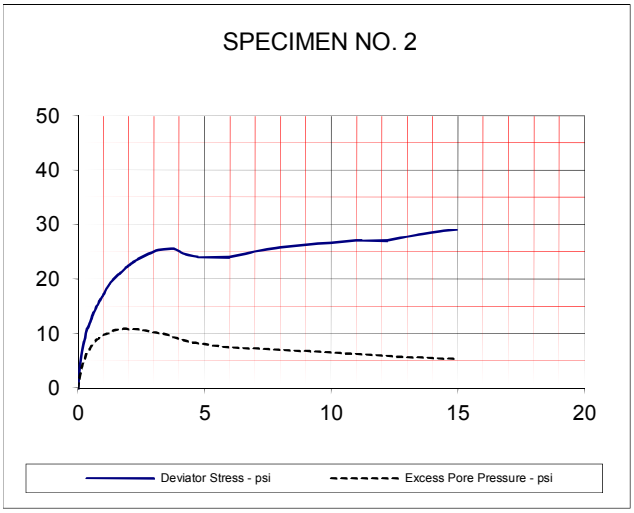
PROJECT:Phase1 Ash Strorage Area Embankment Investigation
LOCATION: Cason, Texas
PROJECT NO: G 4207-146
CLIENT: AEP, Welsh Power Plant
DATE: 12/4/12

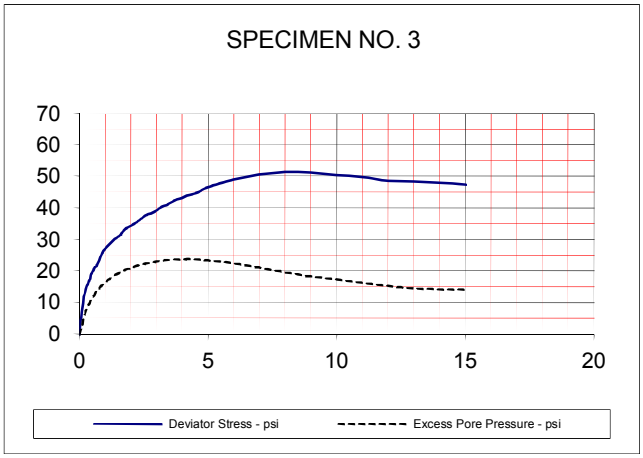
ETTL Engineers & Consultants

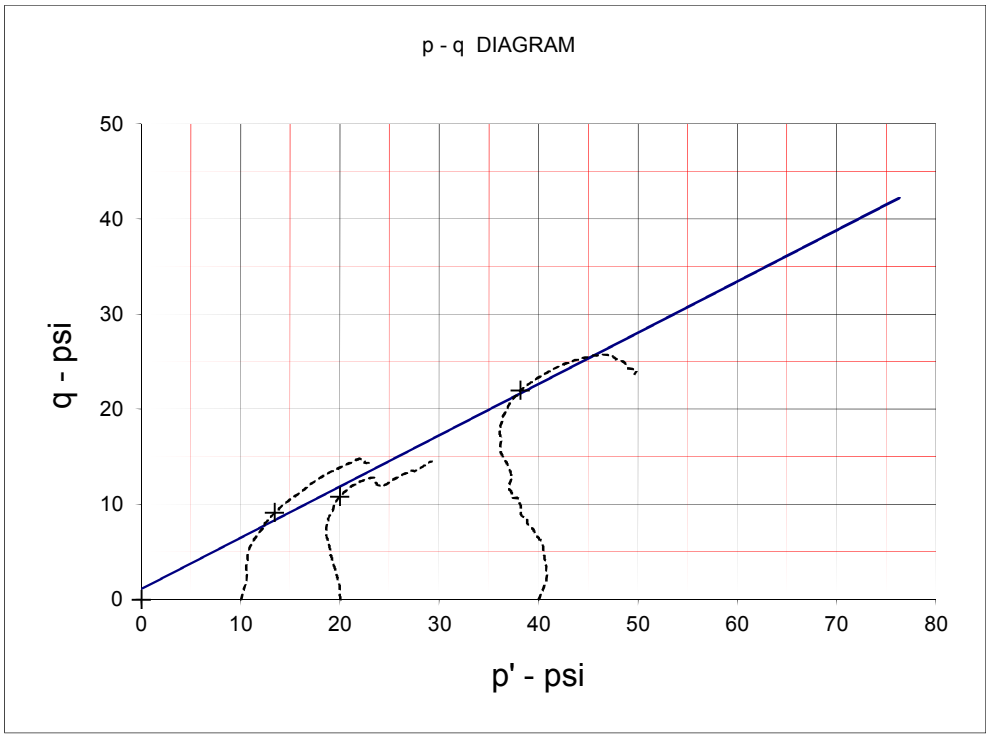
PLATE: B-CD.1

C.U. B-5 28'-30', Native upper Clay, GG Program





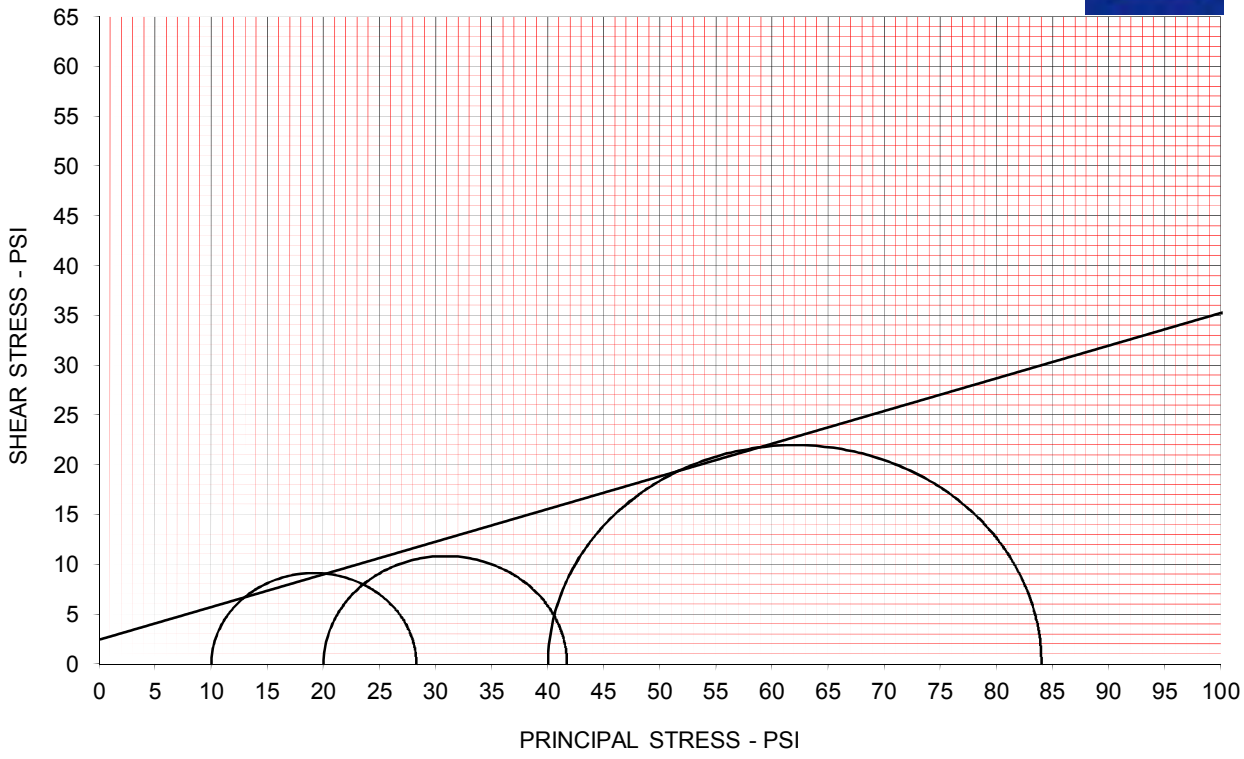




EFFECTIVE STRESS PARAMETERS	R^2 = 0.982	α (deg) = 28.3	a (psi) = 1.1
PROJECT:Phase1 Ash Strorage Area Embankment Investigation		TYPE OF TEST & NO: CD Triaxial - CD-1	
PROJECT NO: G 4207-146		***ETTL Engineers & Consultants***	PLATE: B-CD.2
DESCRIPTION: Light Gray & Redd. Brown Fat Clay, (CH)			

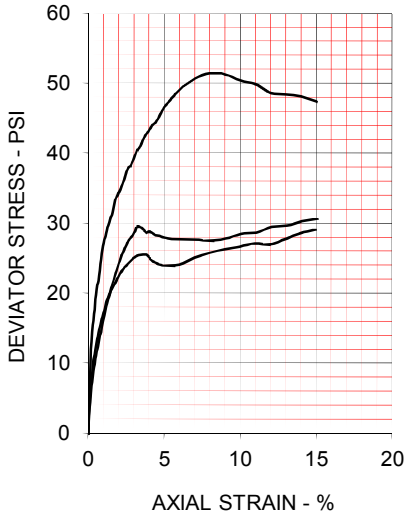
C.U. B-5 28'-30', Native upper Clay, GG Program

ASTM D4767 - CU TRIAXIAL SHEAR TEST REPORT



GREGORY GEOTECHNICAL SOFTWARE

TOTAL STRESS PARAMETERS	ϕ = 18.2 deg	c = 2.5 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	22.8	24.4	26.5	
Dry Density - pcf	103.4	97.6	97.7	
Diameter - inches	1.43	1.44	1.45	
Height - inches	3.18	3.26	3.18	
AT TEST				
Final Moisture - %	24.2	26.7	25.7	
Dry Density - pcf	104.5	100.1	102.6	
Calculated Diameter (in.)	1.43	1.42	1.43	
Height - inches	3.17	3.22	3.10	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	18.26	21.69	43.98	
Total Pore Pressure - psi	65.7	70.9	83.8	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.2	1.8	4.2	
σ_1 Failure - psi	28.26	41.69	83.98	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: Undistrubed Shelby Tube, Trimmed
DESCRIPTION: Light Gray & Redd. Brown Fat Clay, (CH)
SAMPLE LOCATION: B-5 28'-30'
ASSUMED SPECIFIC GRAVITY: 2.67
LL: 58 PI: 38 %-200: 85.8 % Clay Fraction: 42.4
REMARKS: Calculated at peak Pore Pressure

PROJECT INFORMATION

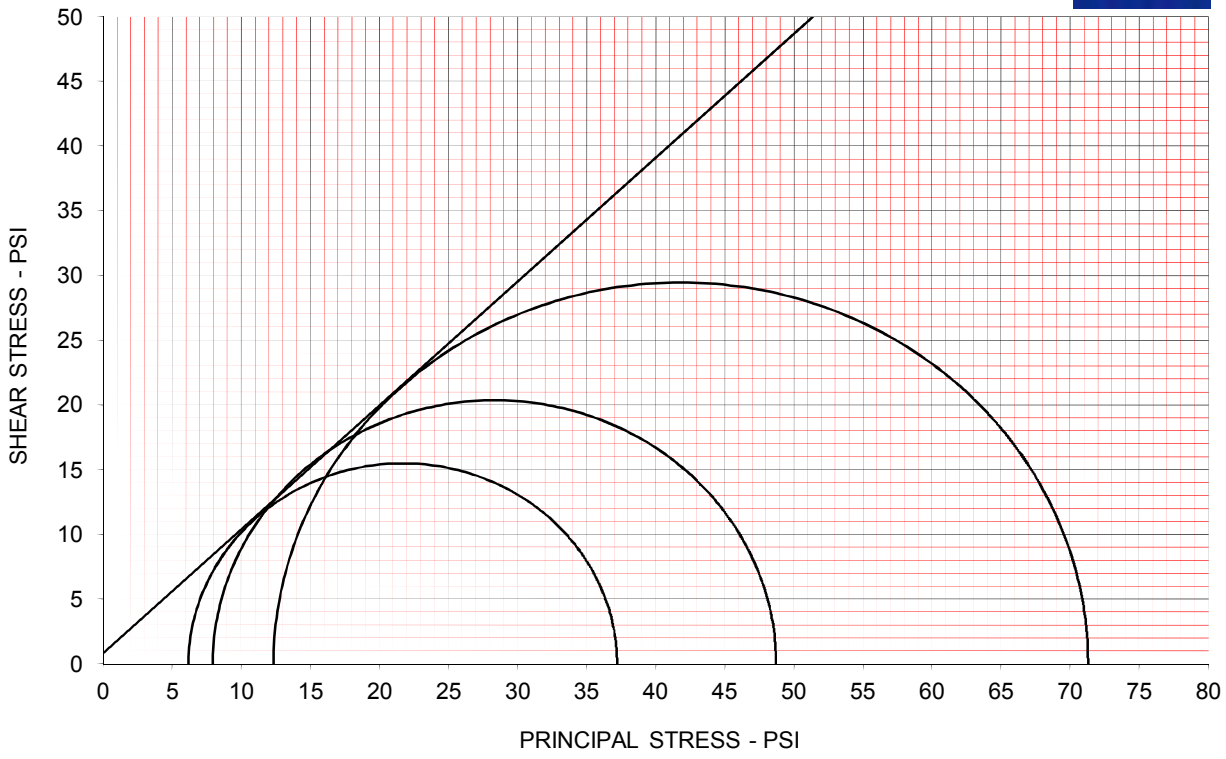
PROJECT:Phase1 Ash Strorage Area Embankment Investigation
LOCATION: Cason, Texas
PROJECT NO: G 4207-146
CLIENT: AEP, Welsh Power Plant
DATE: 12/4/12

ETTL Engineers & Consultants

PLATE: B-CD.3

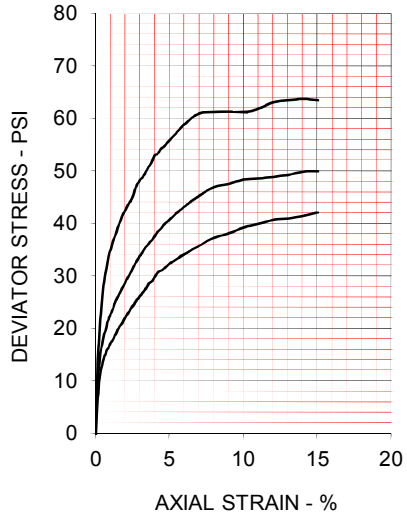
C.U. B-5 28'-30', Native upper Clay, GG Program

ASTM D4767 - CU TRIAXIAL SHEAR TEST REPORT



GREGORY GEOTECHNICAL SOFTWARE

EFFECTIVE STRESS PARAMETERS	ϕ ' = 43.7 deg	c' = 0.9 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	111.7	109.3	104.2	
Dry Density - pcf	41.5	42.4	43.4	
Diameter - inches	1.40	1.40	1.40	
Height - inches	3.00	2.99	2.90	
AT TEST				
Final Moisture - %	99.1	99.4	95.2	
Dry Density - pcf	41.8	43.0	45.3	
Calculated Diameter (in.)	1.39	1.39	1.38	
Height - inches	2.98	2.97	2.85	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	31.01	40.76	58.95	
Total Pore Pressure - psi	63.8	72.1	87.7	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	4.4	5.0	6.0	
σ_1' Failure - psi	37.17	48.68	71.26	
σ_3' Failure - psi	6.16	7.92	12.31	

TEST DESCRIPTION

TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: SPT Samples, Pre-consolidated to 7, 14, 28psi
DESCRIPTION: Dk Gray Elastic Silt, (MH), Comp. Bottom Ash
SAMPLE LOCATION: Composite Sample B-8(18'-20') & B-20(17'-19')
ASSUMED SPECIFIC GRAVITY: 2.6
LL: 97 PL: 87 PI: 10 Percent -200: 89.2
REMARKS: Calculated Maximum Stress Ratio

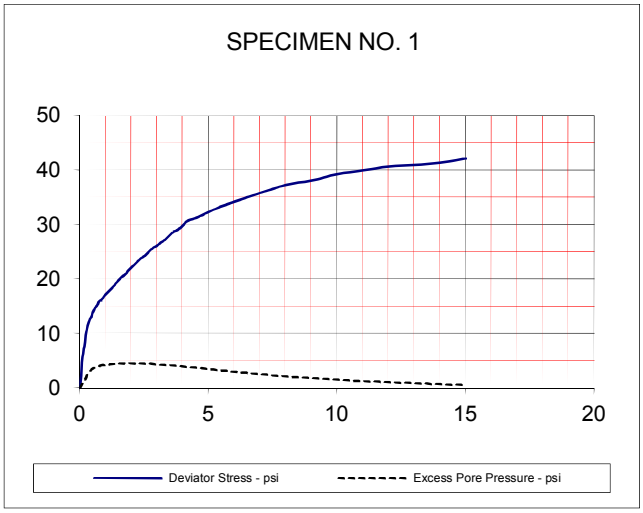
PROJECT INFORMATION

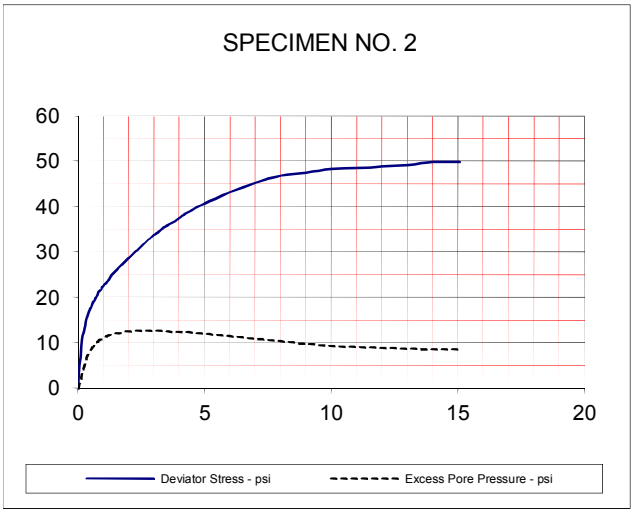
PROJECT:Phase1 Ash Strorage Area Embankment Investigation
LOCATION: Cason, Texas
PROJECT NO: G 4207-146
CLIENT: AEP, Welsh Power Plant
DATE: 12/16/12

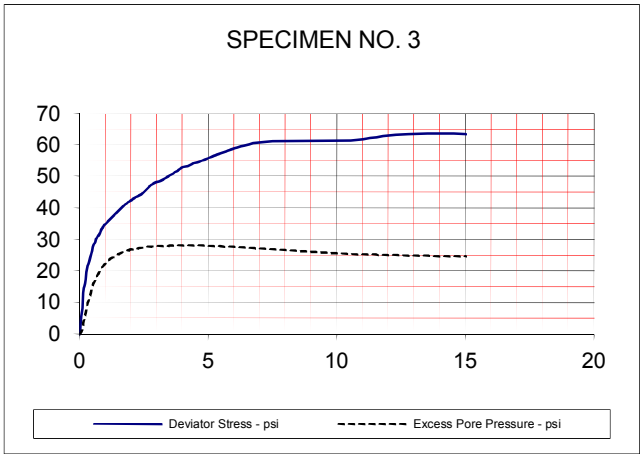
ETTL Engineers & Consultants

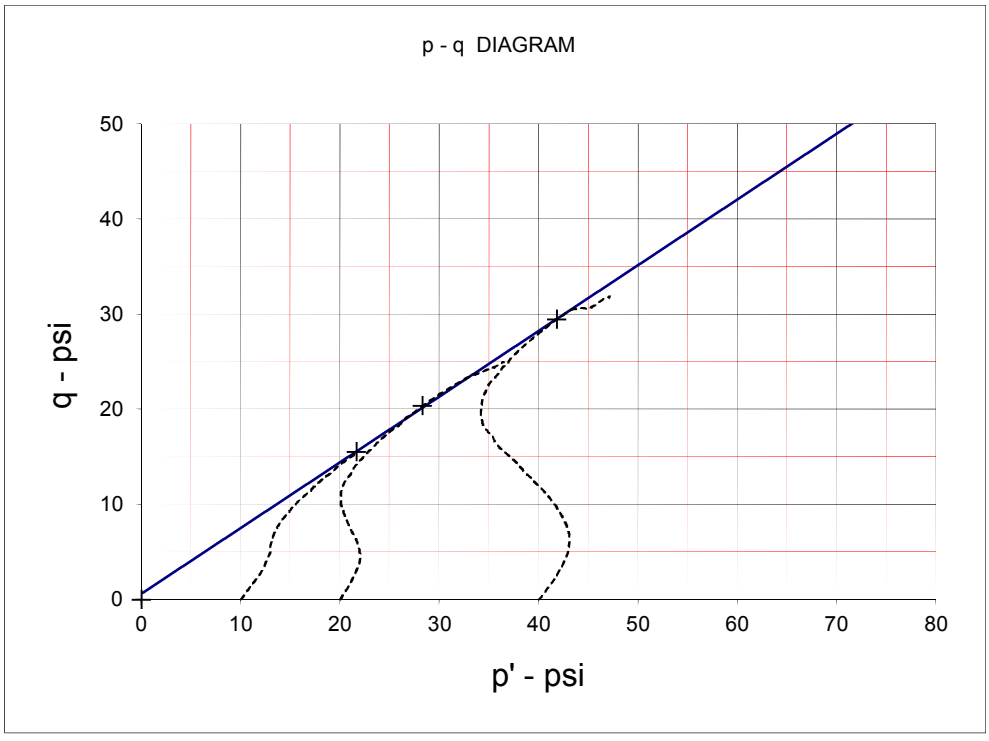
PLATE: B-CD.1

C.U. B-8(18'-20') & B-20(17'-19') Dark Gray Plastic Fly Ash, GG Program





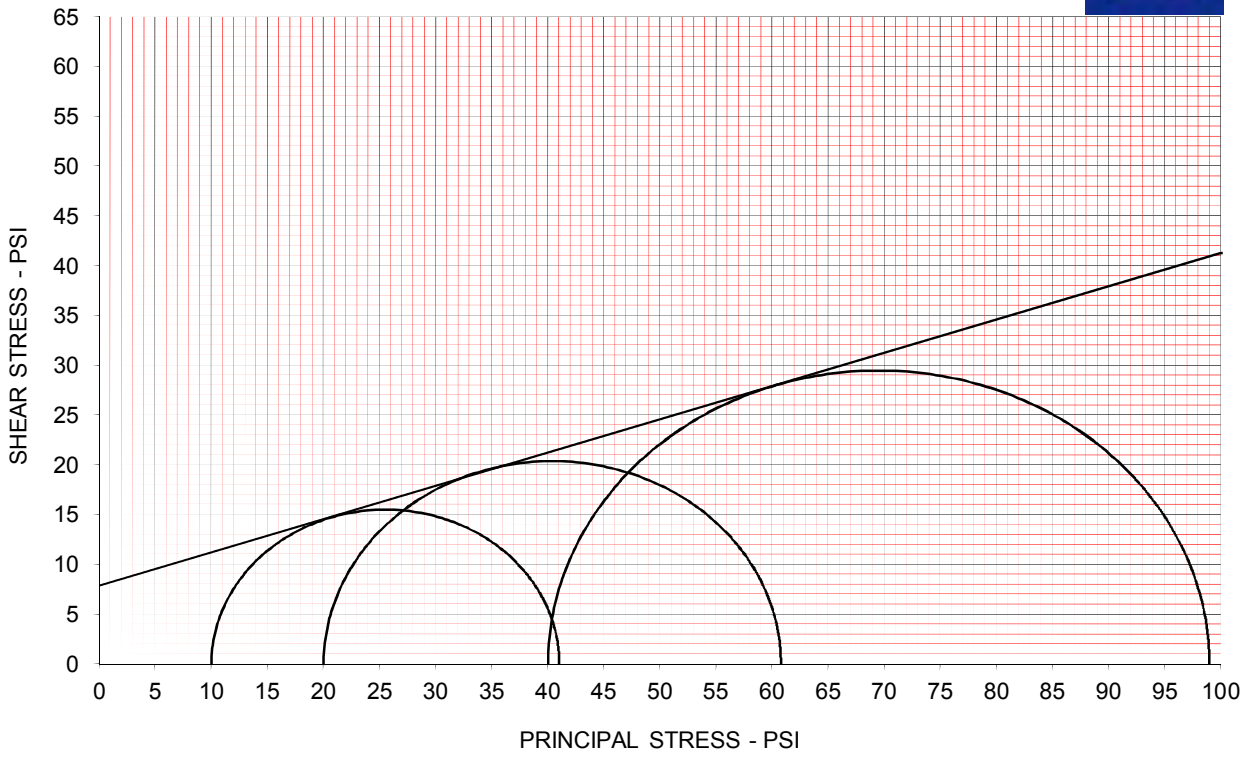




EFFECTIVE STRESS PARAMETERS	R^2 = 1.000	α (deg) = 34.7	a (psi) = 0.6
PROJECT:Phase1 Ash Strorage Area Embankment Investigation		TYPE OF TEST & NO: CD Triaxial - CD-1	
PROJECT NO: G 4207-146		***ETTL Engineers & Consultants***	PLATE: B-CD.2
DESCRIPTION: Dk Gray Elastic Silt, (MH), Comp. Bottom Ash			

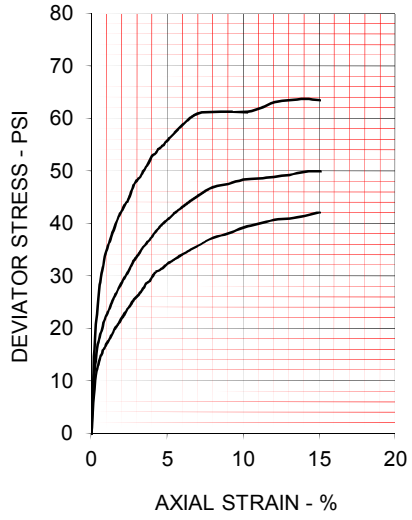
C.U. B-8(18'-20') & B-20(17'-19') Dark Gray Plastic Fly Ash, GG Program

ASTM D 4767 - CU TRIAXIAL SHEAR TEST REPORT



GREGORY GEOTECHNICAL SOFTWARE

TOTAL STRESS PARAMETERS	ϕ = 18.5 deg	c = 7.9 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	111.7	109.3	104.2	
Dry Density - pcf	41.5	42.4	43.4	
Diameter - inches	1.40	1.40	1.40	
Height - inches	3.00	2.99	2.90	
AT TEST				
Final Moisture - %	99.1	99.4	95.2	
Dry Density - pcf	41.8	43.0	45.3	
Calculated Diameter (in.)	1.39	1.39	1.38	
Height - inches	2.98	2.97	2.85	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	31.01	40.76	58.95	
Total Pore Pressure - psi	63.8	72.1	87.7	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	4.4	5.0	6.0	
σ_1 Failure - psi	41.01	60.76	98.95	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: SPT Samples, Pre-consolidated to 7, 14, 28psi
DESCRIPTION: Dk Gray Elastic Silt, (MH), Comp. Bottom Ash
SAMPLE LOCATION: Composite Sample B-8(18'-20') & B-20(17'-19')
ASSUMED SPECIFIC GRAVITY: 2.6
LL: 97 PL: 87 PI: 10 Percent -200: 89.2
REMARKS: Calculated Maximum Stress Ratio

PROJECT INFORMATION

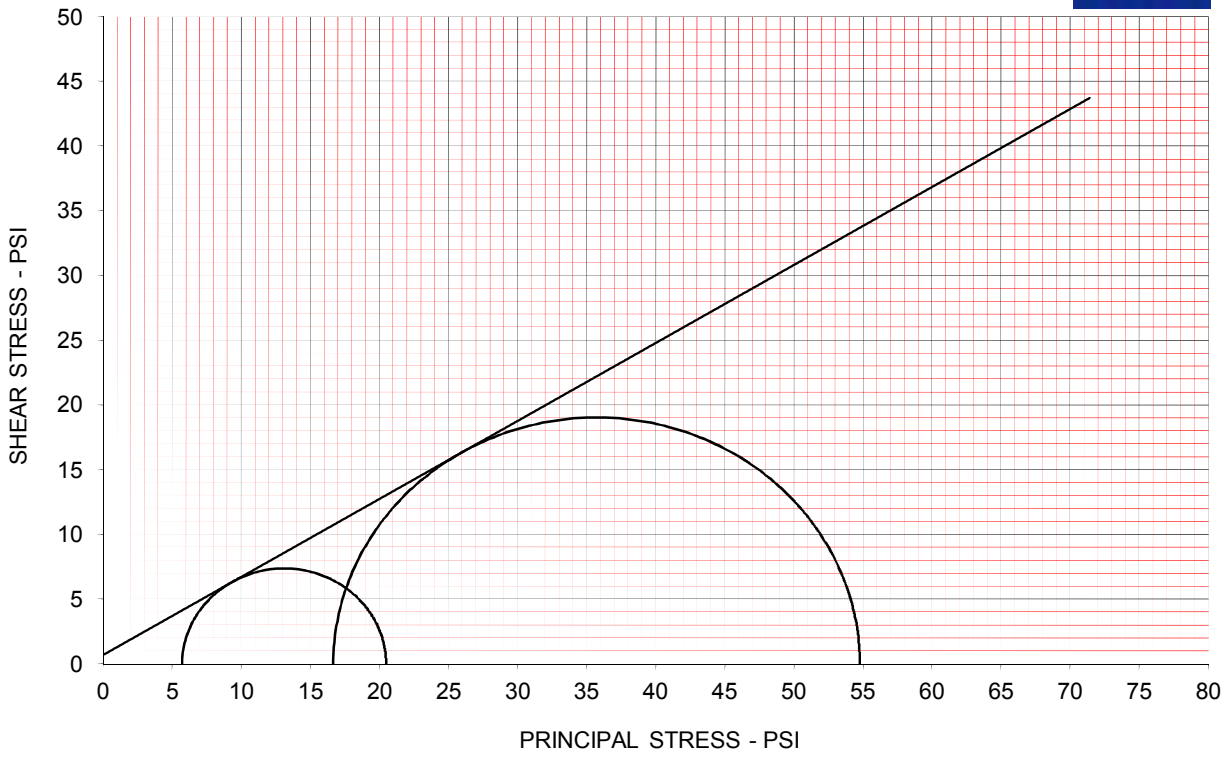
PROJECT:Phase1 Ash Strorage Area Embankment Investigation
LOCATION: Cason, Texas
PROJECT NO: G 4207-146
CLIENT: AEP, Welsh Power Plant
DATE: 12/16/12

ETTL Engineers & Consultants

PLATE: B-CD.3

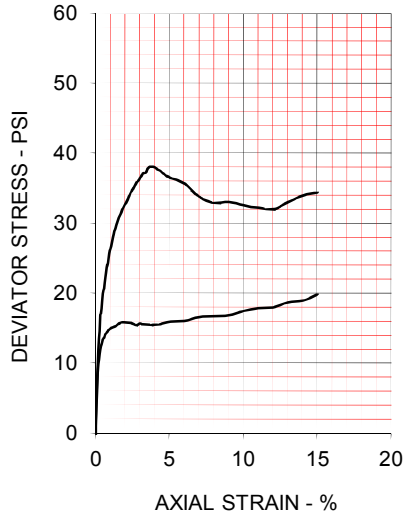
C.U. B-8(18'-20') & B-20(17'-19') Dark Gray Plastic Fly Ash, GG Program

ASTM D4767 - CU TRIAXIAL SHEAR TEST REPORT



GREGORY GEOTECHNICAL SOFTWARE

EFFECTIVE STRESS PARAMETERS	ϕ ' = 31.1 deg	c' = 0.7 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	21.8	23.5		
Dry Density - pcf	105.4	100.2		
Diameter - inches	2.03	2.04		
Height - inches	4.03	4.01		
AT TEST				
Final Moisture - %	27.1	24.9		
Dry Density - pcf	105.5	105.0		
Calculated Diameter (in.)	2.08	2.04		
Height - inches	4.16	4.00		
Effect. Cell Pressure - psi	10.0	40.0		
Failure Stress - psi	14.76	38.10		
Total Pore Pressure - psi	64.3	83.6		
Strain Rate - inches/min.	0.00050	0.00050		
Failure Strain - %	0.9	3.8		
σ_1' Failure - psi	20.46	54.74		
σ_3' Failure - psi	5.70	16.64		

TEST DESCRIPTION

TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: Undistrubed Shelby Tube, Trimmed
DESCRIPTION: Dark Brown Fat Clay, (CH)
SAMPLE LOCATION: B-6 53'-55'
ASSUMED SPECIFIC GRAVITY: 2.67
LL: NT PL: NT PI: NT Percent -200: NT
REMARKS: Calculated at peak Sigma1' - Sigma3'

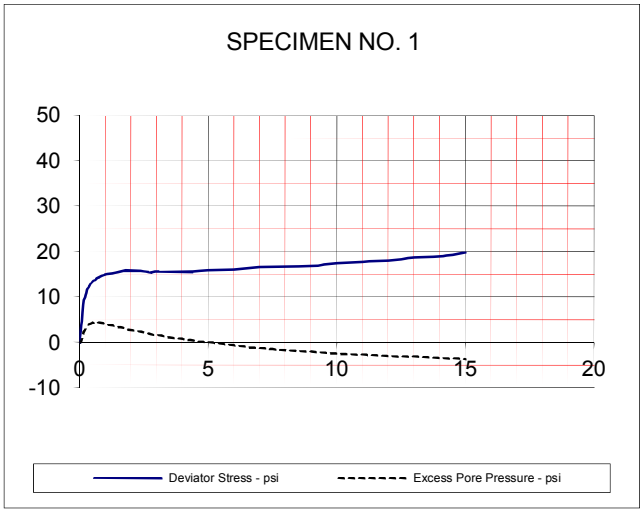
PROJECT INFORMATION

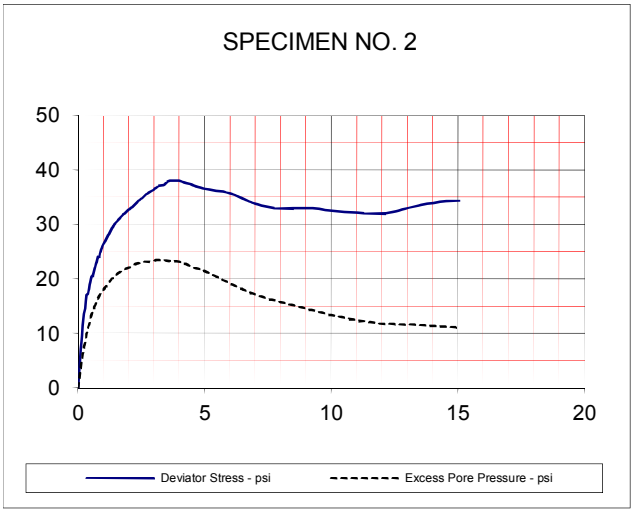
PROJECT:Phase1 Ash Strorage Area Embankment Investigation
LOCATION: Cason, Texas
PROJECT NO: G 4207-146
CLIENT: AEP, Welsh Power Plant
DATE: 12/4/12

