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APPENDIX C

FINAL GEOTECHNICAL DESIGN

NORTH CKD AREA

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DAVENPORT, CALIFORNIA

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EXECUTIVE SUMMARY

This Final Design document is an appendix of the Final Closure Plan for the North Cement Kiln Dust (CKD) area at the Davenport Cement Plant (referred to in this report as the project). Our Final Design presents the results of our site observations; subsurface explorations and geotechnical soil testing are included in Attachments C-1 and C-2. We applied these sources of data to develop our material strength parameters. Those strength parameters were then used in calculations and as computer modeling input for our stability analyses. Our calculations and final results from computer modeling are described herein, with supporting information provided in Attachments C-3 through C-5, and were used to develop the final design plans and specifications.

1.0 INTRODUCTION

This document presents our final design data and calculations in support of the Final Closure Plan for the North Cement Kiln Dust (CKD) area located at the CEMEX Davenport Cement Plant (Plant) in Davenport, California. The locations of the Davenport Site and the North CKD Closure Area are described and presented in the main body of the Final Closure Plan submittal. Our most recent “Conceptual Final CKD Closure Plan and Post Closure Monitoring and Maintenance Plan, North CKD Area,” dated April 13, 2017 included partial design calculations for: a) shotcrete and soil nailed wall design and b) dynamic stability of the proposed liner cap and cover system. Completing these calculations required site specific data that we have recently collected as described in this design report.

We have completed site specific observations of the surface and subsurface conditions at the project site. The collection of data included, observations of a) surface and b) subsurface groundwater seepage occurring since initial work in 2002. We provide data and conditions of soil and groundwater as exposed in 25 test pits (TP) in the upland area to the north east of the CKD. Approximate test pit locations are shown on Figure C-1, and their relative position near the North CKD Area is depicted on Figure C-2. Figures C-3 through C-5 present example photographs from selected test pit excavations.

We also include observations, material logs, and results of Standard Penetration Testing (SPT) from two geotechnical boreholes that were advanced near the proposed shotcrete covered soil nailed wall at the west end of the CKD closure area, on Figure C-6. The two geotechnical borings were advanced between January 30 and February 2, 2018, to provide information on the subsurface conditions in the vicinity of the soil nailed wall, providing additional information to characterize the soil conditions behind the proposed soil nail wall and determine the depth to bedrock (mudstone).

The surface and sub-surface data was then used as input for our design analyses. These analyses included a stability assessment of the: a) likely trench side walls along the Bypass Pipe alignment, b) shotcrete soil nailed wall, c) cap/cover system and d) lined perimeter ditch side slopes. The response of site features and their deformation due to a design-level seismic event were also evaluated. The results of these analyses are provided below in this report, figures and attachments.

2.0 SURFACE AND SUB-SURFACE CONDITIONS

2.1 Surface Conditions and Topography

The project area is contained with-in the Pacific Coast Range foothills. The coast line is less than one half mile to the west of the North CKD closure area. The topography slopes generally to the west and is controlled by erosional terraces that are cut by stream channel valleys. Elevations on the project range from about 115 feet at the Retention Pond to about 287 feet along the North Pond Bypass Pipe. The bases for all vertical elevations and horizontal coordinates are described on Sheet C1 of the Closure Plans.

2.2 Geology and Sub-surface Conditions

The geology in the area of the project was most recently mapped in a compilation by Brabb (et al. 1997). The compiled map shows the following geology units as presented in the map descriptions:

a. Undifferentiated coastal terrace surficial deposits described as: “semi consolidated, moderately well sorted marine sand with thin, discontinuous gravel-rich layers. May be overlain by poorly sorted fluvial and colluvial silt, sand and gravel.”

b. Sedimentary Rocks of the Santa Cruz Mudstone: “Medium to thick-bedded and faintly laminated, blocky-weathering, pale-yellowish-brown siliceous organic mudstone.” This rock mass is shown as dipping at between about 10 and 20 degrees to the southwest.

We observed characteristics similar to both of these mapped units in the test pit explorations northeast of the CKD Areas 1 and 2.

2.3 Test Pit Explorations

We completed 25 test pit excavations on September 11, 2017 to various depths of refusal. The locations of the test pits were just west of the planned Bypass Pipeline (Bypass) and were surveyed after completion. The test pit locations are shown on the map of Figure C-1 and on the site plan of Figure C-2; the test pit logs are provided in Attachment C-1. The results of our observations are provided to: a) help with bidding for material excavations along the Bypass Pipe and b) document materials that will be excavated for use in construction and/or removed from the project site after excavation.

2.4 Engineering Soil Units Observed in Test Pits

The engineering soil units are site specific and grouped by similar engineering features and conditions that are important for characterizing relative soil strength parameters along the North Pond Bypass. In addition to relative strength parameters the soil units provide us with design input for estimates of such things as: a) rock density/rippability, b) erosion potential if used for engineered fill and c) potential use for other applications required to complete the closure such as for the Vegetative Soil Layer, Protective Cover Soil (PCS), Bypass drainage swale backfill or armoring. Representative grab samples were selected for classification in the soil laboratory. The Unified Soil Classification System (USCS) designations provided on the test pit logs (in Attachment C-1) are for the soil particles up to gravel sizes (if present). Attachment C-1 includes a guide to USCS soil description methods and terminology for reference. The engineering soil units are grouped into the following and presented in rough stratigraphic order (upper most first):

2.4.1 Unit A – Topsoil

We observed topsoil at the surface of all the explorations. Topsoil was typically 2 to 3 feet thick and reached a maximum depth in TP 24 of 5.0 feet. We describe the topsoil as light brown to black, loose to compact silt with some clay lenses and a trace of organics. The topsoil has a low plasticity and the USCS designation is ML to CH as shown in the soil laboratory results for Lab Sample ID 17-242 and 17-243.

2.4.2 Unit B1 – Construction Debris Fill

We observed construction debris fill in test pits (TP) 3 through 14 reaching a maximum depth of 16.9 feet in TP 8. The fill was light brown to red brown, loose to compact with varying amounts of debris. The debris consisted of steel bars, steel channel sections, pipe, bricks, plastic sheeting, wood, concrete and rock fragments. The largest concrete and rock fragments measured up to about 4 feet in diameter and were typically tabular or rectangular in shape. Figure C-3 shows an example of construction debris excavated from one of the test pits.

2.4.3 Unit B2 – Cement Kiln Dust (CKD) Fill

CKD was exposed in TP 8 between depths of 1.2 and 4.0 feet. The CKD was similar to that exposed in Area 3. The CKD was light blue-gray, compact to dense silt, USCS designation from field classifications was ML.

2.4.4 Unit C – Residual Native Soil

The residual native soil was excavated in TP 1 through 3 and 14 through 25. This soil unit was weathered to highly weathered. Soil descriptions ranged from loose to progressively very dense with depth, white, tan and red brown, sandy silt to fine sand and iron stained. The USCS classification varies: SM and SP to SW as shown in the soil laboratory results for Lab Sample ID 17-240 and 17-241.

2.4.5 Unit D – Rock

Native rock (Mudstone) was observed in most all test pits with the exception of TP 3, 5, and 8. The excavations typically ended with refusal on rock and the maximum depth of rock was observed in TP 4 at 17.2 feet. Two explorations penetrated through rock and into residual soil, TP 14 and 19. We describe the rock as pinkish to dark brown and tan to black, weathered to fresh, medium dense to hard, iron stained rock. The upper few feet often breaks into cobble and boulder sizes with rectangular slabs up to 3 and 4 feet in maximum dimension. Figures C-4 and C-5 show examples of weathered rock encountered in test pit excavations.

2.5 Groundwater Seepage

We observed minor ground water seepage conditions in TP 11 at a depth of 4.8 feet, TP 12 between 8.6 and 9.0 feet and in TP 13 at 10.0 feet. All the test pits were left open and TP 11 and TP 12 collected about 1 inch of ponded water in the bottom of the excavation after 7 hours with no caving. Minor caving was observed in TP 1, 10 and 13 but did not appear to be related to seepage.

2.6 Borehole Explorations

We sub-contracted with a local geotechnical drilling company to collect subsurface information from two boreholes extended into the CKD near the west end of the Closure project, at the locations shown on Figure C-6. The information was used to characterize the soil and seepage conditions in the CKD and to also determine the depth to native soil/rock upslope and behind the proposed soil nailed wall.

The geotechnical borings were conducted on January 30 through February 2, 2018. The exploration and testing program included the following:

- Clearing underground utilities with the public “one-call” system
- Advancing two soil borings (designated BH1 and BH2) at selected locations on the site
- Obtaining SPT blow counts for each sampled interval
- Retrieving material samples at selected intervals

The two borings were performed along the top of the existing CKD western slope in the vicinity of the proposed soil nail wall. Boring depths were 110 feet and 141.5 feet below ground surface to extend through the CKD deposits and reach underlying materials and bedrock. The number, location, and depth of explorations were selected based on the known site conditions and site access. Sampling was conducted every 5 feet, or otherwise as determined necessary by the on-site field team.

The boring logs are presented in Attachment C-2. It was observed that subsurface materials consisted mainly of CKD, in the form of hard silt, with laminations of hard cemented silt throughout. BH1 encountered CKD to a maximum depth of 110.0 feet (elevation 120 feet) where it was terminated at refusal on native mudstone bedrock. BH2 was also extended through the same CKD strata to a maximum refusal depth of 141.5 feet (elevation 118.5 feet), also reaching native mudstone bedrock.

Laminations and lenses of medium stiff and stiff CKD were encountered sporadically throughout the CKD deposit. Lenses of perched groundwater were also observed, as noted in the boring logs, but were found to be, at most, half a foot thick and dry underneath, likely due to underlying relatively impermeable interbeds of cemented CKD.

Deep soil samples in both borings were observed by the field team for the possible presence of a deep “fill material”, or similar, layer underlying the CKD, as was noted at the base of boring log PZ-13, performed in 1996 by RMC Lonestar at the base of the valley immediately downhill of the North CKD Area (near the former Carpenter Shop and Lime Building). While neither of the recently completed borings BH1 nor BH2 encountered a similar “fill material”, a layer of similar material representing deposits that may have existed prior to the placement of CKD (artificial fill, or naturally eroded colluvium) was incorporated into our stability model below the face of the North CKD Area’s western slope. While there is little available information regarding the potential extent of such a layer below and beyond the toe of the CKD slope – aside from the nearby borings and known surface deposits – its presence had little effect on our stability results, as presented later in this report.

Groundwater seepage conditions appeared minor in the boreholes, defined by wet conditions encountered at the following depth intervals, each of which encompassed a fraction of a foot:

- In BH1: Seepage conditions observed over 0.3 to 0.5-foot intervals, between depths of 30.2 and 30.5 feet and 105.0 and 105.5 feet (elevations of 199.8 and 199.5 feet and 125 and 124.5 feet, respectively)

- In BH2: Seepage conditions observed over a 0.3-foot interval between depths of 65.2 and 65.5 feet (elevations of 194.8 and 194.5 feet, respectively)

Over the course of drilling activities covering 2 days at each hole, enough seepage at those intervals ran down the sides of the borehole to wet the drill rods but water did not accumulate in the bottom of the hole. With the exceptions of the minor areas of apparent seepage previously mentioned, we did not observe any conditions indicating the presence of groundwater.

2.7 Laboratory Testing

A total of 40 soil samples were collected from the two borings (BH1 and BH2) using a split-spoon sampler, and five soil samples were submitted for geotechnical analysis to an independent geotechnical laboratory, AAR Testing Laboratory, Inc., of Redmond, Washington. The soil samples were analyzed for the following parameters:

- Atterberg limits (ASTM Standard D4318)
- Particle size (ASTM Standard D422)

General testing procedures and testing results as generated by the laboratories are provided after the borehole logs in Attachment C-2.

The laboratory results indicate that all five samples were silty sands (SM, per the USCS classification system). In-field observations and manual reworking of the material implied that it was generally silty in nature, as indicated the preceding section. The difference between the field observations and the laboratory identification is likely due to the cemented nature of the silt particles. It is possible that cementation between particles, not broken apart during the sieve analysis, led to larger grain sizes being indicated by the laboratory findings.

3.0 INPUT FOR DESIGN

3.1 Subsurface Conditions Adjacent to the Bypass Pipe

In the area of the Bypass the contractor should plan to grub, strip topsoil and stock pile this material for use in the topsoil cover of the cap and cover system in the North CKD Area. Considering that a rock drainage swale is designed along the surface of the new By-pass pipe, the topsoil likely will not be needed to complete the final constructed surface. Assuming the construction debris fill is not of any use in the current mixed state the debris encountered along the pipe excavation will have to be removed from the project site to a landfill.

Over-excavation of rock likely will be required along approximately 350 lineal feet of the pipe alignment based on preliminary estimates. We anticipate that rock excavation will be required to depths of about 5 feet and can likely be accomplished with a large excavator and “ram-hoe” or breaker bar attachment. In our opinion, based on observations of the open cuts, trench stability should not pose a significant safety issue during construction provided standard support measures (such as the use of a trench box) are used during construction. However, the contractor has ultimate responsibility for trench stability since they are in direct control of the means and methods of work, and they may encounter differing subsurface conditions between the locations where test pits were excavated. Therefore, the contractor should plan to use stable side slopes and/or provide appropriate shoring as needed to maintain safe working conditions.

3.2 Subsurface Conditions East of the Proposed Shotcrete Wall

Based on the findings of the subsurface investigation using the borehole observations, data and soil testing, the current design is feasible. Specifically, soil conditions are appropriate for installing grout encased soil nails and the proposed steel reinforced shotcrete wall appropriate for cover of the steep slope on the west end of Area 3. Further discussion of soil properties selected for design analysis is presented in Sections 4.0 and 5.0.

Our interpretation of the geology east of the soil nailed wall is based on the previously discussed borehole information and earlier, undated topographic maps of the valley as it existed before deposition of the CKD. Based on our site knowledge, the valley floor is very narrow and “v-shaped” rising up in elevation to the east. Thus the critical cross sections used for our stability analyses were selected at the most conservative location where the CKD deposit is thickest. It is important to note that the geological profiles shown in Attachment C-5 are aligned through the center of the old valley. The thickness of CKD rapidly decreases north and south (in and out of the page) of this critical section. Likewise, as the old valley floor rises to the east, the thickness of CKD diminishes with further distance from the soil nailed wall. Thus, our stability analyses represent the site's "worst-case" stability scenario; all reported Factors of Safety associated with the CKD improve greatly in all directions away from the modeled critical section.

4.0 SHOTCRETE AND SOIL NAILED WALL DESIGN

4.1 General

This section describes the analyses used for the design of the soil nail wall and the calculations presented in Attachment C-3.

We followed the Service Load Design (SLD) method provided in the FHWA manual (FHWA 1996). This approach incorporates the following elements:

- Slip surface limiting equilibrium computations;
- The strength of the nail head, tendon, and pullout resistance;
- Allowable loads for the nail tendon, the nail head system, and the pullout resistance, with the factor of safety to be applied to the soil strength;
- Procedures for limiting wall deformation; and
- Design of the soil nails and the wall facing as an integrated soil nail wall system.

4.2 Design Assumptions

We were directed to complete calculations, plans, and specifications to allow support of the previously described slope. We have made several assumptions in completing our work and a selection of the more critical of these are provided below:

We have assumed that ARC will be included in any future discussions or design modifications that incorporate contractor methods and sequence that are different from those specified; including architectural wall features or surface water collection systems.

Failure to include ARC in the on-going design and construction of such features may compromise our assumptions and potentially jeopardize our design.

Typical nailed wall lateral movement for this type of project in similar conditions is within about 1/2 to 3/4 inch at the top of the wall and decreases with depth. This movement is dependent on the actual subsurface conditions encountered and installation/construction methods.

We designed the soil nailed system to support general construction surcharge loads of 150 pounds per square foot (psf) to accommodate the typical surcharge loading from installation equipment situated around the top of project.

We have not accounted for any crane loadings and if any cranes are used on the site the outriggers should be placed on footings following recommendations by ARC.

Cut slopes in the upper portion of the wall may encounter loose fill material from utility trenches. Before nail installation the contractor shall verify utility locations and depths. Any differences from those assumed should be immediately brought to our attention to evaluate the impact to the design.

Excavating within 5 horizontal feet of more than 2 feet in depth immediately below the bottom of the lowest lift of the shotcrete wall for footings shall not occur unless approved by ARC.

4.3 Nail Design

We used the program Goldnail© Version 3.11 to analyze the required nail lengths, tendon strengths, and nail head strength factor. The program is a slip surface, slope stability model based on satisfying the overall limit equilibrium of individual free bodies defined by circular slip surfaces. This method considers the limiting pullout capacity of the nails on both the wall and non-wall sides of the failure surface. It also allows the structural face capacity of the wall facing to be incorporated into the analysis.

We selected a critical representative cross section to determine the nail geometry and strength. The program analyses a series of failure surfaces and calculates the nail forces and lengths for each surface. The output of the program consists of the greatest nail forces necessary for stability of the wall system.

The factors used in the analyses are based on current temporary SLD conditions, as presented in the FHWA manual (FHWA 1996) and are presented in Table 1:

Table 1
Service Load Design (SLD) Design Factors used in Soil Nail Analysis

	SLD Permanent Wall **Static (Dynamic) Factors of Safety**	**SLD Permanent Wall** **Strength Factor**
Friction Angle	1.5 (1.1)	--
Soil Cohesion	1.5 (1.1)	--
Adhesion	--	0.5
Nail Tendon	--	0.55
Nail Head	--	0.67

In Attachment C-3, we present the input and output of the design software program. In general, the upper row of nails is spaced 2 to 3 feet below the top of the wall, and the second row within about 6 feet of the first, followed by 6-horizontal by 6-foot vertical spacing below that portion of the wall. Other spacing was dictated by considering the FHWA recommended maximum distance from the bottom row to the bottom of the wall, and the geometry of the wall.