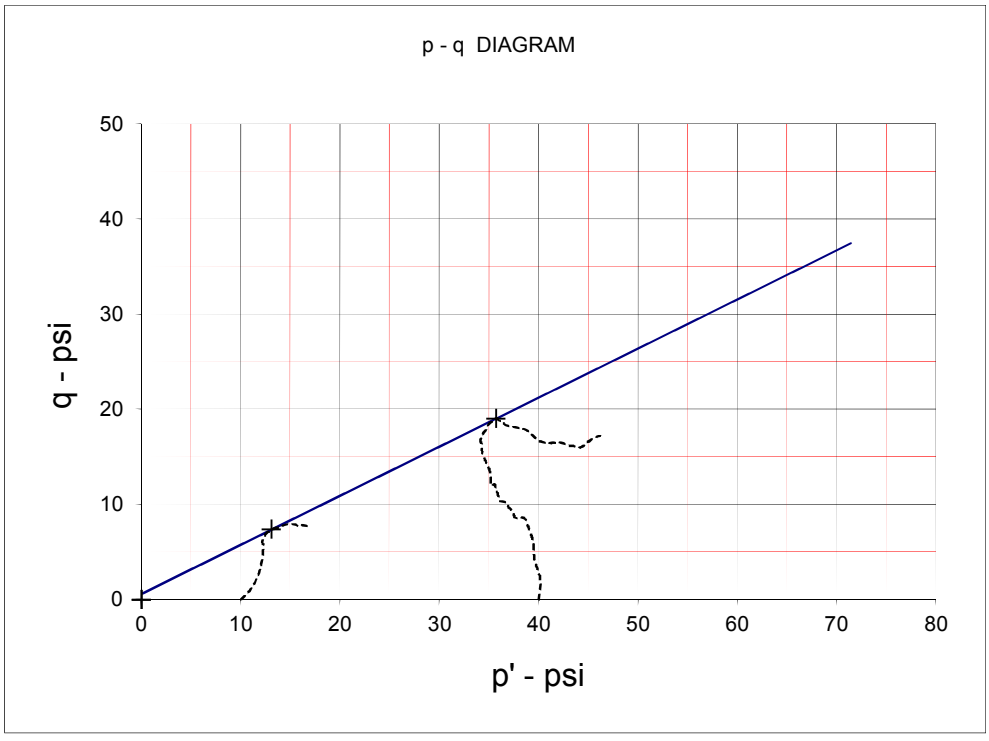
ETTL Engineers & Consultants

PLATE: B-CD.1

C.U. B-9 53'-55', Native lower Clay, GG Program, 2 point



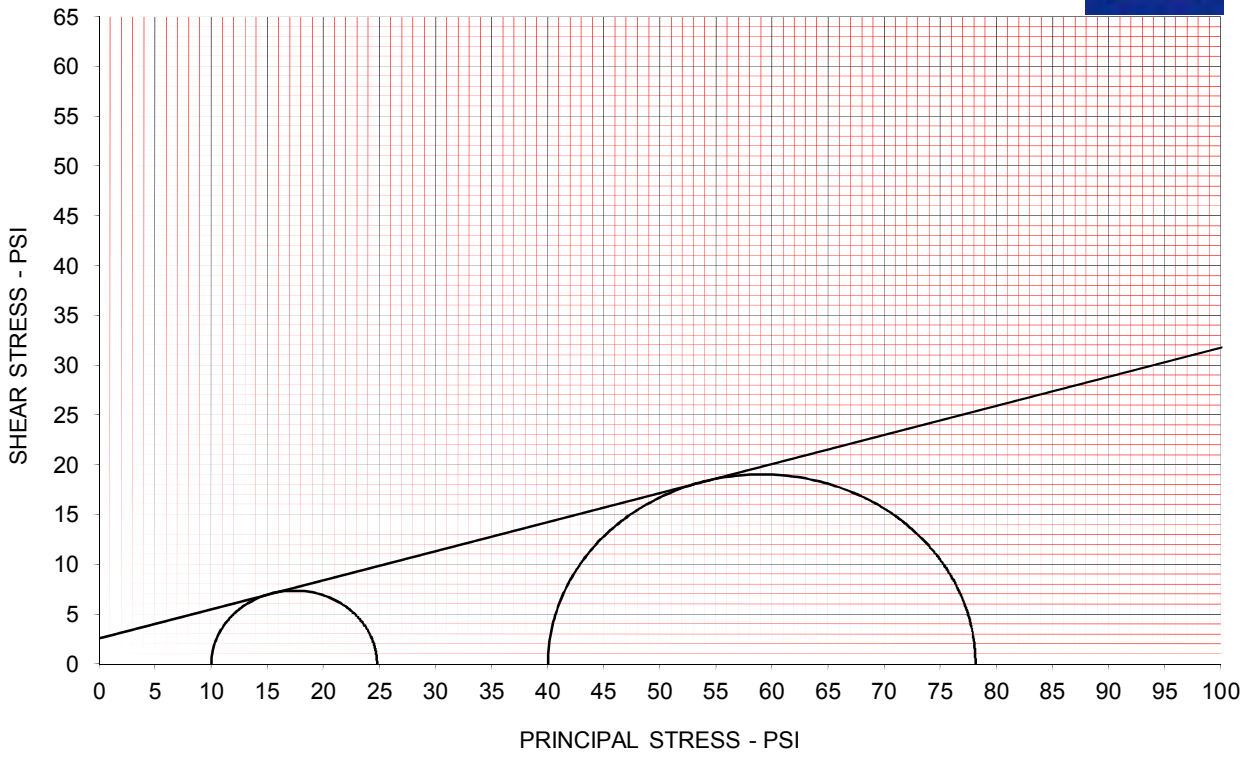




EFFECTIVE STRESS PARAMETERS	R^2 = 1.000	α (deg) = 27.3	a (psi) = 0.6
PROJECT:Phase1 Ash Strorage Area Embankment Investigation		TYPE OF TEST & NO: CD Triaxial - CD-1	
PROJECT NO: G 4207-146		***ETTL Engineers & Consultants***	PLATE: B-CD.2
DESCRIPTION: Dark Brown Fat Clay, (CH)			

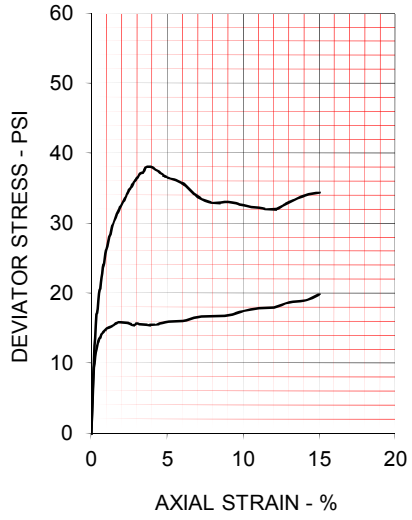
C.U. B-9 53'-55', Native lower Clay, GG Program, 2 point

ASTM D4767 - CU TRIAXIAL SHEAR TEST REPORT



GREGORY GEOTECHNICAL SOFTWARE

TOTAL STRESS PARAMETERS	ϕ = 16.3 deg	c = 2.6 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	21.8	23.5		
Dry Density - pcf	105.4	100.2		
Diameter - inches	2.03	2.04		
Height - inches	4.03	4.01		
AT TEST				
Final Moisture - %	27.1	24.9		
Dry Density - pcf	105.5	105.0		
Calculated Diameter (in.)	2.08	2.04		
Height - inches	4.16	4.00		
Effect. Cell Pressure - psi	10.0	40.0		
Failure Stress - psi	14.76	38.10		
Total Pore Pressure - psi	64.3	83.6		
Strain Rate - inches/min.	0.00050	0.00050		
Failure Strain - %	0.9	3.8		
σ_1 Failure - psi	24.76	78.10		
σ_3 Failure - psi	10.00	40.00		

TEST DESCRIPTION

TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: Undistrubed Shelby Tube, Trimmed
DESCRIPTION: Dark Brown Fat Clay, (CH)
SAMPLE LOCATION: B-6 53'-55'
ASSUMED SPECIFIC GRAVITY: 2.67
LL: NT PL: NT PI: NT Percent -200: NT
REMARKS: Calculated at peak Sigma1' - Sigma3'

PROJECT INFORMATION

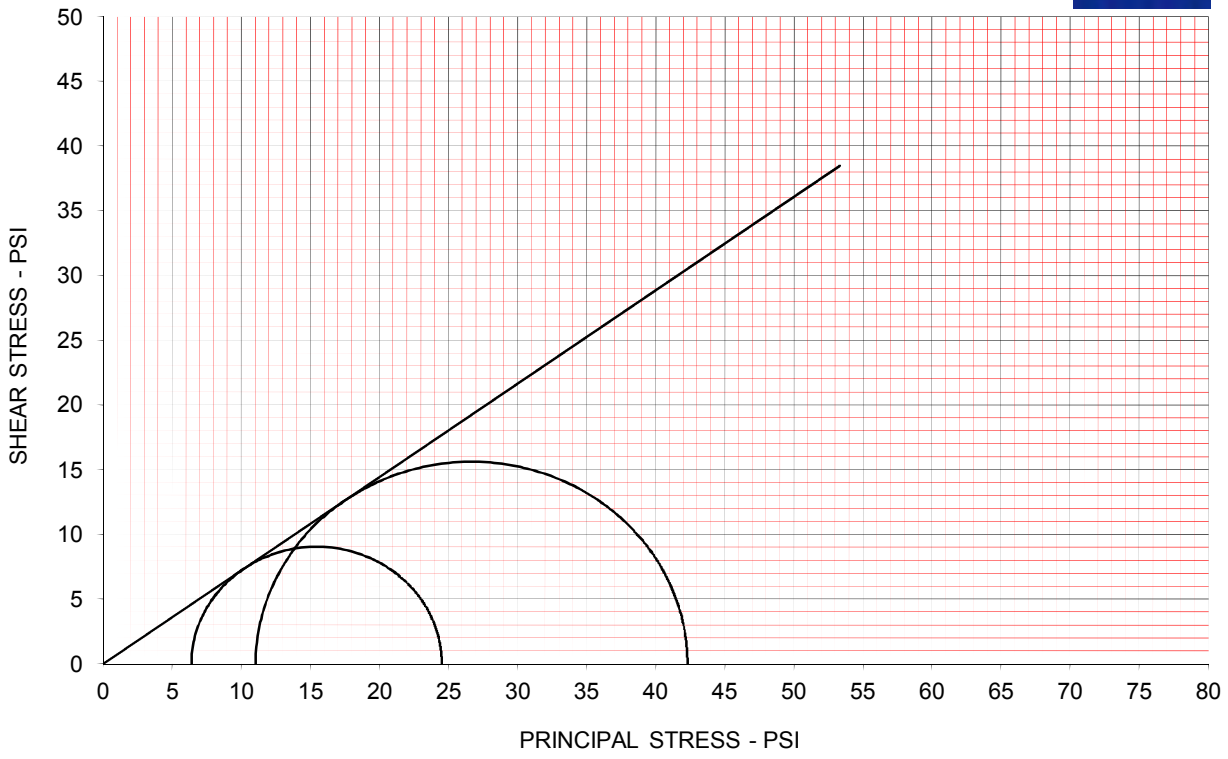
PROJECT:Phase1 Ash Strorage Area Embankment Investigation
LOCATION: Cason, Texas
PROJECT NO: G 4207-146
CLIENT: AEP, Welsh Power Plant
DATE: 12/4/12

ETTL Engineers & Consultants

PLATE: B-CD.3

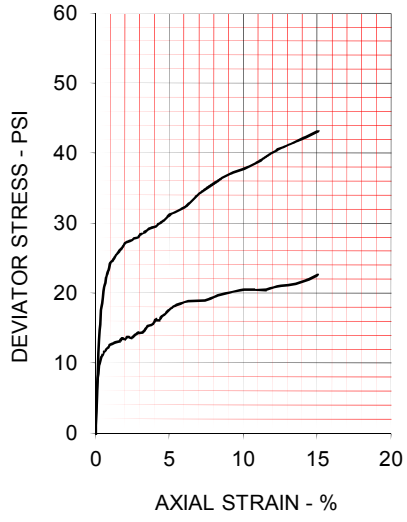
C.U. B-9 53'-55', Native lower Clay, GG Program, 2 point

ASTM D4767 - CU TRIAXIAL SHEAR TEST REPORT



GREGORY GEOTECHNICAL SOFTWARE

EFFECTIVE STRESS PARAMETERS	ϕ ' = 35.8 deg	c' = 0.0 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	16.8	16.6		
Dry Density - pcf	108.5	111.3		
Diameter - inches	1.40	1.40		
Height - inches	2.93	2.87		
AT TEST				
Final Moisture - %	19.4	18.4		
Dry Density - pcf	109.1	112.4		
Calculated Diameter (in.)	1.39	1.39		
Height - inches	2.91	2.84		
Effect. Cell Pressure - psi	10.0	19.9		
Failure Stress - psi	18.12	31.25		
Total Pore Pressure - psi	63.7	68.9		
Strain Rate - inches/min.	0.00050	0.00050		
Failure Strain - %	5.3	5.0		
σ_1' Failure - psi	24.49	42.27		
σ_3' Failure - psi	6.37	11.02		

TEST DESCRIPTION

TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: Remolded to 95% of Max Density by the MDI
DESCRIPTION: Redd. Br. & Lt. Br. Sandy Lean Clay, (CL)
SAMPLE LOCATION: Sample #1, Remolded Sandy Lean Clay
ASSUMED SPECIFIC GRAVITY: 2.67
LL: 29 PL: 18 PI: 11 Percent -200: 62.6
REMARKS: Calculated at a stain of 5%, 40 psi point left out

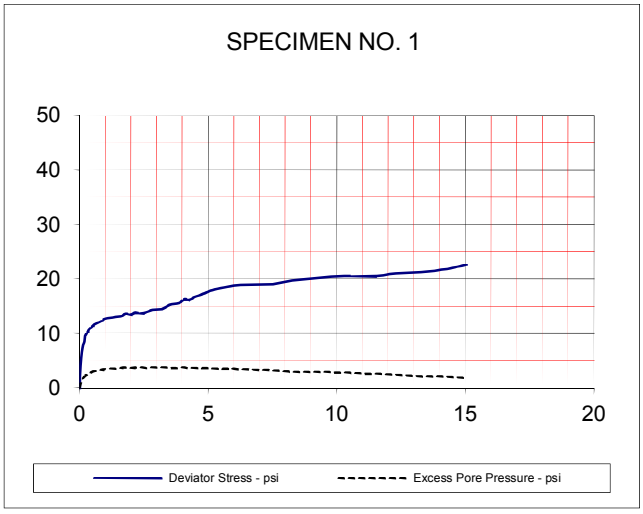
PROJECT INFORMATION

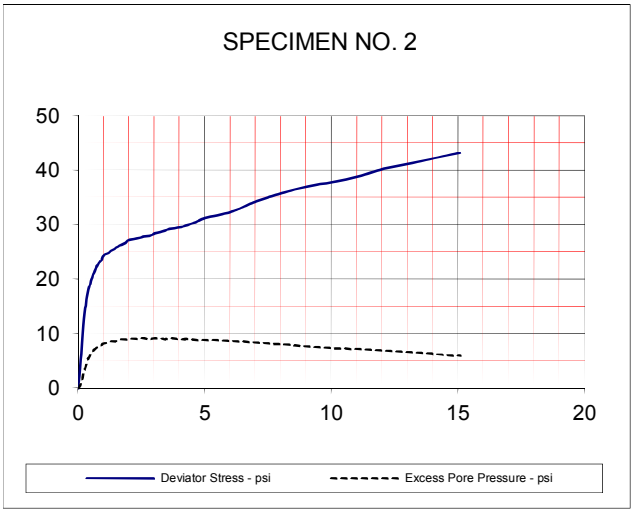
PROJECT:Phase1 Ash Strorage Area Embankment Investigation
LOCATION: Cason, Texas
PROJECT NO: G 4207-146
CLIENT: AEP, Welsh Power Plant
DATE: 12/23/12

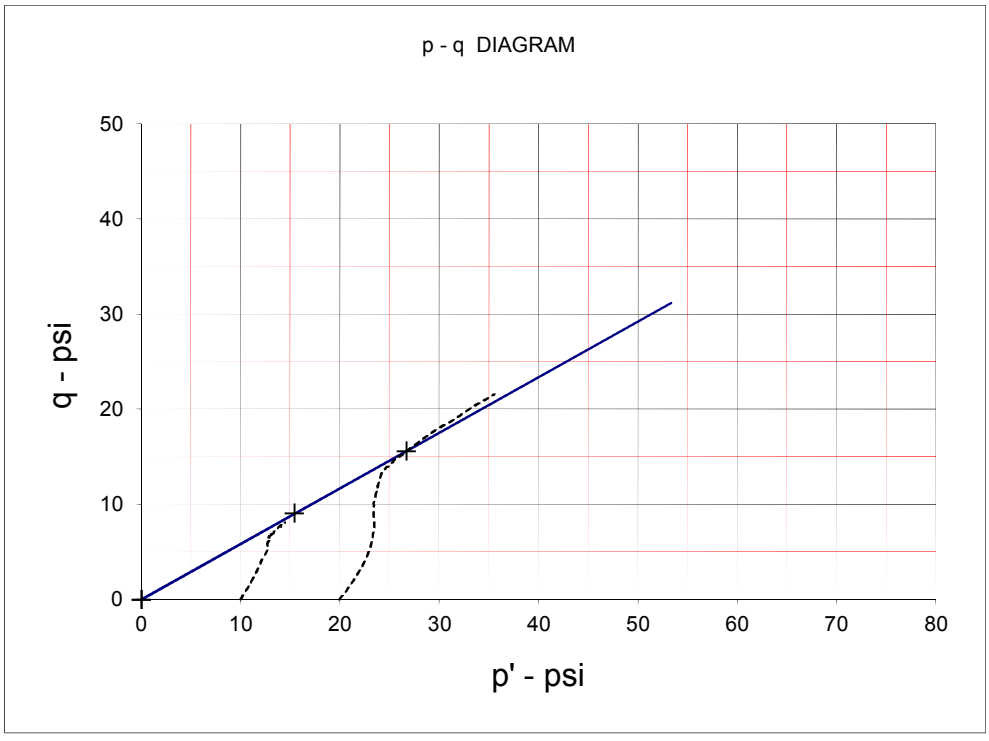
ETTL Engineers & Consultants

PLATE: B-CD.1

C.U. Remolded Native Sandy Lean Clay, GG Program, 2 point 10 & 20 psi



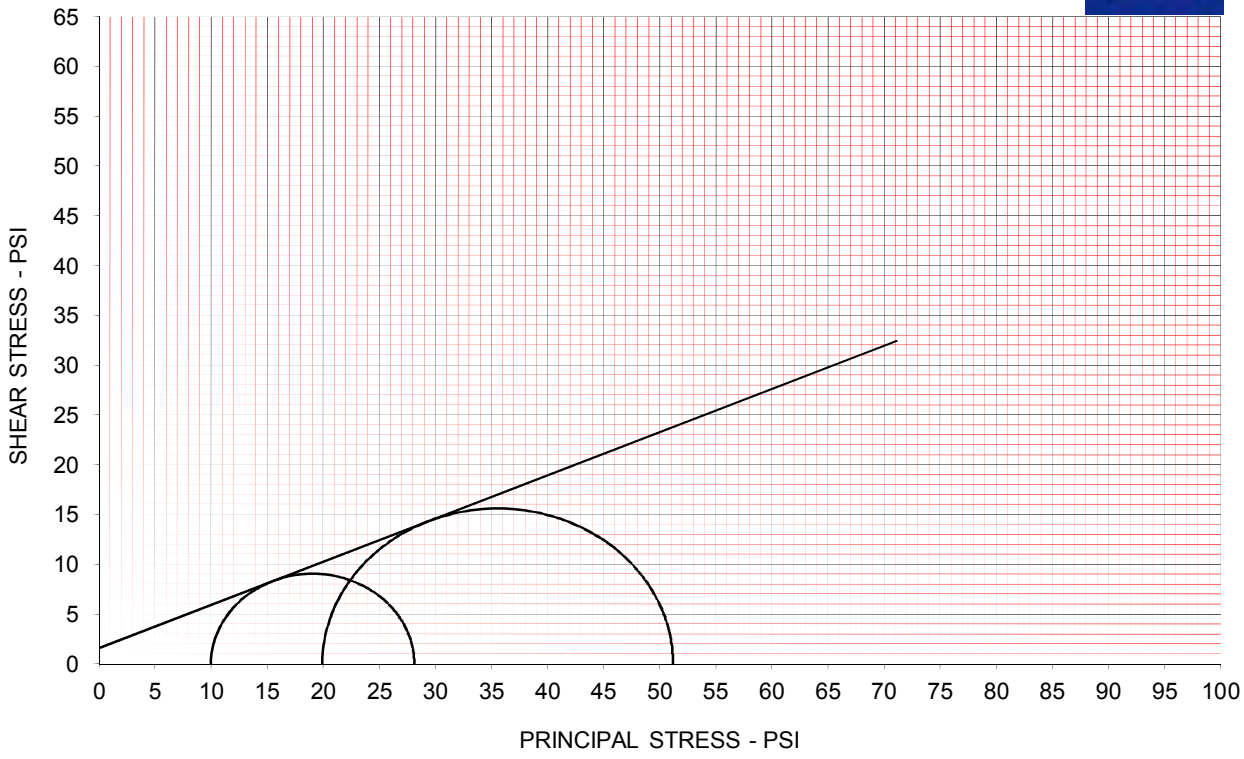




EFFECTIVE STRESS PARAMETERS	R^2 = 1.000	α (deg) = 30.3	a (psi) = 0.0
PROJECT:Phase1 Ash Strorage Area Embankment Investigation		TYPE OF TEST & NO: CD Triaxial - CD-1	
PROJECT NO: G 4207-146		***ETTL Engineers & Consultants***	PLATE: B-CD.2
DESCRIPTION: Redd. Br. & Lt. Br. Sandy Lean Clay, (CL)			

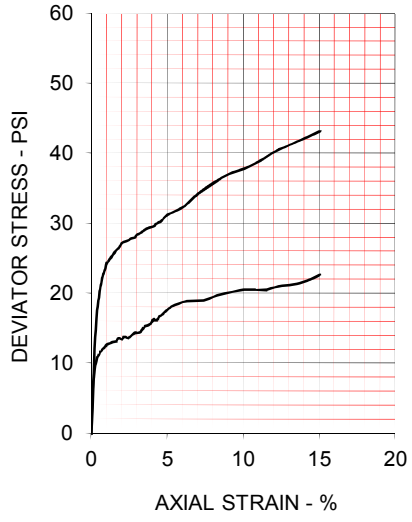
C.U. Remolded Native Sandy Lean Clay, GG Program, 2 point 10 & 20 psi

ASTM D4767 - CU TRIAXIAL SHEAR TEST REPORT



GREGORY GEOTECHNICAL SOFTWARE

TOTAL STRESS PARAMETERS	ϕ = 23.5 deg	c = 1.6 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	16.8	16.6		
Dry Density - pcf	108.5	111.3		
Diameter - inches	1.40	1.40		
Height - inches	2.93	2.87		
AT TEST				
Final Moisture - %	19.4	18.4		
Dry Density - pcf	109.1	112.4		
Calculated Diameter (in.)	1.39	1.39		
Height - inches	2.91	2.84		
Effect. Cell Pressure - psi	10.0	19.9		
Failure Stress - psi	18.12	31.25		
Total Pore Pressure - psi	63.7	68.9		
Strain Rate - inches/min.	0.00050	0.00050		
Failure Strain - %	5.3	5.0		
σ_1 Failure - psi	28.08	51.14		
σ_3 Failure - psi	9.96	19.89		

TEST DESCRIPTION

TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: Remolded to 95% of Max Density by the MDI
DESCRIPTION: Redd. Br. & Lt. Br. Sandy Lean Clay, (CL)
SAMPLE LOCATION: Sample #1, Remolded Sandy Lean Clay
ASSUMED SPECIFIC GRAVITY: 2.67
LL: 29 PL: 18 PI: 11 Percent -200: 62.6
REMARKS: Calculated at a stain of 5%, 40 psi point left out

PROJECT INFORMATION

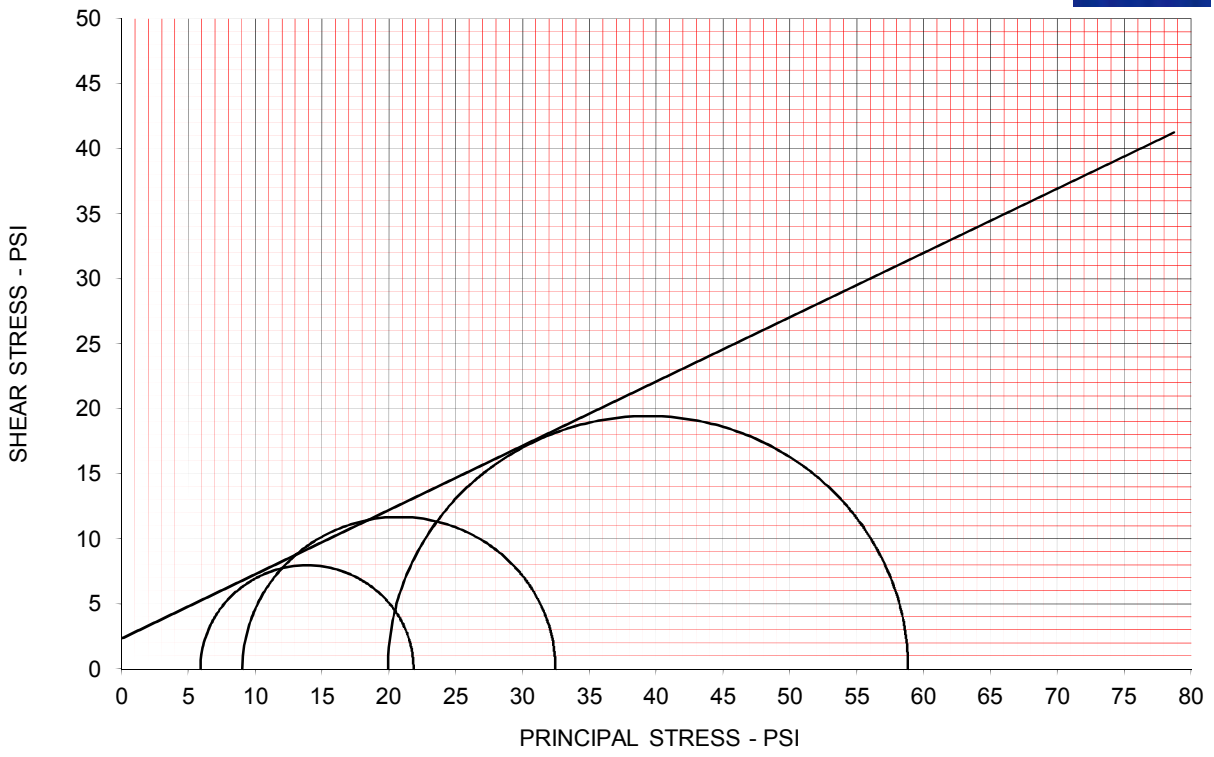
PROJECT:Phase1 Ash Strorage Area Embankment Investigation
LOCATION: Cason, Texas
PROJECT NO: G 4207-146
CLIENT: AEP, Welsh Power Plant
DATE: 12/23/12

ETTL Engineers & Consultants

PLATE: B-CD.3

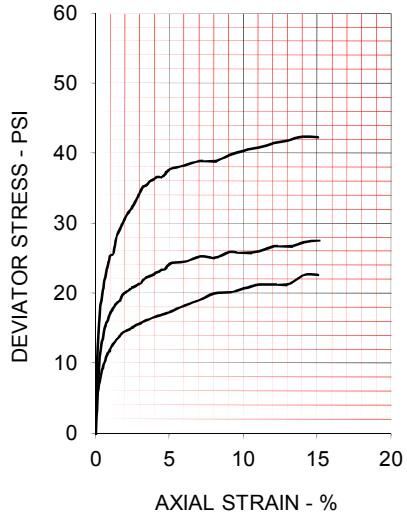
C.U. Remolded Native Sandy Lean Clay, GG Program, 2 point 10 & 20 psi

ASTM D4767 - CU TRIAXIAL SHEAR TEST REPORT



GREGORY GEOTECHNICAL SOFTWARE

EFFECTIVE STRESS PARAMETERS	ϕ ' = 26.3 deg	c' = 2.4 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	23.7	23.7	23.4	
Dry Density - pcf	96.2	96.5	95.8	
Diameter - inches	1.40	1.39	1.39	
Height - inches	2.96	2.80	2.80	
AT TEST				
Final Moisture - %	28.4	26.1	27.8	
Dry Density - pcf	97.3	101.7	98.9	
Calculated Diameter (in.)	1.40	1.37	1.39	
Height - inches	2.98	2.75	2.80	
Effect. Cell Pressure - psi	9.9	20.0	39.9	
Failure Stress - psi	15.94	23.40	38.91	
Total Pore Pressure - psi	64.1	71.0	80.0	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	3.2	4.5	7.0	
σ_1' Failure - psi	21.82	32.43	58.81	
σ_3' Failure - psi	5.88	9.03	19.90	

TEST DESCRIPTION

TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: Remolded to 95% of Max Density by the MDI
DESCRIPTION: Rdsh Brown & Light Gray Fat Clay with sand, (CH)
SAMPLE LOCATION: Sample #2, Remolded Fat Clay
ASSUMED SPECIFIC GRAVITY: 2.67
LL: 62 PL: 20 PI: 42 Percent -200: 78
REMARKS:

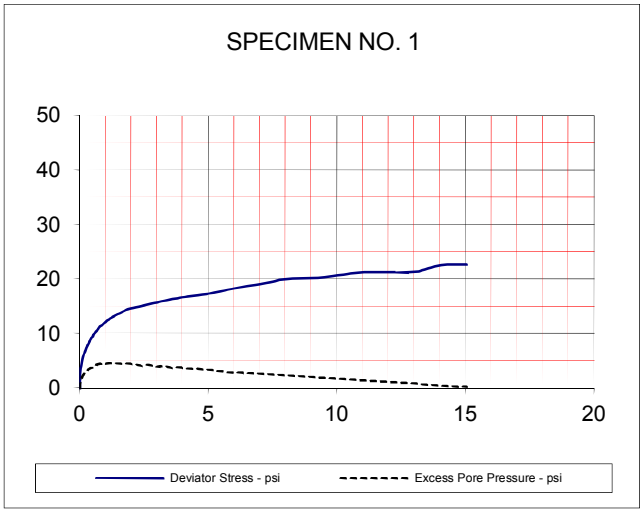
PROJECT INFORMATION

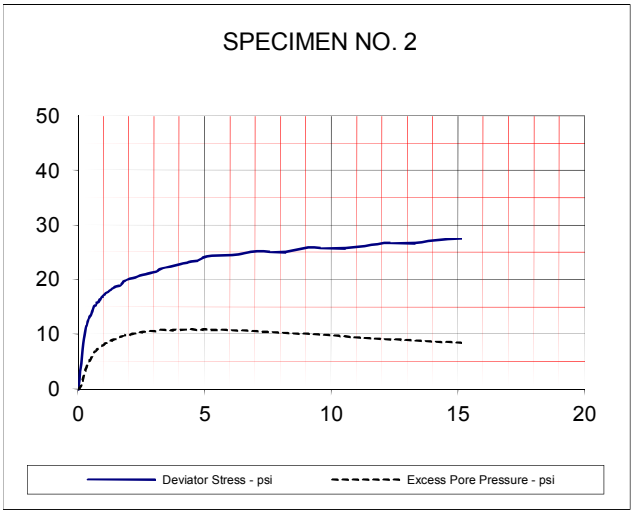
PROJECT:Phase1 Ash Strorage Area Embankment Investigation
LOCATION: Cason, Texas
PROJECT NO: G 4207-146
CLIENT: AEP, Welsh Power Plant
DATE: 12/23/12

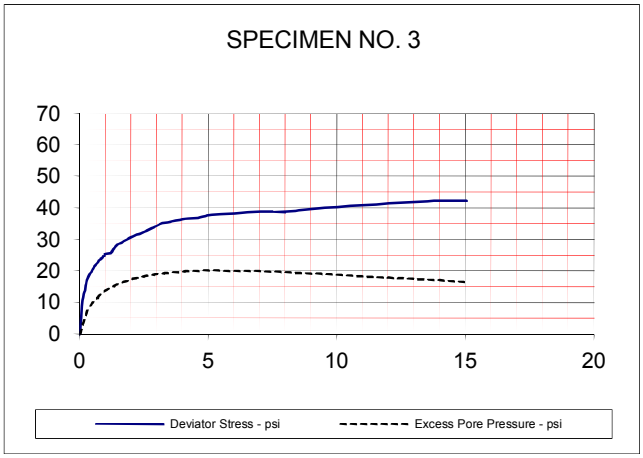
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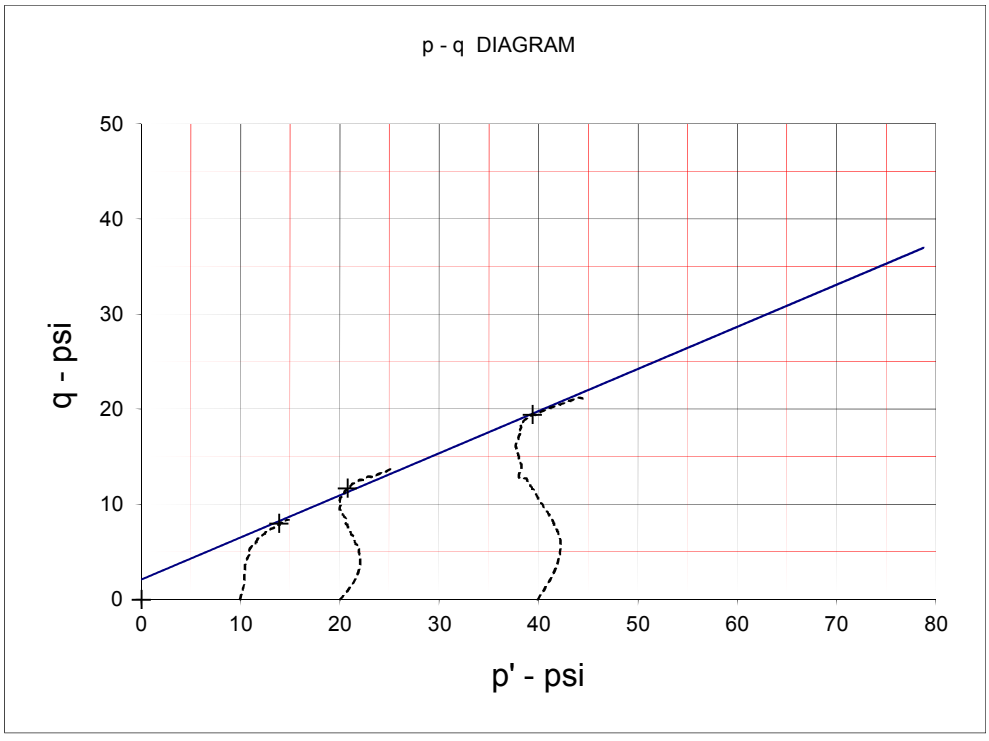
PLATE: B-CD.1

C.U. Remolded Native Fat Clay, GG Program





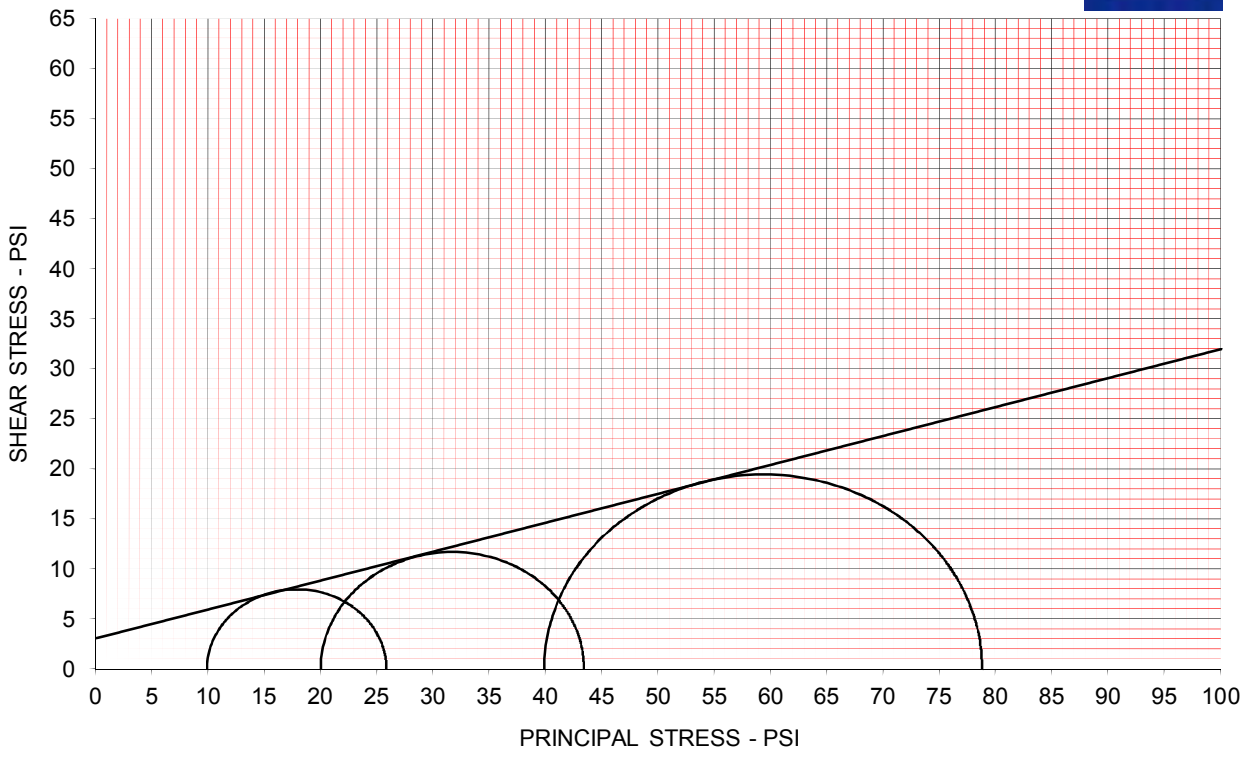




EFFECTIVE STRESS PARAMETERS	R^2 = 0.996	α (deg) = 23.9	a (psi) = 2.1
PROJECT:Phase1 Ash Strorage Area Embankment Investigation		TYPE OF TEST & NO: CD Triaxial - CD-1	
PROJECT NO: G 4207-146		***ETTL Engineers & Consultants***	PLATE: B-CD.2
DESCRIPTION: Rdsh Brown & Light Gray Fat Clay with sand, (CH)			

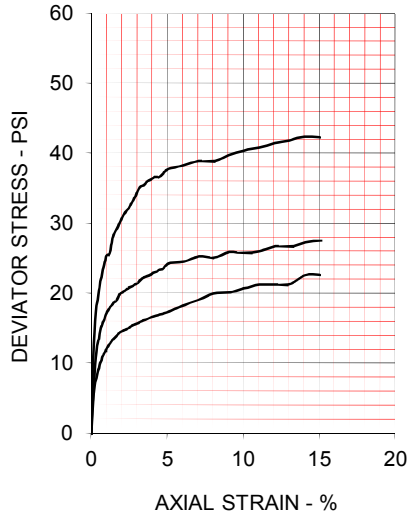
C.U. Remolded Native Fat Clay, GG Program

ASTM D4767 - CU TRIAXIAL SHEAR TEST REPORT



GREGORY GEOTECHNICAL SOFTWARE

TOTAL STRESS PARAMETERS	ϕ = 16.1 deg	c = 3.1 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	23.7	23.7	23.4	
Dry Density - pcf	96.2	96.5	95.8	
Diameter - inches	1.40	1.39	1.39	
Height - inches	2.96	2.80	2.80	
AT TEST				
Final Moisture - %	28.4	26.1	27.8	
Dry Density - pcf	97.3	101.7	98.9	
Calculated Diameter (in.)	1.40	1.37	1.39	
Height - inches	2.98	2.75	2.80	
Effect. Cell Pressure - psi	9.9	20.0	39.9	
Failure Stress - psi	15.94	23.40	38.91	
Total Pore Pressure - psi	64.1	71.0	80.0	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	3.2	4.5	7.0	
σ_1 Failure - psi	25.84	43.40	78.78	
σ_3 Failure - psi	9.90	20.00	39.87	

TEST DESCRIPTION

TYPE OF TEST & NO: CD Triaxial - CD-1
SAMPLE TYPE: Remolded to 95% of Max Density by the MDI
DESCRIPTION: Rdsh Brown & Light Gray Fat Clay with sand, (CH)
SAMPLE LOCATION: Sample #2, Remolded Fat Clay
ASSUMED SPECIFIC GRAVITY: 2.67
LL: 62 PL: 20 PI: 42 Percent -200: 78
REMARKS:

PROJECT INFORMATION

PROJECT:Phase1 Ash Strorage Area Embankment Investigation
LOCATION: Cason, Texas
PROJECT NO: G 4207-146
CLIENT: AEP, Welsh Power Plant
DATE: 12/23/12

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PLATE: B-CD.3

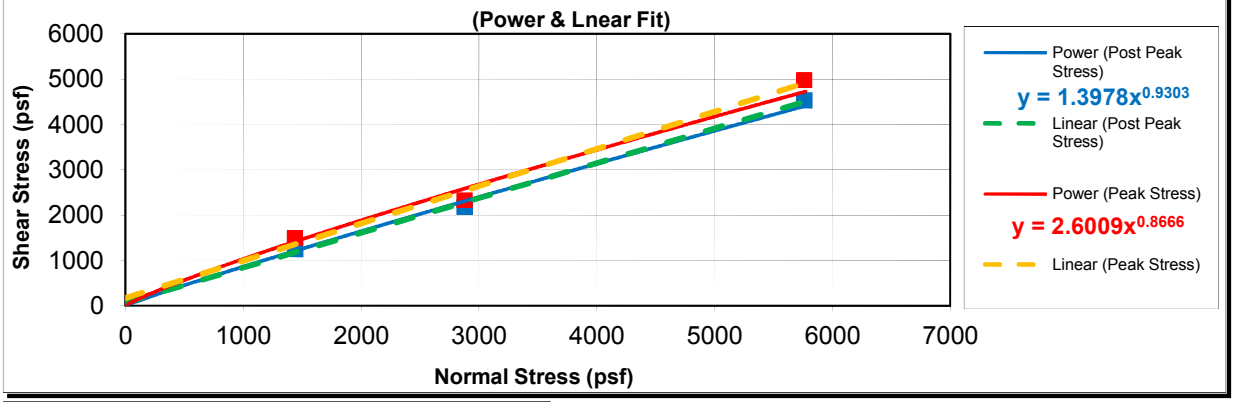
C.U. Remolded Native Fat Clay, GG Program

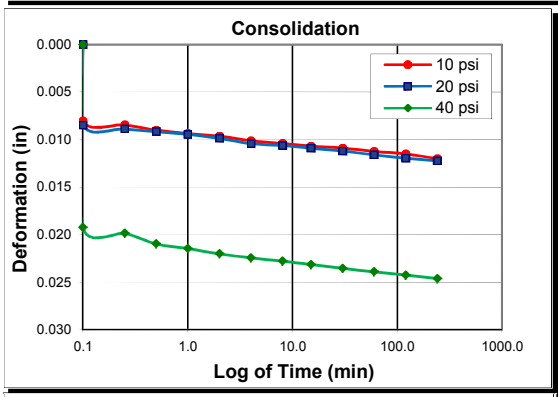
Consolidated Drained Direct Shear

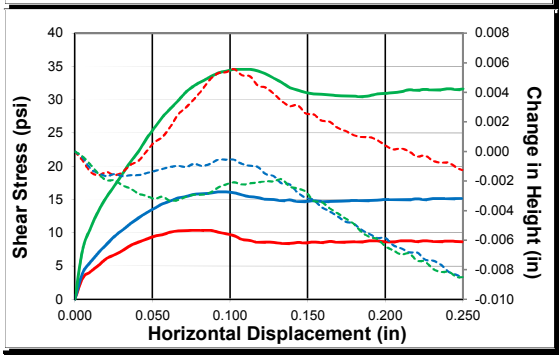
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ASTM D 3080 Direct Shear Test Report







	Linear Strength Parameters			
	Post Peak		Peak	
Friction Angle	37.6 (deg)		39.4 (deg)	
Cohesion	0.5 (psi)	72.0 (psf)	1.2 (psi)	170.6 (psf)

Specimen Number	1	2	3
Initial Sample Data			
Moisture Content-(%):	32.4%	33.0%	32.5%
Dry Density-(lb/ft^3):	81.7	81.3	81.6
Degree of Saturation-(%):	89.4%	89.9%	89.6%
Height-(in):	0.996	0.996	0.996
Diameter-(in):	2.50	2.50	2.50
Before Shear Test Data			
Moisture Content-(%):	34.2%	34.0%	33.9%
Dry Density-(lb/ft^3):	82.7	82.3	83.7
Degree of Saturation-(%):	98.3%	95.1%	98.3%
Height after consolidation-(in):	0.985	0.985	0.972
Height after shear-(in):	0.984	0.984	0.971
Normal Stress-(psf):	**1440**	**2880**	**5760**
Post Peak Failure Stress-(psf):	**1249**	**2180**	**4535**
Peak Failure Stress-(psf):	**1498**	**2326**	**4980**
Strain Rate-(in/min):	0.0005	0.0005	0.0005

Project Information

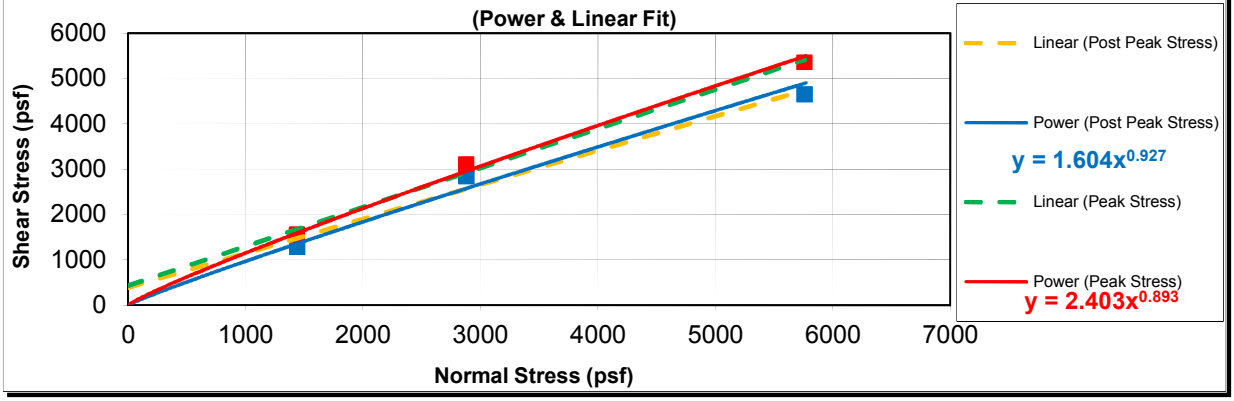
				LL	PL	PI
Project :	Phase 1 Ash Storage Area Embankment Investigation			N/P	N/P	N/P
Client:	AEP, Welch Power Plant			-200%	25	
Project Location:	Cason, Texas					
Material Description:	Dark Grayish Brown Silty Sand, (SM), Economizer Ash					
ETTL Job #:	G 4207-146	**Technician:**	Owen Sanderson	**Remarks**		
Boring;	B-3	**Sample Type:**	Composite SPT			
Depth (ft):	3'-10'	**Molding Method:**	Loosely Compacted in Ring	Particles larger than the No. Sieve removed before remolding.		
Test Date:	December 1, 2014	**Testing Device:**	Humboldt #1			

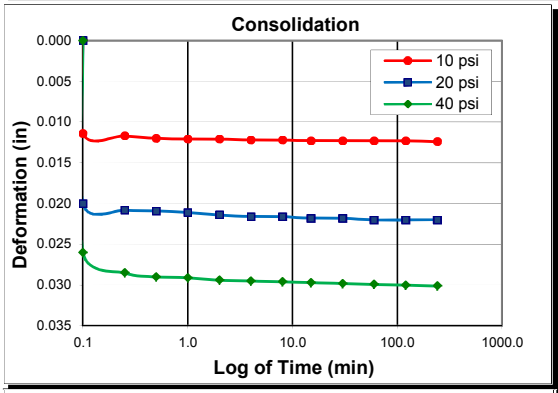
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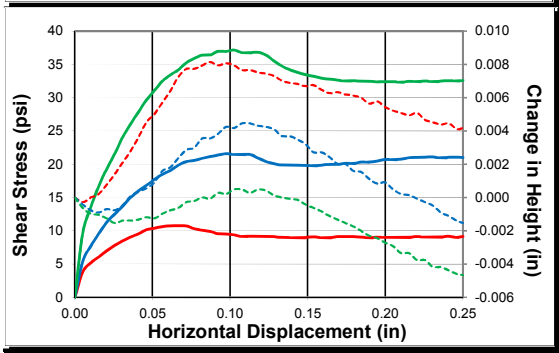
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ASTM D 3080 Direct Shear Test Report







	Linear Strength Parameters			
	Post Peak		Peak	
Friction Angle	37.1 (deg)		40.9 (deg)	
Cohesion	2.68 (psi)	386 (psf)	2.99 (psi)	431 (psf)

Specimen Number	1	2	3
Initial Sample Data			
Moisture Content-(%):	43.7%	42.1%	41.7%
Dry Density-(lb/ft^3):	76.4	77.3	78.2
Degree of Saturation-(%):	100.0%	100.0%	100.0%
Height-(in):	0.989	0.989	0.989
Diameter-(in):	2.50	2.50	2.50
Final Sample Data			
Moisture Content-(%):	41.0%	39.6%	38.4%
Dry Density-(lb/ft^3):	77.0	79.2	81.1
Degree of Saturation-(%):	100.0%	100.0%	100.0%
Height after consolidation-(in):	0.976	0.967	0.959
Height after shear-(in):	0.981	0.965	0.954
Normal Stress-(psf):	**1440**	**2880**	**5760**
Post Peak Failure Stress-(psf):	**1287**	**2848**	**4651**
Peak Failure Stress-(psf):	**1551**	**3110**	**5350**
Strain Rate-(in/min):	0.0003	0.0003	0.0003

Project Information

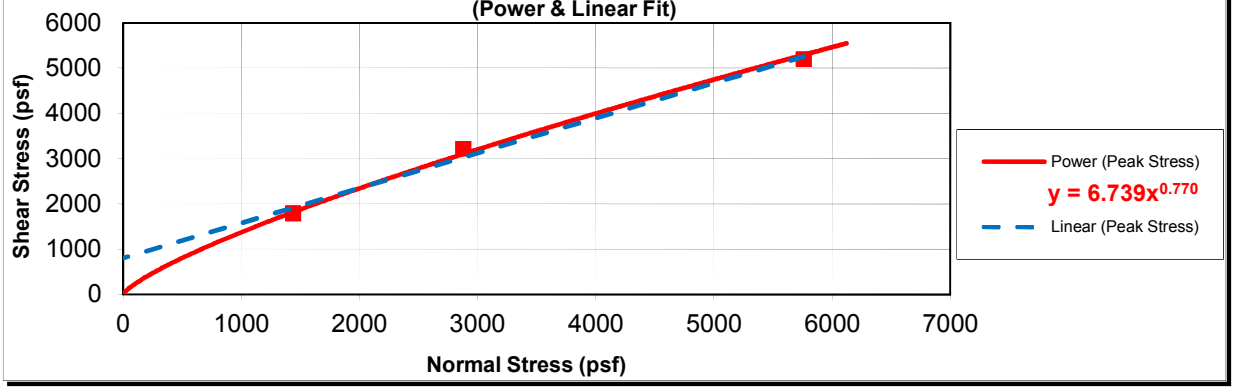
				LL	PL	PI
Project :	Phase 1 Ash Storage Area Embankment Investigation			57	52	5
Client:	AEP, Welch Power Plant					
Project Location:	Cason, Texas			-200%	67	
Material Description:	Lt. Brownish Gray Sandy Elastic Silt, (MH), Fly Ash					
ETTL Job #:	G 4207-146	**Technician:**	Owen Sanderson	**Remarks**		
Boring;	B-2 / B-11	**Sample Type:**	Composite SPT	Particles larger than the No. 10 sieve removed before molding. Sample was lightly cemented		
Depth (ft):	1'-3' / 8'-10'	**Molding Method:**	Loosely Compacted in Ring			
Test Date:	December 8, 2014	**Testing Device:**	Humboldt #1			

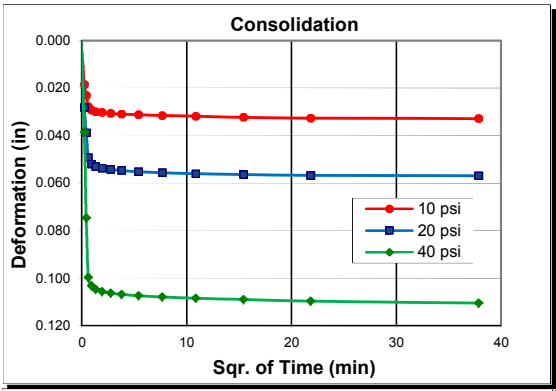
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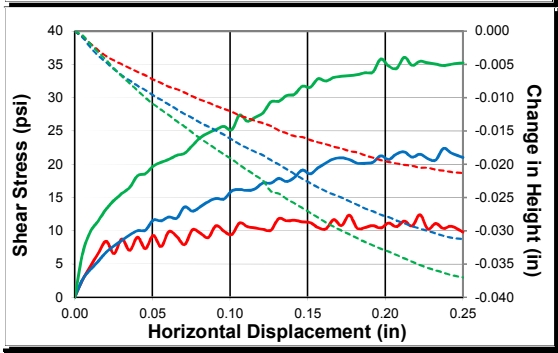
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ASTM D 3080 Direct Shear Test Report







	Linear Strength Parameters	
	Post Peak	Peak
Friction Angle	-	37.7
	(deg)	(deg)
Cohesion		5.56
	(psf)	(psf)

Specimen Number	1	2	3
Initial Sample Data			
Moisture Content-(%):	111.9%	108.9%	112.5%
Dry Density-(lb/ft^3):	40.8	41.7	40.7
Degree of Saturation-(%):	100.0%	100.0%	100.0%
Height-(in):	0.970	0.970	0.970
Diameter-(in):	2.50	2.50	2.50
Final Sample Data			
Moisture Content-(%):	104.4%	98.5%	93.7%
Dry Density-(lb/ft^3):	43.2	45.9	47.9
Degree of Saturation-(%):	100.0%	100.0%	100.0%
Height after consolidation-(in):	0.937	0.937	0.860
Height after shear-(in):	0.916	0.906	0.823
Normal Stress-(psf):	**1440**	**2880**	**5760**
Normal Stress-(psi):			
Peak Failure Stress-(psf):	**1787**	**3224**	**5195**
Strain Rate-(in/min):	0.0001	0.0001	0.0001

Project Information

				LL	PL	PI
Project :	Phase 1 Ash Storage Area Embankment Investigation			**100**	**81**	**19**
Client:	AEP, Welch Power Plant					
Project Location:	Cason, Texas			**-200%**	**100**	
Material Description:	Black Elastic Silt, (MH), Bottom Ash					
ETTL Job #:	G 4207-146	**Technician:**	Owen Sanderson	**Remarks**		
Boring;	B-6	**Sample Type:**	Composite SPT, Remolded			
Depth (ft):	13'-20'	**Molding Method:**	Pre-Consolidated to 9 psi			
Test Date:	December 6, 2014	**Testing Device:**	Humboldt #2			

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Grain Size Analysis by Hydrometer

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HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

Project	Phase 1 Ash Storage Embankment Investigaiton	**Material Origin:**	Geotechnical Boring
Client:	AEP, Welsh Power Plant	**Date Sampled:**	10/7/2014
Job Location:	Cason,Texas	**Sampled By:**	ETTL Drilling Department
ETTL Job No.:	G 4207-146	**Sample Info. Provided By:**	Owen Sanderson, ETTL
Boring / Sample Location:	B-1	**Testing Technician:**	Hermann Walka, P.E.
Sample No.:	composite **Depth (ft.):** 3'-10'	**Test Starting Date:**	12/15/2014
DESCRIPTION:	Dark Brown Silty Sand, (SM) Econamzer Ash	**Test Finishing Date:**	12/17/2014

Starting Masses and Sample Preparation	
Shape of Particles:	Angular
Hardness of Particles:	Soft
Dispersion Device:	Device A
Dispersion Time:	1 minute
Dispersion Agent:	125 mL of a 4% solution of Na -Hex.
Soaking Time:	16 hours
Hydrometer Type:	152H
Starting Mass of Air Dry (whole) sample (g):	173.10
Starting Mass of Oven Dry (whole) sample (g):	165.53
Mass of Air Dry (hydro) Sample (g):	75.00
Mass of Oven Dry (hydro) Sample (g):	71.72
Percent Retained on No. 10 Sieve:	0.00
Specific Gravity:	2.710

D 10 (mm)=	0.0210
D 15 (mm)=	0.0381
D 30 (mm)=	0.0840
D 50 (mm)=	0.2288
D 60 (mm)=	0.3370
D 85 (mm)=	1.007
Cu =	16
Cc =	1

Hydroscopic M.C. of Hydrometer	
Tare Mass (g):	29.92
Tare + Wet Mass (g):	39.98
Tare + Dry Mass (g):	39.54
M.C.%	4.57%

Sieve No.	Mass Retained (g)	%Retained	Grain Dia. (mm)	%Passing
Mechanical Sieve Analysis of Material Retaining on No. 10				
2"	0.00	0.0	50.0	100.0
1"	0.00	0.0	25.0	100.0
3/4"	0.00	0.0	19.0	100.0
3/8"	0.00	0.0	9.50	100.0
No 4	0.00	0.0	4.75	100.0
No 10	0.00	0.0	2.00	100.0
Mechanical Sieve Analysis of Material Retaining on No. 200				
40	24.30	33.9	0.425	66.1
60	34.34	47.9	0.250	52.1
100	43.12	60.1	0.150	39.9
140	43.18	60.2	0.106	39.8
200	53.64	74.8	0.075	25.2

Hydrometer Analysis of Material Passing No. 10 Sieve

Temperature Deg. (C)	Hydrometer Correction	Hydrometer Reading	Corrected Reading	(L)-Hydrometer Factor	(K)-Dia. Factor	(a)-SP.GR. Factor	Time (min)	Grain Dia. (mm)	% Soil Passing
22.0	5.1	21.0	15.9	13.8	0.01308	0.99	0.5	0.0687	22.0
22.0	5.1	17.5	12.4	14.3	0.01308	0.99	1	0.0495	17.2
22.0	5.1	15.5	10.4	14.7	0.01308	0.99	2	0.0355	14.4
22.0	5.1	12.5	7.4	15.2	0.01308	0.99	5	0.0228	10.3
22.0	5.1	11.2	6.1	15.3	0.01308	0.99	15	0.0132	8.5
21.8	5.1	10.0	4.9	15.6	0.01308	0.99	30	0.0094	6.7
21.2	5.3	8.9	3.6	15.8	0.01324	0.99	60	0.0068	4.9
22.0	5.1	7.6	2.5	16.0	0.01308	0.99	120	0.0048	3.5
20.5	5.6	6.0	0.4	16.3	0.01324	0.99	250	0.0034	0.6
21.0	5.4	5.5	0.1	16.3	0.01324	0.99	1440	0.0014	0.1

Measured Specific Gravity of Material Passing No. 10 Sieve, ASTM D 854 Method A

Air Dry M_S (grams)	Bottle #	T_t (deg. C)	M_P (grams)	V_P (mL)	$\rho_{w,t}$ (g/mL)	Oven Dry M_S (grams)	$M_{pw,t}$ (grams)	$M_{pws,t}$ (grams)	SG_t
75.00	12	21.20	162.44	499.09	0.9980	71.72	660.51	705.76	**2.710**

Per ASTM		
% Gravel =	**0.0**	**Gravel** > 4.75 (mm)
% Sand =	**74.8**	4.75 (mm) < **SAND** > .075 (mm)
% Silt =	**24.9**	.075 (mm) < **SILT** > .002 (mm)
%Clay =	**0.3**	**CLAY** < .002 (mm)

Atterberg Limits		
L.L.	P.L.	P.I.
N/P	N/P	N/P

*N/P = Non-Plastic

Note:
Particles larger than the No. 10 sieve removed before conducting test.

Estimated Hydraulic Conductivity by Beyer's equation: $K = C*(d_{10})^2$ (meters / sec)

$U = (d_{60} / d_{10}) = 16.1$

$C = (4.50E-3)\log(500 / U) = 6.72E-03$

d_{10}^2 (mm) = 4.40E-04

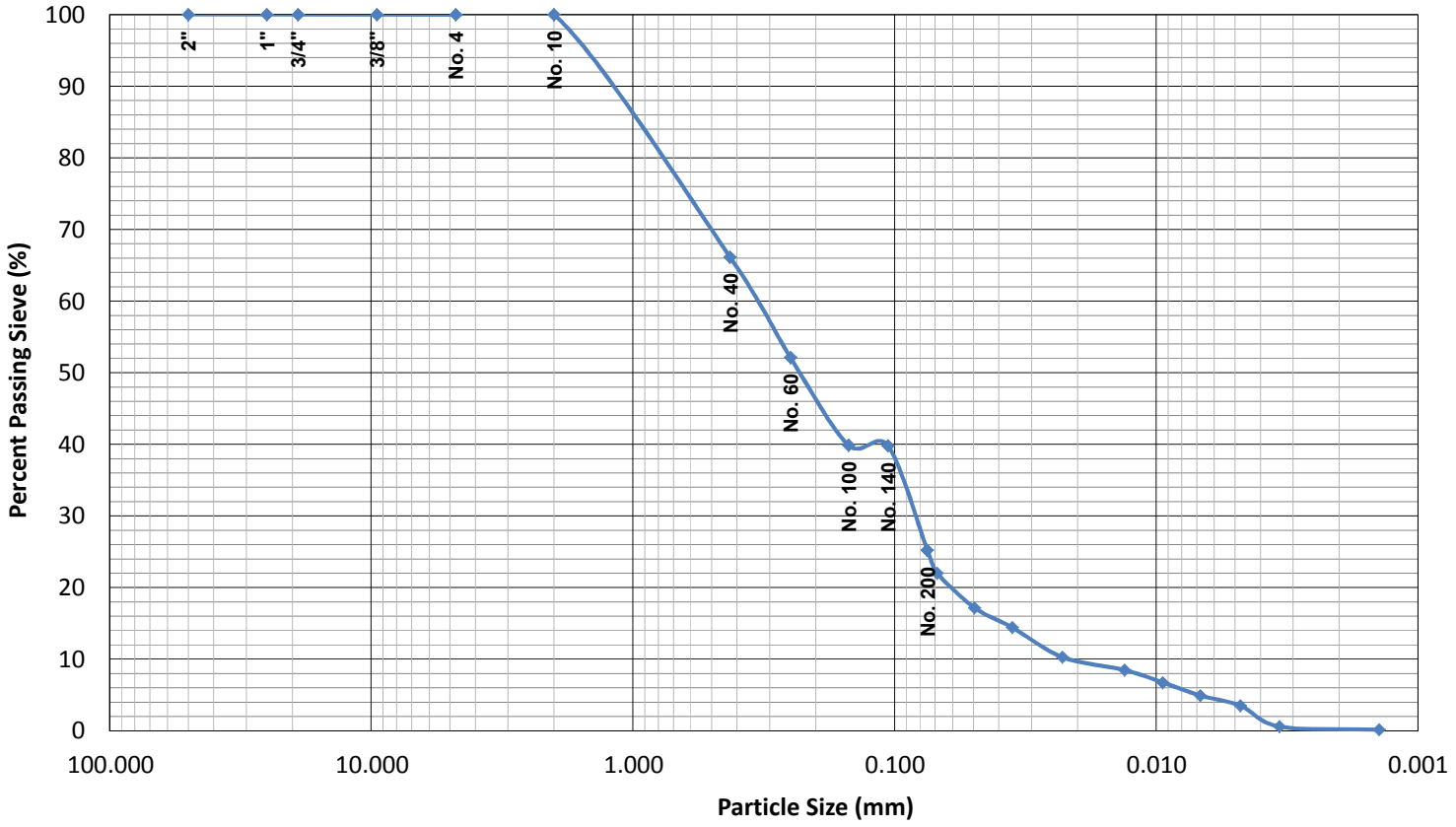
K (cm/sec) = 2.95E-04

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ASTM D 422, Particle Size Distribution Curve By Hydrometer



Sieve No.	Dia. (mm)	% Finer
2"	50.0	100.0
1"	25.0	100.0
3/4"	19.0	100.0
3/8"	9.50	100.0
No. 4	4.75	100.0
No. 10	2.00	100.0
No. 40	0.425	66.1
No. 60	0.250	52.1
No. 100	0.150	39.9
No. 140	0.106	39.8
No. 200	0.075	25.2
Hydrometer Analysis	0.0687	22.0
	0.0495	17.2
	0.0355	14.4
	0.0228	10.3
	0.0132	8.5
	0.0094	6.7
	0.0068	4.9
	0.0048	3.5
	0.0034	0.6
	0.0014	0.1

L.L.	N/P
P.L.	N/P
P.I.	N/P

% Sand	74.8
% Silt	24.9
% Clay	0.3

D_{85}	1.0075
D_{60}	0.3370
D_{50}	0.2288
D_{30}	0.0840
D_{15}	0.0381
D_{10}	0.0210
C_u	16
C_c	1

		Location	Sample No.	Depth (ft)	Description and Classification	Specific Gravity	Technician
PROJECT NAME:	Phase 1 Ash Storage Embankment Investigaiton						
Client:	AEP, Welsh Power Plant				Dark Brown Silty Sand, (SM) Econamzer Ash		Hermann Walka, P.E.
ETTL Inc. Job #	G 4207-146	B-1	composite	3'-10'		2.710	Date: 12/17/14

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GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

Project	Phase 1 Ash Storage Embankment Investigaiton	**Material Origin:**	Geotechnical Boring
Client:	AEP, Welsh Power Plant	**Date Sampled:**	10/8/2014
Job Location:	Cason,Texas	**Sampled By:**	ETTL Drilling Department
ETTL Job No.:	G 4207-146	**Sample Info. Provided By:**	Owen Sanderson, ETTL
Boring / Sample Location:	B-5	**Testing Technician:**	Owen Sanderson
Sample No.:	**Depth (ft.):** 28'-30'	**Test Starting Date:**	12/31/2014
DESCRIPTION:	Light Gray & Reddish Borwn Fat Clay, (CH)	**Test Finishing Date:**	12/31/2014