4.4 Nail Head and Facing Design

The required critical nail head capacities are based on the soil nail analyses (again, as presented in Attachment C-3). There are two failure modes considered in the design approach: (1) facing flexure; and (2) facing punching shear.

The facing consists of a 6.0-inch thick shotcrete wall, with centered welded wire fabric with a grid of 4-inches by 4-inches (W2.9 x W2.9). In addition, two 2'-6" long grade 60, #4 reinforcement bars are placed vertically and one continuous horizontal bar behind the 8 x 8 x ¾ inch thick bearing plate to serve as bearing bars and waler respectively. The soil nail shoring plans should be consulted for additional details with regards to headed studs and the shotcrete facing. The shotcrete compressive strength for design is required to be f'_c = 4,000 psi.

5.0 LINER CAP AND COVER SEISMIC DESIGN

This section discusses and presents the results of the following analyses performed to evaluate the stability and behavior of the proposed CKD cover system:

- Development of seismic design parameters
- Static slope stability
- Seismic slope stability
- Slope deformation analysis (for marginal or low factors of safety)

Construction Drawings sheet N2 depicts the planned geometry of the soil nail wall, and overall site topography is provided by drawing sheet C3. The site will be regraded to a 13.3 percent (7.6 degree) slope prior to placement of the cover system, while the proposed soil nail wall will be installed along the western slope.

Stability analyses were conducted in compliance with California Code of Requirements (CCR) Title 27 requirements for closure of Class II solid waste facilities. Specifically, the evaluation followed the multiple steps identified in CCR Title 27, Section 21750.f.5 for Stability Analysis. Consistent with this section of the CCR, seismic design parameters, including determination of an appropriate peak ground acceleration (PGA), were developed by incorporating regional and local seismic conditions and faulting, site-specific surface and subsurface conditions, and application of established industry procedures in the form of the American Society of Civil Engineering Hazard Assessment Tool (ASCE 2017).

As required by Subsection (A) of the subject CCR section, procedures, assumptions, and computer software used in the analyses are described below. As required by Subsection (B), several different analyses were performed for critical slopes and features, including the incorporation of geomembranes into the design cover. Liquefiable or unstable foundation areas were not evident at the site and therefore did not warrant incorporation into the analysis.

Subsection (C) of the CCR section 21750.f.5 lists steps required for the stability analysis. Each step was followed explicitly, as follows:

- The analysis, and this report, were prepared in accordance with relevant industry standards. Seismic parameters were selected for conditions consistent with the CCR Title 27 definition of maximum credible earthquake (MCE); “the maximum earthquake that appears capable of occurring under the presently known geologic framework”.
- The applicable PGA was determined to be **0.566g**, as detailed in Attachment C-4 (memorandum titled *Seismic Evaluation and Pseudostatic Coefficient Derivation for North Cement Kiln Dust (CKD) Area, CEMEX Davenport Facility;* Anchor QEA 2018). Attachment C-4 also includes a review of local and regional earthquakes during historic times, and the location of active major faults, in support of this PGA determination. No reduction factors (peer-reviewed or otherwise) were applied.
- The results of surface and subsurface investigations of the site are presented herein, along with the selection of engineering properties of relevant soil layers and underlying foundation materials.
- The location of slopes analyzed, relevant calculations, are discussed in Section 4 (for the soil nail system) and in Section 5 (for the soil cover). Figure C-6 identifies the critical slope profile used for analysis of the CKD west slope and soil nail system.

- Profiles of the critical slope geometry, including pertinent soil layers and planned features, are included in graphical form within Appendices C-3 and C-5.

5.1 Stability of CKD and Soil Nail Wall Slope

The stability of the existing and designed CKD area slopes was evaluated using limit equilibrium methods as implemented by the Rocscience SLIDE 7.0 software (SLIDE; Rocscience 2016). The analysis is intended to provide a reasonable indication of the overall stability of a slope, and is generally accepted as the standard of practice for this type of assessment. Selected outputs from the slope stability analyses, including the critical slope profile, are compiled in Attachment C-5 and are referenced in the discussion below.

A rigid, perfectly plastic soil model is used in the limit equilibrium analysis performed by SLIDE. The assumptions inherent to this model are that the anticipated sliding mass remains rigid (i.e., non-deformable) and that the soil strength along the slip plane is fully mobilized at failure.

The inter-slice force functions used in the SLIDE analysis followed the Morgenstern and Price (1965) and Spencer (1967) methods. These two methods satisfy both force and moment equilibrium and are commonly used in practice. The analysis modeled the long-term condition (drained soil strength) rather than the short-term condition (undrained soil strength), due to the unsaturated state of the site.

A representative geologic cross section was developed for the North CKD area for use in the analysis. The geological profile that was developed and used in the SLIDE computer program is depicted on Figure C-6 in Attachment C-5. The cross section was created using the existing topography information (as shown on Sheets C2 and N3 in the Design Plans) and includes the proposed soil nail wall and planned regrading of the CKD. The cross-sectional profile selected for analysis was the same as was used for the soil nail design analysis; it was located through the highest portion of the CKD western slope, where the toe of the slope reaches the base of the valley. This selected profile location is conservative because the majority of the sloping face is shorter; the valley sides slope upward on either side (north and south) of the profile.

Subsurface stratigraphy utilized in the geologic model was derived from the borings conducted for the program. Based on the subsurface investigations performed, the analysis assumed that the soil strata observed in the two soil borings extends uniformly across the site, and that a singular set of soil properties would be appropriate for modeling the CKD. A layer of pre-existing fill or colluvium material was incorporated into the profile below the CKD deposit, as discussed above in Section 2.6.

The soil properties assumed for the Soil Cover, CKD, and underlying fill layer and mudstone bedrock are summarized in Table 2. The friction angles were determined using typical values and correlations to SPT blow counts as recommended by NAVFAC (1986) design guidance. Additional information on the derivation of estimated values is as follows:

- A friction angle of 32 degrees was selected for the Protective Cover Soil, since the low permeability soil will be compacted to at least 90 percent maximum dry density with field verification testing.
- For the CKD, properties were selected to represent the apparent variability of the material and the inconsistent occurrence of laminations and cementation observed throughout. A friction angle of 38 degrees was applied to the CKD because the material was noted as having blow counts (N) of 50 for less than 6 inches of penetration. This value is considered conservative as many correlations provide friction angles of 40 degrees or more for the blow counts observed.
- A potential layer of underlying Fill (or natural colluvium with similar properties) was integrated into the slope stability profile, as a material deposit that may have preceded the placement of CKD. Although not specifically observed in our borings, we applied estimated properties to this layer based on past explorations by others (PZ-13 performed in 1996) and assumed it to be a medium dense granular material.
- A friction angle of 40 degrees was used for the underlying mudstone bedrock, and is considered a typical value for a slightly fractured sedimentary rock. This friction angle, used without any cohesion value, is considered to be significantly conservative, because in reality the mudstone bedrock would feature a significant shear strength.

The cover thickness was modeled as two feet thick, consistent with the project's design intent and with CCR Title 27 Section 21090 for Landfill Closure. The maximum slope of the regraded site is planned be no steeper than 13.3 percent (7.6 degree).

Table 2
Geotechnical Design Parameters used for Slope Stability Analysis

Material	Unit Weight (ɣ), pcf	Drained Conditions	
		Cohesion (c'), psf	Friction Angle (φ'), degrees
Protective Cover Soil	120	-	32
CKD	115	50	38
Fill underlying CKD[1]	120	-	33
Mudstone	125	-	40

Notes:
c': effective cohesion
Φ': effective friction angle
ɣ: unit weight
pcf: pounds per cubic foot
psf: pounds per square foot

1. Fill layer was not directly observed in recently completed borings BH-1 and BH-2, but may be present in some areas based on nearby explorations completed by others in the past.

The critical cross-sectional profile was evaluated by applying a long-term (drained) condition to be representative of the following scenarios:

- Existing Condition (Pre-Cover Placement)
- Post-Construction of Site Cover – Static Condition
- Post-Construction of Site Cover – Pseudo-Static (seismic) Condition

For the pseudo-static (seismic) condition analysis, the selected PGA of 0.566g was applied, by translating it into a constant horizontal force via application of a pseudo-static coefficient. The resulting 'pseudo-static' formulation of a constant horizontal acceleration is 0.283g, suitable for use in limit equilibrium analyses. For more discussion on this analytical requirement, see Anchor QEA (2018), provided in Attachment C-4.

The minimum target factor of safety for engineered slopes under dynamic (seismic) conditions is 1.5 per CCR Title 27; unless a more rigorous analytical method can be used to provide a quantified estimate of the magnitude of movement. (That element of the code is relevant to the analysis presented here; an estimated magnitude of movement is presented and discussed in this report.) The factors of safety corresponding to the most critical slip surfaces are presented in Table 3. Representative outputs from the slope stability analysis are presented in Figures C-5.1, 5.2, and 5.3 in Attachment C-5.

Table 3
Summary of Slope Stability Factors of Safety[1]

Area	Existing Conditions prior to Soil Nail Wall Construction (See Figure C-5.1)	Constructed Soil Nail Wall – Static Analysis (See Figure C-5.2)	Constructed Soil Nail Wall – Seismic Analysis (See Figure C-5.3)
Area 3 CKD West Slope (Typical Cross Section)	1.274	1.599 to 1.605	0.922 to 0.923

Note:
1. Factors of safety against slope movement as determined by SLIDE using the Spencer and GLE/Morgenstern-Price analysis methods

Under static conditions, the calculated factor of safety (1.6) exceeds commonly applied safety expectations. However, under dynamic conditions (for an MCE-level seismic event), the calculated factor of safety was well below the threshold of 1.5 prescribed by CCR Title 27, and below a value of 1.0, implying slope movement. Therefore, per the provisions of CCR Title 27, Section 21750-f.5.D, a more rigorous analytical method was necessary to provide a quantified estimate of the magnitude of potential movement associated with an earthquake, as presented in the next section.

5.2 Seismic Slope Deformation

An estimation of the expected slope deformation due to a design seismic event was evaluated using the U.S. Geological Survey (USGS) Seismic Landslide Movement Model, as applied by Earthquake Records (SLAMMER) software (Jibson 2013). This program conducts permanent-deformation analysis of slopes to estimate slope behavior during earthquakes.

For this site, the Newmark analysis (Newmark 1965) was conducted for a magnitude 7.5 earthquake, with an anticipated ground surface acceleration of 0.566g, as described in Attachment C-4. Additionally, the site critical seismic yield acceleration was determined to be 0.263g using SLIDE, as presented in Figure C-5.4.

Using these inputs, and the simplified empirical models in SLAMMER (Rathje and Saygili 2008 and 2009; Jibson 2007; Ambraseys and Menu 1988), the estimated displacement ranges between less than one-half of an inch, to as much as 5 inches. This result is consistent with methods described by Makdisi and Seed (1978), which results in a mid-range displacement estimate of about 4 to 5 inches for a magnitude 7.5 event.

The seismic deformation analysis indicates that ground motion during an MCE seismic event is not expected to result in a significant degree of slope movement. Up to five inches of deformation appears to be a manageable and repairable amount for the slope and the soil nail wall. The lack of critical, publicly accessible structures in and around the North CKD Area will facilitate the ability to accommodate and manage slope movements that may occur in a seismic event.

We expect that the overall amount of movement in an MCE event can be accommodated without jeopardizing the integrity of the CKD Area foundation or the drainage structures that convey stormwater from, and around, the constructed cover. Some cracking and displacement of surface soils may occur, which can be repaired with surface regrading. The drainage net and geomembrane liner may undergo localized disturbance as well, although these materials are designed with the ability to flex and elongate, which will help to mitigate damages. LLDPE, in particular, has a relatively high strain tolerance - many products can withstand elongation of up to 250 percent, which is within the range of strain expected from up to five inches of overall displacement.

5.3 Stability Analysis of Soil and Geocomposite Cover

In addition to overall slope stability, the stability of the cover materials (soils and geosynthetic materials) was also assessed for installation and long-term stability on sloping subgrades. The key parameters of interest for these analyses are the friction angle of the soils and the interface friction angle between materials. These parameters are a function of soil particle size and shape, relative density of the soils, and the roughness of the geosynthetic surfaces.

The protective cover soil (PCS) will consist of a general fill composed of sandy silt, with a minimum thickness of 18 inches underlying an 8-inch vegetated soil layer. Underlying the PCS is a geocomposite drainage net layer, composed of an HDPE drainage net encapsulated between two non-woven geotextile layers. The total cover thickness is expected to be a minimum of two feet, and a relative density of 90 percent is specified for the PCS (ARC 2017). Based on data summarized by the Naval Facilities Engineering Command (NAVFAC 1986) and geosynthetic interface friction angles estimated by Koerner (2012), the friction angles for the various interfaces incorporated into the cover are summarized in Table 4.

Table 4
Parameters for Infinite Slope Analysis

Material Type	Estimated Friction Angle (φ')[1], degrees
CKD – LLDPE Interface[2]	22
LLDPE – Geonet Interface[2]	28
Geonet – PCS Interface[2]	26
Protective Cover Soil (PCS)[3,4]	32

Notes:
1 Φ': effective friction angle
2 Consistent with Koerner (2012)
3 Assumed to be placed and compacted to 90percent relative density, per construction requirements
4 Consistent with NAVFAC (1986)

Using these interface angles, the factor of safety for slope stability can be calculated using infinite slope theory (USACE 2003) as follows for dry cohesionless materials:

Equation 1

$$FS = \frac{tan\,\varphi'}{tan\,\alpha}$$

where:

FS	=	factor of safety
φ'	=	interface friction angle
α	=	slope angle

Table 5 summarizes the calculated factors of safety for the engineered cover, for the modeled failure surfaces associated with each of the cover material layers, using the friction angle values discussed above.

Table 5
Summary of Factors of Safety for Cover Layer Components on Slope

Cover Material	FS for 13.3Percent Slope
CKD – LLDPE Interface	3.0
LLDPE – Geonet Interface	4.0
Geonet – PCS Interface	3.7
Protective Cover Soil (PCS)	4.7

Notes:
1. Factor of safety against slope movement

The typical minimum target factor of safety for engineered slopes for long-term conditions is 1.5 based on U.S. Army Corps of Engineers recommendations (USACE 2003). All materials placed on a 13.3 percent slope or flatter exceed this target factor of safety (i.e., 1.5). Interface friction angles greater than 12 degrees would meet the target factor of safety of 1.5.

In addition to infinite slope analyses, the stability of the cover system was verified using limit equilibrium analysis as applied by the SLIDE software program (Rocscience 2016). Representative outputs from the slope stability analysis are presented in Figures C-5.4 and C-5.5 in Attachment C-5. The resulting factors of safety are summarized in Table 6, below.

Table 6
CKD Cover Slope Stability Factors of Safety[1]

Area	Constructed CKD Cover– Static Analysis	Constructed CKD Cover– Seismic Analysis
North CKD Cover (Cross Section A-A’)	4.7	1.4

Note:
1. Factor of safety against slope movement

Although the predicted factor of safety under seismic conditions is slightly less than the value of 1.5 mandated by CCR Title 27, displacement analysis conducted in the same manner as described in Section 5.3 indicates that the overall slope deflection will be, at most, only a quarter of an inch.

Geocomposite elements will also be incorporated into the side slopes of drainage ditches and swales. The ditches and swales will typically be 1 to 2.5 feet in depth, with side slopes inclined at 2 horizontal to 1 vertical (2H:1V on the Plans). The sides will be lined with crushed rock filling 6-inch-thick geocells, which will contribute a relatively high friction angle (40 to 45 degrees).

The geocomposite drainage layer beneath the crushed rock will be placed over compacted subgrade. It is expected to receive support from anchoring below crushed rock and shotcrete on both sides of the ditch, as well as passive support at the base of the ditch. Note that the stability of the ditch side slopes may be influenced by other factors beyond the geotechnical considerations, such as installation damages, maintenance activities, excessive flow or debris, etc.

6.0 CONSTRUCTION OVERSIGHT RECOMMENDATIONS

The design engineer should be made available to address geotechnical considerations that may arise during the course of construction. During active material placement and compaction prior to placement of the cover system and PCS, the design engineer and/or construction manager (or selected representative) should evaluate the suitability of on-site or import soils for use as fill as well as the observing lift thickness and compaction of the fill.

The purpose of these observations is to observe compliance with the design concepts, assumptions, specifications, and/or recommendations. These observations will also allow design changes, or evaluation of appropriate construction measures, in the event that conditions differ from those anticipated prior to the start of construction.

7.0 USE OF THIS DESIGN PACKAGE

This design package is for the exclusive use of RMC Pacific Materials, LLC for specific application to the subject property and site. We completed this design in accordance with generally accepted geotechnical practices for the nature and conditions of the work completed in the same or similar localities, at the time the work was performed. We make no other warranty, express or implied.

The assumptions and analyses made here are broad and applied to a large area. The slope stability analyses are limited to the proposed soil nail wall design currently presented. Any modifications to the soil nail height or slope, or modifications to the nail lengths, spacing, inclination, or size would also affect the results of the analyses conducted. Any design changes may affect the analyses discussed in this report.