Starting Masses and Sample Preparation	
Shape of Particles:	N/A
Hardness of Particles:	N/A
Dispersion Device:	Device A
Dispersion Time:	1 minute
Dispersion Agent:	125 mL of a 4% solution of Na -Hex.
Soaking Time:	16 hours
Hydrometer Type:	152H
Starting Mass (whole) sample (g):	200.00
Starting Mass of Oven Dry (whole) sample (g):	159.75
Mass of (hydro) Sample (g):	58.84
Mass of Oven Dry (hydro) Sample (g):	47.00
Percent Retained on No. 10 Sieve:	0.00
Assumed Specific Gravity:	2.670

D 10 (mm)=	N/A
D 15 (mm)=	N/A
D 30 (mm)=	N/A
D 50 (mm)=	0.0057
D 60 (mm)=	0.0113
D 85 (mm)=	0.070
Cu =	N/A
Cc =	N/A

Hydroscopic M.C. of Hydrometer	
Tare Mass (g):	31.61
Tare + Wet Mass (g):	55.31
Tare + Dry Mass (g):	50.54
M.C.%	25.20%

Sieve No.	Mass Retained (g)	%Retained	Grain Dia. (mm)	%Passing
Mechanical Sieve Analysis of Material Retaining on No. 10				
2"	0.00	0.0	50.0	100.0
1"	0.00	0.0	25.0	100.0
3/4"	0.00	0.0	19.0	100.0
3/8"	0.00	0.0	9.50	100.0
No 4	0.00	0.0	4.75	100.0
No 10	0.00	0.0	2.00	100.0
Mechanical Sieve Analysis of Material Retaining on No. 200				
40	0.66	1.4	0.425	98.6
60	0.93	2.0	0.250	98.0
100	1.24	2.6	0.150	97.4
140	4.38	9.3	0.106	90.7
200	6.69	14.2	0.075	85.8

Hydrometer Analysis of Material Passing No. 10 Sieve

Temperature Deg. (C)	Hydrometer Correction	Hydrometer Reading	Corrected Reading	(L)-Hydrometer Factor	(K)-Dia. Factor	(a)-SP.GR. Factor	Time (min)	Grain Dia. (mm)	% Soil Passing
21.2	5.3	44.5	39.2	9.9	0.01340	1.00	0.5	0.0596	83.3
21.2	5.3	41.0	35.7	10.6	0.01340	1.00	1	0.0436	75.9
21.2	5.3	39.0	33.7	10.9	0.01340	1.00	2	0.0313	71.6
21.0	5.4	37.0	31.6	11.2	0.01340	1.00	5	0.0201	67.2
21.0	5.4	34.0	28.6	11.7	0.01340	1.00	15	0.0118	60.9
21.0	5.4	31.2	25.8	12.2	0.01340	1.00	30	0.0085	54.9
20.5	5.6	29.5	23.9	12.5	0.01340	1.00	60	0.0061	50.9
20.5	5.6	27.6	22.0	12.7	0.01340	1.00	120	0.0044	46.9
20.5	5.6	26.2	20.6	13.0	0.01340	1.00	250	0.0031	43.9
20.5	5.6	25.0	19.4	13.2	0.01340	1.00	1440	0.0013	41.3

Per ASTM		
% Gravel =	**0.0**	**Gravel** > 4.75 (mm)
% Sand =	**14.2**	4.75 (mm) < **SAND** > .075 (mm)
% Silt =	**43.4**	.075 (mm) < **SILT** > .002 (mm)
%Clay =	**42.4**	**CLAY** < .002 (mm)

Note:

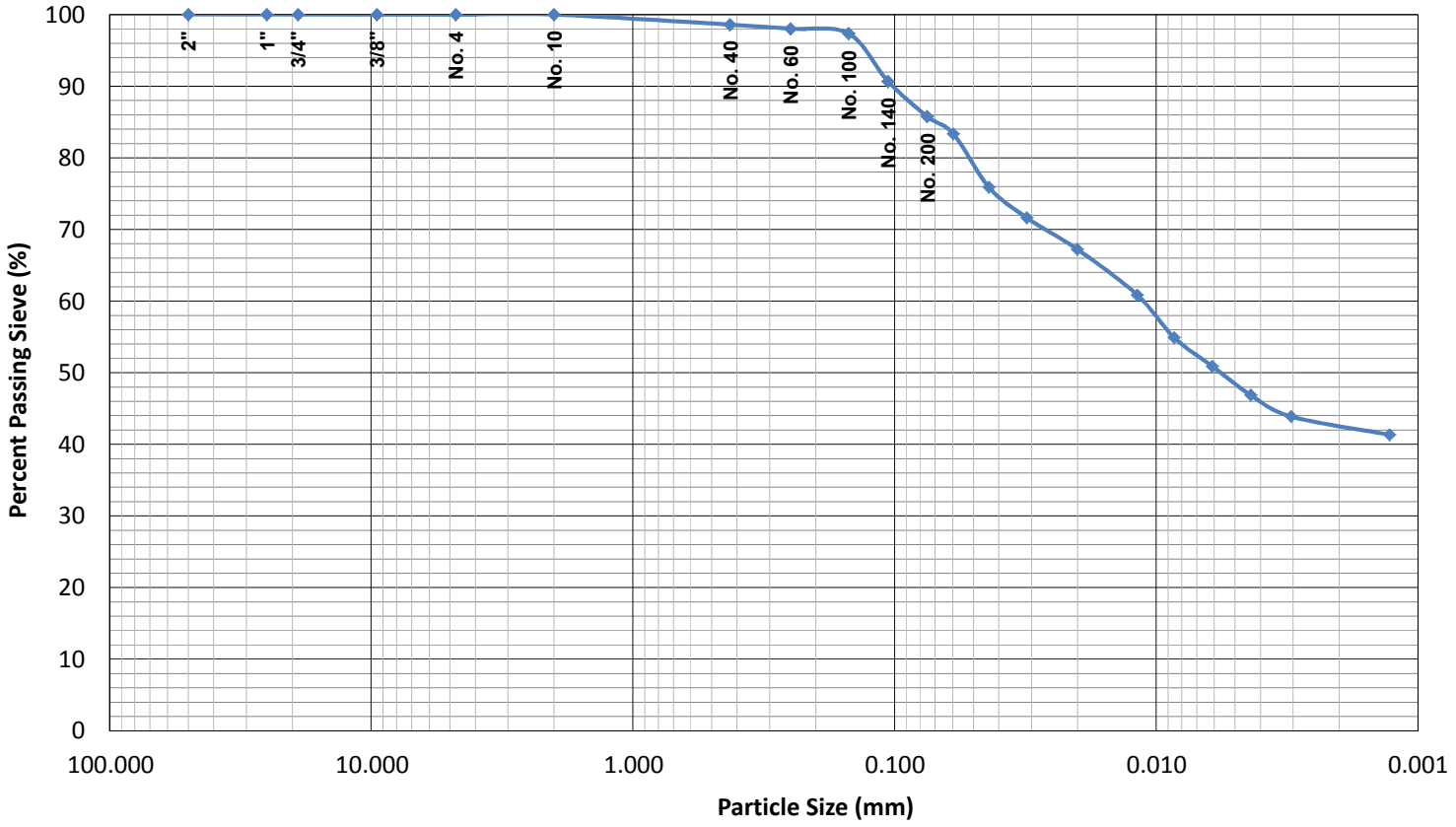
Atterberg Limits		
L.L.	**P.L.**	**P.I.**
58	**20**	**38**

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ASTM D 422, Particle Size Distribution Curve By Hydrometer



Sieve No.	Dia. (mm)	% Finer
2"	50.0	100.0
1"	25.0	100.0
3/4"	19.0	100.0
3/8"	9.50	100.0
No. 4	4.75	100.0
No. 10	2.00	100.0
No. 40	0.425	98.6
No. 60	0.250	98.0
No. 100	0.150	97.4
No. 140	0.106	90.7
No. 200	0.075	85.8
Hydrometer Analysis	0.0596	83.3
	0.0436	75.9
	0.0313	71.6
	0.0201	67.2
	0.0118	60.9
	0.0085	54.9
	0.0061	50.9
	0.0044	46.9
	0.0031	43.9
	0.0013	41.3

L.L.	58
P.L.	20
P.I.	38

% Sand	14.2
% Silt	43.4
% Clay	42.4

D_{85}	0.0698
D_{60}	0.0113
D_{50}	0.0057
D_{30}	N/A
D_{15}	N/A
D_{10}	N/A
C_u	N/A
C_c	N/A

PROJECT NAME:	Phase 1 Ash Storage Embankment Investigaiton	Location	Sample No.	Depth (ft)	Description and Classification	Assumed S.G.	Technician
Client:	AEP, Welsh Power Plant				Light Gray & Reddish Borwn Fat Clay, (CH)		Owen Sanderson
ETTL Inc. Job #	G 4207-146	B-5		28'-30'		2.670	Date: 12/31/14

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GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

HYDROMETER AND MECHANICAL ANALYSIS OF SOIL BINDER, ASTM D422

Project	Phase 1 Ash Storage Embankment Investigaiton	**Material Origin:**	Geotechnical Boring
Client:	AEP, Welsh Power Plant	**Date Sampled:**	10/7/2014
Job Location:	Cason,Texas	**Sampled By:**	ETTL Drilling Department
ETTL Job No.:	G 4207-146	**Sample Info. Provided By:**	Owen Sanderson, ETTL
Boring / Sample Location:	B-11	**Testing Technician:**	Hermann Walka, P.E.
Sample No.:	**Depth (ft.):** 18'-20'	**Test Starting Date:**	1/7/2015
DESCRIPTION:	Black Elastic Silt, (MH) Bottom Ash	**Test Finishing Date:**	1/9/2015

Starting Masses and Sample Preparation	
Shape of Particles:	N/A
Hardness of Particles:	N/A
Dispersion Device:	Device A
Dispersion Time:	1 minute
Dispersion Agent:	125 mL of a 4% solution of Na -Hex.
Soaking Time:	16 hours
Hydrometer Type:	152H
Starting Mass of Air Dry (whole) sample (g):	320.00
Starting Mass of Oven Dry (whole) sample (g):	238.12
Mass of Air Dry (hydro) Sample (g):	34.04
Mass of Oven Dry (hydro) Sample (g):	25.33
Percent Retained on No. 10 Sieve:	0.00
Assumed Specific Gravity:	2.32

D 10 (mm)=	N/A
D 15 (mm)=	N/A
D 30 (mm)=	0.0025
D 50 (mm)=	0.0060
D 60 (mm)=	0.0083
D 85 (mm)=	0.025
Cu =	N/A
Cc =	N/A

Hygroscopic M.C. of Hydrometer	
Tare Mass (g):	29.86
Tare + Wet Mass (g):	43.03
Tare + Dry Mass (g):	39.66
M.C.%	34.4%

Sieve No.	Mass Retained (g)	%Retained	Grain Dia. (mm)	%Passing
Mechanical Sieve Analysis of Material Retaining on No. 10				
2"	0.00	0.0	50.0	100.0
1"	0.00	0.0	25.0	100.0
3/4"	0.00	0.0	19.0	100.0
3/8"	0.00	0.0	9.50	100.0
No 4	0.00	0.0	4.75	100.0
No 10	0.00	0.0	2.00	100.0
Mechanical Sieve Analysis of Material Retaining on No. 200				
40	0.00	0.0	0.425	100.0
60	0.00	0.0	0.250	100.0
100	0.26	1.0	0.150	99.0
140	0.38	1.5	0.106	98.5
200	0.65	2.6	0.075	97.4

Hydrometer Analysis of Material Passing No. 10 Sieve

Temperature Deg. (C)	Hydrometer Correction	Hydrometer Reading	Corrected Reading	(L)-Hydrometer Factor	(K)-Dia. Factor	(a)-SP.GR. Factor	Time (min)	Grain Dia. (mm)	% Soil Passing
20.5	5.6	27.5	21.9	12.9	0.01438	1.05	0.5	0.0730	90.9
20.5	5.6	27.0	21.4	12.9	0.01438	1.05	1	0.0516	88.8
20.5	5.6	26.5	20.9	13.0	0.01438	1.05	2	0.0367	86.7
20.5	5.6	26.0	20.4	13.0	0.01438	1.05	5	0.0232	84.7
20.5	5.6	24.0	18.4	13.3	0.01438	1.05	15	0.0135	76.4
20.5	5.6	21.5	15.9	13.8	0.01438	1.05	30	0.0098	66.0
20.0	5.7	18.8	13.1	14.2	0.01456	1.05	60	0.0071	54.1
20.0	5.7	16.8	11.1	14.5	0.01456	1.05	120	0.0051	45.8
19.5	5.9	14.7	8.8	15.0	0.01456	1.05	250	0.0036	36.4
19.5	5.9	10.9	5.0	15.6	0.01456	1.05	1440	0.0015	20.6

Measured Specific Gravity of Material Passing No. 10 Sieve, ASTM D 854 Method A

Air Dry M_S (grams)	Bottle #	T_t (deg. C)	M_P (grams)	V_P (mL)	$\rho_{w,t}$ (g/mL)	Oven Dry M_S (grams)	$M_{pw,t}$ (grams)	$M_{pws,t}$ (grams)	SG_t
17.79	11	25.50	179.23	499.22	0.9969	16.23	676.91	686.14	**2.32**

Per ASTM		
% Gravel =	**0.0**	**Gravel** > 4.75 (mm)
% Sand =	**2.6**	4.75 (mm) < **SAND** > .075 (mm)
% Silt =	**73.1**	.075 (mm) < **SILT** > .002 (mm)
%Clay =	**24.4**	**Clay Fraction** < .002 (mm)

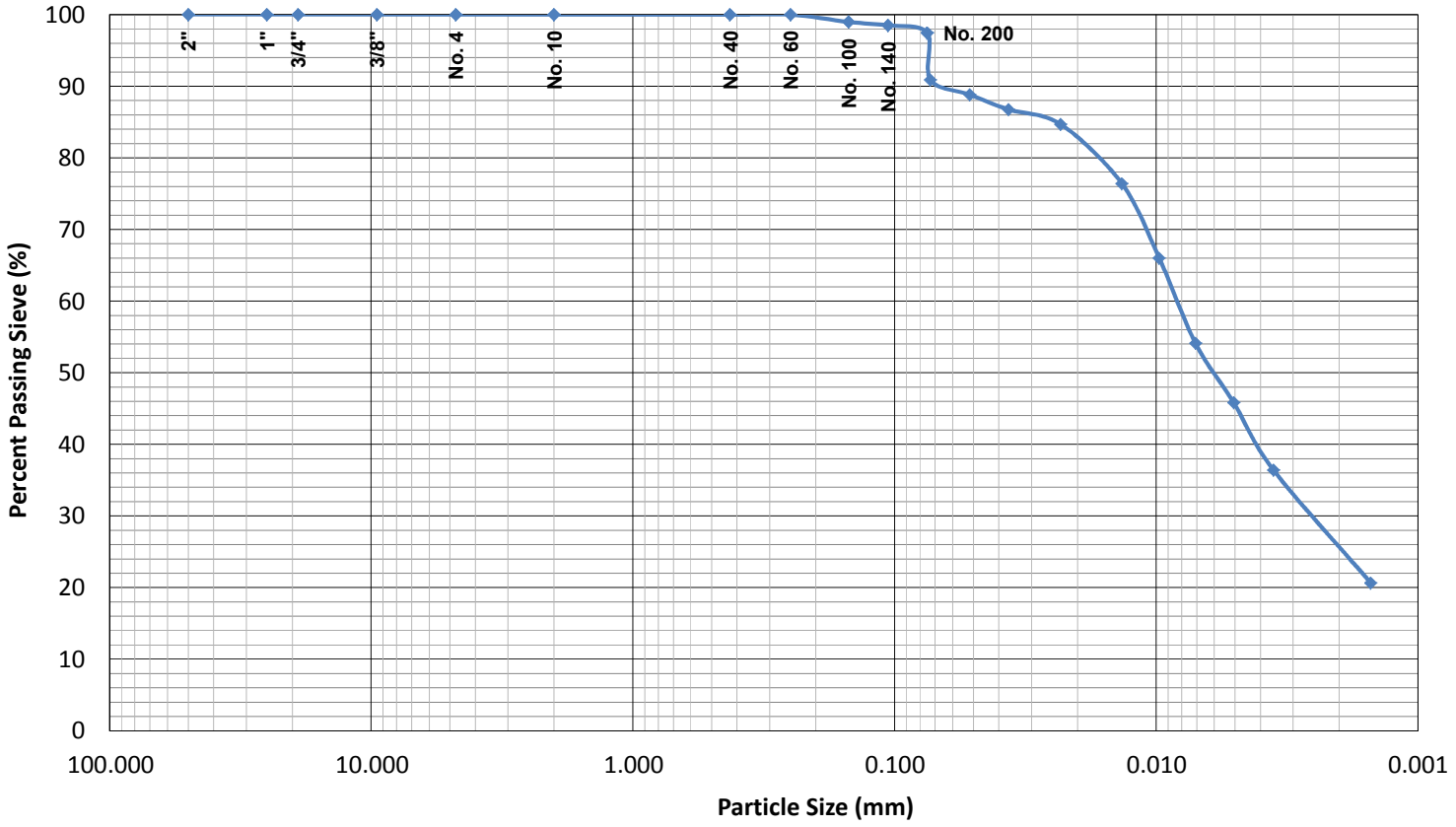
Atterberg Limits		
L.L.	**P.L.**	**P.I.**
124	**107**	**17**

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ASTM D 422, Particle Size Distribution Curve By Hydrometer



Sieve No.	Dia. (mm)	% Finer
2"	50.0	100.0
1"	25.0	100.0
3/4"	19.0	100.0
3/8"	9.50	100.0
No. 4	4.75	100.0
No. 10	2.00	100.0
No. 40	0.425	100.0
No. 60	0.250	100.0
No. 100	0.150	99.0
No. 140	0.106	98.5
No. 200	0.075	97.4
Hydrometer Analysis	0.0730	90.9
	0.0516	88.8
	0.0367	86.7
	0.0232	84.7
	0.0135	76.4
	0.0098	66.0
	0.0071	54.1
	0.0051	45.8
	0.0036	36.4
	0.0015	20.6

L.L.	124
P.L.	107
P.I.	17

% Sand	2.6
% Silt	73.1
% Fines	24.4

D_{85}	0.0249
D_{60}	0.0083
D_{50}	0.0060
D_{30}	0.0025
D_{15}	N/A
D_{10}	N/A
C_u	N/A
C_c	N/A

PROJECT NAME:	Phase 1 Ash Storage Embankment Investigaiton	Location	Sample No.	Depth (ft)	Description and Classification	Assumed S.G.	Technician
Client:	AEP, Welsh Power Plant				Black Elastic Silt, (MH) Bottom Ash		Hermann Walka, P.E.
ETTL Inc. Job #	G 4207-146	B-11		18'-20'		2.450	Date: 01/09/15

Hydraulic Conductivity by Mercury Permeameter

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

Hydraulic Conductivity Determination Flexible Wall Permeameter (Mercury Permometer Test) ASTM D 5084, Method E

Project Information

Project: Phase 1 Ash Storage Area Embankment Investigation
Client/Arch./Engr.: AEP, Welch Power Plant
Project Location: Cason, Texas
Job No.: G 4207-146

Sample Information

Location / Boring No: **B-6**
Sample No.: Depth (ft.): **13-20** **ft.**
Material Origin: Geotechncial Boring, Composite SPT sample, Remolded
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Black Elastic Silt, (MH), Bottom Ash
Sampled By: ETTL Drilling Department Date Sampled: 10/11/2014
Technician: Hermann Walka, P.E. Test Date: 12/9/2014

Sample Data

Initial Sample Data

Wet Wt: of Sample :	37.98	g
Diameter :	1.364	in
Length :	1.133	in
Area:	1.462	in^2
Volume :	1.657	in^3
Unit Wt.(wet):	**87.3**	pcf
Unit Wt.(dry):	**41.4**	pcf
Specific Gravity:	2.32	
Calculated % saturation:	102.9	
Void ratio (e) =	2.50	
Porosity (n)=	0.71	
Measured B-Value:	100.0	%

Moisture Content Data

	Before Test	After Test
Tare Wt:	70.78	66.59
Wet Wt.+tare:	82.80	102.22
Dry Wt.+tare:	76.48	84.42
Dry Wt. Soil:	5.70	17.83
Water Wt.:	6.32	17.80
% moist.:	**110.9**	**99.8**

Molding Properties

Molding/Preparation Method: Pre-consolidated with 9.5 psi, Remolded
Max Dry Density(pcf) = OMC =
% of Max Density = +/- OMC =
LL: 100 PI: 19 -200%: 100

Test Readings

Z_1(Mercury Height Difference @ t_1): 5.2 cm Hydraulic Gradient = 22.61

Reading Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)
12/9/2014	184	5.5	1.162	25.0	0.889	9.43E-07	2.67E-03
12/9/2014	246	5.3	1.362	25.0	0.889	8.48E-07	2.40E-03
12/9/2014	326	5.1	1.562	25.0	0.889	7.54E-07	2.14E-03
12/9/2014	427	4.9	1.762	25.0	0.889	6.68E-07	1.89E-03

Summary Table

Hydraulic conductivity	**k =**	**8.03E-07**	**cm/sec**	**2.28E-03**	**ft/day**
Void Ratio	e =	2.50			
Porosity	n =	0.71			
Bulk Density	γ =	1.40	g/cm^3	87.3	pcf
Water Content	W =	0.74	cm^3/cm^3	(at 20 deg)	
Intrinsic Permeability	k_{int} =	8.23E-12	cm^-	(at 20 deg)	

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Hydraulic Conductivity Determination Flexible Wall Permeameter (Mercury Permometer Test) ASTM D 5084, Method E

Project Information

Project: Phase 1 Ash Storage Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Project Location: Cason, Texas
Job No.: G 4207-146

Sample Information

Location / Boring No: **Sample #1, Remolded Sandy Lean Clay**
Sample No.: Depth (ft.): **ft.**
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Redd. Brown & Light Brown Sandy Lean Clay, (CL)
Sampled By: ETTL Drilling Department Date Sampled: 10/7/2014
Technician: Hermann Walka, P.E. Test Date: 12/14/2014

Sample Data

Initial Sample Data

Wet Wt: of Sample :	149.82	g
Diameter :	1.399	in
Length :	2.929	in
Area:	1.538	in^2
Volume :	4.504	in^3
Unit Wt.(wet):	**126.7**	pcf
Unit Wt.(dry):	**108.4**	pcf
Assumed Specific Gravity:	2.67	
Calculated % saturation:	83.5	
Void ratio (e) =	0.54	
Porosity (n)=	0.35	
Measured B-Value:	99.0	%

Moisture Content Data

Before Test		After Test	
Tare Wt:	0.00	Tare Wt:	72.25
Wet Wt.+tare:	149.82	Wet Wt.+tare:	225.47
Dry Wt.+tare:	128.28	Dry Wt.+tare:	200.53
Dry Wt. Soil:	128.28	Dry Wt. Soil:	128.28
Water Wt.:	21.54	Water Wt.:	24.94
% moist.:	**16.8**	% moist.:	**19.4**

Molding Properties

Molding/Preparation Method: Molded to 95% Max Den. based on MDI
Estimated Max Dry Density(pcf) = 111.5 Est. OMC = 15.0
% of Max Density = 97.3 +/- OMC = 1.8
LL: 29 PI: 11 -200%: 63

Test Readings

Z_1(Mercury Height Difference @ t_1): 2.5 cm Hydraulic Gradient = 4.19

Reading Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)
12/15/2014	24	3.4	0.678	25.0	0.889	2.23E-05	6.33E-02
12/15/2014	32	3.2	0.878	25.0	0.889	2.30E-05	6.52E-02
12/15/2014	41	3.0	1.078	25.0	0.889	2.35E-05	6.67E-02
12/15/2014	51	2.8	1.278	25.0	0.889	2.41E-05	6.84E-02

Summary Table

Hydraulic conductivity	**k =**	**2.32E-05**	**cm/sec**	**6.59E-02**	**ft/day**
Void Ratio	e =	0.54			
Porosity	n =	0.35			
Bulk Density	γ =	2.03	g/cm^3	126.7	pcf
Water Content	W =	0.29	cm^3/cm^3	(at 20 deg)	
Intrinsic Permeability	k_{int} =	2.38E-10	cm^-	(at 20 deg)	

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Hydraulic Conductivity Determination Flexible Wall Permeameter (Mercury Permometer Test) ASTM D 5084, Method E

Project Information

Project: Phase 1 Ash Storage Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Project Location: Cason, Texas
Job No.: G 4207-146

Sample Information

Location / Boring No: **Sample #2, Remolded Fat Clay**
Sample No.: Depth (ft.): **ft.**
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Redd. Brown & Light Gray Fat Clay with sand, (CH)
Sampled By: ETTL Drilling Department Date Sampled: 10/7/2014
Technician: Hermann Walka, P.E. Test Date: 12/22/2014

Sample Data

Initial Sample Data

Wet Wt: of Sample :	65.86	g
Diameter :	1.395	in
Length :	1.368	in
Area:	1.528	in^2
Volume :	2.091	in^3
Unit Wt.(wet):	**119.9**	pcf
Unit Wt.(dry):	**97.4**	pcf
Assumed Specific Gravity:	2.67	
Calculated % saturation:	86.8	
Void ratio (e) =	0.71	
Porosity (n)=	0.42	
Measured B-Value:	97.0	%

Moisture Content Data

Before Test		After Test	
Tare Wt:	69.11	Tare Wt:	69.60
Wet Wt.+tare:	82.43	Wet Wt.+tare:	139.33
Dry Wt.+tare:	79.93	Dry Wt.+tare:	123.30
Dry Wt. Soil:	10.82	Dry Wt. Soil:	53.70
Water Wt.:	2.50	Water Wt.:	16.03
% moist.:	**23.1**	% moist.:	**29.9**

Molding Properties

Molding/Preparation Method: Molded to 95% Max Den. based on MDI
Estimated Max Dry Density(pcf) = 100.0 Est. OMC = 21.4
% of Max Density = 97.4 +/- OMC = 1.7
LL: 62 PI: 42 -200%: 78

Test Readings

Z_1(Mercury Height Difference @ t_1): 3.6 cm Hydraulic Gradient = 12.88

Reading Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)
12/24/2014	2521	3.7	1.412	24.0	0.910	1.63E-07	4.61E-04
12/24/2014	2809	3.6	1.512	24.0	0.910	1.60E-07	4.54E-04
12/24/2014	3101	3.5	1.612	24.0	0.910	1.58E-07	4.49E-04
12/24/2014	3440	3.4	1.712	24.0	0.910	1.56E-07	4.41E-04

Summary Table

Hydraulic conductivity	**k =**	**1.59E-07**	**cm/sec**	**4.51E-04**	**ft/day**
Void Ratio	e =	0.71			
Porosity	n =	0.42			
Bulk Density	γ =	1.92	g/cm^3	119.9	pcf
Water Content	W =	0.36	cm^3/cm^3	(at 20 deg)	
Intrinsic Permeability	k_{int} =	1.63E-12	cm^-	(at 20 deg)	

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Hydraulic Conductivity Determination Flexible Wall Permeameter (Mercury Permometer Test) ASTM D 5084, Method E

Project Information

Project: Phase 1 Ash Storage Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Project Location: Cason, Texas
Job No.: G 4207-146

Sample Information

Location / Boring No: **B-13**
Sample No.: | Depth (ft.): **7'-9'** **ft.**
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Reddish Brown, Light Brown & Light Gray Sandy Lean Clay, (CL)
Sampled By: ETTL Drilling Department Date Sampled: 10/7/2014
Technician: Owen Sanderson, ETTL Test Date: 2/17/2015

Sample Data

Initial Sample Data

Wet Wt: of Sample :	545.33	g
Diameter :	2.707	in
Length :	2.715	in
Area:	5.754	in^2
Volume :	15.62	in^3
Unit Wt.(wet):	**132.9**	pcf
Unit Wt.(dry):	**114.8**	pcf
Calculated % saturation:	93.2	%
Assumed Specific Gravity:	2.67	
Void ratio (e) =	0.45	
Porosity (n)=	0.31	
Measured B-Value:	99.0	%
Cell Presure:	60.0	psi
Back Presure:	57.0	psi
Max/Min Stress:	3.0	psi

Moisture Content Data

Before Test		After Test	
Tare Wt:	132.79	Tare Wt:	68.95
Wet Wt.+tare:	228.06	Wet Wt.+tare:	619.15
Dry Wt.+tare:	215.09	Dry Wt.+tare:	539.95
Dry Wt. Soil:	82.30	Dry Wt. Soil:	471.00
Water Wt.:	12.97	Water Wt.:	79.20
% moist.:	**15.8**	% moist.:	**16.8**

Molding Properties

Molding/Preparation Method: Trimmed Shelby Tube
Estimated Max Dry Density(pcf) = Est. OMC =
% of Max Density = +/- OMC =

LL: 40 PI: 23 -200%: 67.6

Test Readings

Z_1(Mercury Height Difference @ t_1): 5.1 cm Hydraulic Gradient = 9.24

Reading Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)
2/18/2015	870	5.7	0.959	25.0	0.889	1.00E-07	2.83E-04
2/18/2015	1005	5.6	1.059	25.0	0.889	9.68E-08	2.74E-04
2/18/2015	1128	5.5	1.159	25.0	0.889	9.56E-08	2.71E-04
2/18/2015	1263	5.4	1.259	25.0	0.889	9.40E-08	2.66E-04

Summary Table

Hydraulic conductivity	**k =**	**9.66E-08**	**cm/sec**	**2.74E-04**	**ft/day**
Void Ratio	e =	0.45			
Porosity	n =	0.31			
Bulk Density	γ =	2.13	g/cm^3	132.9	pcf
Water Content	W =	0.29	cm^3/cm^3	(at 20 deg (	
Intrinsic Permeability	k_{int} =	9.90E-13	cm^2	(at 20 deg (	

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Hydraulic Conductivity Determination Flexible Wall Permeameter (Mercury Permometer Test) ASTM D 5084, Method E

Project Information

Project: Phase 1 Ash Storage Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Project Location: Cason, Texas
Job No.: G 4207-146

Sample Information

Location / Boring No: **B-15**
Sample No.: | Depth (ft.): **8'-10'** **ft.**
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Grayish Brown & Light Gray with Redd. Brown Fat Clay, (CH) with ferrics partings
Sampled By: ETTL Drilling Department Date Sampled: 10/7/2014
Technician: Owen Sanderson, ETTL Test Date: 2/17/2015

Sample Data

Initial Sample Data

Wet Wt: of Sample :	526.77	g
Diameter :	2.720	in
Length :	2.782	in
Area:	5.811	in^2
Volume :	16.17	in^3
Unit Wt.(wet):	**124.1**	pcf
Unit Wt.(dry):	**98.6**	pcf
Calculated % saturation:	99.9	%
Assumed Specific Gravity:	2.67	
Void ratio (e) =	0.69	
Porosity (n)=	0.41	
Measured B-Value:	99.0	%
Cell Presure:	60.0	psi
Back Presure:	57.0	psi
Max/Min Stress:	3.0	psi

Moisture Content Data

Before Test		After Test	
Tare Wt:	69.46	Tare Wt:	68.14
Wet Wt.+tare:	180.50	Wet Wt.+tare:	605.30
Dry Wt.+tare:	157.70	Dry Wt.+tare:	493.04
Dry Wt. Soil:	88.24	Dry Wt. Soil:	424.90
Water Wt.:	22.80	Water Wt.:	112.26
% moist.:	**25.8**	% moist.:	**26.4**

Molding Properties

Molding/Preparation Method: Trimmed Shelby Tube

Estimated Max Dry Density(pcf) = Est. OMC =
% of Max Density = +/- OMC =

LL: 59 PI: 38 -200%: 85

Test Readings

Z_1(Mercury Height Difference @ t_1): 5.1 cm Hydraulic Gradient = 9.02

Reading Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)
2/18/2015	3480	6.1	0.559	25.0	0.889	1.41E-08	4.00E-05
2/18/2015	4980	6.0	0.659	25.0	0.889	1.18E-08	3.33E-05
2/18/2015	6720	5.9	0.759	25.0	0.889	1.01E-08	2.88E-05
2/18/2015	9420	5.7	0.939	25.0	0.889	9.15E-09	2.59E-05

Summary Table

Hydraulic conductivity	**k =**	**1.13E-08**	**cm/sec**	**3.20E-05**	**ft/day**
Void Ratio	e =	0.69			
Porosity	n =	0.41			
Bulk Density	γ =	1.99	g/cm^3	124.1	pcf
Water Content	W =	0.41	cm^3/cm^3	(at 20 deg)	
Intrinsic Permeability	k_{int} =	1.16E-13	cm^2	(at 20 deg)	

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Hydraulic Conductivity Determination Flexible Wall Permeameter (Mercury Permometer Test) ASTM D 5084, Method E

Project Information

Project: Phase 1 Ash Storage Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Project Location: Cason, Texas
Job No.: G 4207-146

Sample Information

Location / Boring No: **B-22**
Sample No.: | Depth (ft.): **33'-35'** **ft.**
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Grayish Brown, Yellowish Brown & Redd. Brown Sandy Lean Clay, (CL) with sand pockets
Sampled By: ETTL Drilling Department Date Sampled: 10/7/2014
Technician: Owen Sanderson, ETTL Test Date: 2/17/2015

Sample Data

Initial Sample Data

Wet Wt: of Sample :	535.53	g
Diameter :	2.747	in
Length :	2.746	in
Area:	5.925	in^2
Volume :	16.27	in^3
Unit Wt.(wet):	**125.3**	pcf
Unit Wt.(dry):	**103.7**	pcf
Calculated % saturation:	91.7	%
Assumed Specific Gravity:	2.67	
Void ratio (e) =	0.61	
Porosity (n)=	0.38	
Measured B-Value:	99.0	%
Cell Presure:	60.0	psi
Back Presure:	57.0	psi
Max/Min Stress:	3.0	psi

Moisture Content Data

Before Test		After Test	
Tare Wt:	126.74	Tare Wt:	69.07
Wet Wt.+tare:	207.40	Wet Wt.+tare:	617.26
Dry Wt.+tare:	193.47	Dry Wt.+tare:	511.70
Dry Wt. Soil:	66.73	Dry Wt. Soil:	442.63
Water Wt.:	13.93	Water Wt.:	105.56
% moist.:	**20.9**	% moist.:	**23.8**