Subsurface soil conditions interpreted from our observations and explorations accomplished at the site and soils properties inferred from the field and tests formed the basis for developing our soil nail wall design. The nature and extent of variations in subsurface conditions between the explorations and groundwater conditions with time may not become evident until construction. If variations then appear evident, it will be necessary for ARC to re-evaluate this design. We recommend that contingencies for unanticipated conditions be included during construction to confirm the conditions indicated by the explorations and/or provide corrective recommendations adapted to the conditions identified during the work.

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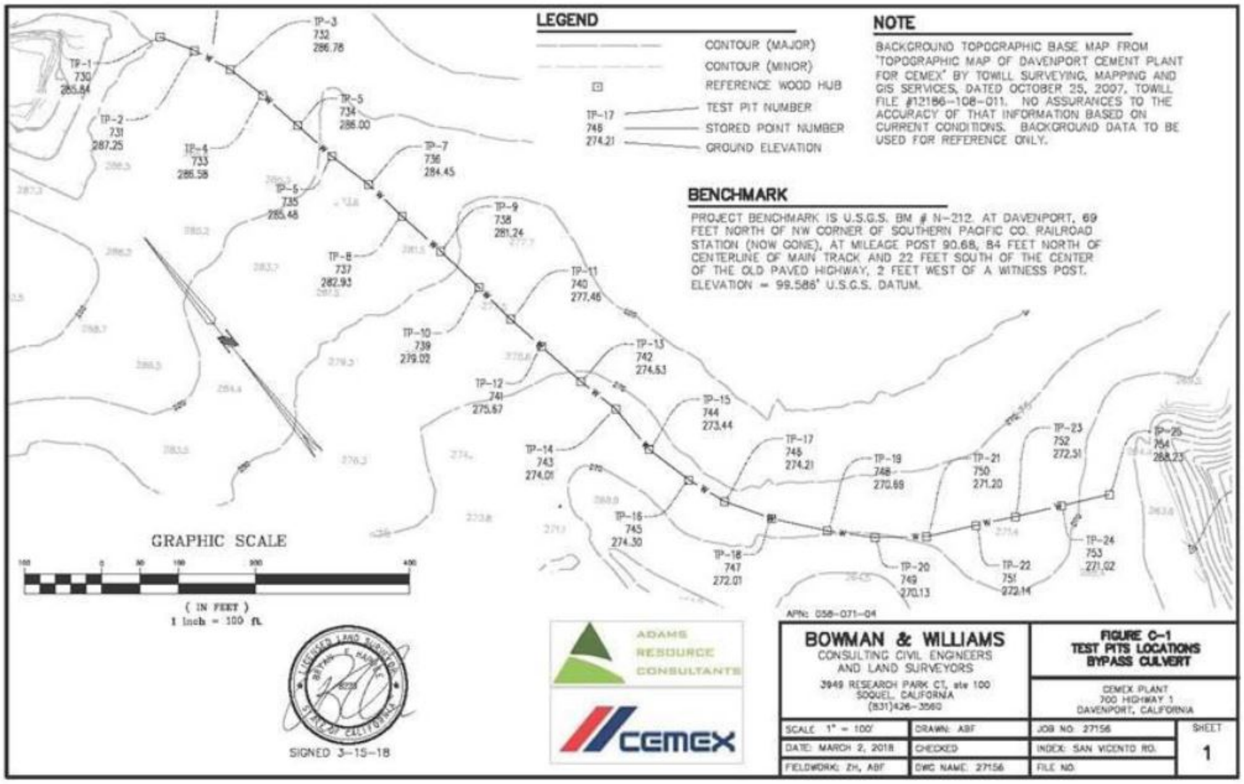


Figure C-1: Survey Map Showing Test Pit locations near the Bypass Pipeline alignment.

All locations and dimensions shown are approximate.

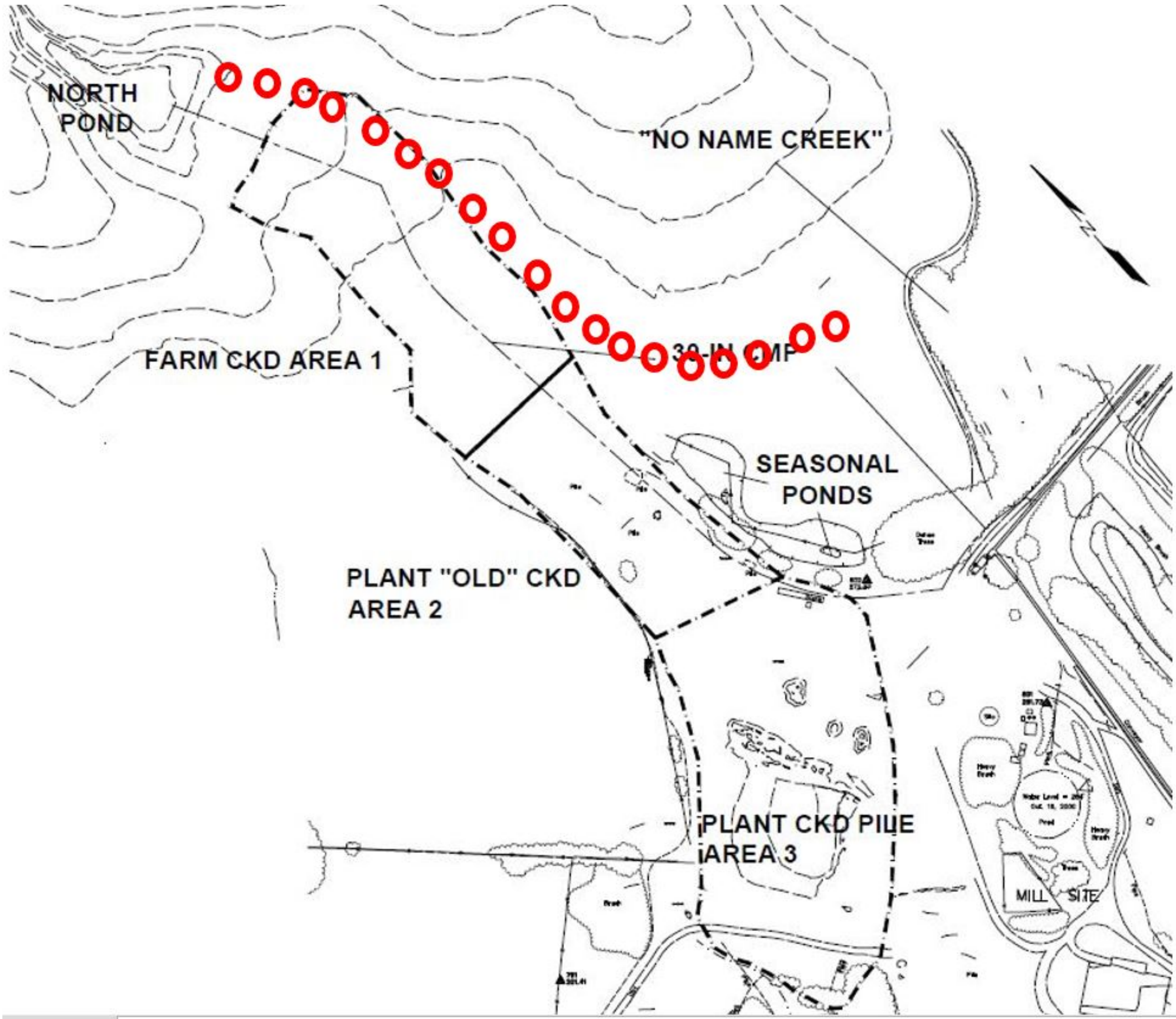


Figure C-2: Approximate Locations of Test Pits Relative to CKD Deposit Areas.

Figure C-3: Test Pit 5 example of excavated construction debris. View Northward.

Figure C-4: Test Pit 24 example of cut slope stand-up in excavated topsoil through weathered rock.

Figure C-5: Test Pit 25 example of excavation in weathered rock (Mudstone). View toward west.

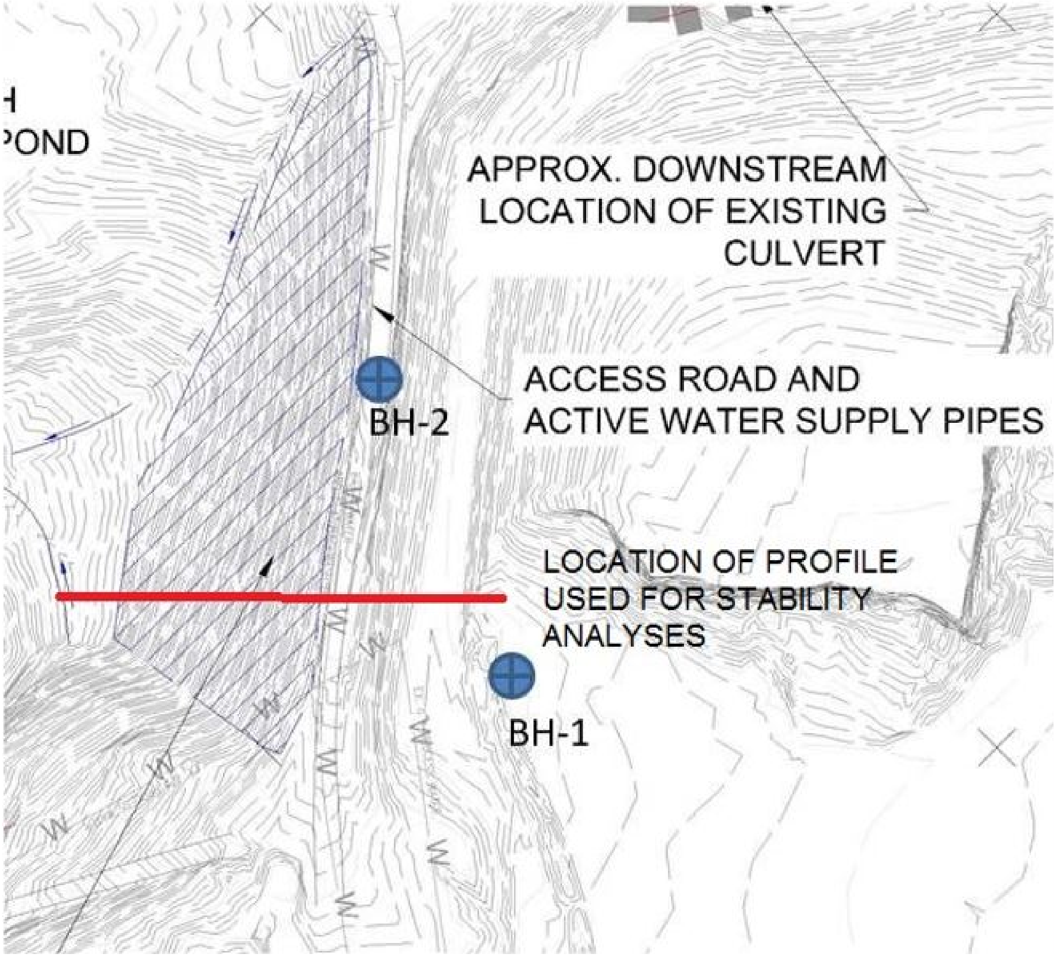


Figure C-6: Approximate Locations of Geotechnical Borings (BH) and Profile for Stability Analysis.

Shotcrete Wall shown by Hatched Area.

ATTACHMENT C-1

GEOTECHINCAL TEST PIT LOGS AND TESTING RESULTS

Test Pit 1 (TP-1)

Ground Elevation: 285.8 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 2.5	Soil Unit A: Light Brown, Loose, SILT with Trace Some Gray Angular Rock Gravel Grading with Depth. Mottled Coloring from 1.5 to 2.5 feet. (Topsoil), (USCS = ML)
2.5 to 8.0	Soil Unit C: Dark Brown to Black, Damp, Loose to Medium Dense, SILT with Trace Gray Angular Boulders. Iron Staining. (Residual), (USCS = ML)
8.0 to 13.0	Soil Unit D: Light Brown to Black, Medium Dense, Angular Gravel to Cobbles. Heavy Iron Staining. (Mudstone)

TP-1 Terminated 09-11-2017 at 13.0 feet, refusal on rock.

No Groundwater Seepage.

Minor Caving from 2.5 to 8.0 feet.

Test Pit 2 (TP-2)

Ground Elevation: 287.3 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 2.0	Soil Unit A: Light Brown, Loose to Medium Dense, SILT, (Topsoil). (USCS = ML)
2.0 to 5.5	Soil Unit C: Dark Brown, Medium Dense, SILT, little sand with Trace Angular Gravel. (Residual), (USCS = ML to SM)
5.5 to 14.0	Soil Unit D: Light Brown to Black, Medium Dense to Dense, Angular Gravel to Cobbles. Little Staining. (Mudstone)

TP-2 Terminated 09-11-2017 at 14.0 feet, refusal on rock.

No Groundwater Seepage.

No Caving.

Test Pit 3 (TP-3)

Ground Elevation: 286.8 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 1.5	Soil Unit A: Light Brown, Loose to Medium Dense, SILT, some sand. (Topsoil), (USCS = ML)
1.5 to 5.0	Soil Unit B1: Brown, Loose to Medium Dense, SILT, some Angular Gravel few Rebar (Fill). (USCS = ML)
5.0 to 11.0	Soil Unit C: Brown, Medium Dense to Dense, SILT and Weathered Rock fragments increase at depth ranges from Angular Cobbles to Boulders. (Residual) (USCS = ML to SM)
11.0 to 17.0	Soil Unit C: White to Reddish Brown, SAND, Iron Stained, Trace Wood Fragments. (Residual) (USCS = SP)

TP-3 Terminated 09-11-2017 at 17.0 feet, refusal on rock.

No Groundwater Seepage.

No Caving.

Test Pit 4 (TP-4)

Ground Elevation: 286.6 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 1.5	Soil Unit A: Light Brown, Loose, SILT, trace sand, (Topsoil), (USCS = ML)
1.5 to 5.0	Soil Unit B1: Light Brown, Loose, SILT and Weathered Angular Gravel, trace Angular Cobbles, few Rebar, Concrete Boulders and Metal Pipe, (Fill), (USCS = ML)

5.0 to 16.0	Soil Unit B1: Light Brown, Loose to Medium Dense, SILT and Angular Gravel, few Concrete Boulders, (Fill), (USCS = ML)
16.0 to 17.2	Soil Unit D: Pinkish to Red Brown, Very Dense Rock, (Mudstone).

TP-4 Terminated 09-11-2017 at 17.2 feet, refusal on rock.

Groundwater Seepage at 16.0 feet after exposed for 3 hours.

No Caving.

Test Pit 5 (TP-5)

Ground Elevation: 286.0 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 1.5	Soil Unit A: Light Brown, Loose, SILT, little sand, (Topsoil), (USCS = ML to SM)
1.5 to 8.0	Soil Unit B1: Light Brown, Loose to Medium Dense, SILT little sand, angular boulders, bricks, wood and rebar at depth, (Fill), (USCS = ML to SM)

TP-5 Terminated 09-11-2017 at 8.0 feet, refusal on rock fragments.

No Groundwater Seepage.

No Caving.

Test Pit 6 (TP-6)

Ground Elevation: 285.5 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 1.6	Soil Unit A: Light Brown, Loose, SILT, little sand, trace wood, (Topsoil), (USCS = ML to SM)

1.6 to 3.0	Soil Unit B1: Light Brown, Loose to Medium Dense, SILT little sand and gravel, wood and metal at depth, (Fill), (USCS = ML to SM)
3.0 to 8.5	Soil Unit B1: Light Brown, Loose to Medium Dense, SILT little sand and gravel, bricks, wood and metal pipe at depth, (Fill), (USCS = ML to SM)

TP-6 Terminated 09-11-2017 at 8.5 feet, refusal on rock fragments.

No Groundwater Seepage.

No Caving.

Test Pit 7 (TP-7)

Ground Elevation: 284.5 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 2.0	Soil Unit A: Light Brown, Loose, SILT, little sand, trace wood and angular gravel, (Topsoil), (USCS = ML to SM)
2.0 to 13.2	Soil Unit B1: Light Brown, Loose to Medium Dense, SILT little sand, gravel and cobbles, wood, concrete and metal at depth, (Fill), (USCS = ML to SM)
13.2 to 15.8	Soil Unit D: Pinkish, Dense, Rock (Mudstone).

TP-7 Terminated 09-11-2017 at 15.8 feet, refusal on rock fragments.

No Groundwater Seepage.

No Caving.

Test Pit 8 (TP-8)

Ground Elevation: 282.9 feet

Observation Depths (feet)	Description of Subsurface Conditions

0.0 to 1.0	Soil Unit A: Light Brown, Loose, SILT, little sand, and trace angular gravel, (Topsoil), (USCS = ML to SM)
1.0 to 2.0	Soil Unit B2: Light Brown, Medium Dense, SILT trace reddish cobbles and silty gravel, (CKD Fill), (USCS = ML)
2.0 to 4.0	Soil Unit B2: Light Blue Gray, Medium Dense to Dense, SILT, (CKD Fill). (USCS = ML)
4.0 to 16.9	Soil Unit B1: Brown, Loose to Medium Dense, SILT and Gravel with trace wood, (Fill), (USCS = ML)

TP-8 Terminated 09-11-2017 at 16.9 feet, refusal on rock fragments.

No Groundwater Seepage.

No Caving.