Molding Properties

Molding/Preparation Method: Trimmed Shelby Tube
Estimated Max Dry Density(pcf) = Est. OMC =
% of Max Density = +/- OMC =

LL: 49 PI: 32 -200%: 61.3

Test Readings

Z_1(Mercury Height Difference @ t_1): 5.2 cm Hydraulic Gradient = 9.33

Reading Date	elapsed t (seconds)	Z (pipet @ t)	ΔZp (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)
2/18/2015	4920	5.9	0.812	25.0	0.889	1.41E-08	4.00E-05
2/18/2015	6720	5.6	1.062	25.0	0.889	1.39E-08	3.95E-05
2/18/2015	9360	5.3	1.412	25.0	0.889	1.39E-08	3.94E-05
2/18/2015	12960	4.8	1.862	25.0	0.889	1.41E-08	4.00E-05

Summary Table

Hydraulic conductivity	**k =**	**1.40E-08**	**cm/sec**	**3.97E-05**	**ft/day**
Void Ratio	e =	0.61			
Porosity	n =	0.38			
Bulk Density	γ =	2.01	g/cm^3	125.3	pcf
Water Content	W =	0.35	cm^3/cm^3	(at 20 deg (	
Intrinsic Permeability	k_{int} =	1.44E-13	cm^2	(at 20 deg (	

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Unit Weight Determination by Direct Measurement

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Laboratory Determination of Density (Unit Weight) of Soil Specimens, ASTM D 7263

Method B, Direct Measurement

Project Information

Project: Phase 1 Ash Storage Area Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Location: Cason, Texas
ETTL Job No.: G 4207-14

Sample Information

Boring No: **B-4**
Sample No.: _____ Depth: **18-20** **ft.** Date Sampled: 10/8/2014
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Black Elastic Silt, (MH) Bottom Ash
Sampled By: ETTL Drilling Department
Technician: Owen Sanderson, ETTL Test Date: 12/30/2014
Sample Type: Disturbed SPT Sample, Trimmed

Test Data

Minimum of 3 Readings

	Diameter (in)	Height (in)	
Diameter (top)	1.386	2.369	Height 1
Diameter (Middle)	1.380	2.374	Height 2
Diameter (bottom)	1.391	2.371	Height 3

Sample Properties

LL	PI	% Passing No. 200

Ave. Diameter (in)	Ave. Height (in)	Area (in^2)	Volume (in^3)	Wet Wt. (g)	Dry Wt. (g)	Total Unit Weight (lbf/ft^3)	Dry Unit Weight (lbf/ft^3)
1.386	2.371	1.508	3.58	77.67	32.5	**82.7**	**34.7**

Ave. Diameter (mm)	Ave. Height (mm)	Area (mm^2)	Volume (L)	Wet Wt. (Kg)	Dry Wt. (Kg)	Total Unit Weight (kN/m^3)	Dry Unit Weight (kN/m^3)
35.20	60.23	973	0.0586	0.0777	0.0325	13.00	5.45

Phase Volumes:

Solids (V_s)	**0.86**	in^3	**Specific Gravity**	**2.32**	**Estimated**	Tare #	O
Voids (Vv)	**2.72**	in^3	**e - Void Ratio**	**3.170**		Tare Wt. (g)	69.49
Water (V_w)	**2.76**	in^3	**η - Total Porosity**	**76.0%**		Wet Wt.(g)	147.1
			Degree of Saturation	**100.0%**		Dry Wt. (g)	102
						ASTM D 2166, Moisture Content	**138.7%**

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Laboratory Determination of Density (Unit Weight) of Soil Specimens, ASTM D 7263

Method B, Direct Measurement

Project Information

Project: Phase 1 Ash Storage Area Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Location: Cason, Texas
ETTL Job No.: G 4207-14

Sample Information

Boring No: **B-4**
Sample No.: _____ Depth: **13-15** **ft.** Date Sampled: 10/8/2014
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Light Brown Elastic Silt with sand, (MH) Fly Ash
Sampled By: ETTL Drilling Department
Technician: Owen Sanderson, ETTL Test Date: 12/30/2014
Sample Type: Disturbed SPT Sample, Trimmed

Test Data

Minimum of 3 Readings

	Diameter (in)	Height (in)	
Diameter (top)	1.393	2.770	Height 1
Diameter (Middle)	1.357	2.775	Height 2
Diameter (bottom)	1.390	2.779	Height 3

Sample Properties

LL	PI	% Passing No. 200
81	5	82.1

Ave. Diameter (in)	Ave. Height (in)	Area (in^2)	Volume (in^3)	Wet Wt. (g)	Dry Wt. (g)	Total Unit Weight (lbf/ft^3)	Dry Unit Weight (lbf/ft^3)
1.380	2.775	1.496	4.15	93.28	42.5	**85.6**	**39.0**

Ave. Diameter (mm)	Ave. Height (mm)	Area (mm^2)	Volume (L)	Wet Wt. (Kg)	Dry Wt. (Kg)	Total Unit Weight (kN/m^3)	Dry Unit Weight (kN/m^3)
35.05	70.48	965	0.0680	0.0933	0.0425	13.46	6.14

Phase Volumes:

Solids (V_s)	**1.04**	in^3	**Specific Gravity**	**2.50**	**Estimated**	Tare #	T
Voids (Vv)	**3.11**	in^3	**e - Void Ratio**	**2.989**		Tare Wt. (g)	65.13
Water (V_w)	**3.10**	in^3	**η - Total Porosity**	**74.9%**		Wet Wt.(g)	158.36
			Degree of Saturation	**99.8%**		Dry Wt. (g)	107.64
						ASTM D 2166, Moisture Content	**119.3%**

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Laboratory Determination of Density (Unit Weight) of Soil Specimens, ASTM D 7263

Method B, Direct Measurement

Project Information

Project: Phase 1 Ash Storage Area Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Location: Cason, Texas
ETTL Job No.: G 4207-14

Sample Information

Boring No: **B-6**
Sample No.: Depth: **13-15** **ft.** Date Sampled: 10/11/2014
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Black Elastic Silt, (MH) Bottom Ash
Sampled By: ETTL Drilling Department
Technician: Owen Sanderson, ETTL Test Date: 11/26/2014
Sample Type: Disturbed SPT Sample, Trimmed

Test Data

Minimum of 3 Readings

	Diameter (in)	Height (in)	
Diameter (top)	1.450	1.546	Height 1
Diameter (Middle)	1.437	1.546	Height 2
Diameter (bottom)	1.451	1.546	Height 3

Sample Properties

LL	PI	% Passing No. 200
100	19	100.0

Ave. Diameter (in)	Ave. Height (in)	Area (in^2)	Volume (in^3)	Wet Wt. (g)	Dry Wt. (g)	Total Unit Weight (lbf/ft^3)	Dry Unit Weight (lbf/ft^3)
1.446	1.546	1.642	2.54	58.06	29.2	**87.1**	**43.8**

Ave. Diameter (mm)	Ave. Height (mm)	Area (mm^2)	Volume (L)	Wet Wt. (Kg)	Dry Wt. (Kg)	Total Unit Weight (kN/m^3)	Dry Unit Weight (kN/m^3)
36.73	39.27	1059	0.0416	0.0581	0.0292	13.70	6.89

Phase Volumes:

Solids (V_s)	**0.77**	in^3	**Specific Gravity**	**2.32**	**Estimated**	Tare #	C
Voids (Vv)	**1.77**	in^3	**e - Void Ratio**	**2.296**		Tare Wt. (g)	64.48
Water (V_w)	**1.764**	in^3	**η - Total Porosity**	**69.7%**		Wet Wt.(g)	122.48
			Degree of Saturation	**100%**		Dry Wt. (g)	93.67
						ASTM D 2166, Moisture Content	**98.7%**

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Laboratory Determination of Density (Unit Weight) of Soil Specimens, ASTM D 7263

Method B, Direct Measurement

Project Information

Project: Phase 1 Ash Storage Area Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Location: Cason, Texas
ETTL Job No.: G 4207-14

Sample Information

Boring No: **B-7**
Sample No.: _____ Depth: **8-10** **ft.** Date Sampled: 10/10/2014
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Dark Gray Elastic Silt, (MH) Composite Bottom Ash
Sampled By: ETTL Drilling Department
Technician: Owen Sanderson, ETTL Test Date: 12/30/2014
Sample Type: Disturbed SPT Sample, Trimmed

Test Data

Minimum of 3 Readings

	Diameter (in)	Height (in)	
Diameter (top)	1.336	2.157	Height 1
Diameter (Middle)	1.307	2.211	Height 2
Diameter (bottom)	1.335	2.170	Height 3

Sample Properties

LL	PI	% Passing No. 200

Ave. Diameter (in)	Ave. Height (in)	Area (in^2)	Volume (in^3)	Wet Wt. (g)	Dry Wt. (g)	Total Unit Weight (lbf/ft^3)	Dry Unit Weight (lbf/ft^3)
1.326	2.179	1.381	3.01	67.40	26.1	**85.3**	**33.0**

Ave. Diameter (mm)	Ave. Height (mm)	Area (mm^2)	Volume (L)	Wet Wt. (Kg)	Dry Wt. (Kg)	Total Unit Weight (kN/m^3)	Dry Unit Weight (kN/m^3)
33.68	55.35	891	0.0493	0.0674	0.0261	13.41	5.19

Phase Volumes:

Solids (V_s)	**0.638**	in^3	**Specific Gravity**	**2.50**	**Estimated**	Tare #	L
Voids (Vv)	**2.372**	in^3	**e - Void Ratio**	**3.718**		Tare Wt. (g)	66.05
Water (V_w)	**2.528**	in^3	**η - Total Porosity**	**78.8%**		Wet Wt.(g)	133.37
			Degree of Saturation	**100%**		Dry Wt. (g)	92.09
						ASTM D 2166, Moisture Content	**158.5%**

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Laboratory Determination of Density (Unit Weight) of Soil Specimens, ASTM D 7263

Method B, Direct Measurement

Project Information

Project: Phase 1 Ash Storage Area Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Location: Carson, Texas
ETTL Job No.: G 4207-14

Sample Information

Boring No: **B-7**
Sample No.: _____ Depth: **18-20** **ft.** Date Sampled: 10/10/2014
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Dark Grayish Brown Sandy Elastic Silt, (MH) Composite Fly Ash
Sampled By: ETTL Drilling Department
Technician: Owen Sanderson, ETTL Test Date: 12/30/2014
Sample Type: Disturbed SPT Sample, Trimmed

Test Data

Minimum of 3 Readings

	Diameter (in)	Height (in)	
Diameter (top)	1.391	2.635	Height 1
Diameter (Middle)	1.391	2.639	Height 2
Diameter (bottom)	1.416	2.652	Height 3

Sample Properties

LL	PI	% Passing No. 200

Ave. Diameter (in)	Ave. Height (in)	Area (in^2)	Volume (in^3)	Wet Wt. (g)	Dry Wt. (g)	Total Unit Weight (lbf/ft^3)	Dry Unit Weight (lbf/ft^3)
1.399	2.642	1.538	4.06	89.96	39.7	**84.4**	**37.2**

Ave. Diameter (mm)	Ave. Height (mm)	Area (mm^2)	Volume (L)	Wet Wt. (Kg)	Dry Wt. (Kg)	Total Unit Weight (kN/m^3)	Dry Unit Weight (kN/m^3)
35.54	67.11	992	0.0666	0.0900	0.0397	13.25	5.84

Phase Volumes:

Solids (V_s)	**0.971**	in^3	**Specific Gravity**	**2.50**	**Estimated**	Tare #	D
Voids (Vv)	**3.092**	in^3	**e - Void Ratio**	**3.186**		Tare Wt. (g)	66.57
Water (V_w)	**3.076**	in^3	**η - Total Porosity**	**76.1%**		Wet Wt.(g)	156.5
			Degree of Saturation	**99.5%**		Dry Wt. (g)	106.23
						ASTM D 2166, Moisture Content	**126.8%**

From Trimmings

Main Office: 1717 East Erwin Street Tyler, Texas 75702 Phone: 903-595-4421 Fax: 903-595-6113
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Laboratory Determination of Density (Unit Weight) of Soil Specimens, ASTM D 7263

Method B, Direct Measurement

Project Information

Project: Phase 1 Ash Storage Area Embankment Investigation
Client/Arch./Engr.: AEP, Welsh Power Plant
Location: Cason, Texas
ETTL Job No.: G 4207-14

Sample Information

Boring No: **B-9**
Sample No.: _____ Depth: **20-21** **ft.** Date Sampled: 10/9/2014
Material Origin: Geotechnical Boring
Sampling Info. provided By: Owen Sanderson, ETTL
Material Description: Light Gray Cemented Fly Ash
Sampled By: ETTL Drilling Department
Technician: Owen Sanderson, ETTL Test Date: 12/29/2014
Sample Type: Trimmed Nx Rock Core

Test Data

Minimum of 3 Readings

	Diameter (in)	Height (in)	
Diameter (top)	1.867	4.316	Height 1
Diameter (Middle)	1.966	4.267	Height 2
Diameter (bottom)	1.950	4.275	Height 3

Sample Properties

LL	PI	% Passing No. 200

Ave. Diameter (in)	Ave. Height (in)	Area (in^2)	Volume (in^3)	Wet Wt. (g)	Dry Wt. (g)	Total Unit Weight (lbf/ft^3)	Dry Unit Weight (lbf/ft^3)
1.928	4.286	2.919	12.51	382.01	314.8	**116.3**	**95.9**

Ave. Diameter (mm)	Ave. Height (mm)	Area (mm^2)	Volume (L)	Wet Wt. (Kg)	Dry Wt. (Kg)	Total Unit Weight (kN/m^3)	Dry Unit Weight (kN/m^3)
48.96	108.86	1883	0.2050	0.3820	0.3148	18.27	15.06

Phase Volumes:

Solids (V_s)	**7.702**	in^3	**Specific Gravity**	**2.50**	**Estimated**	Tare #	G
Voids (Vv)	**4.807**	in^3	**e - Void Ratio**	**0.624**		Tare Wt. (g)	71.12
Water (V_w)	**4.108**	in^3	**η - Total Porosity**	**38.4%**		Wet Wt.(g)	205.74
			Degree of Saturation	**85%**		Dry Wt. (g)	182.07
						ASTM D 2166, Moisture Content	**21.3%**
							From Trimmings

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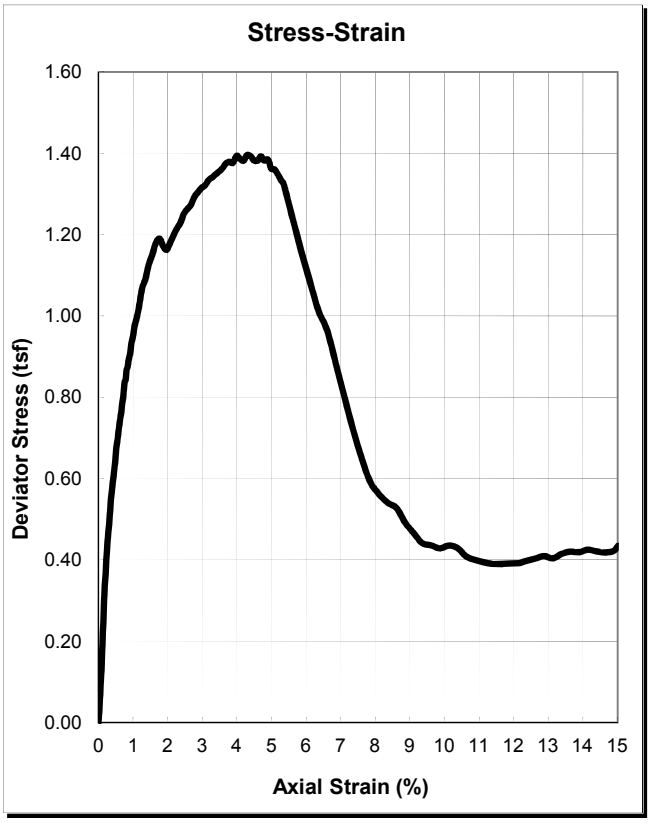
Undrained Unconsolidated Triaxial Compression

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ASTM D 2850 Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

Project: Phase 1 Fly Ash Storage Embankment Investigation
Client: AEP, Welsh Power Plant
Location: Cason, Texas
Material: Lt. Brown, Lt. Gray & Redd. Brown Clayey Sand, (SC)

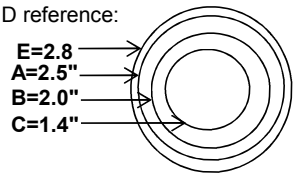


ETTL Project No.:	G 4207-14	
Boring No.:	B-2	
Sample No. / Depth (ft.):	33'-35'	
Specimen Trimming ID:	E	(whole)
Height:	6.515	inches
Diameter:	2.798	inches
Height / Diameter Ratio:	2.33	
Initial Moisture Content:	**16.1%**	(trimmings)
Initial Dry Unit Weight:	**110.0**	lbs./ft^3
Initial Total Unit Weight:	127.7	lbs./ft^3
Specific Gravity:	2.670	(assumed)
Initial Void Ratio:	0.515	
Initial Saturation:	83.6	%
Pocket Pentronmeter:	2.75	tsf
Hand Torvane:	N/T	tsf
Rate of Strain:	1.0	%/min
Chamber Pressure:	**20.7**	**psi**
Peak Strain:	**4.29**	**%**
Cor. Maximum Deviator Stress:	**1.39**	**tsf**
Cor. Maximum Deviator Stress:	2780	psf
Cor. Maximum Deviator Stress:	19.3	psi
Cor. Secant Modulus at 1/2 Peak Stress:	2.63E+05	psf
Strain at 50% Max Stress (e_{50}):	5.30E-03	in/in
Initial Tangent Modulus:	4.39E+05	psf
Atterbergs LL / PI:	30	15
Passing No. 200 Sieve:	38.8	%
Sampling Method:	2.8 in. Shelby Tube	
Type of Specimen:	Undisturbed	

Unconsolidated-Undrained Shear Strength	
1390	psf

Membrane Correction Factor (tsf) = 0.005

Specimen Trimming ID reference:



This test has been run to a maximum % strain of: 15.0

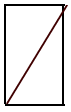
Measured Angle of Fracture from Horizontal: 45

Remarks:

Sketch of Fracture:

Technician: L. Dailey Date: 12/29/2014

Picture of Fracture:



Shear

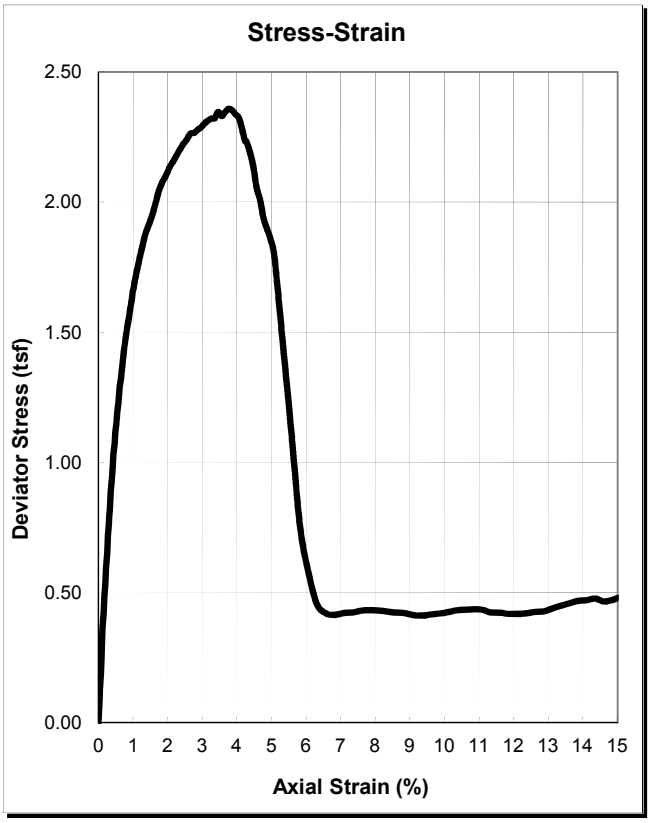
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ASTM D 2850 Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

Project:	Phase 1 Fly Ash Storage Embankment Investigation
Client:	AEP, Welsh Power Plant
Location:	Cason, Texas
Material:	Gray & Yellowish Brown Fat Clay, (CH)

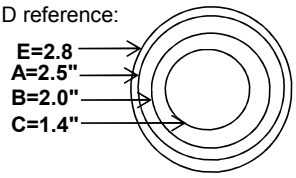


ETTL Project No.:	G 4207-14	
Boring No.:	B-4	
Sample No. / Depth (ft.):	38'-40'	
Specimen Trimming ID:	E	(whole)
Height:	6.523	inches
Diameter:	2.790	inches
Height / Diameter Ratio:	2.34	
Initial Moisture Content:	**24.3%**	(trimmings)
Initial Dry Unit Weight:	**99.0**	lbs./ft^3
Initial Total Unit Weight:	123.0	lbs./ft^3
Specific Gravity:	2.670	(assumed)
Initial Void Ratio:	0.684	
Initial Saturation:	94.8	%
Pocket Pentronmeter:	4.5+	tsf
Hand Torvane:	N/T	tsf
Rate of Strain:	1.0	%/min
Chamber Pressure:	**23.7**	**psi**
Peak Strain:	**3.76**	**%**
Cor. Maximum Deviator Stress:	**2.35**	**tsf**
Cor. Maximum Deviator Stress:	4707	psf
Cor. Maximum Deviator Stress:	32.7	psi
Cor. Secant Modulus at 1/2 Peak Stress:	4.61E+05	psf
Strain at 50% Max Stress (e_{50}):	5.12E-03	in/in
Initial Tangent Modulus:	7.52E+05	psf
Atterbergs LL / PI:	N/T	N/T
Passing No. 200 Sieve:	N/T	%
Sampling Method:	2.8 in. Shelby Tube	
Type of Specimen:	Undisturbed	

Unconsolidated-Undrained Shear Strength	
2353	psf

Membrane Correction Factor (tsf) = 0.005

Specimen Trimming ID reference:



This test has been run to a maximum % strain of: 15.0

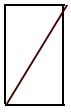
Measured Angle of Fracture from Horizontal: 45

Remarks: Slickensided

Sketch of Fracture:

Technician: L. Dailey Date: 12/29/2014

Picture of Fracture:



Shear

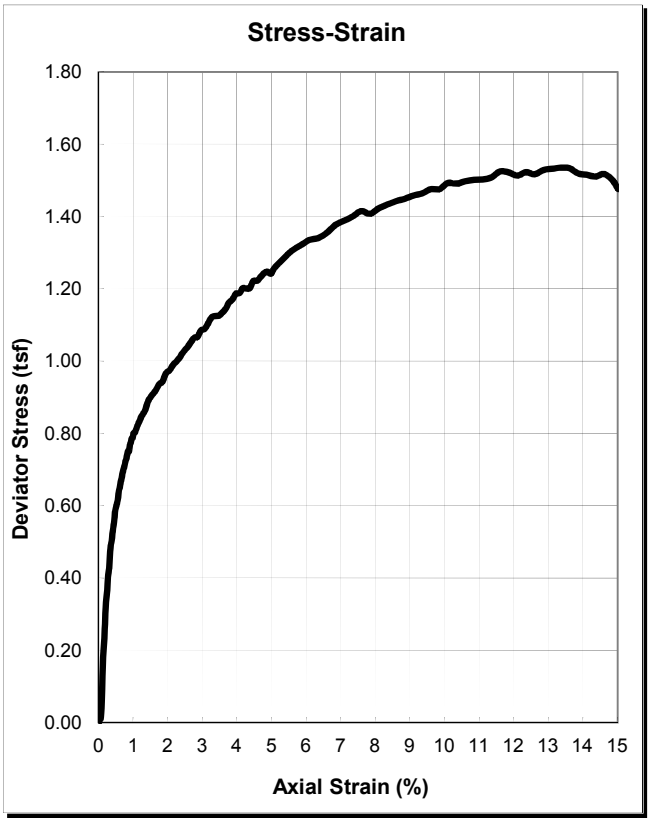
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ASTM D 2850 Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

Project:	Phase 1 Fly Ash Storage Embankment Investigation
Client:	AEP, Welsh Power Plant
Location:	Cason, Texas
Material:	Light Gray & Redd. Brown Fat Clay with sand, (CH)

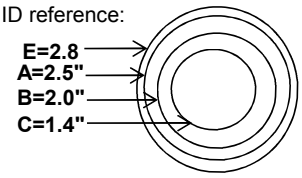


ETTL Project No.:	G 4207-14	
Boring No.:	B-9	
Sample No. / Depth (ft.):	28'-30'	
Specimen Trimming ID:	E	(whole)
Height:	6.496	inches
Diameter:	2.774	inches
Height / Diameter Ratio:	2.34	
Initial Moisture Content:	**21.1%**	(trimmings)
Initial Dry Unit Weight:	**105.5**	lbs./ft^3
Initial Total Unit Weight:	127.8	lbs./ft^3
Specific Gravity:	2.670	(assumed)
Initial Void Ratio:	0.579	
Initial Saturation:	97.3	%
Pocket Pentronmeter:	1.75	tsf
Hand Torvane:	N/T	tsf
Rate of Strain:	1.0	%/min
Chamber Pressure:	**17.6**	**psi**
Peak Strain:	**13.4**	**%**
Cor. Maximum Deviator Stress:	**1.52**	**tsf**
Cor. Maximum Deviator Stress:	3037	psf
Cor. Maximum Deviator Stress:	21.1	psi
Cor. Secant Modulus at 1/2 Peak Stress:	1.85E+05	psf
Strain at 50% Max Stress (e_{50}):	8.29E-03	in/in
Initial Tangent Modulus:	6.22E+05	psf
Atterbergs LL / PI:	70	50
Passing No. 200 Sieve:	83.1	%
Sampling Method:	2.8 in. Shelby Tube	
Type of Specimen:	Undisturbed	

Unconsolidated-Undrained Shear Strength	
1518	psf

Membrane Correction Factor (tsf) = 0.017

Specimen Trimming ID reference:



This test has been run to a maximum % strain of: 15.0

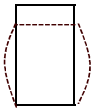
Measured Angle of Fracture from Horizontal: N/A

Remarks:

Sketch of Fracture:

Technician: L. Dailey Date: 12/29/2014

Picture of Fracture:



Barrel

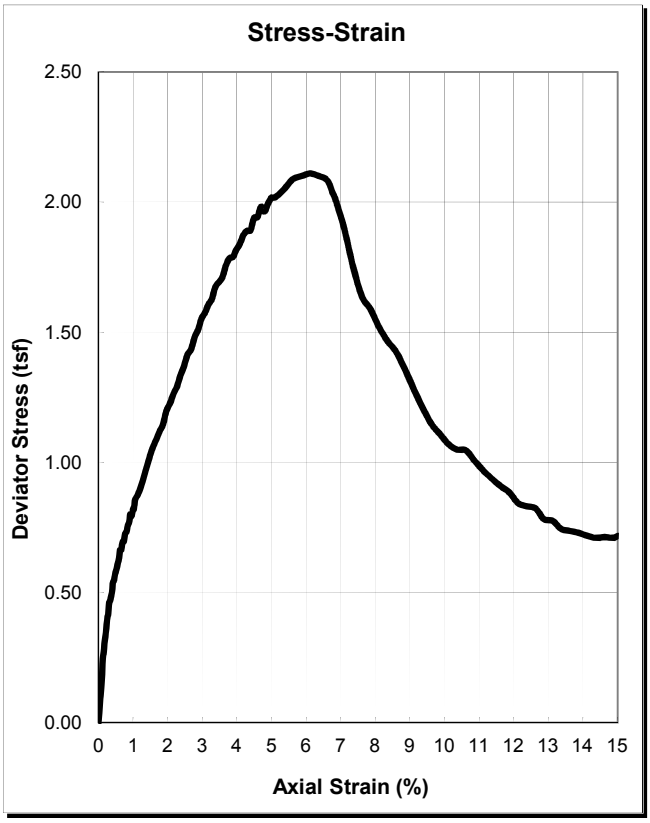
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ASTM D 2850 Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

Project:	Phase 1 Fly Ash Storage Embankment Investigation
Client:	AEP, Welsh Power Plant
Location:	Cason, Texas
Material:	Redd. Brown & Graysish Br. Sandy Lean Clay, (CL)

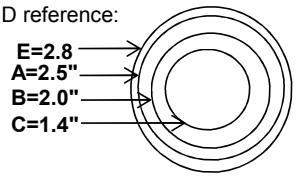


ETTL Project No.:	G 4207-14	
Boring No.:	B-10	
Sample No. / Depth (ft.):	33'-35'	
Specimen Trimming ID:	B	(trimmed)
Height:	4.452	inches
Diameter:	2.056	inches
Height / Diameter Ratio:	2.17	
Initial Moisture Content:	**22.1%**	(trimmings)
Initial Dry Unit Weight:	**107.4**	lbs./ft^3
Initial Total Unit Weight:	131.1	lbs./ft^3
Specific Gravity:	2.670	(assumed)
Initial Void Ratio:	0.552	
Initial Saturation:	100.0	%
Pocket Pentronmeter:	1.00	tsf
Hand Torvane:	N/T	tsf
Rate of Strain:	1.0	%/min
Chamber Pressure:	**20.7**	**psi**
Peak Strain:	**6.11**	**%**
Cor. Maximum Deviator Stress:	**2.10**	**tsf**
Cor. Maximum Deviator Stress:	4199	psf
Cor. Maximum Deviator Stress:	29.2	psi
Cor. Secant Modulus at 1/2 Peak Stress:	1.37E+05	psf
Strain at 50% Max Stress (e_{50}):	1.54E-02	in/in
Initial Tangent Modulus:	4.83E+05	psf
Atterbergs LL / PI:	N/T	N/T
Passing No. 200 Sieve:	N/T	%
Sampling Method:	Sample Trimmed, Shelby Tube	
Type of Specimen:	Undisturbed	

Unconsolidated-Undrained Shear Strength	
2099	psf

Membrane Correction Factor (tsf) = 0.010

Specimen Trimming ID reference:



This test has been run to a maximum % strain of: 15.0

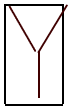
Measured Angle of Fracture from Horizontal: N/A

Remarks:

Sketch of Fracture:

Technician: L. Dailey Date: 12/29/2014

Picture of Fracture:



Cone

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APPENDIX C
Piezometer Data

WELSH POWER PLANT - PHASE 1 LANDFILL - PIEZOMETER DATA

Adjusted Water Elevation (feet)

PIEZOMETER	B-4	B-8	B-11	B-17	B-18	B-19	AD-1	AD-9	AD-11	AD-13	AD-14	Primary Pond	Secondary Pond
Top of Casing	381.32	375.12	381.37	348.76	348.71	372.78	357.57	343.09	342.18	347.00	345.43	336.2	340.01
Total Depth	45.09	44.59	44	32.56	32.49	25.29	28.71	37.15	22.1	19.2	21.27		
Date													
11/9/2014	350.68	339.44	355.43	333.14	333.03	356.29	337.49	330.18	327.97	332.01	330.17		
11/14/2014	350.71	339.29	355.32	332.74	332.76	356.14	337.34	329.76	327.93	331.89	329.99	333.15	329.69
11/18/2014	349.42	338.82	353.295	332.645	332.74	357.07	337.67	329.92	328.29	332	330.23		
11/25/2014	350.7	338.88	355.07	332.71	332.52	356.23	337.11	329.19	327.78	332.17	330.44	333.1	
12/3/2014	350.97	339.22	355.22	332.76	332.585	356.18	337.26	329.77	327.97	332.4	330.73	332.9	329.7
12/9/2014	351.03	339.2	355.1	332.86	332.51	355.93	336.67	329.99	327.83	332.38	330.88	332.9	329.5
12/16/2014	351.19	339.3	354.89	332.88	332.79	356.25	337.22	330.04	327.75	332.86	331.53	332.9	
12/23/2014	351.07	339.04	355.29	333.09	332.96	355.36	337.4	330.42	328.01	332.75	331.35	333.08	
High	351.2	339.4	355.4	333.1	333.0	357.1	337.7	330.4	328.3	332.9	331.5	333.2	329.7
Low	349.4	338.8	353.3	332.6	332.5	355.4	336.7	329.2	327.8	331.9	330.0	332.9	329.5
Average	350.7	339.1	355.0	332.9	332.7	356.2	337.3	329.9	327.9	332.3	330.7	333.0	329.6

APPENDIX E
SEISMIC DESIGN PARAMETERS

Design Maps Summary Report

User–Specified Input

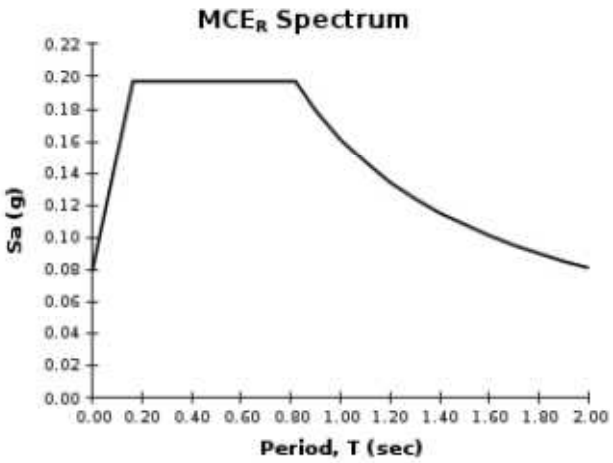
Report Title	AEP Welsh SES - Phase 1 Landfill Vertical Expansion Mon January 19, 2015 17:41:40 UTC
Building Code Reference Document	2009 NEHRP Recommended Seismic Provisions (which utilizes USGS hazard data available in 2008)
Site Coordinates	33.04776°N, 94.84488°W
Site Soil Classification	Site Class D – "Stiff Soil"
Risk Category	I/II/III

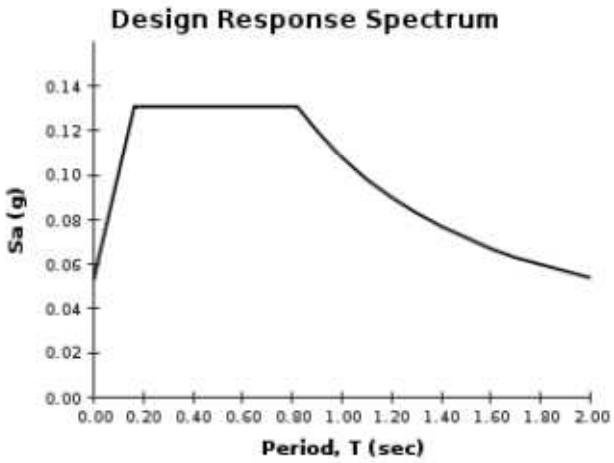


USGS–Provided Output

S_S =	0.123 g	S_{MS} =	0.197 g	S_{DS} =	0.131 g
S_1 =	0.067 g	S_{M1} =	0.161 g	S_{D1} =	0.108 g

For information on how the S_S and S_1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please view the detailed report.





For PGA_M, T_L, C_{RS}, and C_{R1} values, please view the detailed report.

Although this information is a product of the U.S. Geological Survey, we provide no warranty, expressed or implied, as to the accuracy of the data contained therein. This tool is not a substitute for technical subject-matter knowledge.

Design Maps Detailed Report

2009 NEHRP Recommended Seismic Provisions (33.04776°N, 94.84488°W)

Site Class D – "Stiff Soil", Risk Category I/II/III

Section 11.4.1 — Mapped Acceleration Parameters and Risk Coefficients

Note: Ground motion values contoured on Figures 22-1, 2, 5, & 6 below are for the direction of maximum horizontal spectral response acceleration. They have been converted from corresponding geometric mean ground motions computed by the USGS by applying factors of 1.1 (to obtain S_{SUH} and S_{SD}) and 1.3 (to obtain S_{1UH} and S_{1D}). Maps in the Proposed 2015 NEHRP Provisions are provided for Site Class B. Adjustments for other Site Classes are made, as needed, in Section 11.4.3.

Figure 22–1: Uniform–Hazard (2% in 50–Year) Ground Motions of 0.2-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B

Figure 22–2: Uniform–Hazard (2% in 50–Year) Ground Motions of 1.0-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B

Figure 22–3: Risk Coefficient at 0.2-Second Spectral Response Period

Figure 22–4: Risk Coefficient at 1.0-Second Spectral Response Period

Figure 22–5: Deterministic Ground Motions of 0.2-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B

Figure 22–6: Deterministic Ground Motions of 1.0-Second Spectral Response Acceleration (5% of Critical Damping), Site Class B

Section 11.4.2 — Site Class

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Chapter 20.

Table 20.3–1 Site Classification

Site Class	$\overline{v}_s$	$\overline{N}$ or $\overline{N}_{ch}$	$\overline{s}_u$
A. Hard Rock	>5,000 ft/s	N/A	N/A
B. Rock	2,500 to 5,000 ft/s	N/A	N/A
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50	>2,000 psf
D. Stiff Soil	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
E. Soft clay soil	<600 ft/s	<15	<1,000 psf
	Any profile with more than 10 ft of soil having the characteristics: • Plasticity index PI > 20, • Moisture content w ≥ 40%, and • Undrained shear strength $\overline{s}_u$ < 500 psf		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

Section 11.4.3 — Site Coefficients, Risk Coefficients, and Risk–Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameters

Equation (11.4–1):	$C_{RS}S_{SUH}$ = 0.904 x 0.136 = 0.123 g
Equation (11.4–2):	S_{SD} = 1.500 g
S_S ≡ "Lesser of values from Equations (11.4–1) and (11.4–2)" = 0.123 g	
Equation (11.4–3):	$C_{R1}S_{1UH}$ = 0.849 x 0.079 = 0.067 g
Equation (11.4–4):	S_{1D} = 0.600 g
S_1 ≡ "Lesser of values from Equations (11.4–3) and (11.4–4)" = 0.067 g	

Table 11.4–1: Site Coefficient F_a

Site Class	Spectral Response Acceleration Parameter at Short Period				
	$S_S \leq 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = D and S_S = 0.123 g, F_a = 1.600

Table 11.4–2: Site Coefficient F_v

Site Class	Spectral Response Acceleration Parameter at 1–Second Period				
	$S_1 \leq 0.10$	$S_1 = 0.20$	$S_1 = 0.30$	$S_1 = 0.40$	$S_1 \geq 0.50$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = D and S_1 = 0.067 g, F_v = 2.400

Equation (11.4–5): $S_{MS} = F_a S_S = 1.600 \times 0.123 = 0.197$ g

Equation (11.4–6): $S_{M1} = F_v S_1 = 2.400 \times 0.067 = 0.161$ g

Section 11.4.4 — Design Spectral Acceleration Parameters

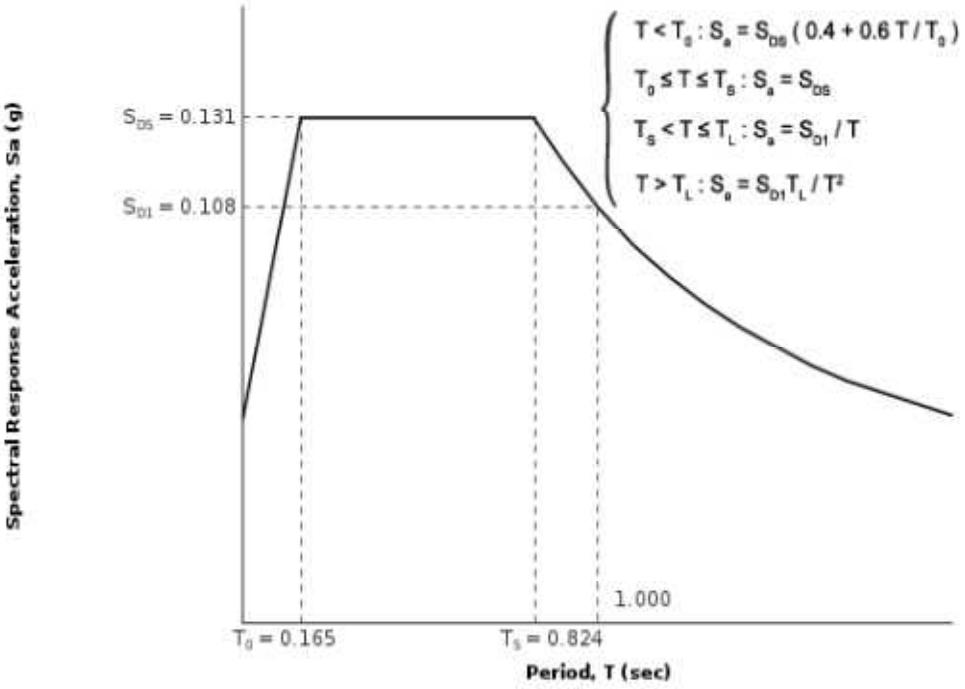
Equation (11.4–7): $S_{DS} = \frac{2}{3} S_{MS} = \frac{2}{3} \times 0.197 = 0.131$ g

Equation (11.4–8): $S_{D1} = \frac{2}{3} S_{M1} = \frac{2}{3} \times 0.161 = 0.108$ g

Section 11.4.5 — Design Response Spectrum

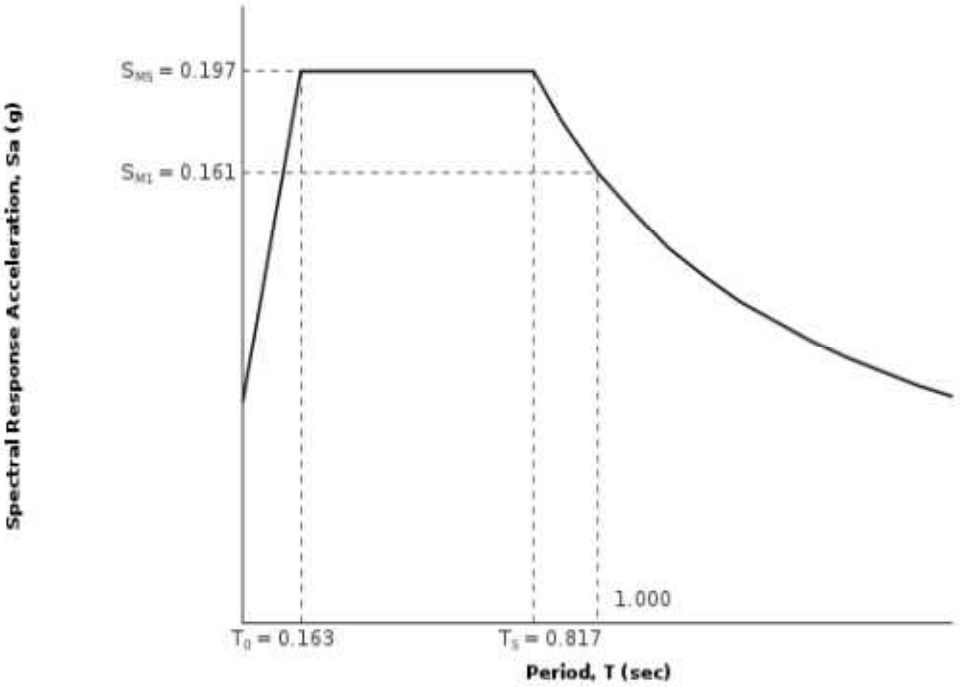
Figure 22–7: Long–period Transition Period, T_L (s)

Figure 11.4–1: Design Response Spectrum



Section 11.4.6 — MCE_R Response Spectrum

The MCE_R response spectrum is determined by multiplying the design response spectrum above by 1.5.



Section 11.8.3 — Additional Geotechnical Investigation Report Requirements for Seismic Design Categories D through F

Table 11.8–1: Site Coefficient F_{PGA}

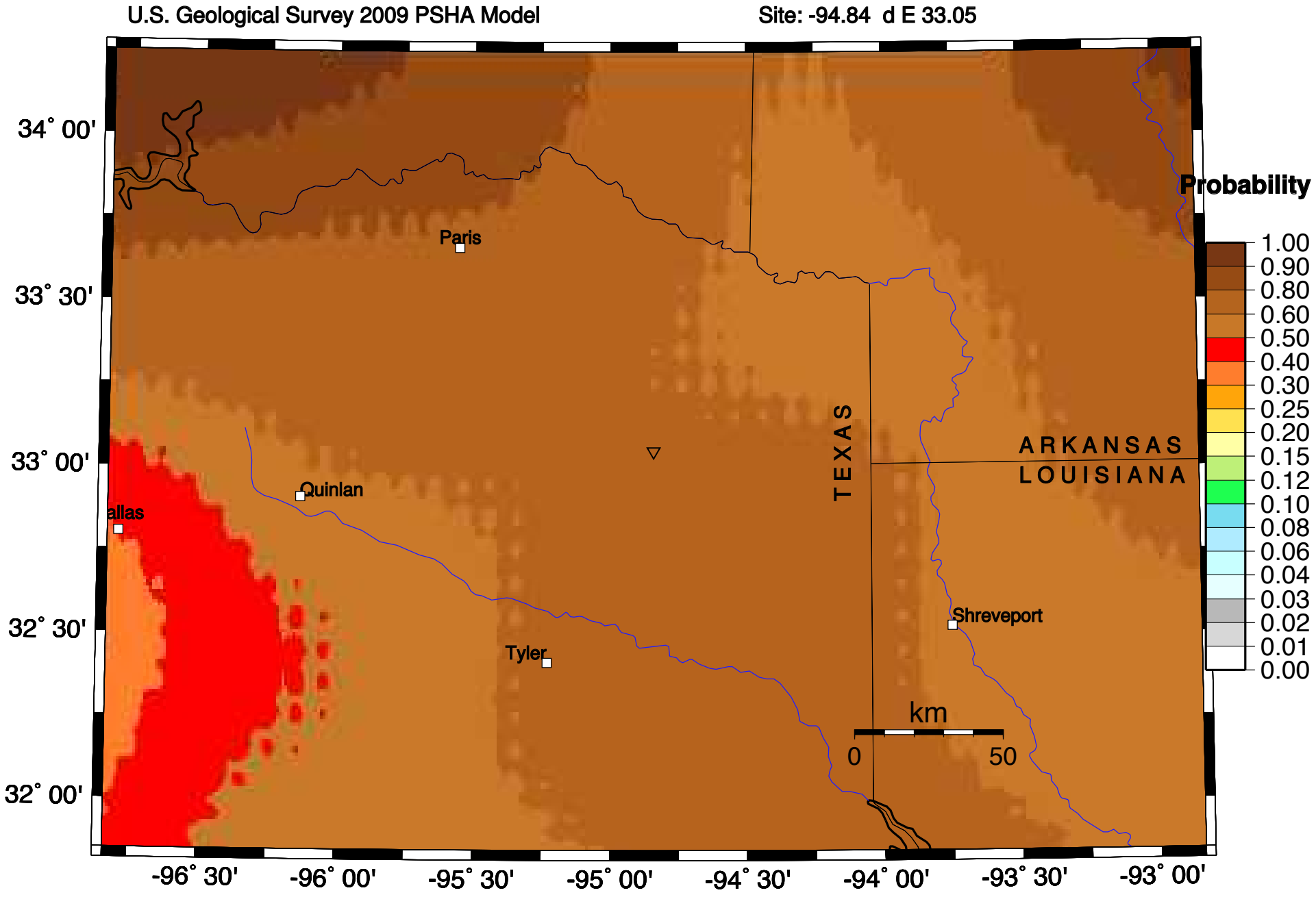
Site Class	Mapped MCE Geometric Mean Peak Ground Acceleration, PGA				
	PGA ≤ 0.10	PGA = 0.20	PGA = 0.30	PGA = 0.40	PGA ≥ 0.50
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of PGA

For Site Class = D and PGA = 0.058 g, F_{PGA} = 1.600

Mapped PGA	PGA = 0.058 g
Equation (11.8–1):	$PGA_M = F_{PGA}PGA = 1.600 \times 0.058 = 0.093$ g

Probability of earthquake with M > 5.0 within 10000 years & 50 km



GMT 2015 Jan 22 01:10:26 **Earthquake probabilities from USGS OFR 08-1128 PSHA. 50 km maximum horizontal distance. Site of interest: triangle. Epicenters mb>5 black circles; rivers blue.**

ATTACHMENT 3

Construction QAQC Specifications

SPECIFICATION COVER SHEET

Specification Number:	**CE-004**
Revision:	**3**
Date:	**May 3, 2006**

TITLE: Specification for Excavation

+Scope of Changes:

[X] Revision (Full Procedure)

[ ] Change Sheet, Affected pages: _____

Summary of Changes:

This specification is revised to incorporate portions of the standard specifications from Sargent & Lundy, Mountaineer and Mitchell

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Specification Owner (Organization): Civil Engineering

Prepared by: Pedro Amaya (AEP) Pedro J Amaya Date: 11/03/2006

Reviewed by: Dan Kocunik (S&L) Daniel Kocunik Date: 5/03/2006

Approved by: Thomas R. Zelina (AEP) Thomas R Zelina Date: 11/06/2006

SPECIFICATION FOR EXCAVATION

CE-004

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SPECIFICATION FOR EXCAVATION

CE-004

4-1.0 DESCRIPTION OF WORK

The work shall consist of performing all operations necessary to excavate material of whatever characteristic encountered in accordance with the requirements of this specification and to excavate to the lines, grades, and typical cross-sections shown on the drawings.

The work shall also include all loading, hauling, dumping, and spreading the material in fill areas, spoil areas, or stockpiles, including dewatering, as directed by Owner's engineer.

4-2.0 DEFINITIONS

4-2.1 Rock

Rock is defined as the in situ bedrock formation that can be excavated only by continuous systematic drilling and blasting, or by any other recognized hard rock quarrying procedure. Rock shall include deposits so firmly cemented, laminated, or foliated that they cannot be removed by common earthmoving equipment, or other similarly hard material as well as rocks, boulders (exceeding 2 cubic yards in volume), and disattached masonry or concrete pieces measuring one cubic yard or greater in volume. Removal of hard material will not be considered rock excavation because of intermittent drilling and blasting that is performed merely to increase production. Blasting procedure is contained in Technical Specification CE-004A.

4-2.2 Cohesive Material

Cohesive material is defined as all clays and other clayey silt or clay sand soils in which the absorbed water and particle attraction work unitedly to produce a mass which holds together and deforms plastically at varying water contents. These materials are classified as GC, SC, ML, MH, CL or CH in the Unified Soil Classification System, ASTM D2487. Materials classified as GM, GP-GM, GW-GM, SW-SM, SP-SM, or SM shall be identified as cohesive if the fines are plastic (plasticity index greater than zero).

4-2.3 Granular Material

Granular material is defined as sand, gravel, and sand and gravel, bottom ash, and boiler slag. These materials are classified as GW, GP, SW, and SP in the Unified Soil Classification System, ASTM D2487. Materials classified as GM, GP-GM, GW-GM, SW-SM, SP-SM, or SM shall be identified as granular only when the fines are nonplastic (plasticity index equals zero).

4-2.4 Common Material

Common material is defined as cohesive material, granular material, a combination of cohesive and granular materials, or any other materials encountered that can be removed with conventional earthmoving equipment, such as dozers with rippers, scrapers, end loaders, or backhoes/excavators.

4-2.5 Unclassified Material

Unclassified material is defined as any material which must be excavated, but for which the Owner has chosen not to provide specific classifications for pay purposes, or the nature of which may be unknown to the Owner.

4-2.6 Confined Excavation

Confined excavation is defined as the removal of soil or rock from a small or restricted area where the generally accepted methods of mass earthmoving cannot be applied. Typical examples include, but are not limited to, the excavation for pipe trenches, catch basins, manholes, conveyor bent foundations, and headwall foundations.

4-2.7 Dragline Excavation

Dragline excavation is defined as the removal of soil from below a water surface, from a steep slope on which mass haul equipment cannot operate, or of material too wet to be removed using the generally accepted methods of mass earth moving, and which requires the use of a dragline, clam bucket, or similar equipment.

4-2.8 Hand Excavation

Hand excavation is defined as the removal of soil or rock using manual labor and hand tools such as shovels and jackhammers.

4-2.9 Borrow Excavation

Borrow excavation is defined as the removal of material outside the planned lines and grades of the project necessary to provide the required volume of fill material to complete the project.

4-2.10 Stockpile Excavation

Stockpile excavation is defined as the removal of material from a stockpile.

4-2.11 Free Haul Distance

Free haul distance is defined as the distance that excavated material shall be hauled without additional compensation. The limits of this distance shall be indicated on the project drawings or described in the instructions to bidders.

4-2.12 Flowable Fill

Flowable fill shall consist of an approved mix and shall comply with the material requirements of ACI 229. Flowable fill shall contain fly ash from an American Electric Power source. Flowable fill shall have a slump between 8 and 12 inches, an air content of 15% (+/- 5%) and shall be pumpable under required pressure. Flowable fill shall have a 3 day compressive strength of at least 25 psi and a 28-day compressive strength between 50 and 100 psi unless otherwise shown on the drawings. Maximum particle size shall not exceed 0.5 inch.

4-3.0 GENERAL REQUIREMENTS

4-3.1 Excavation Requirements

At least 48 hours before proceeding with excavations, call Miss Utility West Virginia (1-800-245-4848), or state equivalent. Underground utility drawings were performed based on available plant drawings. Reasonable efforts have been made to identify underground utilities; however, unidentified utilities may exist. Locate all utilities and obtain plant excavation permits prior to start of any excavation or trenching operation. Upon encountering any unidentified utilities, the Contractor shall immediately notify the Owner. Stake, flag or paint locations of known utilities within the work area.

Excavation includes incidental clearing; excavation, transportation, and disposal of excavated materials; protection, sheeting, shoring, bracing and cofferdams; dewatering of excavation and Work areas as required to properly install and complete the Work, regardless of the nature of materials encountered in excavating. The Contractor is responsible for movement of construction machinery and equipment over pipes and utilities during construction. Report damage to utility lines or subsurface construction immediately to the Owner. Where excavations are for structural elements, ensure that footing subgrades have been inspected and approved by the Owner's engineer prior to concrete placement.

To prevent the undermining of existing structures, there shall be no excavation slopes within 5 feet of the base of an existing footing or foundation, unless such footing or foundation is properly protected against settlement and erosion damage. Excavations shall extend a sufficient distance from the structures for placing and removing concrete formwork, installing services, other constructions, and for inspections.

Determine if any excavated material of a hazardous nature, as classified in the National Emissions Standards, OSHA or EPA regulations, will result from the work. Inform the Owner immediately upon discovery of a hazardous material encountered during the work.

4-3.2 Additional Excavation

Additional excavation performed by contractor for its own convenience shall be subject to approval by Owner's engineer and shall be replaced as required by Owner's engineer. All such work shall be at no additional cost to Owner.

4-3.3 Care of Water and Erosion Control

Contractor shall maintain all excavations free of water by sumps, pumping, or other methods approved by the Owner's engineer. The methods used shall be adequate to ensure the work is performed under dry conditions that the stability of any excavation is not impaired, and that erosion is prevented. Surface water and water from other sources shall be intercepted and diverted away from the excavation or into sumps and then pumped to a natural drainage course or site drainage system and in accordance with Specification CE-008, Surface Drainage Systems. Where silty or otherwise contaminated matter is introduced into the drainage in violation of state and/or federal regulations, the contractor shall correct the condition at no additional cost to the Owner. Contractor shall be responsible for payment of any fines that may be incurred due to its negligence.

4-3.4 Excavation Procedure

Contractor shall comply with all OSHA rules and regulations including, but not limited to, 29 CFR Part 1926, Subpart P-Excavations. Any option permitted by the referenced OSHA requirements which requires a submittal by a registered professional engineer shall be submitted to Owner prior to commencing excavation. Failure to comply with these requirements shall stop all excavation work, and the contractor shall immediately take corrective measures to bring the excavation into compliance at no cost to Owner. Earth excavation shall be of sufficient dimensions to allow for placing of formwork for concrete, inspection of formwork and surfaces of completed concrete, and for placing and inspecting dampproofing, waterproofing, pipework, electrical ductwork, etc.

4-3.5 Finished Surfaces

Finished excavated surfaces shall be protected against damage by movement of construction equipment, rain, frost or other causes, which may impair the bearing capacity of the subgrade.

4-4.0 REQUIREMENTS FOR BORROW EXCAVATION

4-4.1 Location

Borrow areas for required fills shall be shown on the drawings or as designated by the Owner's engineer or as selected by the contractor subject to approval by the Owner's engineer. Investigations in the borrow areas shown on the drawings have shown that material for use in the work can be produced from such borrow areas. There is no guarantee as to what percentage of material will be suitable for the production of materials for fills. If a contractor proposes to use a borrow area other than those shown on the drawings, he shall make such investigations at his own expense and furnish proof to the Owner's engineer that the borrow material satisfies the specifications for the designated structures.

4-4.2 Drainage

The control of water in the borrow areas shall be in accordance with Section 4-3 of this specification and in CE-008, Surface Drainage Systems.

4-4.3 Reclamation

When the borrow operations are complete, the contractor shall return any materials excavated from the borrow area, considered to be unsuitable as fill, to the borrow area. The area shall then be graded to drain and to blend with the existing topography. Finally, the area shall be seeded and mulched in accordance with specification CE-007, Erosion and Sediment Control. This work shall be done at the direction and to the satisfaction of the Owner's engineer.

4-5.0 USE AND DISPOSAL OF EXCAVATED MATERIAL

4-5.1 Fill

Subject to the approval of the Owner's engineer, excavated material may be used for fill providing such material conforms to the requirements of specification CE-006, Fill.

4-5.2 Spoil

Excavated material not suitable for fill or excess material must be disposed of in spoil areas. The location of spoil areas shall be shown on the project drawings or designated by the Owner's engineer. Material disposed of in the spoil areas shall be spread in 12" lifts and tracked in with a D-8 or larger dozer. Slopes shall be no steeper than 2H:1V and shall be tracked and backbladed by a dozer. The allowable total height of spoil piles shall be designated by Owner's engineer. Upon completion of spoil operations, the spoil piles shall be seeded and mulched in accordance with specification CE-007, Erosion and Sediment Control.

4-6.0 MEASUREMENT FOR PAYMENT

The unit of measurement will be the cubic yard for each class of material specified for excavation. Quantities shall be determined by actual field surveys taken before excavation begins and after it is complete. However, no payment will be made for excavation beyond the planned lines and grades unless specifically authorized by the Owner's engineer. Payment for excavation shall include all material, labor, and equipment for:

- Cofferdams or other temporary construction necessary to perform the required excavation.
- Excavation of the material.
- Transportation of materials from the excavation to points of final use, to disposal areas, and to temporary stockpiles, all within the specified free-haul distance.

- Reclamation work at all borrow and spoil sites excluding seeding.

- Removal and disposal of oversize materials from otherwise suitable materials.

- Pumping, bailing, draining, and all other work necessary to maintain the excavations in a dry condition and in good order during construction and of removing such temporary construction where required.

SPECIFICATION COVER SHEET

Specification Number:	**CE-005**
Revision:	**2**
Date:	**May 3, 2006**

TITLE: Specification for Foundation Preparation

+Scope of Changes:

[X] Revision (Full Procedure)

[ ] Change Sheet, Affected pages: _____

Summary of Changes:

This specification is revised to incorporate portions of the standard specifications from Sargent & Lundy, Mountaineer and Mitchell.

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Specification Owner (Organization): Civil Engineering

Prepared by: Pedro Amaya (AEP) Pedro J Amaya Date: 11/3/2006

Reviewed by: Dan Kocunik (S&L) Daniel Kocunik Date: 5/3/2006

Approved by: Thomas R. Zelina (AEP) T.R. Zelina Date: 11/06/2006

SPECIFICATION FOR FOUNDATION PREPARATION

CE-005

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SPECIFICATION FOR FOUNDATION PREPARATION

CE-005

5-1.0 DESCRIPTION OF WORK

The work shall comprise of the performance of all operations necessary for the preparation of earth and rock foundations in accordance with the requirements of this specification and the project drawings.

Foundation preparation shall consist of the removal of all unsatisfactory material directly underlying the foundation of a structure. This specification covers the requirements of preparing that foundation.

5-2.0 GENERAL REQUIREMENTS

Foundation preparation shall commence after removal of overburden by excavation in accordance with Specification CE-004, Excavation.

All contractor foundation treatment and preparation must be completed and approved by the Owner's engineer before fill placement or placement of concrete.

At least 48 hours before proceeding with excavations call Miss Utility West Virginia (1-800-245-4848), or state equivalent. Underground utility drawings were performed based on available plant drawings. Reasonable efforts have been made to identify underground utilities; however, unidentified utilities may exist. Locate all utilities and obtain plant excavation permits prior to start of any excavation or trenching operation. Upon encountering any unidentified utilities, the Contractor shall immediately notify the Owner. Stake, flag or paint locations of known utilities within the work area.

5-2.1 Bedrock Foundations

Any and all blasting or ripping shall be done so as not to cause damage to the rock at or below the designated foundation elevation. All blasting must be done in accordance with Specification No. CE-004A, Blasting. The Owner's engineer shall inspect the blasted or ripped surface to ascertain whether any damage has occurred during the blasting or ripping operations. If, in the Owner's engineer's opinion, damage has occurred, the contractor shall repair it to the satisfaction of the Owner's engineer at no additional compensation. Rock-fill, filters, transition material, and impervious fill shall be placed immediately within any section of the foundation when it has met the specification and received the approval of the

Owner's engineer, except those areas where drilling and grouting are to be performed.

5-2.2 Earth Foundation

The Owner's engineer shall inspect the area immediately after excavation and, if it meets his approval, the required fill shall then be immediately applied except where drilling or grouting is required. Where soft or excessively wet foundation material is encountered, such material shall be excavated to firm material as judged by Owner's engineer.

5-3.0 CONSTRUCTION OF BEDROCK FOUNDATIONS

5-3.1 Bedrock Foundations Under Rock Fill and Rock-Soil Fill

All rock overhangs or steeply sloping rock surfaces shall be excavated to the lines and grades shown on the drawings or as the Owner's engineer requires. After completion of excavation to the foundation elevation under rock fill and rock-soil fill. The foundation subgrade shall be prepared by removing loose and/or weathered rock and pockets of fines, sand, rock rubble or gravel and other objectionable material from the in-place rock surface including areas of depression, large crevices, and open rock joints. All soil and debris must be removed from potholes, joints, cracks, and cavities. Joints and cavities shall be excavated to the greatest depth practicable. At the direction of the Owner's engineer, the contractor shall backfill cavities, joints, cracks, and potholes with either concrete or rock fill to be compacted using the approved power tampers as specified in Specification CE-006, Fill.

The work shall be performed so as to present a regular surface on which to place rock or rock-soil fill. Contractor shall protect exposed surfaces prior to the placement of fill material. Any concrete or slurry grout material that has been damaged or has deteriorated prior to the placement of rock and rock-soil fill shall be removed and replaced by contractor at no additional compensation.

5-3.2 Bedrock Foundations Under Impervious Fill Zones

After the overburden has been removed to the design elevation, the foundation subgrade shall be prepared by removing loose and/or weathered rock and pockets of fines, sand, rock rubble or gravel and other objectionable material from the in-place rock surface including areas of depression, large crevices, and open rock joints. The final rock foundation subgrades shall be thoroughly cleaned by use of water jets, compressed air jets, or other approved method, and all materials shall be removed from cavities, potholes, and exposed open joints and cracks. Where open joints or cracks are infilled with seams of sand and clay or other soft or undesirable materials, they shall be cleaned out to the greatest depth practicable

with the aid of trowels, prey-bars, and air and water jets as required to perform the work.

Thin surface cracks and fractures shall be filled with slurry grout whereas zones of badly fractured rock may be capped with lean concrete. Slurry grouting shall be in accordance with Specification CE-015, Drilling and Grouting. Potholes and cavities may be filled with concrete or approved impervious fill compacted by approved power tampers as specified in Specification CE-006, Fill. The work shall be performed so as to present a regular surface on which to place impervious fill. Contractor shall protect exposed surfaces prior to the placement of fill material. Any concrete or slurry grout material that has been damaged or has deteriorated prior to the placement of impervious fill shall be removed and replaced by contractor at no additional compensation.

5-3.3 Bedrock Foundations Directly Under Structures

After the overburden has been removed to the design elevation, the foundation subgrade shall be prepared by removing loose and/or weathered rock and pockets of fines, sand, rock rubble or gravel and other objectionable material from the in-place rock surface including areas of depression, large crevices, and open rock joints. The final rock foundation subgrades shall be thoroughly cleaned by use of water jets, compressed air jets, or other approved method, and all materials shall be removed from cavities, potholes, and exposed open joints and cracks. Where open joints or cracks are infilled with seams of sand and clay or other soft or undesirable materials, they shall be cleaned out to the greatest depth practicable with the aid of trowels, prey-bars, and air and water jets as required to perform the work.

Thin surface cracks and fractures shall be filled with slurry grout. Slurry grouting shall be in accordance with Specification CE-015, Drilling and Grouting. Overexcavations shall be filled with the same concrete as is used for the concrete foundation.

5-4.0 CONSTRUCTION OF EARTH FOUNDATIONS

5-4.1 Earth Foundations Under Rock Fill and Rock-Soil Fill

After completion of excavation, earth foundation subgrades shall be drained and cleaned of unconsolidated or wet materials, debris, or other weak and objectionable materials to the satisfaction of Owner's engineer before fill materials are placed. Immediately after approval of the prepared surface, all areas to be covered by rock fill and rock-soil fill shall be immediately covered with a layer of compacted rock-soil material as specified in Specification CE-006, Fill. Additional layers of rock fill or rock-soil material, as required by the specifications, shall be applied immediately following compaction, testing, and

approval of the first layer to prevent softening of the prepared surface. If, in the opinion of the Owner's engineer, any previously approved surfaces becomes contaminated with objectionable material, the placed materials shall be removed and the foundation prepared again to the approval of Owner's engineer and at no additional compensation.

5-4.2 Earth Foundations Under Impervious Fill Zones

After excavating, the foundation under either impervious rolled or impervious dumped fill zones shall be drained and cleaned of loose or wet materials, any pervious soils and debris, or other weak and objectionable materials, and the edges feathered at soil-rock contacts to the approval of Owner's engineer before fill material is placed. When the earth foundations for the impervious fill have been excavated to final grade, the Owner's engineer may require that this surface be scarified and loosened by means of a ripper or other method, and that the entire foundation area for the impervious fill be compacted to the requirements of Specification CE-006, Fill. If necessary, Owner's engineer may require that the surface be moistened or dried prior to the placing of the impervious fill to create a satisfactory bond between the foundation and the fill materials.

5-4.3 Proofrolling

Proofrolling shall be performed with appropriate equipment at the direction of the Owner's engineer in the presence of the testing agency. When specified, the earth foundation, prior to the placement of fill or footings, having been stripped of all vegetation and organic matter, will be scarified. Water will be added if, in the opinion of the Owner's engineer, it is necessary, and then the foundation will be compacted as per the specifications for the particular type of material contained in Specification CE-006, Fill.

Soft or unsuitable material shall either be removed and replaced or recompacted. If bearing areas are not suitable, the Contractor may be required to carry the excavation deeper to more suitable bearing material and backfill with compacted fill per Specification CE-006, Fill. Approved subgrades shall be protected against damage by construction equipment, rain, frost, or other causes, which could impair the bearing capacity of the subgrade. If the bearing capacity is impaired before fill or concrete is placed upon subgrade, scarification, moisture conditioning and/or recompaction shall be performed. The bearing area shall be relatively smooth at the time of placement of concrete.

The equipment used for proofrolling shall be equipment such as a dump truck loaded with a minimum of 6 cubic yards of soil or a minimum 15 ton pneumatic-tired roller having not less than 4 pneumatic wheels. Under working conditions the roller shall deliver a compression of not less than 150 pounds per square inch of tire tread. Compact the surface of the subgrade to be proofrolled. Proofroll the

surface by making a minimum of two coverage's with the proofrolling equipment at a speed not greater than 3 mph. Each succeeding trip of the proofroller shall be offset by not greater than one tire width. Make additional passes over areas of suspected instability.