Test Pit 9 (TP-9)

Ground Elevation: 281.2 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 1.0	Soil Unit A: Light Brown to Black, Loose, SILT, little sand, (Topsoil), (USCS = ML to SM)
1.0 to 9.8	Soil Unit B1: Light Brown, Loose to Medium Dense, SILT, bricks, and concrete angular cobbles, (Fill), (USCS = ML)
9.8 to 16.1	Soil Unit C: Light Brown, Dense to Very Dense, Rock, fractures into 1 to 2inch slabs, iron staining, (Mudstone).

TP-9 Terminated 09-11-2017 at 16.1 feet, refusal on rock.

No Groundwater Seepage.

No Caving.

Test Pit 10 (TP-10)

Ground Elevation: 279.0 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 1.2	Soil Unit A: Light Brown, Loose, SILT, little sand, (Topsoil), (USCS = ML to SM)
1.2 to 7.0	Soil Unit B1: Light Brown, Loose to Medium Dense, SILT, with angular cobbles and boulders, (Fill), (USCS = ML)
7.0 to 8.7	Soil Unit C: Light Brown, Very Dense, Rock, iron staining. (Mudstone).

TP-10 Terminated 09-11-2017 at 8.7 feet, refusal on rock bedding plane.

No Groundwater Seepage.

Minor Caving.

Test Pit 11 (TP-11)

Ground Elevation: 277.5 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 1.3	Soil Unit A: Light Brown, Loose, SILT, little sand, (Topsoil), (USCS = ML to SM)
1.3 to 8.0	Soil Unit B1: Light Brown, Loose to Medium Dense, SILT, with plastic sheeting, steel rods at 4.8 feet, angular cobbles and boulders, (Fill), (USCS = ML)
8.0 to 14.0	Soil Unit D: Pinkish, Very Dense, Rock, (Mudstone)
14.0 to 16.0	Soil Unit D: Pinkish, Very Dense, Rock, (Fossiliferous Mudstone)

TP-11 Terminated 09-11-2017 at 16.0 feet, refusal on rock.

Groundwater Seepage at 4.8 feet and 1-inch deep accumulation after 7 hours.

No Caving.

Test Pit 12 (TP-12)

Ground Elevation: 275.7 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 1.5	Soil Unit A: Light Brown, Loose, SILT, little sand, (Topsoil). (USCS = ML to SM)
1.5 to 10.7	Soil Unit B1: Light Brown to Black, Loose to Medium Dense, SILT, with plastic sheeting, (Fill), (USCS = ML)
10.7 to 16.8	Soil Unit D: Pinkish, Very Dense, Rock, (Mudstone)

TP-12 Terminated 09-11-2017 at 16.8 feet, refusal on rock.

Groundwater Seepage at 8.6 to 9.0 feet. 1-inch deep water after 7 hours.

No Caving.

Test Pit 13 (TP-13)

Ground Elevation: 274.6 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 1.4	Soil Unit A: Light Brown, Loose, SILT, little sand, (Topsoil), (USCS = ML to SM)
1.4 to 11.0	Soil Unit B1: Light Brown to Black, Loose to Medium Dense, SILT, with plastic sheeting, steel bars, (Fill), (USCS = ML)
11.0 to 15.7	Soil Unit D: Tan, Very Dense, Rock, iron staining. (Mudstone)

TP-13 Terminated 09-11-2017 at 15.7 feet, refusal on rock.

Minor Groundwater Seepage at 10.0 feet. No accumulation/ponding.

Minor Caving 8.0 to 11.0 feet.

Test Pit 14 (TP-14)

Ground Elevation: 274.0 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 0.9	Soil Unit A: Light Brown, Loose, SILT, little sand, (Topsoil), (USCS = ML to SM)
0.9 to 3.5	Soil Unit B1: Light Brown to Black, Loose to Medium Dense, SILT, with plastic sheeting, steel bars, trace cobbles, (Fill), (USCS = ML)
3.5 to 6.5	Soil Unit C: Dark Brown to Black, Medium Dense, SILT, (Residual), (USCS = ML)
6.5 to 9.0	Soil Unit D: Tan, Very Dense, Rock, slight iron staining, (Mudstone)
9.0 to 15.5	Soil Unit C: Dark Brown to Black, Medium Dense, SILT, (Residual), (USCS = ML)

TP-14 Terminated 09-11-2017 at 15.5 feet, refusal on rock.

No Groundwater Seepage.

No Caving.

Test Pit 15 (TP-15)

Ground Elevation: 273.4 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 1.6	Soil Unit A: Dark Brown, Loose, SILT, (Topsoil), (USCS = ML)
1.6 to 6.0	Soil Unit C: Tan, Medium Dense, SILT with fine sand, iron staining (Residual), (USCS = ML to SW-SM)
6.0 to 6.6	Soil Unit D: Tan, Very Dense, Rock, slight iron staining, (Mudstone)

TP-15 Terminated 09-11-2017 at 6.6 feet, refusal on rock.

No Groundwater Seepage.

No Caving.

Test Pit 16 (TP-16)

Ground Elevation: 273.4 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 2.1	Soil Unit A: Dark Brown, Loose, SILT, (Topsoil), (USCS = ML)
2.1 to 9.3	Soil Unit C: Tan, Medium Dense, SILT with fine sand, iron staining, (Residual), (USCS = ML to SM)
9.3 to 10.3	Soil Unit D: Tan, Very Dense, Rock, (Mudstone)

TP-16 Terminated 09-11-2017 at 10.3 feet, refusal on rock.

No Groundwater Seepage.

No Caving.

Test Pit 17 (TP-17)

Ground Elevation: 274.2 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 1.8	Soil Unit A: Dark Brown, Loose, SILT, (Topsoil), (USCS = ML)
1.8 to 7.1	Soil Unit C: Tan, Medium Dense, SILT with fine sand, iron staining, (Residual), (USCS = ML to SM)
7.1 to 9.0	Soil Unit D: Tan, Very Dense, Rock, (Mudstone)

TP-17 Terminated 09-11-2017 at 9.0 feet, refusal on rock.

No Groundwater Seepage.

No Caving.

Test Pit 18 (TP-18)

Ground Elevation: 272.0 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 4.0	Soil Unit A: Dark Brown, Loose, clayey SILT, (Topsoil), (USCS = ML)
4.0 to 5.2	Soil Unit C: Gray, Medium Dense, SILT and fine sand, (Residual), (USCS = ML to SM)
5.2 to 6.8	Soil Unit C: Tan, Medium Dense, SILT and fine sand, iron staining, (Residual), (USCS = ML to SM)
6.8 to 7.1	Soil Unit D: Tan, Very Dense, Rock, (Mudstone)

TP-18 Terminated 09-11-2017 at 7.1 feet, refusal on rock.

No Groundwater Seepage.

No Caving.

Test Pit 19 (TP-19)

Ground Elevation: 270.7 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 1.8	Soil Unit A: Dark Brown, Loose, SILT, (Topsoil), (USCS = ML)
1.8 to 6.0	Soil Unit C: Gray, Medium Dense, SILT and fine sand, (Residual Soil), (USCS = ML to SM)

6.0 to 8.6	Soil Unit C: Tan, Medium Dense, SILT and fine sand, iron staining, (Residual), (USCS = ML to SM)
8.6 to 13.0	Soil Unit D: Tan, Very Dense, Rock, (Mudstone)
13.0 to 18.4	Soil Unit C: Brown, Medium Dense, clayey SILT and fine sand, iron staining, (Residual), (USCS = ML)

TP-19 Terminated 09-11-2017 at 18.4 feet.

No Groundwater Seepage.

No Caving.

Test Pit 20 (TP-20)

Ground Elevation: 270.1 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 1.5	Soil Unit A: Dark Brown, Loose, SILT, (Topsoil), (USCS = ML)
1.5 to 3.5	Soil Unit D: Tan, Very Dense, Rock, (Mudstone)

TP-20 Terminated 09-11-2017 at 3.5 feet, refusal on rock.

No Groundwater Seepage.

No Caving.

Test Pit 21 (TP-21)

Ground Elevation: 271.2 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 2.5	Soil Unit A: Dark Brown, Loose, SILT, (Topsoil), (USCS = ML)

2.5 to 13.5	Soil Unit C: Tan, Medium Dense, SILT with fine sand, iron staining, (Residual), (USCS = ML to SM)
13.5 to 15.0	Soil Unit D: Tan, Very Dense, Rock, (Mudstone)

TP-21 Terminated 09-11-2017 at 15.0 feet, refusal on rock.

No Groundwater Seepage.

No Caving.

Test Pit 22 (TP-22)

Ground Elevation: 272.0 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 3.0	Soil Unit A: Dark Brown, Loose, clayey SILT, (Topsoil) (USCS = ML)
3.0 to 6.3	Soil Unit C: Gray, Medium Dense, SILT and fine sand, (Residual), (USCS = ML to SM)
6.3 to 13.0	Soil Unit C: Tan, Medium Dense, SILT and fine sand, iron staining, (Residual), (USCS = ML to SM)
13.0 to 14.0	Soil Unit D: Dark Brown, Very Dense, Weathered Rock, (Mudstone)

TP-22 Terminated 09-11-2017 at 14.0 feet, refusal on rock.

No Groundwater Seepage.

No Caving.

Test Pit 23 (TP-23)

Ground Elevation: 272.5 feet

Observation Depths (feet)	Description of Subsurface Conditions

0.0 to 3.0	Soil Unit A: Dark Brown, Loose, clayey SILT, (Topsoil). (USCS = ML TO CH)
3.0 to 6.6	Soil Unit C: Mottled Tan, Medium Dense, SILT and fine sand, (Residual), (USCS = ML to SM)
6.6 to 9.2	Soil Unit C: Red Brown, Medium Dense, SILT and fine sand, iron staining, (Residual), (USCS = ML to SM)
9.2 to 10.5	Soil Unit D: Dark Brown, Very Dense, Weathered Rock, (Mudstone)

TP-23 Terminated 09-11-2017 at 10.5 feet, refusal on rock.

No Groundwater Seepage.

No Caving.

Test Pit 24 (TP-24)

Ground Elevation: 271.0 feet

Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 1.5	Soil Unit A: Gray Brown, Loose, SILT, (Topsoil), (USCS = ML)
1.5 to 5.0	Soil Unit A: Light Brown, Loose, SILT some sand (Topsoil), (USCS = ML to SM)
5.0 to 5.6	Soil Unit C: Mottled Tan, Medium Dense, SILT and fine sand, (Residual), (USCS = ML to SP-SM)
5.6 to 8.5	Soil Unit C: Red Brown, Medium Dense, SILT and fine sand, iron staining, (Residual), (USCS = ML to SP-SM)
8.5 to 10.0	Soil Unit D: Dark Brown, Very Dense, Weathered Rock, (Mudstone)

TP-24 Terminated 09-11-2017 at 10.5 feet, refusal on rock.

No Groundwater Seepage.

No Caving.

Test Pit 25 (TP-25)

Ground Elevation: 268.2 feet

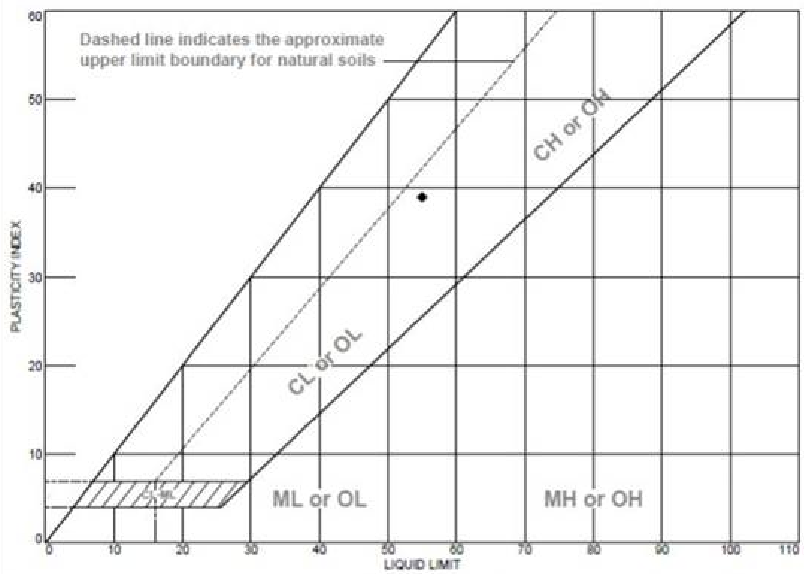
Observation Depths (feet)	Description of Subsurface Conditions
0.0 to 2.8	Soil Unit A: Gray Brown, Loose, SILT, (Topsoil), (USCS = ML)
2.8 to 5.8	Soil Unit C: Mottled Tan, Medium Dense, SILT and fine sand, (Residual), (USCS = ML to SM)
5.8 to 10.6	Soil Unit C: Red Brown, Medium Dense, SILT and fine sand, iron staining, (Residual), (USCS = ML to SM)
10.6 to 12.0	Soil Unit D: Dark Brown, Very Dense, Weathered Rock, (Mudstone)

TP-25 Terminated 09-11-2017 at 10.5 feet, refusal on rock.

No Groundwater Seepage.

No Caving.

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	TP-24 poorly graded sand with silt	NV	NP	NP	65.4	11.3	SP-SM
■	TP-15 well-graded sand with silt	NV	NP	NP	61.3	11.8	SW-SM
▲	TP-12 sandy silt	NV	NP	NP	75.7	63.9	ML
◆	TP-23 sandy fat clay	55	16	39	90.6	63.3	CH

Project No. 17-664 **Client:** Adams Resource

Project: 2017 Laboratory Testing

●**Source of Sample:** Project #J-045 Cemex **Sample Number:** 17-240
■**Source of Sample:** Project #J-045 Cemex **Sample Number:** 17-241
▲**Source of Sample:** Project #J-045 Cemex **Sample Number:** 17-242
◆**Source:** Project #J-045 Cemex **Depth:** 0-3' **Sample No.:** 17-243

Remarks:

A.A.R. Testing Laboratory, Inc.

Lab Sample ID

Project No.: J-045-05-16 Date: April 1, 2018

Figure C-1.3: Summary of Geotechnical Soil Laboratory Testing Results for Grab Samples from Test Pits.

ADAMS RESOURCE CONSULTANTS

Major Division			Symbol	Description
Coarse-Grained Soils - More than 50% (1) Retained on No. 200 Sieve	Gravels and Gravelly Soils - More than 50% (1) of Coarse Fraction Retained on No. 4 Sieve	≤5% Fines (5)	GW	Well-graded gravel and gravel with sand, little to no fines
			GP	Poorly-graded gravel and gravel with sand, little to no fines
		≥15% Fines (5)	GM	Silty gravel and silty gravel with sand
			GC	Clayey gravel and clayey gravel with sand
	Sands and Sandy Soil - 50% (1) or More of Coarse Fraction Passes No. 4 Sieve	≤5% Fines (5)	SW	Well-graded sand and sand with gravel, little to no fines
			SP	Poorly-graded sand and sand with gravel, little to no fines
		≥15% Fines (5)	SM	Silty sand and silty sand with gravel
			SC	Clayey sand and clayey sand with gravel
Fine-Grained Soils - 50% (1) or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less than 50%		ML	Silt, sandy silt, gravelly silt, silt with sand or gravel
			CL	Clay of low to medium plasticity; silty, sandy, or gravelly clay, lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50% or More		MH	Elastic silt, clayey silt, silt with micaceous or diatomaceous fine sand or silt
			CH	Clay of high plasticity, sandy or gravelly clay, fat clay with sand or gravel
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			PT	Peat, muck and other highly organic soils

Relative Density or Consistency Using Standard Penetration Test Values

Cohesionless Soils (a)

Density (c)	N. blows/ft (c)	Relative Density %
Very loose	0 to 4	0 to 15
Loose	4 to 10	15 to 35
Medium Dense	10 to 30	35 to 65
Dense	30 to 50	65 to 85
Very Dense	over 50	> 85

Cohesive Soils (b)

Consistency	N. blows/ft (c)	Undrained Shear Strength(d) (psf)
Very soft	0 to 2	< 250
Soft	2 to 4	250 - 500
Medium Stiff	4 to 8	500 - 1000
Stiff	8 to 15	1000 - 2000
Very Stiff	15 to 30	2000 - 4000
Hard	over 30	>4000

(a) Soils consisting of gravel, sand, and silt, either separately or in combination, possessing no characteristics of plasticity, and exhibiting drained behavior. (b) Soils possessing the characteristics of plasticity, and exhibiting undrained behavior. (c) Refer to text of ASTM D 1586 for definition of N; in normally consolidated cohesionless soils relative density terms are based on N values corrected for overburden pressures. (d) Undrained shear strength = 1/2 unconfined compression strength.

Component Definitions by Gradation

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

(3) Estimated Percentage

Component	Percentage by Weight
(Trace)	<5
(Few)	5 to 10
(Little)	15 to 25
(And) or adjectives	25 to 50
With	- Non-primary coarse constituents: ≥ 15% - Fines content between 5% and 15%

Adjectives: Gravelly, Sandy, or Silty

Laboratory Tests

Test	Designation
Moisture (6)	M
Density	D
Grain Size	G
Hydrometer	H
Atterberg Limits (6)	A
Consolidation	C
Unconfined	U
UU Triax	UU
CU Triax	CU
CO Triax	CO
Permeability	P

(6) If plotted on log.

Samples

SS	SPT Sampler (2.0" OD)
HD	Heavy Duty Split Spoon
SH	Shelby Tube
P	Push Tube Sampler
B	Bulk
C	Cored
G	Grab

Unless otherwise noted, drive samples advanced with 140 lb. hammer with 30 in. drop.