The subgrade shall be considered failed if, under the action of proofrolling, the subgrade yields, pumps, or is otherwise unstable as determined by the Owner's engineer. Remove all failed areas a minimum depth of two feet or as directed by Owner and replace with satisfactory fill approved by the Owner's engineer compacted as specified for "Structural Fill" in Specification C-006, Fill. No fill shall be placed until the subgrade has been accepted by the Owner's engineer.

5-5.0 MEASUREMENT FOR PAYMENT

The units of measurement for payment for all work specified are established below. Contractor's bid prices shall cover all costs of performing the work of foundation preparation including the furnishing of labor and materials.

- Excavation of unsuitable materials shall be performed and measured in accordance with Specification CE-004, Excavation.

- Measurement for payment for the preparation of bedrock foundations will be made for the actual surface areas, measured in square yards, of all surfaces prepared as required by Owner's engineer. Calculations shall be based on the actual area of panels with minimum dimensions of 5' by 5' with no allowances made for local irregularities within that area.
- Measurement for payment for slurry grout and lean concrete shall be in accordance with Specification CE-015, Drilling and Grouting.

SPECIFICATION COVER SHEET

Specification Number: CE-006
Revision: 1
Date: November 8, 2006

TITLE: Specification for Fill

+Scope of Changes:

[X] Revision (Full Procedure)

[ ] Change Sheet, Affected pages: _____

Summary of Changes:
This specification is revised to incorporate portions of the standard specifications from Sargent & Lundy, Mountaineer and Mitchell.

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Specification Owner (Organization): Civil Engineering

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SPECIFICATION FOR FILL

CE-006

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SPECIFICATION FOR FILL

CE-006

6-1.0 DESCRIPTION OF WORK

The work to be performed under this specification shall consist of spreading and compacting fill material to the elevations, lines, grades, and cross-sections indicated on the project drawings.

6-2.0 DEFINITIONS

The type of fills specified and definitions of compaction methods are defined as follows.

6-2.1 Cohesive Soils

All clays and other clayey-silt or clayey-sand soils in which the absorbed water and particle attraction work unitedly to produce a mass which holds together and deforms plastically at varying water contents, shall be designated as cohesive soils.

Cohesive material is suitable for use as both “General Fill” and “Structural Fill” if it contains not more than 1 percent organic or other deleterious material, has a maximum rock size of 2 inches, has a liquid limit of less than 40 and a plasticity index of less than 25. Acceptable cohesive materials are soils, which are classified as GC, SC, ML, CL, (or GM, GP-GM, GW-GM, SW-SM, SP-SM, or SM if the fines are plastic) in the Unified Soil Classification System, ASTM D2487.

6-2.2 Granular Soils

Sand, gravel, sand and gravel, bottom ash, boiler slag, and crushed stone having a top size no greater than 1.5” in diameter and a fines content of no more than 12% by weight passing the No. 200 sieve as determined by ASTM D1140.

These specifications may be used for all boiler slags and bottom ash obtained from the Big Sandy, Clinch River, Conesville, Gavin, Mitchell, Muskingum River, Sporn, and Tanners Creek Plants. Boiler slag or bottom ash from other plants may only be used with the specific written permission of the Civil engineering Division of AEPSC, and in accordance with specific instructions issued at that time.

6-2.3 Soft Rock and Rock-Soil Mixtures

Soft rock and rock-soil mixtures shall consist of claystones, mudstones, shales, highly weathered rock and general random combinations of rock and soil. The maximum size of the rock in the fill shall be 6" in diameter. This material shall not be used in the upper 6 feet of fills beneath structures or within 2 feet of buried utilities.

6-2.4 Rockfill

Rockfill shall consist of relatively hard, clean rocks with fines content of less than 5% by weight passing the No. 200 sieve as determined by ASTM D1140, and with a maximum size as indicated in the project specifications or on the project drawings. Rockfill shall not be used in structural fills beneath structures.

6-2.5 Silt

Silt is a soil in which the particle size is from 0.002 to 0.074 mm and which possesses little or no plasticity or cohesion (PI < 4 in general). Silt shall not be used as fill directly beneath structures.

6-2.6 Fly Ash

Fly ash is the finely divided residue that results from the combustion of ground or powdered coal and which is collected from the exhaust gases by electrostatic or mechanical precipitators or fabric filters. Fly ash is, typically, made up of spherical, uniform particles ranging in size from 1 micron to 100 microns. Fly ash shall not be used as fill directly beneath structures.

6-2.7 FGDS

FGDS is an acronym for Flue Gas Desulfurization Sludge. The FGDS is a fixated mixture of FGD filter cake, fly ash, and the fixating agent that is usually lime. The material is primarily silt sized and typically has a moisture content of 35% to 65% or higher.

6-2.8 Hand Compaction

Fill which is placed adjacent to walls or other structures which are sensitive to lateral loads induced by compaction, including conduits, pipes, multiple arches and ellipses, or other structures so designated by the Owner's engineer shall be hand compacted.

Hand compaction shall be defined as the compaction effort produced by manually tamping the soil or by compacting with the following types of equipment: gas or diesel tamper, vibratory plate compactor, trench compactors, and vibratory or static rollers with a maximum drum width of 33" or less.

6-2.9 Structural Fill

Structural Fill is fill placed beneath equipment, buildings, tanks, walls, retaining walls, conveyor foundations and other similar structures or equipment sensitive to settlement. "Structural Fill" is also fill placed beneath roads and railroad tracks and fill supporting buried structures such as drainage manholes, electrical manholes and vaults, and underground tanks and oil separators.

6-2.10 General Fill

General Fill is fill which does not support structures and fill for areas which are not exceptionally sensitive to settlement. "General Fill" includes fill for laydown and work areas, unpaved parking areas, material storage areas, and tank spill containment compounds.

6.2.11 **Thermal Backfill Material**

Backfill material shall consist of particles of rock that will pass the No. 4 (4.75mm) sieve and be retained on the No. 200 (0.75mm) U.S. Standard Sieve.

The material shall be bonded, subangular sand, preferably silicic sand (the primary constituent of which is quartz).

The material shall contain kaolin-base clay, in an amount not less than 5% and not more than 8%.

The dry compacted density shall be approximately 2,700 pounds per cubic yard.

The material shall be free of rubble, stones, organic matter, salts, ashes, cinders, other boiler wastes, and any other material(s) which may injure the cable or conduit or increase the thermal resistivity of the backfill.

The material shall conform to the following sieve analysis (sieve sizes are U.S. Standard Series):

Sieve Size	% Passing By Weight
3/8”	100
#4	95 – 100
#8	85 – 95
#16	60 – 75
#30	35 – 60
#100	10 – 30
#200	2 - 8

6-3.0 FOUNDATION PREPARATION

Foundation preparation for fills shall be done in accordance with Specification CE-005, Foundation Preparation. Proofrolling is required prior to placement of the initial lift. No fill shall be placed until the subgrade has been accepted by the Owner’s engineer.

6-4.0 CONSTRUCTION OF FILLS

6-4.1 Submittals

Samples of materials to be used as fill shall be submitted 30 days prior to use to verify compliance with these specifications.

6-4.2 Placement

Fill shall not be placed upon frozen surfaces nor shall snow, ice, or frozen earth be incorporated in the fills. Fill shall be placed in lifts to the nominal loose thickness tabulated below unless otherwise specified in the project specifications:

Cohesive Soils	8”
Granular Soils	9”
Hand Compaction	3”
Soft Rock and Rock Soil	9”
Rock	18”
Fly Ash	12”
FGD Sludge	12”-48”

Successive lifts shall not be placed until the lift under construction has been compacted in accordance with the requirements of paragraph 6-6.0 of this specification, tested, and approved by the Owner’s engineer.

6-4.3 Slopes

Fills shall be sloped and crowned to prevent the ponding of water. The slope and crown shall be maintained throughout construction. Cohesive fill areas not being worked prior to periods of anticipated precipitation shall be uniformly sloped transversely and longitudinally and given a smooth tight surface to shed water. Temporary construction slopes within the fill shall not be steeper than 2.0 horizontal to 1.0 vertical. The exterior slopes of all fills shall be graded and dressed smooth prior to the placing of any slope protection (e.g., topsoil, stone, etc.). For areas designated as root zones, the fill shall be placed in 12” thick loose lifts and compacted by four passes of the specified compactor.

If the fill is to be placed on an original hillside or an existing embankment with slope of between 5 and 20 percent, the original ground shall be scarified to a depth of 6 inches to provide a bond between the ground and the fill to be placed thereon and the first layer of fill shall be placed, blended and compacted.

If the fill is to be placed on an existing hillside or embankment which has a slope of greater than 20 percent, the fill shall be keyed into the toe of the slopes of the original hillside or the existing fill and shall be continuously benched to key the fill into the underlying ground to ensure that new Work is constructed on a firm foundation free of loose or disturbed material. Keys at the toe shall be 10 feet wide by 1 foot deep.

Benches on the slope shall be a minimum of 1 foot deep normal to the slope and about 10 feet wide. Benches shall slope 2 percent downhill and shall be horizontal longitudinally, following the natural contours. Material excavated from benches shall be mixed with new fill and compacted.

All fills shall be constructed to a line not more than 6" outside the designated lines shown on the drawings.

6-5.0 MOISTURE CONTROL

6-5.1 Cohesive Soils

All cohesive soils used for fill shall have a moisture content as designated in the project specifications or on the project drawings. In the absence of a project specification moisture content range, the contractor shall ensure that the moisture content is sufficient to allow the soil to be compacted to a minimum of 95% of the maximum density as determined by ASTM D698 (Standard Proctor) for general fill. Acceptable moisture range is ± 3 percent of the optimum moisture content. If the material is to directly support structures, it shall be compacted to a minimum of 100% as determined by ASTM D698 and the moisture content shall be ± 2 percent of the optimum moisture content.

If the fill is too dry, sufficient water shall be added to the material by a method approved by the Owner's engineer to bring the moisture content into the acceptable range. If the fill material is too wet, the material shall be disced, harrowed, or otherwise aerated to reduce the moisture content to within the specified limits. In addition, the moisture content of the fill shall be relatively uniform for each lift. If, in the opinion of the Owner's engineer, the moisture content of any lift is too variable, that lift shall be disced, scarified, or mixed by an approved technique to provide relatively uniform moisture content.

6-5.2 Granular Soils

Granular soils shall have sufficient water applied to the fill immediately ahead of the compactor to ensure adequate saturation of the material during compaction to achieve the required in place density.

6-5.3 Soft Rock and Rock-Soil Mixtures

All soft rock and rock-soil mixtures shall have a moisture content for the minus ¾" fraction of the material in the range designated in the project specifications or on the project drawings. In the absence of a project specified range, the contractor shall ensure that the moisture content for the minus ¾" fraction is sufficient to allow the material to be compacted to a minimum of 95% of the maximum density as determined by ASTM D698 (Standard Proctor). All the provisions of Section 6-5.1 shall apply to these soils.

6-5.4 Rock

There is no moisture content requirement for the compaction of rock fills.

6-5.5 Silt

Silt fill shall have a moisture content as designated in the project specifications or on the project drawings. In the absence of a project specified moisture content range, the contractor shall ensure that the moisture content is sufficient to allow the soil to be compacted to a minimum of 95% of the maximum density as determined by ASTM D698 (Standard Proctor). Acceptable moisture range is ± 3 percent of the optimum moisture content. When the fill is too dry, sufficient water shall be added to the material by a method approved by the Owner's engineer to bring the moisture content into the acceptable range. When the fill material is too wet, the material shall be disced, harrowed, or otherwise aerated to reduce the moisture content to within the above specified limited.

6-5.6 Fly Ash

Fly ash fill shall have a moisture content as designated in the project specifications or on the project drawings. In the absence of a project specified moisture content range, the contractor shall ensure that the moisture content is sufficient to allow the soil to be compacted to a minimum of 95% of the maximum density as determined by ASTM D698 (Standard Proctor). When the fill is too dry, sufficient water shall be added to the material by a method approved by the Owner's engineer to bring the moisture content into the acceptable range. When the fill material is too wet, the material shall be disced, harrowed, or otherwise aerated to reduce the moisture content to within the above specified limits.

6-5.7 FGDS

The moisture content of the FGDS is determined at the producing plant, and, because of the nature of the material, adjusting the moisture content in the field (specifically lowering it) is impractical. Therefore, unless moisture control requirements are addressed in the project specifications, there are no moisture control requirements for FGDS. However, compaction controls shall be in accordance with Section 6-6.7 of this specification.

6-6.0 COMPACTION

All compaction equipment shall be inspected by the Owner's engineer prior to use. Contractor will cooperate with Owner's engineer by correcting any equipment problems noted in the inspection. Cleaning teeth on sheepsfoot rollers shall be checked for wear and properly adjusted. The frequency of vibration of vibratory rollers shall be checked, and shall be at the manufacturer's specification prior to use.

6-6.1 Cohesive Soils

Each lift of cohesive material shall be placed in near horizontal layers and compacted with a sheepsfoot or padfoot roller or compactor to a minimum dry density of 95% of the Standard Proctor maximum density as determined by ASTM D698 for general fills and 100% for structural fills. In the absence of field density and Proctor testing, the cohesive soil shall be compacted by a minimum of six complete coverages of the compactor. The compactor shall be weighted such that its feet or pads penetrate the entire lift in the initial pass and walk out about one half their length during the application of the coverages. The Owner's engineer shall have the right, at any time during the execution of the work, to vary the weight of the roller to secure optimum compaction. The compaction units shall travel at speeds that do not cause the pads or feet to churn up or toss the soil. Each coverage shall overlap the adjacent coverage a minimum of 1'. If the compacted surface is too dry or too smooth in the opinion of the Owner's engineer to bond properly with the succeeding lift, it shall be moistened, scarified, or loosened by discing, harrowing, or any other approved method prior to placement of the succeeding layer.

When the surface of a lift is sealed for weather protection with a smooth drum or pneumatic tired roller, that surface shall be scarified prior to placing the succeeding lift. The total depth of the succeeding lift, including the scarified material, shall be a nominal 6" (loose). When contractor utilizes compactors with tandem drums (e.g., Cat 825), one machine pass equals one compaction pass unless otherwise stated in writing by the Owner's engineer.

Large continuous areas shall be uniformly filled to cover the entire length and width of the area to be filled before the next layer of material is placed.

6-6.2 Granular Soils

The compaction unit shall be a pull type or self-propelled vibratory compactor of a type submitted for review and approval by the Owner's engineer prior to mobilizing it. Each lift shall be compacted to the relative density as determined by ASTM D4253 and ASTM D4254, designated in the project specifications or on the project drawings. In the absence of a project designated relative density, the material shall be compacted to a minimum relative density of 80% for general fills and 85% for structural fills. If in-situ density and relative density testing cannot be performed, then the material shall be compacted by six complete coverages of the approved roller. The compaction units shall travel at speeds not exceeding 2.5 miles per hour. Each coverage shall overlap the adjacent coverage a minimum of 18".

6-6.3 Hand Compacted Backfill

Each 4" loose lift of backfill material shall be compacted with four coverages of the equipment referenced in Section 6-2.8. The power of the engine driving the vibratory compactor shall be such as to maintain the maximum frequency and vibratory impact force specified in the manufacturer's operation manual. Each coverage shall overlap the adjacent coverage by 20% of the width of the compactor.

Backfill placing and compacting adjacent to concrete structures shall not commence until a minimum of three days has elapsed after the concrete was poured. Backfill shall be kept at equal heights around the structure so as not to induce unequal stresses on the structure as the backfill is placed. In addition, hand compaction will be performed to the following minimum horizontal distance requirements from adjacent structures before machine compaction can commence. For structural walls and rigid retaining walls a minimum horizontal distance of 3' + H shall be maintained where "H" is the height differential between the backfill as it is being placed and the grade elevation of the inward side of the wall (see Sketch 6 A-1).

6-6.3.1 Special Requirements

The transporting, unloading, and spreading of backfill material for hand compaction shall be done with equipment that does not exceed a static weight of 1 ton. Large dozers, endloaders, or other similar equipment used to transport, unload, and spread backfill material for machine compaction shall conform to the minimum distances form structures as specified in Section 6-6.3 of this specification.

Under no circumstances shall any equipment come in contact with any structure. If contact does occur, all work shall immediately cease, the Owner's engineer shall be notified, and a damage inspection made. In the event of structural damage, the contractor will either make the repairs under the direction of the Owner's engineer or be billed for such repairs made by another contractor under the Owner's engineer's directions.

In the event that a hand operated vibratory compactor cannot be used immediately adjacent to the structure because of possible structural damage (i.e., dowels outside of the concrete, interferences with conduit sleeve, or other obstructions necessitating hand tampers), hand tampers are to be used. The hand tampers shall not weigh less than 20 lbs. and shall have a tamping face not larger that 6" x 6". Backfill lifts shall not exceed 3". Hand tamping shall be performed using a minimum of four tamps with an average drop of 24" per tamp lift.

When applicable specifications do not specify a minimum strength requirement for newly placed concrete structures prior to backfilling, compaction of fill adjacent to structures shall not be started until the following intervals have elapsed:

Footings and slabs	24 hours
Walls, columns and piers backfilled on all sides simultaneously	7 days
Retaining walls where ratio of depth of fill to wall thickness is less than three	7 days
Retaining walls where ratio of depth of fill to wall thickness is greater than three	14 days

6-6.4 Soft Rock and Rock-Soil Mixtures

Soft rock and rock-soil mixtures shall be compacted with a vibratory sheepsfoot roller to a minimum of 95% of the Standard Proctor maximum density for the minus ¾" fraction, as determined by ASTM D698 for general fills. The roller shall be approved by the Owner's engineer. Each coverage of the roller shall overlap the adjacent coverage by at least 1'. The roller shall vibrate at a minimum frequency of 30 cps. Care shall be taken to prevent nesting of larger rock pieces in the fill.

6-6.5 Rockfill

Rockfill materials shall be compacted with four complete coverages of the treads of a D8 bulldozer or equivalent approved by the Owner's engineer. Care shall be taken to prevent nesting of rock pieces in the fill.

6-6.6 Fly Ash

Fly ash shall be compacted with a pneumatic tired compactor or a smooth drum, vibratory, or static roller (towed or self propelled) to a minimum of 95% of the Standard Proctor maximum density as determined by ASTM D698.

6-6.7 FGDS

FGDS shall be tracked in with the treads of a bulldozer using low ground pressure tracks when placed in lifts exceeding 12" in thickness. The bulldozer shall endeavor to crush all large clods or boulders of FGDS that may have formed during the initial setting phase at the plant stackout pad.

When constructing engineered fills using FGDS, test pads will be constructed to determine the optimum compaction methods (including equipment type, lift thickness, and number of passes). The Owner's engineer shall direct the construction of the test pad and the test procedures to be used in determining the optimum compaction methods.

6-7.0 WATER CONTROL

Contractor shall maintain all fill operations free of water by ditches, sumps, pumping, or other methods approved by Owner's engineer. Each layer of fill shall be placed so that the surface is free draining. Runoff and other water shall be directed in ditches and channels to a natural waterway or into the site drainage system. Water directed off the site shall be treated for silt and sediment removal in accordance with Specification CE-007, Erosion and Sediment Control, and in

accordance with federal, state, and local laws. All water from fills, embankments, or natural slopes shall be directed to minimize erosion.

Where springs or seepage are present in the area to be filled, the contractor shall construct groundwater intercept drains or French drains (stone filled ditches) as directed by the Owner's engineer prior to placing any fill. These drains shall discharge beyond the limits of the fill.

6-8.0 DUST CONTROL

The Contractor shall be responsible for obtaining a dust control permit and shall be responsible for controlling dust caused by the grading operation in compliance with that permit. Water shall be applied uniformly and lightly to prevent muddy, slippery or other hazardous conditions. The application shall be frequent enough to adequately control the dust nuisance. However, excessive application that would affect compacting operations shall be avoided.

6-9.0 GRADING TOLERANCES

The acceptable deviation from lines and grades indicated on the project drawings shall be as shown in Table 1. The Contractor shall use data from that table which is applicable to the project.

6-10.0 MEASUREMENT FOR PAYMENT

The unit of measure for payment shall be the cubic yard of each type of fill placed. The quantities of each type of fill to be paid for shall be the total number of cubic yards of material placed, compacted, and constructed to the lines and grades shown on the project drawings. Volumes will be computed from field cross-section measurements of the compacted fill. For progress payments, the quantities to be paid for will be based either on load counts of fill materials placed or interim field surveys or any other proposed method acceptable to the Owner's engineer. The quantity records shall be kept on a daily basis with daily and cumulative total submitted to the Owner's engineer on a weekly basis.

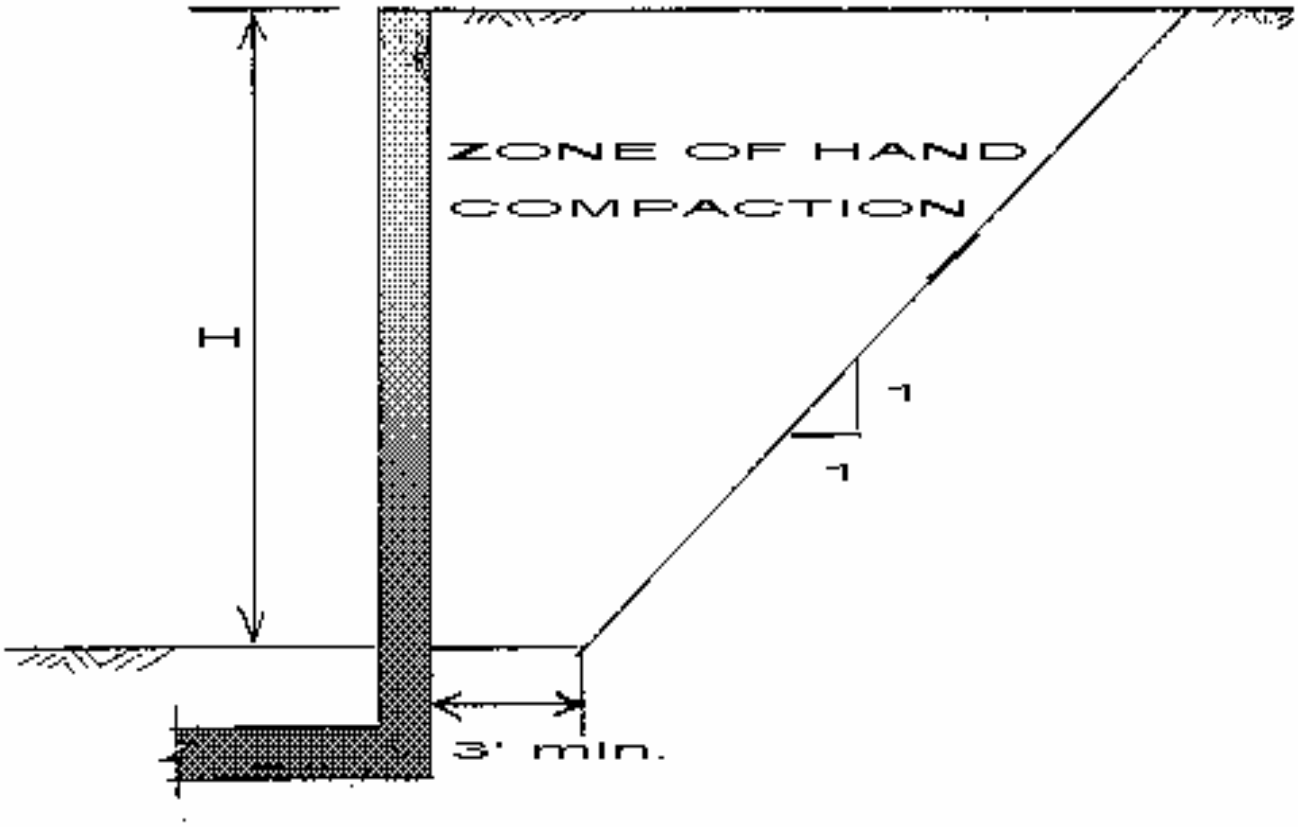
For final payment, either actual cross-sections shall be used or quantities shall be calculated from lines and grades shown on the drawings where cross-sections cannot be obtained. The payment will be considered full compensation for all work performed in constructing the fill as specified, including payment, moisture control, compaction, proofrolling, and water control (excluding French drains).

For the compacted structure backfill requirements, the contractor shall submit to the Owner's engineer prior to the start of work a method and form to be used for accounting purposes for tracking the quantities of hand compacted backfill placed by the contractor.

TABLE 1

ACCEPTABLE DEVIATION		
Type of Installation-Excavation or Fill	**Maximum Acceptable Deviation From Line (Feet)**	**Maximum Acceptable Deviation From Grade(1) (Feet)**
General Earthwork		
Building Area	±0.3	+0.0 to -0.1
General Site Area	±0.3	±0.2
Parking Lot	±0.3	±0.1
Switchyard	±0.3	±0.1
Material Storage Area	±0.5	+0.1 to - 0.3
Roads and Tracks		
Road Embankment or Subgrade	±0.2	+0.1 to -0.0
Track Embankment or Subgrade	±0.1	+0.1 to -0.0
Drainage Facilities		
Permanent Drainage Channel	±0.3	0.0 to - 0.1
Slope Drainage Benches and Drainage Diversion Dikes	±0.5	±0.1
Ponds and Spill Containment Areas		
Pond Dikes and Top Edge of Excavated Ponds	±0.5	+0.25 to -0.0
Pond Bottoms (Top of Liner)	-	+0.1 to - 0.2
Oil Spill Containment Area Dikes	±0.5	+0.1 to -0.0
Spill Containment Area Top of Liner	-	±0.1

Notes:
After initial settlement has taken place. Initial settlement is that settlement that will occur up to the time of determination and acceptance of final grade elevations by the Owner.



SKETCH
6A - 1

SPECIFICATION COVER SHEET

SPECIFICATION NUMBER:	**CE-006A**
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TITLE: Earthwork (Backfill) Testing

+Scope of Changes:

[X] Revision (Full Procedure) New

[ ] Change Sheet, Affected pages: _____

Summary of Changes:

This specification is prepared to incorporate the standard specification from Sargent & Lundy and portions of the Mountaineer and Mitchell standard specifications.

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SECTION CE-006A

EARTHWORK (BACKFILL) TESTING

PART 1 - GENERAL

101. EXTENT

The intent of this Specification is to define the requirements for Earthwork Testing to be performed by a Testing Service hired by Owner.

101.1 The Work shall include, but not be limited to, the following items:

a. Testing for suitability of material prior to and during use.

b. Visual observations.

c. Laboratory testing of materials.

d. Field-testing to assure compliance of materials and placement procedures with Design Drawings and Specifications.

102. REFERENCE DOCUMENTS

102.1 Standards, Specifications, manuals, codes and other publications of nationally recognized organizations and associations are referenced herein. Methods, Equipment and materials specified herein shall comply with the specified and applicable portions of the referenced documents, in addition to federal, state or local codes having jurisdiction.

102.2 References to these documents are to the latest issue date of each document, unless otherwise indicated, together with the latest additions, addenda, amendments, supplements, etc., thereto, in effect as of the date of Contract for the Work.

102.3 Abbreviations listed indicate the forms used to identify the reference documents in the Specification tests.

102.4 ASTM - American Society for Testing and Materials

a. D422 - Test Method for Particle-Size Analysis of Soils.

b. D698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.

c. D1140 - Test Method for Amount of Material in Soils Finer Than the No. 200 Sieve.

d. D1556 - Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

e. D1557 - Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.

f. D2167 - Test Method for Density and Unit Weight of Soil In Place by the Rubber Balloon Method.

g. D2216 - Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.

h. D2434 – Test Methods for Permeability of Granular Soils (Constant Head).

i. D2487 - Classification of Soils for Engineering Purposes (Unified Soil Classification System).

j. D2488 - Practice for Description and Identification of Soils (Visual-Manual Procedure).

k. D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

l. D3017 - Test Methods for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

m. D3385 - Test Method of Infiltration Rate of Soils in Field Using Double Ring Infiltrometer.

n. D4253 - Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.

o. D4254 - Test Method for Minimum Index Density and Unit Weight of Soils and Calculations of Relative Density.

p. D4318 - Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

q. D5084 – Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.

r. D5093 – Test Method for Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer with a Sealed Inner Ring.

103. SUBMITTALS

Testing Service shall submit the following documentation and data. Testing Service's documentation and data shall be submitted via electronic medium in a format compatible for importing into Owner's information systems specified by Owner.

103.1 Documentation

a. Documentation shall include the following:

a1. Daily records.

a2. Testing records and data sheets.

a3. Photographic records if requested by Owner.

a4. Acceptance report.

a5. Final report.

b. All records shall, at a minimum, bear the following:

b1. Uniquely identifying sheet number.

b2. The date.

b3. Project name, project number and location.

b4. Descriptive remarks.

b5. Data for tests.

b6. Written text descriptions for visual observations.

b7. Signature of the Preparer or designated authority.

c. An index or summary report shall be prepared listing all records and reports. The index shall be assembled in a chronological framework for recording and identifying all reports.

103.2 Daily Records

a. Daily records shall include:

a1. Inspection data sheets.

a2. Data sheets listing the number and types of construction Equipment in use by the Contractor and construction Equipment data.

a3. Problem identification reports.

a4. Corrective action reports.

b. Problem identification reports and corrective action reports shall include detailed descriptions of materials and/or workmanship that do not meet a specified design and shall be cross referenced to specific inspection data sheets where the problem was identified and corrected.

103.3 Testing Records

a. Testing records shall include:

a1. Data sheets describing field samples taken.

a2. Laboratory data sheets.

a3. Field test data sheets.

a4. Notes, charts, Drawings, or sketches identifying the location and elevation of field tests or where samples were obtained.

103.4 Photographic Records

a. Photographic records shall include:

a1. Mounted photographs, each with a unique identifying number.

a2. Chart indicating the location from which each photograph was taken.

a3. Summary list giving the date and time of each photograph.

103.5 Acceptance Report

a. All reports and data sheets shall be assembled and summarized into an acceptance report in order to verify that the materials and construction procedures comply with specified design. As a minimum this report shall contain all inspection summary reports, inspection data sheets, problem identification reports and corrective action reports. The acceptance report shall be prepared by the Field Inspector and updated on a daily basis.

103.6 Final Report

a. Report Preparation:

a1. A final report shall be prepared by the Testing Engineer. The final report shall contain all data sheets, testing records, reports and photographs concerning items which were tested.

b. Certification:

b1. The Testing Engineer shall certify the final report and submit the original and three copies to Owner, and one copy to the Contractor.

103.7 Submittals

a. The Testing Service shall submit the following documents:

a1. Qualifications of Testing Engineer, Field Inspectors, and Laboratory Technicians listed in Paragraph 105.

a2. Documentation described in Paragraph 103.1.

a3. Procedures that will be followed for calibration of testing Equipment.

104. PROJECT MEETINGS AND AUDITS

104.1 Project meetings shall be held on a periodic basis during the lifetime of the project. The meetings shall include:

a. A preconstruction meeting.

b. Daily progress meetings.

c. Additional meetings as required to discuss problems or Work deficiencies.

104.2 Preconstruction Meeting

a. The preconstruction meeting shall be used to discuss:

b. Design plans and Specifications.

c. The responsibilities of each party.

d. The lines of authority and communication.

e. Field and laboratory test requirements and sample sizes.

f. Procedures for observance of tests.

g. Coordination between the Contractor and the Field Inspector to obtain timely field samples and tests.

h. Procedure for handling construction deficiencies, repairs, and retesting.

i. Work area security and safety protocol.

j. Conduct a site visit.

104.3 Daily Meetings

a. Daily meetings shall be held at the completion of each day's work to review the work schedule, work completed, results of tests, and to discuss potential construction problems.

104.4 Additional Meetings

a. Additional meetings between the Contractor, the Field Inspector, and the Testing Engineer (if necessary) shall be held immediately after a Work deficiency is identified or a problem arises. These meetings shall be used to define and resolve the deficiency or problem.

105. QUALITY ASSURANCE

105.1 Responsibilities of Testing Personnel

a. Testing Engineer:

a1. The Testing Engineer shall be responsible for the performance of activities specified herein, such as inspection, sampling, testing, and documentation; and for preparation of and certification of the Final Report. In addition he shall have the responsibility of daily coordination with Field Inspectors, the Contractor, and Owner to discuss daily progress, review completed Work, perform visual inspections, review test results and discuss and resolve any current or potential construction problems.

b. Field Inspector:

b1. The Field Inspector shall be responsible for performing visual examinations and for performing field and laboratory tests. He shall be responsible for reporting to the Testing Engineer the results of any inspections or Work that is of unacceptable quality or that does not meet the specified design requirements. The Field Inspector shall be under the direct supervision of the Testing Engineer.

105.2 Qualifications of Testing Personnel

a. Testing Engineer:

a1. The Testing Engineer shall be a registered professional civil engineer or a certified engineering geologist in the State in which the Work is to be performed who possesses sufficient practical, technical, or managerial experience and adequate communication skills to successfully oversee and implement Earthwork Testing activities.

b. Field Inspector:

b1. The Field Inspector shall have adequate formal academic training and sufficient practical and technical experience needed to execute and record inspection activities conducted at the site and perform laboratory and field-testing. This includes demonstrated knowledge of:

b1.1 Field practices relating to construction techniques used for the type of earthwork being performed.

b1.2 Construction and compaction Equipment.

b1.3 All permit requirements, codes and regulations concerning material and Equipment installation.

b1.4 Observation and testing procedures.

b1.5 Testing Equipment.

b1.6 Documentation procedures.

b1.7 Site safety.

PART 2 – PRODUCTS

Not Applicable

PART 3 - EXECUTION

301. GENERAL REQUIREMENTS FOR VISUAL OBSERVATIONS DURING TESTING

301.1 Scope

a. This paragraph describes requirements for visual observations that shall be provided for all types of testing.

301.2 Visual Observations

a. Record daily atmospheric conditions. Take appropriate actions when unsuitable construction conditions exist.

b. Record type and size of compaction Equipment in use.

b1. For sheepsfoot rollers, record the drum diameter and length, empty and ballasted weight, arrangement of feet, length and face area of feet, and the yoking arrangement.

b2. For rubber-tired rollers, record the tire inflation pressure, spacing of tires, and empty and ballasted wheel loads.

b3. For vibratory rollers, record the static weight, imparted dynamic force, operating frequency of vibration, and drum diameter and length.

b4. For hand tampers, record make, model number, size, and compactive effort.

c. Observe and record compactive effort, uniformity of compaction and scarification and connection between compacted lifts. Record number of passes of a roller by type, size, and weight of roller.

d. For proofrolling, record the type, size, and weight of compaction Equipment or other vehicles used for proofrolling.

302. INSPECTION AND TESTING OF THE SUBGRADE

302.1 Scope

a. This paragraph describes requirements for inspection and testing for:

a1. Subgrade to receive fill.

a2. Subgrade beneath foundations.

a3. Subgrade beneath liners.

302.2 Visual Observations of the Subgrade

a. Visual Observations shall include:

a1. Visual Observations listed in Paragraph 301.

a2. Observe stripping and removal of topsoil and removal of all organic and undesirable material.

a3. Observe that there are no moisture seeps, puddling, or ponding.

a4. Observe proofrolling to identify soft spots, and observe removal of material in soft spots.

a5. Observe compaction of the subgrade prior to placement of fill. Inspect for any settlement due to soft areas in the subgrade.

a6. Verify measurements and determine that the depth and slope of an excavation meets design requirements and that there are no sidewall failures from moisture seeps.

302.3 Laboratory Tests

a. See Table 1 for minimum requirements of laboratory tests.

302.4 Field Tests

a. See Table 2 for minimum requirements of field tests.

303. INSPECTION AND TESTING FOR EMBANKMENT FILL

303.1 Scope

a. This paragraph describes requirements for inspection and testing for:

a1. Mass earthwork.

a2. Construction of liquid retention dikes.

303.2 Visual Observation of the Material Source During Construction

a. Visual observations shall include:

a1. Inspect soils to assure that they are uniform.

a2. Inspect to ensure that only suitable soil is transported to the site, observe segregation operations when unsuitable soils are present, and observe removal of organic soils, roots, stumps, and stones.

a3. Observe changes in color or texture that can be indicative of a change in soil type or moisture content.

a4. Observe moisture-conditioning activities to ensure that any required substantial changes in moisture content are made at the source.

303.3 Visual Observations of Fill Placement

a. Visual observations listed in Paragraph 301.

b. Observe removal of roots, rocks, rubbish, or out-of-specification soil.

c. Observe and record changes in soil characteristics necessitating a change in construction procedures.

d. Observe adequate clod size reduction for clay soils.

e. Observe procedures to be followed to adjust the soil moisture content to obtain uniform moisture content.

f. Observe procedures followed to adjust the soil moisture content in the event of a significant rainfall or drought during construction.

g. Observe and record that final grade is consistent with design grade specified on the Design Drawings.

303.4 When fly ash, bottom ash or boiler slag is used for on-site filling operations, records shall be maintained of the following information. These records shall be provided to the Owner:

a. Source and type of ash.

b. Date of residual applications.

c. Location of ash utilization.

d. Volume of ash utilized in tons.

e. Ash receiver.

f. Intended use of ash.

303.5 Laboratory Tests

a. See Table 1 for minimum requirements of laboratory tests.

303.6 Field Tests

a. See Table 2 for minimum requirements of field tests.

304. INSPECTION AND TESTING FOR STRUCTURAL BACKFILL AND CULVERT AND UTILITIES TRENCH BACKFILL

304.1 Scope

a. This paragraph describes requirements for inspection and testing for:

a1. Structural bedding beneath foundations.

a2. Structural backfill.

a3. Sewer, pressure line, or culvert trench backfill.

a4. Catch basin, manhole, pump sump or other utility appurtenance backfill.

a5. Electrical duct bank and electrical cable backfill.

304.2 Visual Observations shall include:

a. Visual observations listed in Paragraph 301.

b. Observe that there is no standing water in the excavation and that the bottom of the excavation is not soft when a structure or utility is being installed.

c. Observe that proper materials are being used for bedding and backfill and there is proper placement, lift thickness, and compaction of bedding and backfill.

d. Observe that the proper compaction Equipment is being used to compact backfill.

304.3 Laboratory Testing

a. See Table 1 for minimum requirements for laboratory tests.

304.4 Field Testing

a. See Table 2 for minimum requirements for field tests.

305. INSPECTION AND TESTING FOR ROAD AND AREA PAVING AND PLACEMENT OF RAILROAD SUBBALLAST AND BALLAST

305.1 Scope

a. This paragraph describes requirements for inspection and testing for:

a1. Road and pavement subgrade (all types of pavement).

a2. Trackwork subgrade, subballast and ballast.

a3. Crushed rock base and subgrade material.

a4. Crushed rock area surfacing, parking lot surfacing, and laydown area surfacing.

305.2 Visual observations shall include:

a. Visual observations listed in Paragraph 301.

b. Observe proofrolling to identify soft spots in the subgrade, and observe removal of material from soft spots.

c. Observe compaction of the subgrade prior to placement of subballast or base.

d. Observe that there is proper placement and compaction of any backfill around culverts, pipes, or other utilities installed under a road.

e. Observe and record that final grade is consistent with design grade specified on the Design Drawings.

305.3 Laboratory Testing

a. See Table 1 for minimum requirements for laboratory tests.

305.4 Field Testing

a. See Table 2 for minimum requirements for field tests.

306. SAMPLING PATTERN

306.1 The Testing Engineer shall establish a completely random sampling pattern for determining the choice of sampling points for field tests. Each block of Work shall be subdivided into a sampling grid with at least 10 times as many grids as samples or tests to be taken. The grid shall have a numeric numbering system devised to distinguish each set of tests for a specific area from all other sets of tests. Each lift shall have a separate grid.

306.2 Sampling points shall be chosen by a random number generator or other acceptable method to obtain uniform coverage. Tests shall be numbered beginning with test number one and no numbers shall be skipped. In areas where a test of any type fails to meet Specification criteria and a retest is performed, the retest shall have the same test number as the original test except that an "R" shall follow the test designation.

307. LABORATORY AND FIELD TESTS

307.1 Laboratory Tests

a. Table 1 presents requirements for the minimum frequency of laboratory tests.

307.2 Field Tests

a. Table 2 presents requirements for the minimum frequency of field tests.

b. The coordinate location and elevation of the ground shall be recorded for every field test.

TABLE 1

LABORATORY TESTS - MINIMUM FREQUENCY OF TEST

No.	Type of Fill or Backfill	Test (1)				
		Moisture Content	**Atterberg Limits LL and PI (2)**	**Grain Size (3)**	**Moisture Density Curve**	**Hydraulic Conductivity**
		ASTM D2216	**ASTM D4318**	**ASTM D422**	**ASTM D 1557, or ASTM D 698, or ASTM D 4253 and D4254 (5)**	**ASTM D2434, D5084 (6)**
1	Subgrade to receive fill. Subgrade beneath foundations.	---	---	---	1 per 2 acres per material.	---
2	Embankment fill.	1 per 5000 cubic yards.	1 per 5000 cubic yards.	1 per 5000 cubic yards.	1 per 5000 cubic yards. For all changes in material.	---
3	Structural bedding beneath foundations and structural backfill.	1 per 2000 cubic yards.	1 per 2000 cubic yards.	1 per 2000 cubic yards.	1 per 2000 cubic yards. For all changes in material.	---
4	Culvert or pipe trench bedding and backfill.	1 per 2000 cubic yards.	1 per 2000 cubic yards.	1 per 2000 cubic yards.	1 per 2000 cubic yards. For all changes in material.	---
5	Electrical duct bank and cable backfill.	1 per 2000 cubic yards.	1 per 2000 cubic yards.	1 per 2000 cubic yards.	1 per 2000 cubic yards. For all changes in material.	---
6	Railroad track, road or pavement subgrade.	---	---	---	1 per 2 acres. 1 per material.	---
7	Railroad subballast, road base and crushed rock surfacing.	1 per 5000 cubic yards.	---	(4)	1 per 5000 cubic yards. 1 per material.	---
8	Liquid retention dikes.	2 per acre per lift. 1 per 2000 cubic yards.	1 per acre per lift. 1 per 2000 cubic yards.	1 per acre per lift. 1 per 2000 cubic yards.	1 per 2000 cubic yards. For all changes in material.	1 per 10,000 cubic yards.

Notes:

(1) Multiple requirements are given for some tests, such as number of tests per acre and one test per a given number of cubic yards. The requirement which results in the most frequent testing shall be used.

(2) Liquid Limit and Plasticity Index.

(3) Sieve Analysis only. For liquid retention dikes, include one hydrometer test for every third sieve analysis.

(4) Not required if certification is received from the Contractor on the gradation. If no certification is received, then perform gradation tests at the rate of one (1) per 500 cubic yards.

(5) The effectiveness of the compactive effort as measured by field tests shall be compared to laboratory compaction data and specification requirements. Forms used to record data from field tests shall also contain cross-reference to specification requirements.

(6) The appropriate test shall be selected based on the permeability and/or hydraulic conductivity requirements for the material.

TABLE 2
FIELD TESTS - MINIMUM FREQUENCY OF TEST

No.	Type of Fill or Backfill	Test (1)				
		Wet and Dry Density	**Moisture Content**	**Infiltration Rate (2)**		
		ASTM D1556, D2167 or D2922	**ASTM D3017 or ASTM D2216**	**ASTM D3385, D5093 (3)**	**Lift Thickness Uncompacted**	**Lift Thickness Compacted**
1	Subgrade to receive fill. Subgrade beneath foundations.(4)	5 per acre.	5 per acre.	---	---	---
2	Embankment fill.	1 per acre per lift. 1 per 500 cubic yards.	1 per acre per lift. 1 per 500 cubic yards.	---	5 per acre per lift.	5 per acre per lift.
3	Structural bedding beneath foundations and structural backfill.	4 per acre per lift. 1 per 200 cubic yards.	4 per acre per lift. 1 per 200 cubic yards.	---	5 per acre per lift.	5 per acre per lift.
4	Culvert or pipe trench bedding and backfill.	1 per 250 linear feet per lift. 1 per 200 cubic yards.	1 per 250 linear feet per lift. 1 per 200 cubic yards.	---	5 per acre per lift.	5 per acre per lift.
5	Electrical duct bank and cable backfill.	1 per 250 linear feet per lift. 1 per 200 cubic yards.	1 per 250 linear feet per lift. 1 per 200 cubic yards.	---	5 per acre per lift.	5 per acre per lift.
6	Railroad track, road or pavement subgrade (compacted).	1 per 250 feet of road. 5 per acre.	1 per 250 feet of road. 5 per acre.	---	---	1 per 1000 feet of road. 5 per acre.
7	Railroad subballast, road base and crushed rock surfacing.	1 per 250 feet of road. 5 per acre.	1 per 250 feet of road. 5 per acre.	---	---	1 per 250 feet of road. 5 per acre.
8	Liquid retention dikes.	1 per acre per lift. 1 per 500 cubic yards.	1 per acre per lift. 1 per 500 cubic yards.	1 per 10 acres per lift. 1 per 10,000 cubic yards.	1 per acre per lift.	1 per acre per lift.

Notes:

(1) Multiple requirements are given for some tests. For example, number of tests per acre per lift and one test per a given number of cubic yards. The requirement which results in the most frequent testing shall be used.

(2) If clay is specified for construction of the dike.

(3) The appropriate test shall be selected based on the specified requirements for the material.

(4) Tests on subgrade where no structure or structural fill is to be placed can be reduced to 1 per acre.

308. VERIFICATION AND CALIBRATION

308.1 Verification of Selected Field Tests

a. The following tests shall be verified at the following frequency:

Test Requiring Verification	**Frequency of Verification Test**
Nuclear In-Place Density – ASTM D2922 and Nuclear In-Place Moisture Content, ASTM D3017.	After meeting ASTM initial calibration test requirements, one rubber balloon (ASTM D2167) or sand core (ASTM D1556) density and moisture content verification per 10 nuclear density tests.
“Quick" Moisture Content Test using Microwave, Gas Stove, frying pan, infrared oven, etc.	One standard oven-dry moisture content (ASTM D2216) test per 10 quick tests.
Lift thickness measured using a shaft or shovel.	One lift thickness verified by surveying every two acre-lifts.

308.2 Calibration

a. Prior to the start of testing, the Testing Engineer shall submit procedures for calibration of field and laboratory testing Equipment. These procedures shall meet ASTM requirements.

309. TEST RESULT ACCEPTANCE CRITERIA

309.1 Listed below are the criteria for acceptance of test results. Requirements which must be met are given in other project Specifications.

Test	**Acceptance Criteria**
Gradation	Average of results of any ten consecutive grain size tests shall be within the specified limits. Not less than 80% shall meet Specification requirements.
Atterberg Limits	Average of results of any ten consecutive liquid limit tests shall be above the minimum specified or below the maximum specified, whichever is required. Average of results of any ten consecutive plasticity index determinations shall be within the range specified. Not less than 80% of tests shall meet Specification requirements.
Density and Moisture Content	All in place tests shall meet the minimum requirements. If requirements are not met, the soil shall be recompacted.
Hydraulic Conductivity	The results of all tests shall indicate a hydraulic conductivity equal to or less than the specified maximum hydraulic conductivity.

310. CORRECTIVE ACTION PROCEDURE

310.1 Failure of Material Quality Tests

a. The Testing Engineer and Owner shall be notified immediately if Gradation or Atterberg Limits tests do not meet acceptance criteria. Failure to meet acceptance criteria of one or more of these groups of tests may indicate problems with the quality of soil materials. The Contractor shall cease all construction activities until the source of the problem or "below specification" materials is identified. Construction shall not begin again until materials and installation procedures, which result in a fill meeting Specification criteria, are identified for use.

310.2 Failure of Field Density or Moisture Content Tests

a. If the results of field density or moisture content tests fail to meet acceptance criteria, those tests shall be re-run after recompaction. Judgment shall be used to select re-test locations suspected of having lower than specified density or out-of-specification moisture content. If the results of the re-test meet Specification requirements, the compaction can be considered acceptable. If the results of the re-test shows out-of-specification densities or moisture contents, the Testing Engineer shall immediately inform Owner of the extent of the defective area. The defective area shall be removed and reconstructed or recompacted.

END OF SECTION

SPECIFICATION COVER SHEET

Specification Number: CE-007
Revision: 1
Date: May 3, 2006

TITLE: Specification for Erosion and Sediment Control

+Scope of Changes:

[X] Revision (Full Procedure)

[ ] Change Sheet, Affected pages: _____

Summary of Changes:
This specification is revised to incorporate portions of the standard specifications from Sargent & Lundy, Mountaineer and Mitchell

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Specification Owner (Organization): Civil Engineering

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SPECIFICATION

FOR

EROSION AND SEDIMENT CONTROL

CE 007

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SPECIFICATION

EROSION AND SEDIMENT CONTROL

CE 007

7-1.0 SCOPE

The work to be performed under this specification shall comprise the supply of all material, labor and equipment to protect embankment slopes and land fill areas as shown in the drawings and as specified in the project specifications and permits, and to trap and prevent sediment from leaving the site and entering local waterways.

7-2.0 MATERIALS

The materials approved for use shall be as specified below, or as specified in the project specifications. There shall be no deviation from these requirements without prior written authorization by the Owner. These requirements may not apply to Owner supplied materials.

7-2.1 Riprap

Riprap shall be quarried rock from site excavation or from an approved commercial source. Riprap designated to be used on the downstream slopes of the dams shall, in general, grade from 3 inches to stone having a maximum dimension of 2 feet or as otherwise specified by Owner's engineer.

Individual block shall be angular and reasonably equidimensional. Material, as placed, shall contain not more than 5 per cent of materials finer than 1 inch.

Riprap shall be of acceptable quality, sound, free from structural defects and foreign substances such as soil, shale and organic materials. Rock shall have no shale seams. Hard and angular shaped rock with width and thickness less than one-third its length, and shall have a minimum specific gravity of 2.6 when tested in accordance with ASTM C 127.

7-2.2 Gravel Filter

Gravel filter material shall consist of crushed rock, screenings from crushed rock, crushed gravel or processed bank run sand and gravel. Crushed limestone may not be used as gravel filter material. Gravel filter material will be free of deleterious amounts of weak, flat, elongated, friable, organic or argillaceous material. Gradation of the material shall conform to the following limits:

Screen Size	Per Cent Passing By Weight
3 inch	100
2 inch	100 – 80
1 inch	85 – 55
No. 4	60 – 30
No. 20	30 – 5
No. 50	15 – 0
No. 200	5 – 0

The Material shall be smoothly graded within these limits and shall show no skip or gap grading. Care shall be taken to keep the material uniform throughout the work.

7-2.3 Sand Filter

Sand filter material shall be composed of clean and durable materials free from deleterious amounts of weak, flat, friable, argillaceous, or organic materials. It shall be prepared by crushing clean sound rock or gravel, or excavated from natural deposits and processed to meet the specifications. Crushed limestone may not be used as Sand filter material.

Screen Size	Per Cent Passing by Weight
2 inch	100
No. 4	100-74
No. 10	92-62
No. 20	76-50
No. 50	50-26
No. 100	28-7
No. 200	6-0

Materials shall be well graded within the limits shown and show no skip or gap grading. The uniformity coefficient shall be greater than 4. Care shall be taken to keep the materials uniform throughout the work, and to prevent segregation.

7-2.4 Topsoil

Topsoil shall consist of soil stripped and stockpiled on designated site areas. It shall have at least 4 percent of organic material and be free of roots, stones, and other foreign material.

Topsoil shall have a pH not lower than 5.0 nor higher than 7.0.

7-2.5 Fertilizer

Fertilizer shall be furnished in containers plainly marked with the chemical analysis of the product and it shall have the following composition by weight (unless otherwise specified in the project specifications):

Per Cent Minimum	
Nitrogen	10
Available Phosphorus (in acid form)	10
Water soluble potash	10

At least 50 percent by weight of the nitrogen content of the fertilizer shall be derived from organic materials.

7-2.6 Seed

Grass seed shall be of the previous year's crop and in no case shall the weed seed content exceed 1 percent by weight. The grass shall conform to the following requirements unless otherwise specified in the project specifications.

On an acreage basis the seed mixture shall consist of:

12 lbs. Kentucky Blue Grass
40 lbs. Kentucky 31 Fescue
15 lbs. Domestic Rye Grass
3 lbs. White Dutch Clover
for fall application, ¾ bushel Winter Rye shall be added.

All seed shall bear dealer's tags showing recent tests and an analysis of each type of seed. The clover seed shall be inoculated.

The seed shall be delivered premixed in the proportion specified above. All seed shall comply with State and Federal Seed Laws.

A manufacturer's Certificate of Compliance to the specification shall be submitted by the manufacturers with each shipment of each type of seed. These certificates shall include the guaranteed percentages of purity, weed content and germination.

7-2.7 Mulch

Mulch shall consist of hay, straw or wood cellulose fiber. Hay or straw shall be applied at the rate of two (2) tons per acre and asphalt emulsion at

the rate of 200 lbs. per acre. For use in a spraying machine, wood cellulose fiber shall be applied at the rate of 1500 lbs. per acre.

7-2.8 Lime

Lime shall be applied at the minimum rate of two (2) tons per acre or higher as determined by soil tests. Generally, it takes two (2) tons per acre to raise the pH by one point; an optimum range of pH 6.8 to 7.0 shall be attained.

7-2.9 Geotextile

Geotextiles for silt fences and filters shall conform to specification CE-013, Geotextiles, and shall be the size and type indicated on the project drawings or in the project specifications.

7-3.0 PLACEMENT AND CONSTRUCTION

7-3.1 Riprap

The method of loading, handling and placing shall be such as to cause a minimum of segregation or breakage of the material. The finished rock blanket shall, at all points, have a minimum thickness equal to that shown on the drawings. Overfilling in excess of the paylines shown on the drawings shall not be paid for. The finished rock surface shall show a generally uniform condition with approximate equal distribution of the various sized rocks. It shall be free of ice, frozen materials, mud, organic materials and debris when placed. Riprap shall not be dropped onto the geotextile bedding from a height of more than 1 foot. Any geotextile damaged during placement shall be repaired or replaced at the Contractor's expense.

7-3.2 Filters

Filter materials shall be placed to the lines and grades shown on the drawings or described in the project specifications. This material shall be free of snow, ice, frozen material, mud, organic material and debris. The material will be handled in such a manner to minimize segregation of the coarse particles, and the methods used to dump and spread the material shall be such as to produce a well-graded mass. The material will be compacted by tracking in with a D-8 dozer on horizontal surfaces, and if possible on sloping surfaces. Lift thickness shall be 6 inches loose. Any impervious or low permeability material tracked into the filter material shall be removed and spoiled.

7-3.3 Topsoil

Topsoil shall be obtained from designated stockpiles, loaded hauled, deposited and spread to a minimum depth of 6 inches on those areas

designated in the field. After the topsoil is spread, it shall be carefully prepared by spading or harrowing and raking with iron rakes. All large, stiff clods or lumps, large stones, roots, stumps, litter and other foreign material shall be removed from the topsoil and disposed of in designated spoil areas. On all slopes 3:1 or steeper, the surface shall be roughened, either by stairstep grading or grooving if slopes will be mowed (as designated on the drawings or in the project specifications). The compaction shall be equivalent to that produced by a hand roller weighing from 75 to 100 lbs. per foot of width. All depressions caused by settlement or rolling shall be filled with additional topsoil and regraded and rolled until it presents a reasonable appearance consistent with the highest quality of workmanship.

7-3.4 Fertilizer

Fertilizer shall be spread on the top layer of topsoil at the rate of 600 lbs. per acre and worked into the seedbed. The dull depth of topsoil shall then be spaded or harrowed and graded to the required cross section.

7-3.5 Seeding

After the topsoil has been prepared as described in Paragraphs 3.3 and 3.4, grass seed conforming to the requirements of Paragraph 2.7 shall be carefully placed thereon at the rate stated in Paragraph 2.7. Seeding shall be done in two directions at right angles to each other. Seeding on slopes shall be done by means of an approved drill seeder. No seeding shall be done during windy weather or when the ground is frozen, we or otherwise unsuitable. As soon as the seed is placed, it shall be thoroughly covered with at thin layer of topsoil by harrowing or digging. Unless otherwise stated in the project specifications hydro seeding is acceptable.

7-3.6 Mulching

Immediately after seeding, the area shall be protected by mulch of hay or straw at the rate stated in Paragraph 2.8. Mulch shall be spread uniformly by hand, mechanical spreaders or by blowers. The quantity if mulch and its method of application shall be such as to allow sunlight to penetrates and air to circulate over the prepared seedbed, but also, partially shade the ground, reduce erosion, and conserve soil mixture. The method of spreading and holding mulch shall be such as to prevent displacement of the soil or seed of the prepared seedbed. Mulching of any given area shall be completed within 24 hours after the seed in that area has been spread and the surface compacted.

Mulch shall be held in place by means of stakes and twine or by spraying of asphalt emulsion shall be sufficient to bond together the mulch particles without creating a heavy coating of asphaltic materials which would affect germination or sprouting of the seed.

7-3.7 Liming

The ground limestone shall be evenly distributed and worked lightly into the top of the soil to a depth of three (3) inches, either by hand or machine at least five (5) days before applying commercial fertilizer.

7-3.8 Application by Spray Machine

The application of fertilizer, grass seed, lime and mulch may be accomplished in one operation by the use of an approved spraying machine.

7-4.0 CARE DURING CONSTRUCTION

7-4.1 Seeded Areas

Periodically, the seeded areas shall be carefully and suitably sprinkled with water to produce a satisfactory growth.

If necessary, suitable signs or barricades of brush or other materials shall be placed to protect the seeded areas.

After the grass has appeared, all areas and parts of areas, which fail to show a uniform stand of grass, for any reason whatsoever, shall be reseeded until all areas are covered with a satisfactory growth of grass.

The Contractor shall care for all seeded areas until the work has been accepted, without compensation in addition to the amount regularly to be paid under this item. Care shall include all regarding, refertilizing and reseeding, which may be required.

7-4.2 Rock Slope Areas

Areas, which are provided with riprap, dumped rock, or filter material, shall be maintained to line, grade and slope. Voids, depressions, or any other visible discontinuities shall be redressed until final acceptance by the Owner's engineer.

7-4.3 Silt Fence Maintenance

After installation, the Contractor shall be responsible for satisfactorily maintaining the fence until it is no longer required.

The Contractor shall inspect the fence after every rainfall and at least daily during a prolonged rainfall.

The Contractor shall be responsible for replacing portions of the fence that tear, start to decompose, or in any way become ineffective.

Sediment deposits shall be removed when the deposit reaches one-half the height of the silt fence or when heavy runoff or high water is expected. When removing sediment deposits, care shall be taken not to tear the fabric or to dig up the bottom of the geotextile and disturb the anchorage.

7-5.0 CONSTRUCTION SEDIMENT CONTROL

A construction sediment control plan shall be initiated to prevent the release of sediment into local waterways. This plan shall consist of the construction of silt fences, filter barriers, temporary sediment traps, temporary sediment basins, diversion dikes, diversion channels, gravel road entrances, and any other structures necessary to keep water discharged from the site in compliance with local, state, and federal laws regarding suspended solids.

Contractor shall install and construct all sediment control structures in the locations indicated on the drawings, and/or as directed by Owner. All sediment control structures shall be constructed in accordance with these specifications, the project drawings, and any pertinent local, state, or federal regulations.

Where Owner has not indicated a specific plan on the project drawings, Contractor shall develop and propose a sediment control plan. This plan must be submitted with the Contractor's bid. The plan should consist of a location plan marked to show the location, and extent, of the different types of sediment control structures, and all design calculations for storm water release structures, basin sizing, etc.

7-5.1 Definitions

The following are definitions and descriptions of various standard sediment control structures.

7-5.1.1 Gravel Entrance

A gravel entrance is a pad located at the intersection of all construction site roads with public roads. The pad shall be constructed of clean gravel or crushed stone, be 6 inches thick, 50 feet long, and extend the full width of the road. The pad shall be constructed with aggregate conforming to the following gradation:

Sieve Size	% Finer Than
3 ½"	100-90
2 ½'	60-25
1 ½"	15
¾"	5

After constructing the pad, the Contractor shall be responsible for maintaining the pad, keeping it clean and functional. Maintenance of the pad shall be considered a normal operating expense of theContractor, and shall not be paid for as a separate pay item.

7-5.1.2 Silt Fence

A silt fence is a temporary sediment barrier consisting of a specified Geotextile stretched across and attached to supporting posts, and entrenched. The fence may have wire fence fabric for support.

Silt fences will be installed below disturbed areas where erosion would occur in the form of sheet and rill erosion. Following are additional guidelines for the location of silt fences when specific locations are not specified on the Design Drawings.

- Not further than 10 feet from the toe of slopes or the end of large graded areas
- On natural ground just uphill of cut slopes
- On the upstream edge of the bank of a natural drainage course traversing the property
- At the property line where earthwork is performed up to the property line
- Along the edge of subgrade earthwork for strip-type construction such as is required for access roads and railroad tracks
- Along side of ditches during construction of permanent erosion control surfacing

Posts for silt fences shall be either 4-inch diameter wood or 1.33 pound per linear foot steel, with a minimum length of 5 feet. Steel posts shall have projections for fastening wire to them. Posts shall be spaced a maximum distance of 6 feet.

A 4” x 4” slot trench shall be excavated along the fence line on the upstream side of the fence. The bottom 8 inches of the filter fabric shall be placed in the trench, backfilled, and tamped to anchor the fabric. The fence will be a minimum of 18 inches high. See Section 4.3 of this specification for silt fence maintenance.

7-5.1.3 Filter Barrier

A filter barrier is similar in concept to a silt fence, but it is stretched across a swale, ditch, or waterway where the water velocity does not exceed 6 ft/sec.

The height of the filter barrier shall be a minimum of 15 inches and a maximum of 18 inches. The barrier shall be constructed of Geotextile filter fabric supported by wood stakes. The wood stakes shall be 1 in. x 2 in. x 3 ft., and shall be driven firmly into the ground. The stakes shall be spaced a maximum of 3 ft. apart.

7-5.1.4 Diversion Dike

A diversion dike is a small ridge of compacted soil located at the top or base of a disturbed area. The purpose of the dike is to divert storm runoff from higher drainage areas away from unprotected slopes to a stabilized outlet, or to direct sediment-laden runoff to a sediment trapping facility.

7-5.1.5 Diversion Channel

A diversion channel is a ditch constructed to intercept and divert storm water runoff. Diversion channels shall be constructed at the locations shown on the drawings, and to the lines and grades indicated, or at the direction of the Owner.

7-5.1.6 Temporary Sediment Trap

A temporary sediment trap is a small ponding area formed by constructing an earthen embankment, with a gravel or crushed stone outlet, across drainage swale or ditch below drainage areas of less than 5 acres.

The gravel or crushed stone outlet will be constructed in accordance with the riprap sections of this specification.

The pool area shall be cleared, if necessary, and the area under the embankment shall be stripped.

Soil compaction shall be in accordance with Specification CE-006, Fill.

7-5.1.7 Temporary Sediment Basin

A temporary sediment basin is a pond formed by construction an embankment of compacted soil across a drainage way with a controlled storm water release structure, below drainage areas greater than 5 acres. If an emergency spillway is provided, the

principle storm water release structure must pass a minimum flow of 0.2 cfs per acre of drainage area. If an emergency spillway is not provided, the principal storm water release structure must pass the entire peak flow anticipated from a 10 year, 24hr. storm. Basin volume must be 67 cubic feet per acre of drainage area, and the length to width ratio of the basin must be at least 2 to 1.

If an emergency spillway is included, the crest of the embankment must be at least 1 foot above the inlet to the principal release structure. If an emergency spillway is not included the crest of the embankment must be at least 3 feet above the inlet to the primary release structure.

Soil compaction shall be in accordance with Specification CE 2006, Fill.

7-5.1.8 Miscellaneous Structures

Various other structures may be required to effectively manage storm water and control sediment such as paved flumes, energy dissipators, pipes, etc. Where these structures are required they shall be constructed in accordance with the relevant specifications (i.e.: SES 3000 Structural Concrete; CE-008 Surface Drainage Systems; CE-004 Excavation; CE-006 Fill).

7-5.1.9 Maintenance of Structures

Periodic maintenance of the various sediment control structures may be necessary during the course of the construction project to keep them operating efficiently and as planned. This maintenance will include removal and disposal of silt, and replacement or repair of damaged structures, and any other work thought necessary by the Owner.

7-5.1.10 Removal of Temporary Structures

Upon the completion of the construction project, after permanent erosion control measures are in place, and operating, Contractor shall remove all temporary structures, and reclaim the areas they occupied with regrading and seeding as directed by Owner.

7-6.0 MEASUREMENT FOR PAYMENT

7-6.1 Riprap

The unit measurement for riprap is the cubic yard. The quantity to be paid for shall be the number of cubic yards furnished, placed, and spread by the Contractor as computed by the Owner from multiplying the area of the material in place by the design thickness. The contract unit price shall be full compensation for furnishing, loading, hauling, and placing the riprap. Alternately, the unit of measurement may be the ton.

7-6.2 Filter Materials

The unit measurement for filter materials is the cubic yard. The quantity to be paid for shall be the number of cubic yards as computed by the Owner from the finished lines, grades, and slopes shown on the drawings. The contract unit price shall be full compensation for furnishing, loading, and compacting the filter material.

7-6.3 Seeded Areas

The unit of measurement for seeded areas is the square yard. The quantity to be paid for shall be the number of square yards topsoiled, seeded and mulched as computed by the Owner from design drawing lines and grades or as directed. The contract unit price shall be full compensation for excavating from stockpile, loading, hauling, spreading, compacting, and shaping topsoil and fertilizing, liming, seeding and mulching the areas to be protected.

7-6.4 Gravel Entrance

The unit of measurement for payment for a Gravel Entrance shall be the square yard. The total number of square yards for payment shall be determined by multiplying the actual length and width of each Gravel Entrance installed.

7-6.5 Silt Fence

The unit of measurement for payment for the installation of silt fence shall be the linear foot. The total number of linear feet paid for shall be measured along the axis of the installed fence and rounded to the nearest foot.

Payment shall be full compensation for the supply of all fence material including Geotextile, posts, wire mesh backing, and miscellaneous hardware, equipment, tools, material and labor necessary to install the fence.

7-6.6 Filter Barrier

The unit of measurement for payment for filter barriers shall be the linear foot. The total length of barrier to be paid for shall be measured along the axis of the installed fence and rounded to the nearest foot.

Payment shall be full compensation for supplying and installing the barrier, including all Geotextile, posts, wire mesh, hardware, tools, equipment and labor.

7-6.7 Diversion Dike

The unit of measurement for payment for diversion dikes shall be the linear foot. Payment shall be for the total number of linear feet of dike installed.

7-6.8 Diversion Channel

Construction of diversion channels shall be done in accordance with Specifications CE-008, Surface Drainage Systems, and CE-004 Excavation. Payment will be in accordance with CE-004 Excavation.

7-6.9 Temporary Sediment Trap

Construction of a temporary sediment trap will be performed in accordance with Specification CE-002 Clearing and Grubbing; CE-003 Stripping; CE-004 Excavation and CE-006 Fill. Excavation and fill shall be either common or unclassified.

The gravel or stone spillway shall be paid for as riprap specified in Section 6.1 of this Specification.

7-6.10 Temporary Sediment Basin

Payment for construction of a temporary sediment basin shall be in accordance with the pertinent sections of Specifications CE-002 Clearing and Grubbing; CE-003 Stripping; CE-004 Excavation; CE-005 Foundation Preparation; CE-006 Fill; CE-008 Surface Drainage Systems, and any other specifications, which might apply to a specific installation.

7-6.11 Maintenance of Structures

Owner shall issue an Extra Work Order for any maintenance required on sediment control structures, such as the removal and spoiling of silt, repair of fence tears, etc., unless Owner determines that the maintenance is required because of faulty construction or defective or non-specification materials, performed or supplied by Contractor. Contractor shall make repairs required by faulty construction or defective or non-specification materials at no cost to Owner.