Symbols

Cement grout surface seal
Bentonite seal
(4)
Filter pack with blank casing section
Screened casing or Hydrotip with filter pack
End cap
Groundwater Seepage

(1) Percentage by dry weight
(2) Deleted
(3) In General Accordance with Standard Practice for Description and Identification of Soils (ASTM D-2488)

(4) Depth of ground water
∇ ATD = At time of drilling
▼ Static water level (date)
(5) Combined USCS DUAL symbols used for fines between 5% and 15%

Classifications of soils in this report are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D-2487 and D-2488 were used as an identification guide for the Unified Soil Classification System.

ADAMS RESOURCE CONSULTANTS

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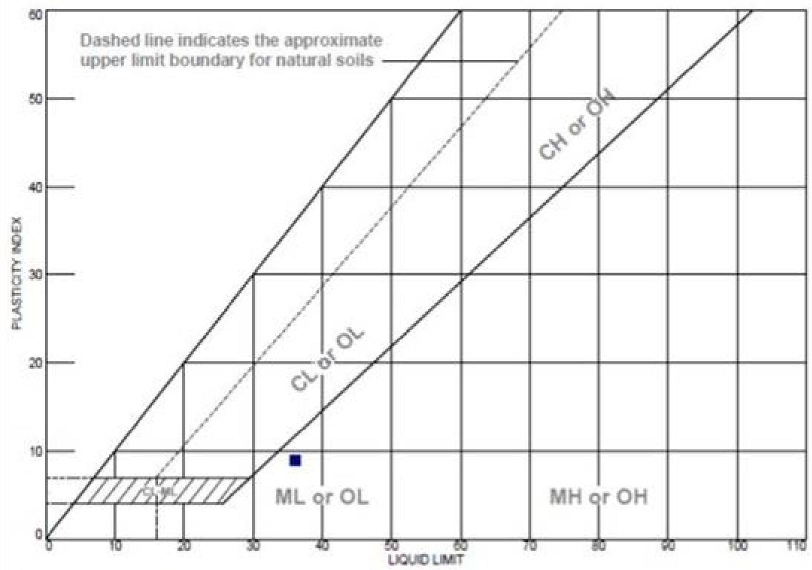
SOIL DESCRIPTION METHODS

FIGURE A-1

ATTACHMENT C-2

GEOTECHINCAL BOREHOLE LOGS
AND TESTING RESULTS

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BH-1 SS-01 silty sand	NV	NP	NP	58.9	31.2	SM
■	BH-1 SS-09 silty sand with gravel	36	27	9	39.2	21.3	SM
▲	BH-1 SS-16 silty sand with gravel	NV	NP	NP	42.1	24.7	SM
◆	BH-2 SS-02 silty sand	NV	NP	NP	59.4	39.2	SM
▼	BH-2 SS-11 silty sand with gravel	NV	NP	NP	56.5	45.4	SM

Project No. 17-664 **Client:** Adams Resource

Project: 2018 Laboratory Testing

●**Source:** Project #J-045 Cemex **Depth:** 5'-6.5' **Sample No.:** 18-019
■**Source:** Project #J-045 Cemex **Depth:** 45'-46.5' **Sample No.:** 18-020
▲**Source:** Project #J-045 Cemex **Depth:** 85'-86.5' **Sample No.:** 18-021
◆**Source:** Project #J-045 Cemex **Depth:** 10'-10.9' **Sample No.:** 18-022
▼**Source:** Project #J-045 Cemex **Depth:** 65'-65.7' **Sample No.:** 18-023

Remarks:

A.A.R. Testing Laboratory, Inc.

Nick Averill

Tested By: Nick Averill **Checked By:** Nick Averill

Project No.: J-045-05-16 Date: April 1, 2018

Figure C-2.1: Summary of Geotechnical Soil Laboratory Testing Results for Grab Samples from Boreholes.

ADAMS RESOURCE CONSULTANTS

LOG OF EXPLORATORY BORING

PROJECT NAME	**Adams Resource Consultants Company**	BORING NO.	**BH1**
LOCATION	**CEMEX Facility, Davenport, California**	PAGE	**1 of 6**
DRILLED BY	**Cascade Drilling, Inc.**	LOGGED BY	**C. Janisch**
DRILL METHOD	**Hollow Stem Auger**	TOTAL DEPTH	**110.0 ft.**
BOREHOLE DIAMETER	**8 inches**	DATE COMPLETED	**2/2/18**
SAMPLING METHOD	**2 in. by 1.5 ft. SPT**		

SAMPLING METHOD	RECOVERY (FEET)	BLOW COUNTS	SAMPLE ID	SAMPLE DEPTH (FEET)	DEPTH IN FEET	LITHO-LOGIC COLUMN	LITHOLOGIC DESCRIPTION	GRA %	SAND %	FINES %
					0		**0 to 15.5 feet: SILT (ML)**, hard, dry to damp, purplish gray silt, cement kiln dust (CKD).			
SS	1.8	12 35 38	BH1-SS01 @0916	5.0-6.5	5			0	3	97
								0	3	97
SS	1.5	10 20 20	BH1-SS02 @0950	10.0-11.5	10		@ 10.0 feet: same as above.	0	0	100
SS	1.3	16 37 38	BH1-SS03 @1010	14.5-16.0	15			0	0	100
							15.5 to 16.2 feet: SILT (ML), lense of white, crystallized, cemented silt with sand. Crystallized into gravel-sized particles. Pockets of CKD throughout.	0	10	90
							16.2 to 20.0 feet: SILT (ML), grades back to CKD. @ 16.3 feet: lamination of brown, dry to damp silt with coarse to medium sand (<5%), 0.1' thick. @ 16.4 feet: hard cementation present.	0	0	100
					20					

REMARKS

Blow counts adjusted to standard 2-inch OD sampler. Lithologic description and particle size distribution based on field observations in accordance with ASTM DZ488. Cuttings are highly moisture sensitive and have low remolded strength.

ANCHOR QEA

LOG OF EXPLORATORY BORING

- PROJECT NAME: **Adams Resource Consultants Company**
- LOCATION: **CEMEX Facility, Davenport, California**
- DRILLED BY: **Cascade Drilling, Inc.**
- DRILL METHOD: **Hollow Stem Auger**
- BOREHOLE DIAMETER: **8 inches**
- SAMPLING METHOD: **2 in. by 1.5 ft. SPT**
- BORING NO.: **BH1**
- PAGE: **2 of 6**
- LOGGED BY: **C. Janisch**
- TOTAL DEPTH: **110.0 ft.**
- DATE COMPLETED: **2/2/18**

SAMPLING METHOD	RECOVERY (FEET)	BLOW COUNTS	SAMPLE ID	SAMPLE DEPTH (FEET)	DEPTH IN FEET	LITHO-LOGIC COLUMN	LITHOLOGIC DESCRIPTION	GRA %	SAND %	FINES %
SS	1.0	7 38/5"	BH1-SS04 @1025	20.0-21.0			**20.0 to 30.0 feet: SILT (ML)**, very stiff, dry, brown, with trace gravel, gravel is crystallized white mineral.	5	0	95
							@ 20.8 feet: lense of hard, dry, white crystallized powder.	0	10	90
							@ 20.9 feet: grades back to CKD, as on previous page.	0	0	100
SS	1.2	12 38/4"	BH1-SS05 @1040	25.0-25.8	25			0	0	100
SS	0.5	38/3"	BH1-SS06 @1100	30.0-30.3	30		**30.0 to 30.2 feet: SILT (ML)**, hard, moist, brown silt with low plasticity. @ 30.2 feet: perched groundwater observed.	0	0	100
							30.2 to 30.5 feet: SILT (ML), soft, wet, light brown.	0	15	85
							30.5 to 35.0 feet: SILT (ML) @ 30.5 feet: white crystallized rock, can break with high finger strength.			
SS	0.3	31/3"	BH1-SS07 @1120	35.0-35.3	35		**35.0 to 58.0 feet: SILT (ML)**, hard, dry, brown, slightly sandy silt with trace gravel, gravel consisting of white crystallized fragments.	1	5	94
					40					

REMARKS

Blow counts adjusted to standard 2-inch OD sampler. Lithologic description and particle size distribution based on field observations in accordance with ASTM DZ488. Cuttings are highly moisture sensitive and have low remolded strength.

ANCHOR QEA

LOG OF EXPLORATORY BORING

PROJECT NAME	**Adams Resource Consultants Company**	BORING NO.	**BH1**
LOCATION	**CEMEX Facility, Davenport, California**	PAGE	**3 of 6**
DRILLED BY	**Cascade Drilling, Inc.**	LOGGED BY	**C. Janisch**
DRILL METHOD	**Hollow Stem Auger**	TOTAL DEPTH	**110.0 ft.**
BOREHOLE DIAMETER	**8 inches**	DATE COMPLETED	**2/2/18**
SAMPLING METHOD	**2 in. by 1.5 ft. SPT**		

SAMPLING METHOD	RECOVERY (FEET)	BLOW COUNTS	SAMPLE ID	SAMPLE DEPTH (FEET)	DEPTH IN FEET	LITHO-LOGIC COLUMN	LITHOLOGIC DESCRIPTION	GRA %	SAND %	FINES %
SS	1.5	5 9 15	BH1-SS08 @1140	40.0-41.5			**35.0 to 58.0 feet: SILT (ML)**, continued. Grades to very stiff, damp, and more gravel.	10	10	80
SS	1.5	9 17 16	BH1-SS09 @1200	45.0-46.5	45		@ 45.0 feet: same as above.	10	10	80
SS	0.3	31/3"	BH1-SS10 @1310	50.0-50.5	50		@ 50.0 feet: grades to hard, oxidation present.	10	10	80
							@ 52.0 feet: woven blue fabric debris observed.			
SS	1.0	10 31/5"	BH1-SS11 @1340	55.0-56.0	55		@ 55.0 feet: no oxidation or fabric. Metal fragment.			
							58.0 to 65.0 feet: SILT (ML), hard, dry, purplish gray (CKD).			
					60					

REMARKS

Blow counts adjusted to standard 2-inch OD sampler. Lithologic description and particle size distribution based on field observations in accordance with ASTM DZ488. Cuttings are highly moisture sensitive and have low remolded strength.

ANCHOR QEA

LOG OF EXPLORATORY BORING

PROJECT NAME	**Adams Resource Consultants Company**	BORING NO.	**BH1**
LOCATION	**CEMEX Facility, Davenport, California**	PAGE	**4 of 6**
DRILLED BY	**Cascade Drilling, Inc.**	LOGGED BY	**C. Janisch**
DRILL METHOD	**Hollow Stem Auger**	TOTAL DEPTH	**110.0 ft.**
BOREHOLE DIAMETER	**8 inches**	DATE COMPLETED	**2/2/18**
SAMPLING METHOD	**2 in. by 1.5 ft. SPT**		

SAMPLING METHOD	RECOVERY (FEET)	BLOW COUNTS	SAMPLE ID	SAMPLE DEPTH (FEET)	DEPTH IN FEET	LITHOLOGIC COLUMN	LITHOLOGIC DESCRIPTION	GRA %	SAND %	FINES %
SS	1.5	6 11 25	BH1-SS12 @1400	50.0-61.5			**58.0 to 65.0 feet: SILT (ML)**, continued. @ 60.9 feet: pocket of cemented fines.	0	0	100
SS	1.5	10 13 13	BH1-SS13 @1419	65.0-66.5	65		**65.0 to 65.5 feet: SILT (ML)**, very stiff, damp to moist, gray, sandy, slightly gravelly silt. @ 65.3 feet: pocket of brown compacted fines.	5	25	70
								2	10	88
							65.5 to 66.0 feet: SILT (ML), transition to purplish hue, decrease in sand and gravel content.	0	0	100
							66.0 to 80.0 feet: SILT (ML), very stiff, dry, purple-gray silt (CKD).			
SS	0.8	7 38/4"	BH1-SS14 @1440	70.0-80.8	70		@ 70.0 feet: same as above.			
								0	0	100
					75					
					80					

REMARKS

Blow counts adjusted to standard 2-inch OD sampler. Lithologic description and particle size distribution based on field observations in accordance with ASTM DZ488. Cuttings are highly moisture sensitive and have low remolded strength.

ANCHOR QEA

LOG OF EXPLORATORY BORING

PROJECT NAME	**Adams Resource Consultants Company**	BORING NO.	**BH1**
LOCATION	**CEMEX Facility, Davenport, California**	PAGE	**5 of 6**
DRILLED BY	**Cascade Drilling, Inc.**	LOGGED BY	**C. Janisch**
DRILL METHOD	**Hollow Stem Auger**	TOTAL DEPTH	**110.0 ft.**
BOREHOLE DIAMETER	**8 inches**	DATE COMPLETED	**2/2/18**
SAMPLING METHOD	**2 in. by 1.5 ft. SPT**		

SAMPLING METHOD	RECOVERY (FEET)	BLOW COUNTS	SAMPLE ID	SAMPLE DEPTH (FEET)	DEPTH IN FEET	LITHO-LOGIC COLUMN	LITHOLOGIC DESCRIPTION	GRA %	SAND %	FINES %
SS	1.5	5 9 9	BH1-SS15 @1505	80.0-81.5			**80.0 to 90.5 feet: SILT (ML)**, very stiff, damp, greenish brown, with gravel and cemented green silt pieces. @ 80.0 to 90.0 feet: drilling alternates between easy and hard. @ 80.8 to 81.1 feet: lense of cemented SILT (ML), green, can break with high finger pressure.	5	5	90
SS	1.5	8 13 20	BH1-SS16 @1530	85.0-85.6	85		@ 85.0 feet: grades to hard.			
SS	0.6	25 38/1"	BH1-SS17 @1600	90.0-90.6	90			0	5	95
							90.5 to 103.0 feet: SILT (ML), hard, dry, purplish gray silt (CKD). Laminations of moderate cementation present.	0	0	100
SS	1.2	8 20 38/2"	BH1-SS18 @1620	95.0-96.2	95		@ 95.0 feet: grades to very stiff, no laminations.			
							@ 96.0 feet: grades to hard, gray.	0	0	100
					100					

REMARKS

Blow counts adjusted to standard 2-inch OD sampler. Lithologic description and particle size distribution based on field observations in accordance with ASTM DZ488. Cuttings are highly moisture sensitive and have low remolded strength.

ANCHOR QEA

LOG OF EXPLORATORY BORING

PROJECT NAME	**Adams Resource Consultants Company**	BORING NO.	**BH1**
LOCATION	**CEMEX Facility, Davenport, California**	PAGE	**6 of 6**
DRILLED BY	**Cascade Drilling, Inc.**	LOGGED BY	**C. Janisch**
DRILL METHOD	**Hollow Stem Auger**	TOTAL DEPTH	**110.0 ft.**
BOREHOLE DIAMETER	**8 inches**	DATE COMPLETED	**2/2/18**
SAMPLING METHOD	**2 in. by 1.5 ft. SPT**		

SAMPLING METHOD	RECOVERY (FEET)	BLOW COUNTS	SAMPLE ID	SAMPLE DEPTH (FEET)	DEPTH IN FEET	LITHO-LOGIC COLUMN	LITHOLOGIC DESCRIPTION	GRA %	SAND %	FINES %
SS	1.8	17 16 38/3"	BH1-SS19 @1650	100.0- 101.3			**90.5 to 103.0 feet: SILT (ML)**, continued. @ 100.0 feet: grades to purple-gray.	0	0	100
							@ 101.7 feet: lamination of dark brown silt with cemented fragments (silt-stone). @ 102.0 feet: end of boring 02/01/2018. Resume 02/02/2018.			
							103.0 to 105.5 feet: SANDY SILT (ML), stiff, wet, black. Perched groundwater observed.			
SS	1.0	4 3 8	BH1-SS20 @0810	105.0- 106.5	105			0	20	80
							105.5 to 105.6 feet: SILT (ML), hard, dry, cemented silt, black with green streaks (silt-stone), fragmented.	0	0	100
							105.6 to 110.0 feet: SILT (ML), grades to fragmented, brown cemented silt.	0	0	100
SS	0.1	50/42"	BH1-SS21 @0855	110.0- 110.1	110		@ 110.0 feet: brown rock fragments, same as above. Total depth: 110.0 feet.			
					115					
					120					

REMARKS

Blow counts adjusted to standard 2-inch OD sampler. Lithologic description and particle size distribution based on field observations in accordance with ASTM DZ488. Cuttings are highly moisture sensitive and have low remolded strength.

ANCHOR QEA

LOG OF EXPLORATORY BORING

PROJECT NAME	**Adams Resource Consultants Company**	BORING NO.	**BH2**
LOCATION	**CEMEX Facility, Davenport, California**	PAGE	**1 of 8**
DRILLED BY	**Cascade Drilling, Inc.**	LOGGED BY	**C. Janisch**
DRILL METHOD	**Hollow Stem Auger**	TOTAL DEPTH	**141.5 ft.**
BOREHOLE DIAMETER	**8 inches**	DATE COMPLETED	**1/31/18**
SAMPLING METHOD	**2 in. by 1.5 ft. SPT**		

SAMPLING METHOD	RECOVERY (FEET)	BLOW COUNTS	SAMPLE ID	SAMPLE DEPTH (FEET)	DEPTH IN FEET	LITHO-LOGIC COLUMN	LITHOLOGIC DESCRIPTION	GRA %	SAND %	FINES %
							0 to 54.0 feet: SANDY SILT (ML), hard, damp, purplish gray, slightly sandy silt, cement kiln dust (CKD). Moderate cementation throughout.			
SS	1.5	8 11 18	BH2-SS01	5.0-6.5	5			0	10	90
							@ 5.8 feet: pocket of soft, moist, light brown clay.			
								0	0	100
SS	1.2	16 38/5"	BH2-SS02	10.0-10.9	10					
							@ 10.5 feet: grades to less sandy, reddish hue, no cementation.			
								0	5	95
SS	0.5	38/5"	BH2-SS03	15.0-15.4	15		@ 15.0 feet: grades to purplish gray, laminations of cemented silt present.			
					20					

REMARKS

Blow counts adjusted to standard 2-inch OD sampler. Lithologic description and particle size distribution based on field observations in accordance with ASTM DZ488. Cuttings are highly moisture sensitive and have low remolded strength.

ANCHOR QEA

LOG OF EXPLORATORY BORING

PROJECT NAME	**Adams Resource Consultants Company**	BORING NO.	**BH2**
LOCATION	**CEMEX Facility, Davenport, California**	PAGE	**2 of 8**
DRILLED BY	**Cascade Drilling, Inc.**	LOGGED BY	**C. Janisch**
DRILL METHOD	**Hollow Stem Auger**	TOTAL DEPTH	**141.5 ft.**
BOREHOLE DIAMETER	**8 inches**	DATE COMPLETED	**1/31/18**
SAMPLING METHOD	**2 in. by 1.5 ft. SPT**		

SAMPLING METHOD	RECOVERY (FEET)	BLOW COUNTS	SAMPLE ID	SAMPLE DEPTH (FEET)	DEPTH IN FEET	LITHO-LOGIC COLUMN	LITHOLOGIC DESCRIPTION	GRA %	SAND %	FINES %
SS	0.5	38/6"	BH2-SS04	20.0-20.5			**0 to 54.0 feet: SILT (ML)**, continued.	0	0	100
							@ 23.0 feet: grades to less sandy.			
SS	0.3	38/4"	BH2-SS05	25.0-25.3	25			0	0	100
SS	0.4	50/3"	BH2-SS06	30.0-30.3	30			0	0	100
SS	1.5	23 23 31	BH2-SS07	35.0-36.3	35			0	0	100
Grab			BH2-GB1 @25'-35' cuttings	36.3			@ 36.0 feet: laminations of hard, dry, brown silt, 1/8 to 1/4 inch. @ 36.4 feet: color change to white gray.			
					40					

REMARKS
Blow counts adjusted to standard 2-inch OD sampler. Lithologic description and particle size distribution based on field observations in accordance with ASTM DZ488. Cuttings are highly moisture sensitive and have low remolded strength.

ANCHOR QEA

LOG OF EXPLORATORY BORING

PROJECT NAME	**Adams Resource Consultants Company**	BORING NO.	**BH2**
LOCATION	**CEMEX Facility, Davenport, California**	PAGE	**3 of 8**
DRILLED BY	**Cascade Drilling, Inc.**	LOGGED BY	**C. Janisch**
DRILL METHOD	**Hollow Stem Auger**	TOTAL DEPTH	**141.5 ft.**
BOREHOLE DIAMETER	**8 inches**	DATE COMPLETED	**1/31/18**
SAMPLING METHOD	**2 in. by 1.5 ft. SPT**		

SAMPLING METHOD	RECOVERY (FEET)	BLOW COUNTS	SAMPLE ID	SAMPLE DEPTH (FEET)	DEPTH IN FEET	LITHO-LOGIC COLUMN	LITHOLOGIC DESCRIPTION	GRA %	SAND %	FINES %
							10.0 to 54.0 feet: SILT (ML), continued.			
SS	1.2	13 31/4"	BH2-SS08	45.0-45.85	45			0	0	100
					50					
							54.0 to 56.3 feet: SILT (ML), very stiff, dry, light green, laminations of hard cemented green silt present.	0	0	100
SS	1.5	5 11 8	BH2-SS09	55.0-56.5	55					
							56.3 to 56.5 feet: SILT (ML), very stiff, moist silt, dark green with brown mottling, organic matter.			
							56.5 to 65.0 feet: SILT (ML), very stiff, dry to damp, green, olive, and brown silt, hard cementation.			
					60					

REMARKS

Blow counts adjusted to standard 2-inch OD sampler. Lithologic description and particle size distribution based on field observations in accordance with ASTM DZ488. Cuttings are highly moisture sensitive and have low remolded strength.

ANCHOR QEA

LOG OF EXPLORATORY BORING

PROJECT NAME	**Adams Resource Consultants Company**	BORING NO.	**BH2**
LOCATION	**CEMEX Facility, Davenport, California**	PAGE	**4 of 8**
DRILLED BY	**Cascade Drilling, Inc.**	LOGGED BY	**C. Janisch**
DRILL METHOD	**Hollow Stem Auger**	TOTAL DEPTH	**141.5 ft.**
BOREHOLE DIAMETER	**8 inches**	DATE COMPLETED	**1/31/18**
SAMPLING METHOD	**2 in. by 1.5 ft. SPT**		

SAMPLING METHOD	RECOVERY (FEET)	BLOW COUNTS	SAMPLE ID	SAMPLE DEPTH (FEET)	DEPTH IN FEET	LITHO-LOGIC COLUMN	LITHOLOGIC DESCRIPTION	GRA %	SAND %	FINES %
SS	1.5	13 15 10	BH2-SS10	60.0-71.5			**56.5 to 65.0 feet: SILT (ML)**, continued.	0	0	100
SS	0.7	30 31/2.5"	BH2-SS11	65.0-65.7	65		**65.0 to 65.5 feet: SILT (ML)**, moist, brown, stiff silt (CAD).	0	5	95
							@ 65.2 feet: perched groundwater observed. @ 65.2 feet: grades to black, moist to wet.	0	5	95
							65.5 to 67.5 feet: SILT (ML) @ 65.5 feet: change to hard cemented silt, olive green with black streaks.	0	0	100
							67.5 to 141.5 feet: SILT (ML), hard, dry, brown silt, with hard cemented gravel-sized pieces.			
SS	0.45	31/4"	BH2-SS12	70.0-70.3	70			0	3	97
					75					
					80					

REMARKS

Blow counts adjusted to standard 2-inch OD sampler. Lithologic description and particle size distribution based on field observations in accordance with ASTM DZ488. Cuttings are highly moisture sensitive and have low remolded strength.

ANCHOR QEA

LOG OF EXPLORATORY BORING

PROJECT NAME	**Adams Resource Consultants Company**	BORING NO.	**BH2**
LOCATION	**CEMEX Facility, Davenport, California**	PAGE	**5 of 8**
DRILLED BY	**Cascade Drilling, Inc.**	LOGGED BY	**C. Janisch**
DRILL METHOD	**Hollow Stem Auger**	TOTAL DEPTH	**141.5 ft.**
BOREHOLE DIAMETER	**8 inches**	DATE COMPLETED	**1/31/18**
SAMPLING METHOD	**2 in. by 1.5 ft. SPT**		

SAMPLING METHOD	RECOVERY (FEET)	BLOW COUNTS	SAMPLE ID	SAMPLE DEPTH (FEET)	DEPTH IN FEET	LITHO-LOGIC COLUMN	LITHOLOGIC DESCRIPTION	GRA %	SAND %	FINES %
SS	0.4	31/4"	BH2-SS13	80.0-80.3			**67.5 to 141.5 feet: SILT (ML)**, continued.	0	0	100
							@ 83.0 feet: end of boring 01/30/2018. Resume 01/31/2018.			
					85					
SS	0	31/1.5"		90.0-90.1	90		@ 90.0 feet: No recovery.			
					95					
					100					

REMARKS

Blow counts adjusted to standard 2-inch OD sampler. Lithologic description and particle size distribution based on field observations in accordance with ASTM DZ488. Cuttings are highly moisture sensitive and have low remolded strength.

ANCHOR QEA

LOG OF EXPLORATORY BORING

PROJECT NAME	**Adams Resource Consultants Company**	BORING NO.	**BH2**
LOCATION	**CEMEX Facility, Davenport, California**	PAGE	**6 of 8**
DRILLED BY	**Cascade Drilling, Inc.**	LOGGED BY	**C. Janisch**
DRILL METHOD	**Hollow Stem Auger**	TOTAL DEPTH	**141.5 ft.**
BOREHOLE DIAMETER	**8 inches**	DATE COMPLETED	**1/31/18**
SAMPLING METHOD	**2 in. by 1.5 ft. SPT**		

SAMPLING METHOD	RECOVERY (FEET)	BLOW COUNTS	SAMPLE ID	SAMPLE DEPTH (FEET)	DEPTH IN FEET	LITHO-LOGIC COLUMN	LITHOLOGIC DESCRIPTION	GRA %	SAND %	FINES %
SS	0.5	31/2"	BH2-SS14	100.0-100.2			**67.5 to 141.5 feet: SILT (ML)**, continued. Grades to dark brown.	0	0	100
					105					
					110					
							@ 114.0 feet: same as above.			
SS	0.7	37/5"	BH2-SS15	115.0-115.4	115			0	3	97
					120					

REMARKS

Blow counts adjusted to standard 2-inch OD sampler. Lithologic description and particle size distribution based on field observations in accordance with ASTM DZ488. Cuttings are highly moisture sensitive and have low remolded strength.

ANCHOR QEA

LOG OF EXPLORATORY BORING

PROJECT NAME	**Adams Resource Consultants Company**	BORING NO.	**BH2**
LOCATION	**CEMEX Facility, Davenport, California**	PAGE	**7 of 8**
DRILLED BY	**Cascade Drilling, Inc.**	LOGGED BY	**C. Janisch**
DRILL METHOD	**Hollow Stem Auger**	TOTAL DEPTH	**141.5 ft.**
BOREHOLE DIAMETER	**8 inches**	DATE COMPLETED	**1/31/18**
SAMPLING METHOD	**2 in. by 1.5 ft. SPT**		

SAMPLING METHOD	RECOVERY (FEET)	BLOW COUNTS	SAMPLE ID	SAMPLE DEPTH (FEET)	DEPTH IN FEET	LITHO-LOGIC COLUMN	LITHOLOGIC DESCRIPTION	GRA %	SAND %	FINES %
							100.0 to 141.5 feet: SILT (ML), continued.			
					125					
SS	0.3	31/2"	BH2-SS16	130.0-130.2	130					
Grab			BH2-GB2 @1300	131.0						
					135					
					140					

REMARKS

Blow counts adjusted to standard 2-inch OD sampler. Lithologic description and particle size distribution based on field observations in accordance with ASTM DZ488. Cuttings are highly moisture sensitive and have low remolded strength.

ANCHOR QEA

LOG OF EXPLORATORY BORING

PROJECT NAME	**Adams Resource Consultants Company**	BORING NO.	**BH2**
LOCATION	**CEMEX Facility, Davenport, California**	PAGE	**8 of 8**
DRILLED BY	**Cascade Drilling, Inc.**	LOGGED BY	**C. Janisch**
DRILL METHOD	**Hollow Stem Auger**	TOTAL DEPTH	**141.5 ft.**
BOREHOLE DIAMETER	**8 inches**	DATE COMPLETED	**1/31/18**
SAMPLING METHOD	**2 in. by 1.5 ft. SPT**		

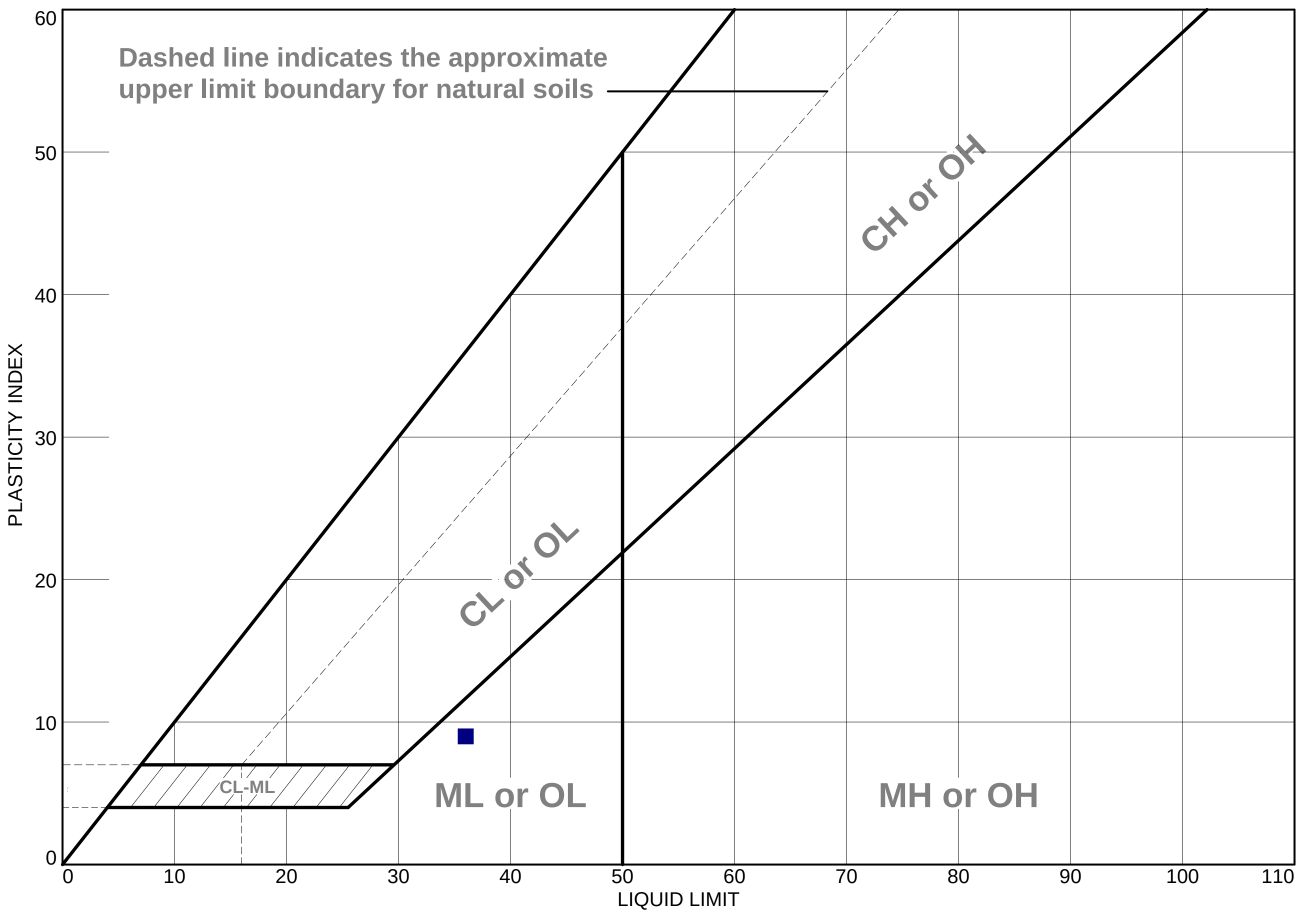
SAMPLING METHOD	RECOVERY (FEET)	BLOW COUNTS	SAMPLE ID	SAMPLE DEPTH (FEET)	DEPTH IN FEET	LITHO-LOGIC COLUMN	LITHOLOGIC DESCRIPTION	GRA %	SAND %	FINES %
							100.0 to 141.5 feet: SILT (ML), continued.			
SS	0.5	38/3"	BH2-SS17	141.0-141.3						
							Total depth: 141.5 feet.			
					145					
					150					
					155					
					160					

REMARKS

Blow counts adjusted to standard 2-inch OD sampler. Lithologic description and particle size distribution based on field observations in accordance with ASTM DZ488. Cuttings are highly moisture sensitive and have low remolded strength.

ANCHOR QEA

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	BH-1 SS-01 silty sand	NV	NP	NP	58.9	31.2	SM
■	BH-1 SS-09 silty sand with gravel	36	27	9	39.2	21.3	SM
▲	BH-1 SS-16 silty sand with gravel	NV	NP	NP	42.1	24.7	SM
◆	BH-2 SS-02 silty sand	NV	NP	NP	59.4	39.2	SM
▼	BH-2 SS-11 silty sand with gravel	NV	NP	NP	56.5	45.4	SM

Project No. 17-664 **Client:** Adams Resource

Project: 2018 Laboratory Testing

●**Source:** Project #J-045 Cemex **Depth:** 5'-6.5' **Sample No.:** 18-019

■**Source:** Project #J-045 Cemex **Depth:** 45'-46.5' **Sample No.:** 18-020

▲**Source:** Project #J-045 Cemex **Depth:** 85'-86.5' **Sample No.:** 18-021

◆**Source:** Project #J-045 Cemex **Depth:** 10'-10.9' **Sample No.:** 18-022

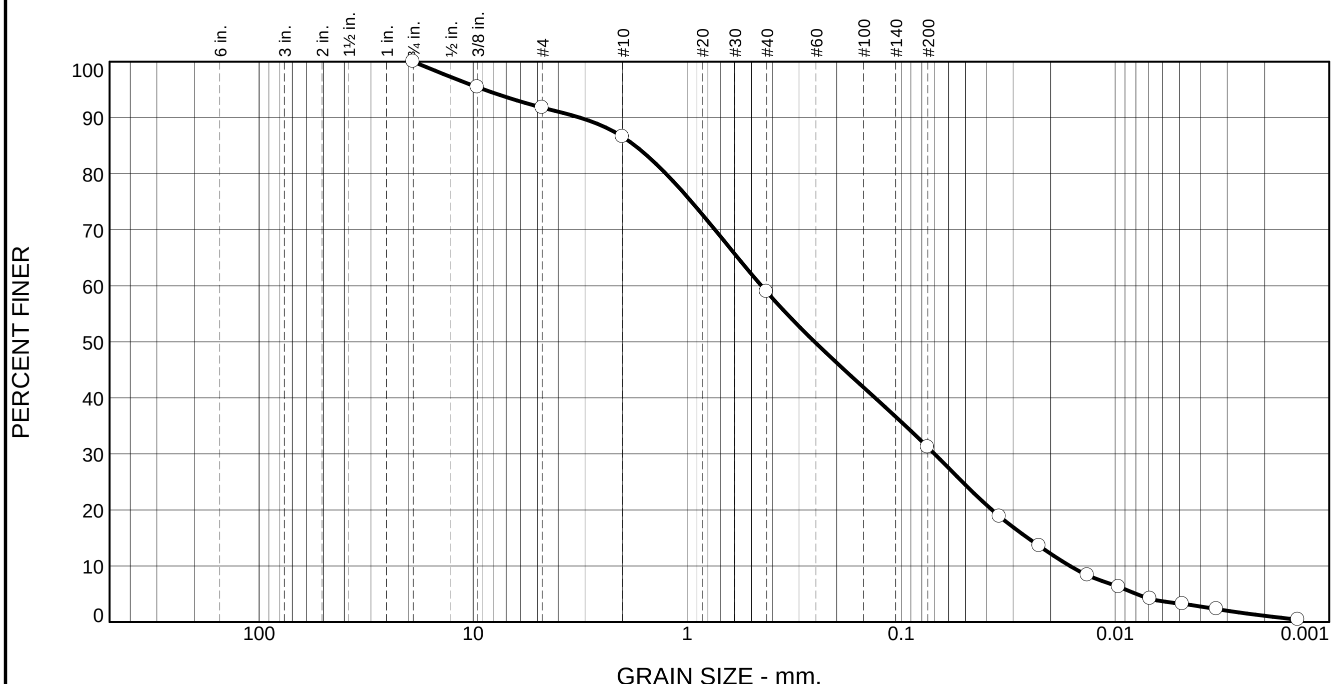
▼**Source:** Project #J-045 Cemex **Depth:** 65'-65.7' **Sample No.:** 18-023

Remarks:

A.A.R. Testing Laboratory, Inc.

Tested By: Nick Averill **Checked By:** Nick Averill

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	8.2	5.2	27.7	27.7	27.9	3.3

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
.75	100.0		
.375	95.4		
#4	91.8		
#10	86.6		
#40	58.9		
#200	31.2		
0.0347 mm.	18.8		
0.0226 mm.	13.6		
0.0134 mm.	8.3		
0.0096 mm.	6.3		
0.0069 mm.	4.2		
0.0048 mm.	3.2		
0.0034 mm.	2.3		
0.0014 mm.	0.4		

* (no specification provided)

Material Description

BH-1 SS-01
silty sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 3.1553 D_{85}= 1.7479 D_{60}= 0.4495
D_{50}= 0.2537 D_{30}= 0.0698 D_{15}= 0.0256
D_{10}= 0.0163 C_u= 27.62 C_c= 0.67

Remarks

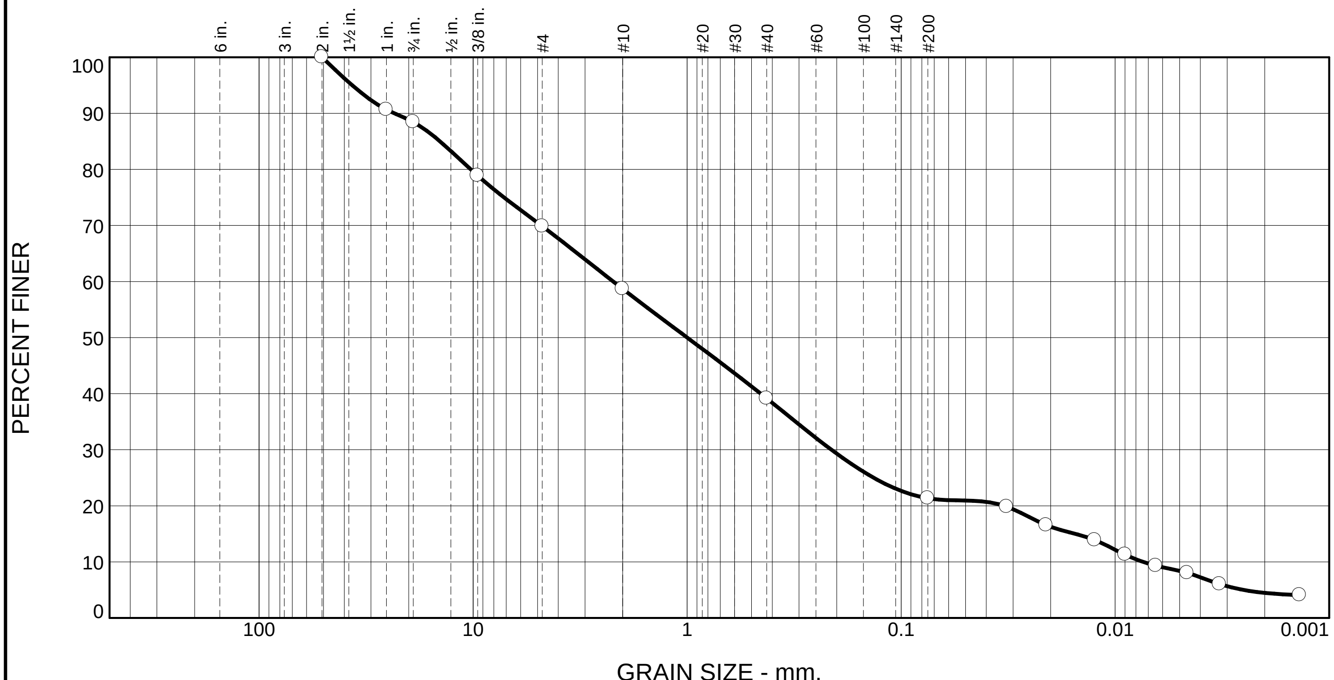
Date Received: 2/5/2018 **Date Tested:** 2/13/2018
Tested By: Nick Averill
Checked By: Nick Averill
Title: Sr. Lab Technician

Source of Sample: Project #J-045 Cemex **Depth:** 5'-6.5' **Date Sampled:** 2/1/2018
Sample Number: 18-019

A.A.R. Testing Laboratory, Inc.

Client: Adams Resource
Project: 2018 Laboratory Testing
Project No: 17-664 .

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	11.6	18.5	11.2	19.5	17.9	12.9	8.4

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
2	100.0		
1	90.7		
.75	88.4		
.375	78.9		
#4	69.9		
#10	58.7		
#40	39.2		
#200	21.3		
0.0321 mm.	19.8		
0.0210 mm.	16.6		
0.0124 mm.	13.9		
0.0090 mm.	11.3		
0.0065 mm.	9.3		
0.0046 mm.	8.0		
0.0032 mm.	6.0		
0.0014 mm.	4.1		

* (no specification provided)

Material Description

BH-1 SS-09
silty sand with gravel

Atterberg Limits (ASTM D 4318)

PL= 27 **LL=** 36 **PI=** 9

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 23.3715 D_{85}= 14.2831 D_{60}= 2.2152
D_{50}= 0.9990 D_{30}= 0.2117 D_{15}= 0.0154
D_{10}= 0.0074 C_u= 299.22 C_c= 2.73

Remarks

Date Received: 2/5/2018 **Date Tested:** 2/13/2018
Tested By: Nick Averill
Checked By: Nick Averill
Title: Sr. Lab Technician

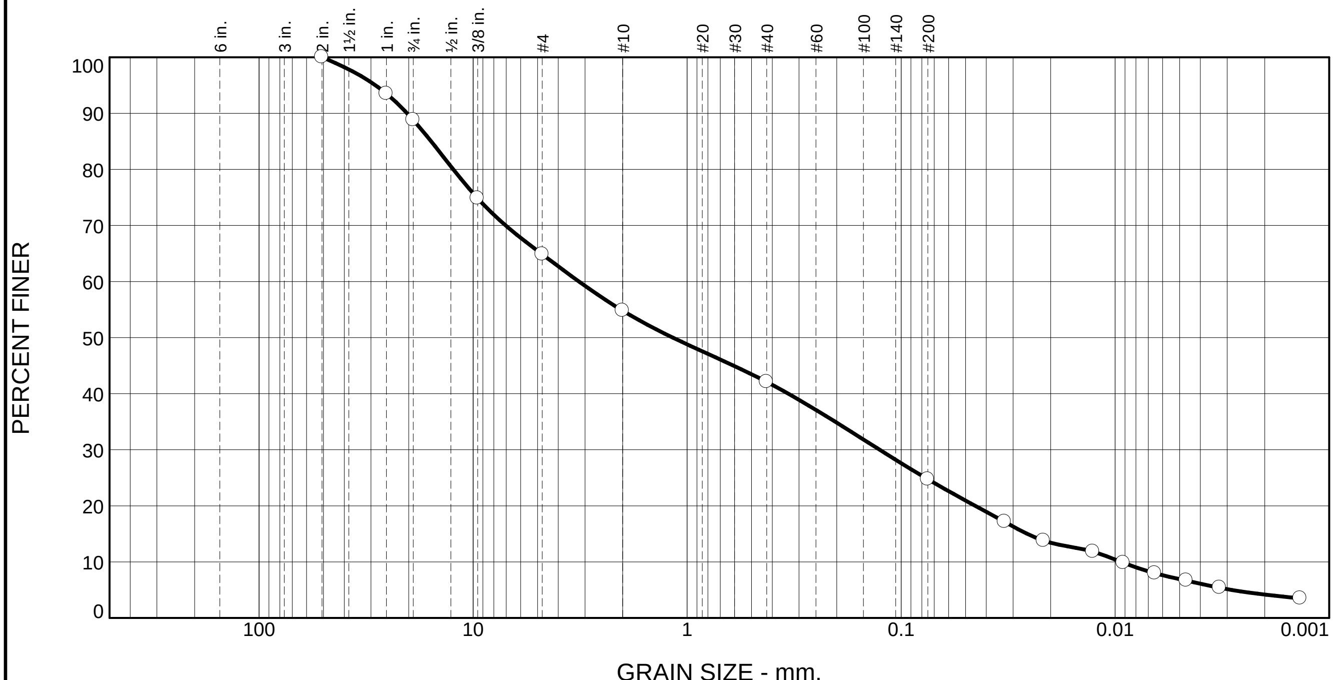
Source of Sample: Project #J-045 Cemex **Depth:** 45'-46.5' **Date Sampled:** 2/1/2018
Sample Number: 18-020

A.A.R. Testing Laboratory, Inc.

Client: Adams Resource
Project: 2018 Laboratory Testing

Project No: 17-664 .

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	11.2	24.0	10.0	12.7	17.4	17.8	6.9

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
2	100.0		
1	93.5		
.75	88.8		
.375	74.8		
#4	64.8		
#10	54.8		
#40	42.1		
#200	24.7		
0.0329 mm.	17.1		
0.0216 mm.	13.8		
0.0127 mm.	11.8		
0.0091 mm.	9.8		
0.0065 mm.	8.0		
0.0047 mm.	6.7		
0.0033 mm.	5.4		
0.0014 mm.	3.5		

* (no specification provided)

Material Description

BH-1 SS-16
silty sand with gravel

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 20.3419 D_{85}= 15.7137 D_{60}= 3.1991
D_{50}= 1.1662 D_{30}= 0.1260 D_{15}= 0.0257
D_{10}= 0.0094 C_u= 341.49 C_c= 0.53

Remarks

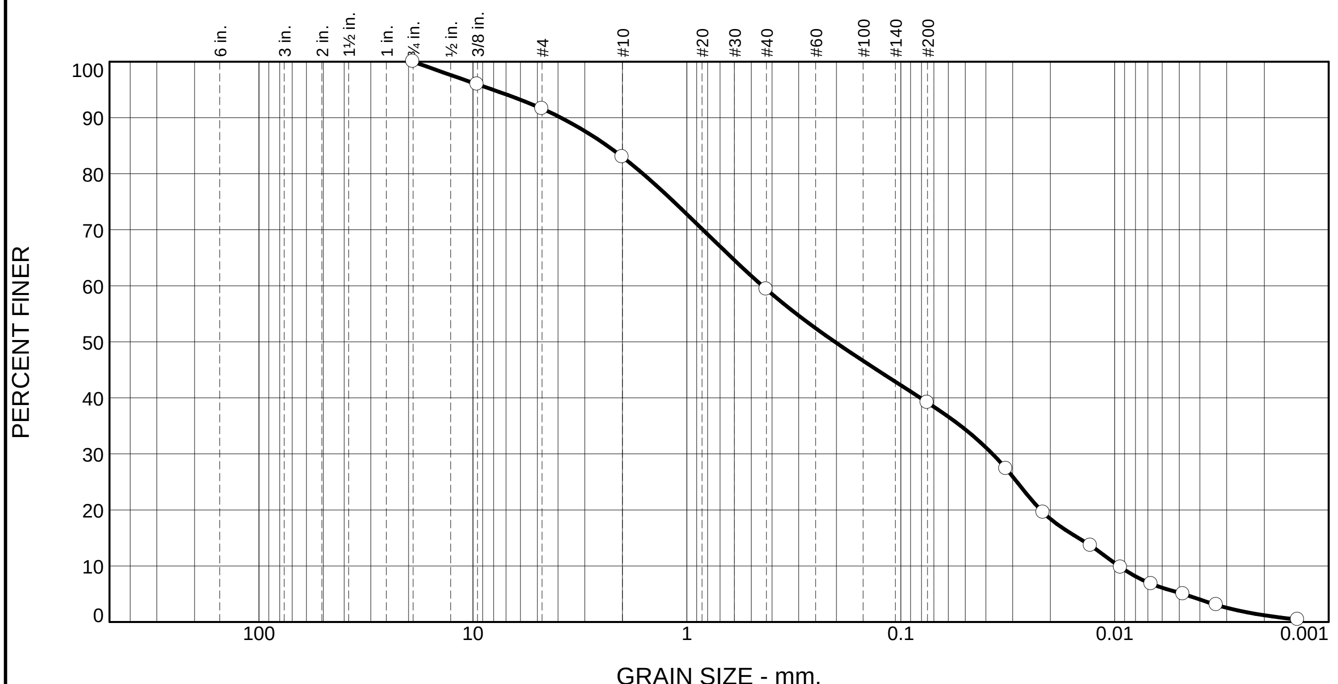
Date Received: 2/5/2018 **Date Tested:** 2/13/2018
Tested By: Nick Averill
Checked By: Nick Averill
Title: Sr. Lab Technician

Source of Sample: Project #J-045 Cemex **Depth:** 85'-86.5' **Date Sampled:** 2/1/2018
Sample Number: 18-021

A.A.R. Testing Laboratory, Inc.

Client: Adams Resource
Project: 2018 Laboratory Testing
Project No: 17-664

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	8.4	8.6	23.6	20.2	34.0	5.2

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
.75	100.0		
.375	95.9		
#4	91.6		
#10	83.0		
#40	59.4		
#200	39.2		
0.0322 mm.	27.4		
0.0216 mm.	19.5		
0.0130 mm.	13.6		
0.0094 mm.	9.8		
0.0067 mm.	6.8		
0.0048 mm.	5.0		
0.0033 mm.	3.1		
0.0014 mm.	0.4		

* (no specification provided)

Material Description

BH-2 SS-02
silty sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 3.8769 D_{85}= 2.3559 D_{60}= 0.4436
D_{50}= 0.2034 D_{30}= 0.0373 D_{15}= 0.0148
D_{10}= 0.0096 C_u= 46.33 C_c= 0.33

Remarks

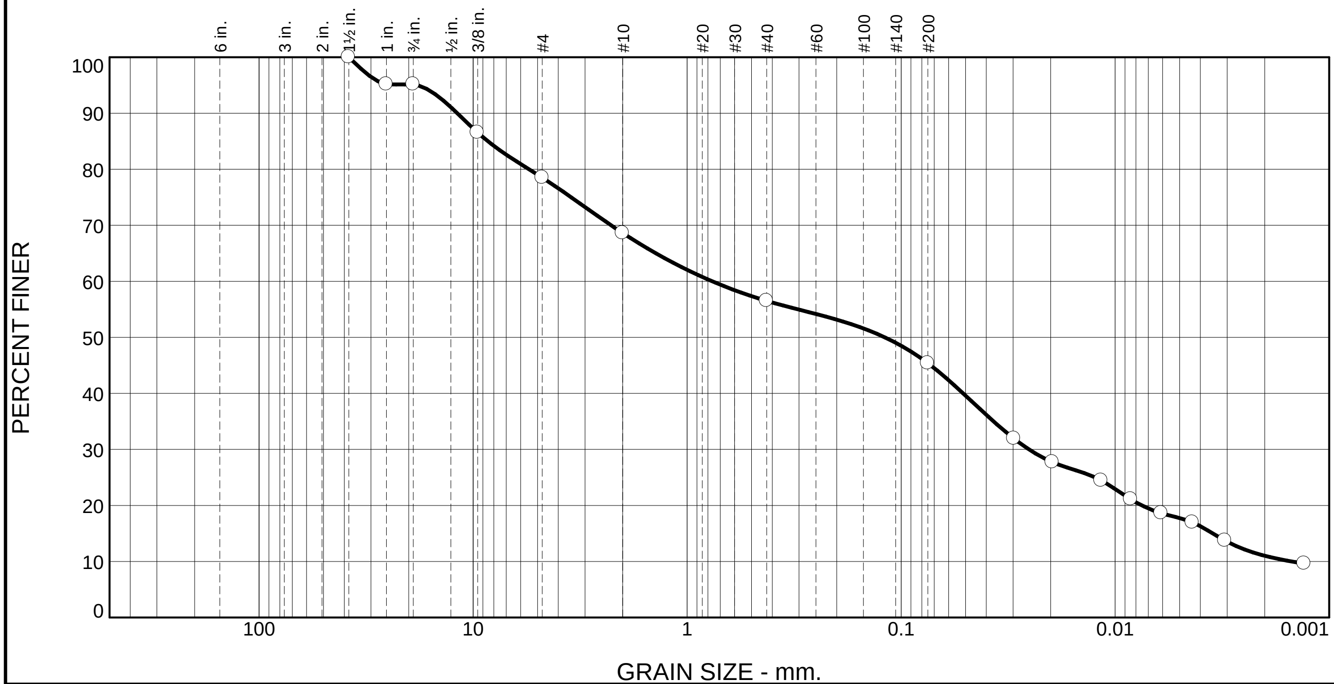
Date Received: 2/5/2018 **Date Tested:** 2/13/2018
Tested By: Nick Averill
Checked By: Nick Averill
Title: Sr. Lab Technician

Source of Sample: Project #J-045 Cemex **Depth:** 10'-10.9' **Date Sampled:** 1/30/2018
Sample Number: 18-022

A.A.R. Testing Laboratory, Inc.

Client: Adams Resource
Project: 2018 Laboratory Testing
Project No: 17-664

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	4.9	16.6	9.9	12.1	11.1	27.7	17.7

Test Results (ASTM D 422 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100.0		
1	95.1		
.75	95.1		
.375	86.5		
#4	78.5		
#10	68.6		
#40	56.5		
#200	45.4		
0.0297 mm.	31.9		
0.0196 mm.	27.7		
0.0116 mm.	24.5		
0.0085 mm.	21.1		
0.0061 mm.	18.6		
0.0044 mm.	17.0		
0.0031 mm.	13.7		
0.0013 mm.	9.6		

* (no specification provided)

Material Description

BH-2 SS-11
silty sand with gravel

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 11.8597 D_{85}= 8.5263 D_{60}= 0.7622
D_{50}= 0.1192 D_{30}= 0.0253 D_{15}= 0.0035
D_{10}= 0.0015 C_u= 510.38 C_c= 0.56

Remarks

Date Received: 2/5/2018 **Date Tested:** 2/13/2018
Tested By: Nick Averill
Checked By: Nick Averill
Title: Sr. Lab Technician

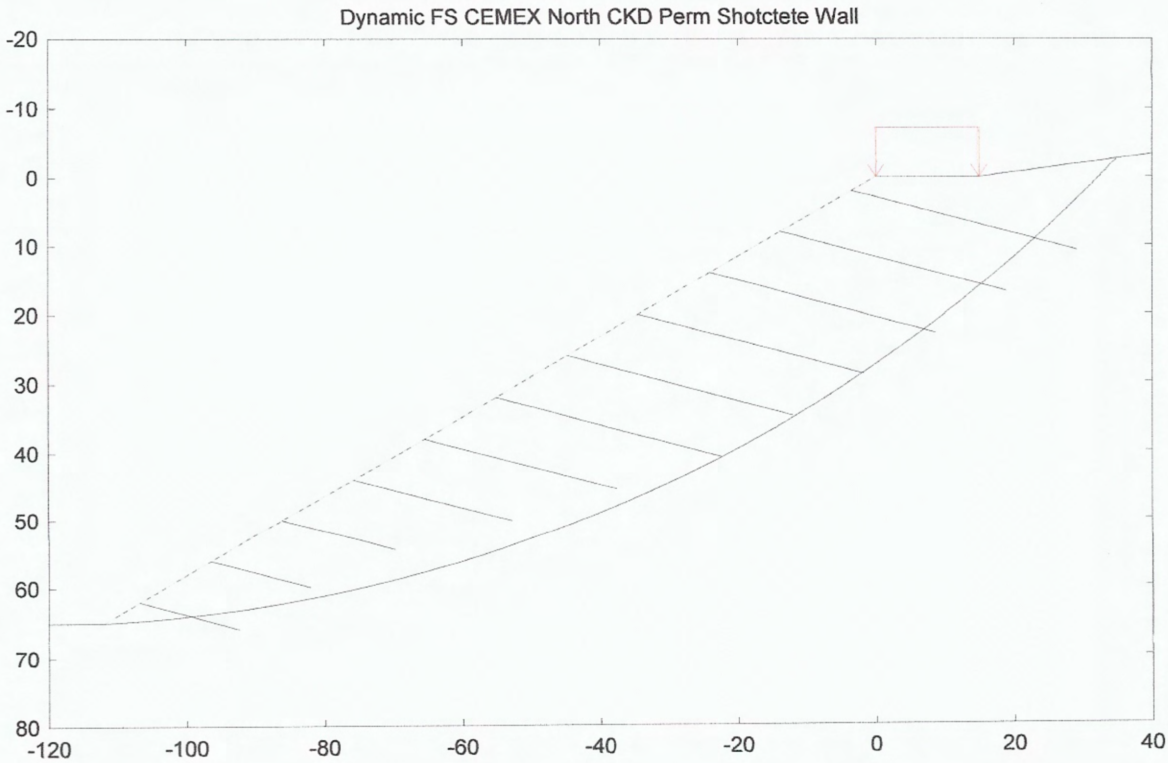
Source of Sample: Project #J-045 Cemex **Depth:** 65'-65.7' **Date Sampled:** 1/30/2018
Sample Number: 18-023

A.A.R. Testing Laboratory, Inc.

Client: Adams Resource
Project: 2018 Laboratory Testing
Project No: 17-664

ATTACHMENT C-3

SOIL NAILED WALL AND FACING CALCULATOINS


Dynamic FS CEMEX North CKD Perm Shotctete Wall
-20
-10
0
10
20
30
40
50
60
70
80
-120
-100
-80
-60
-40
-20
0
20
40

Dynamic FS CEMEX North CKD Perm Shotctete Wall

General Data	
File Indentifier	CEMEXS.GNI
Unit weight of water	62.4
Base depth for analysis	65.0
Seismic Coefficient	0.283
Minimum Base Exit Angle	-15.0
X Search limit (left)	5.0
X Search limit (right)	35.0
Number of slip circles	250
No. of slip circle exits	100

LRFD and Safety Factor Data	
Analysis Mode: (L)RFD or (S)LD (specify L or S)	S
SLD Safety and Strength Factors (mode S only)	
FS for Soil Cohesion	1.1
FS for Soil Friction	1.1
Strength Factor for Head Strength	0.67
Strength Factor for Nail Tendon Strength	0.55
Strength Factor for Nail Pullout Resistance	0.5
LRFD Load Factors (mode L only)	
LF for Unit Weight of Water	1
LF for Unit Weight of Soil	1.2
LF for Surcharge Loads	1.2
LF for Seismic Loads	1
LRFD Resistance Factors (mode L only)	
RF for Soil Cohesion	0.7
RF for Soil Friction Angle	0.7
RF for Head Strength	0.8
RF for Nail Pullout Resistance	0.7
RF for Nail Tendon Strength	0.9

PIEZOMETRIC DATA	X-Value	Piez. Level
Point 1		
Point 2		
Point 3		
Point 4		
Point 5		
Point 6		
Point 7		
Point 8		
Point 9		
Point 10		

Nodal Data

Node No	X-Value	Y-Value	Node No	X-Value	Y-Value	Node No	X-Value	Y-Value
1	-112	65	16			31		
2	0	0	17			32		
3	15	0	18			33		
4	65	-6.65	19			34		
5			20			35		
6			21			36		
7			22			37		
8			23			38		
9			24			39		
10			25			40		
11			26			41		
12			27			42		
13			28			43		
14			29			44		
15			30			45		

Wall Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID	Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID
1	1	2	1	1	11				
2					12				
3					13				
4					14				
5					15				
6					16				
7					17				
8					18				
9					19				
10					20				

Surface Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Seg. No.	Node 1	Node 2	Soil ID
1	2	3	1	11			
2	3	4	1	12			
3				13			
4				14			
5				15			
6				16			
7				17			
8				18			
9				19			
10				20			

Internal Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID	Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID
1					11				
2					12				
3					13				
4					14				
5					15				
6					16				
7					17				
8					18				
9					19				
10					20				

Soil Strength & Pullout Resist. Data

Material ID No.	c	ø	Unit Weight	Pullout Res.
1	50	38	115	9500
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				

Surcharge Pressure Data

Load No	X-value	Vert.	Horiz.
1	15	125	0
2			
3			
4			
5			
6			
7			
8			
9			
10			

Nail Data	Nail Depth	Nail Length	Tendon Strength	Head Strength	Fixed Nail?
Nail Row 1	2	34	59300	15000	
Nail Row 2	8	34	59300	15000	
Nail Row 3	14	34	59300	15000	
Nail Row 4	20	34	59300	15000	
Nail Row 5	26	34	59300	15000	
Nail Row 6	32	34	59300	15000	
Nail Row 7	38	29	59300	15000	
Nail Row 8	44	24	59300	15000	
Nail Row 9	50	17	59300	15000	
Nail Row 10	56	15	59300	15000	
Nail Row 11	62	15	59300	15000	
Nail Row 12					
Nail Row 13					
Nail Row 14					
Nail Row 15					

Horiz. Spacing	6
Nail Declination	15

Design Data

Nail Head Factor = 1.00 for circle no 135
Nail Length Factor = 1.00 for circle no 135

Nail No.	Circle No	Required Nail Tendon Strength
1	135	54490.39
2	129	38487.68
3	123	32189.82
4	119	28812.59
5	113	28458.46
6	111	28212.39
7	65	24434.85
8	2	14303.19
9	134	4227.55
10	2	6896.04
11	135	58234.42

Nail No.	Circle No	Required Nail Length
1		33.86
2		33.86
3		33.86
4		33.86
5		33.86
6		33.86
7		28.88
8		23.90
9		16.93
10		14.94
11		14.94

Output Data

Wall Height = 65.00
Wall Slope = 30.13

Circle Number	Circle X-Intercept	Circle Base Angle	Circle X-Center	Circle Y-Center	Moment Ratio	Force Req'd/ Unit Wall Length
1	5.28	6.94	-133.58	-112.23	1.009	18041.13
2	5.01	7.00	-133.71	-111.90	1.009	17899.02
3	5.02	7.00	-133.71	-111.91	1.009	17903.69
4	5.03	6.99	-133.70	-111.92	1.009	17908.65
5	5.04	6.99	-133.70	-111.93	1.009	17913.86
6	5.05	6.99	-133.69	-111.94	1.009	17919.32
7	5.06	6.99	-133.69	-111.96	1.009	17925.05
8	5.07	6.98	-133.68	-111.97	1.009	17931.06
9	5.08	6.98	-133.67	-111.99	1.009	17937.37
10	5.09	6.98	-133.67	-112.00	1.009	17943.99
11	5.11	6.98	-133.66	-112.02	1.009	17950.93
12	5.12	6.97	-133.65	-112.03	1.009	17958.21
13	5.13	6.97	-133.65	-112.05	1.009	17965.85
14	5.15	6.97	-133.64	-112.07	1.009	17973.86
15	5.16	6.96	-133.63	-112.09	1.009	17982.26
16	5.18	6.96	-133.62	-112.11	1.009	17991.07
17	5.20	6.96	-133.62	-112.13	1.009	18000.31
18	5.22	6.95	-133.61	-112.15	1.009	18010.00
19	5.24	6.95	-133.60	-112.18	1.009	18020.16
20	5.26	6.95	-133.59	-112.20	1.009	18030.81
21	5.28	6.94	-133.58	-112.23	1.009	18041.98

Output Data

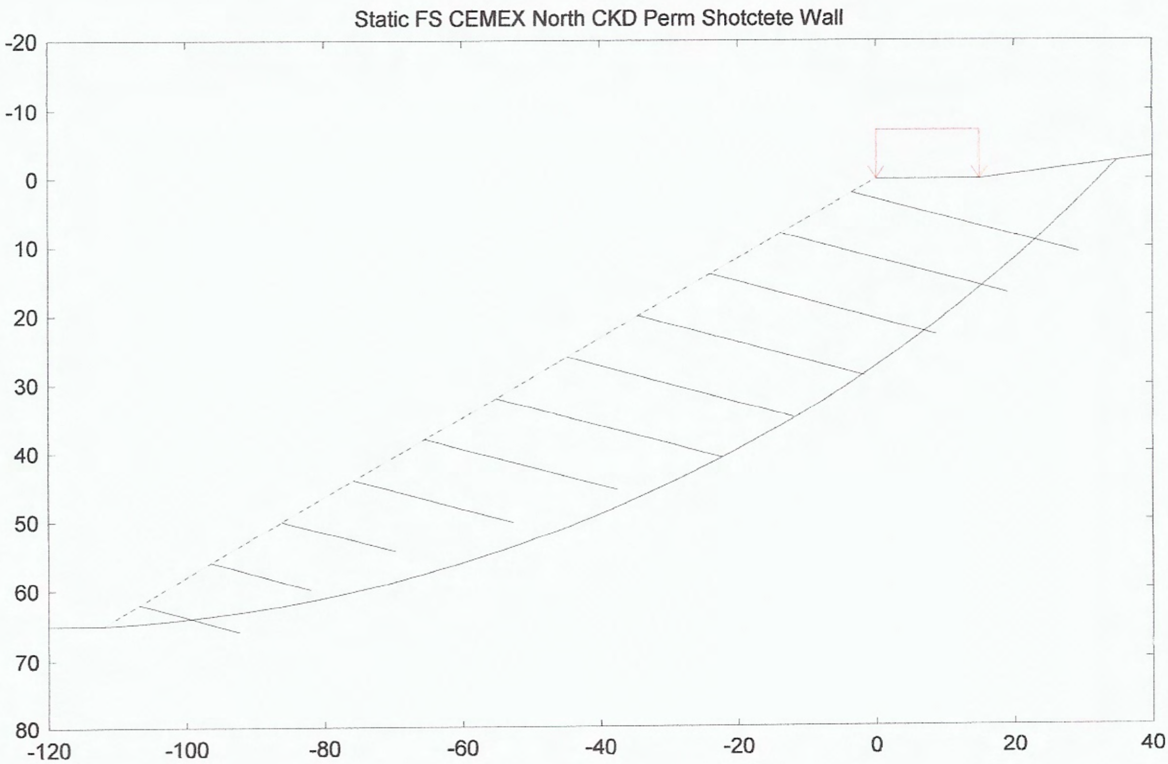
Wall Height = 65.00
Wall Slope = 30.13

Circle Number	Circle X-Intercept	Circle Base Angle	Circle X-Center	Circle Y-Center	Moment Ratio	Force Req'd/ Unit Wall Length
22	5.30	6.94	-133.56	-112.26	1.009	18053.68
23	5.32	6.93	-133.55	-112.29	1.009	18065.95
24	5.35	6.93	-133.54	-112.32	1.009	18078.81
25	5.37	6.92	-133.53	-112.35	1.009	18092.29
26	5.40	6.92	-133.51	-112.38	1.009	18106.41
27	5.43	6.91	-133.50	-112.42	1.009	18121.21
28	5.46	6.90	-133.48	-112.45	1.009	18136.71
29	5.49	6.90	-133.47	-112.49	1.009	18152.95
30	5.53	6.89	-133.45	-112.53	1.009	18169.96
31	5.56	6.88	-133.43	-112.58	1.009	18187.77
32	5.60	6.88	-133.42	-112.62	1.009	18206.41
33	5.64	6.87	-133.40	-112.67	1.009	18225.94
34	5.68	6.86	-133.38	-112.72	1.009	18246.38
35	5.72	6.85	-133.36	-112.77	1.009	18267.77
36	5.76	6.84	-133.33	-112.83	1.009	18290.15
37	5.81	6.83	-133.31	-112.89	1.009	18313.56
38	5.86	6.82	-133.29	-112.95	1.009	18338.05
39	5.91	6.81	-133.26	-113.01	1.008	17995.59
40	5.96	6.80	-133.23	-113.08	1.008	18025.52
41	6.02	6.79	-133.20	-113.15	1.008	18056.97
42	6.08	6.78	-133.17	-113.22	1.008	18089.88
43	6.14	6.76	-133.14	-113.30	1.008	18124.29
44	6.21	6.75	-133.11	-113.38	1.008	18160.26
45	6.28	6.73	-133.07	-113.47	1.008	18197.86
46	6.35	6.72	-133.04	-113.56	1.008	18237.16
47	6.43	6.70	-133.00	-113.65	1.008	18278.21
48	6.51	6.69	-132.96	-113.75	1.008	18321.07
49	6.60	6.67	-132.92	-113.86	1.008	18365.82
50	6.69	6.65	-132.87	-113.97	1.008	18412.53
51	6.78	6.63	-132.83	-114.08	1.008	18461.25
52	6.88	6.61	-132.78	-114.20	1.008	18512.04
53	6.98	6.59	-132.72	-114.33	1.009	18564.99
54	7.09	6.57	-132.67	-114.47	1.009	18620.14
55	7.21	6.55	-132.61	-114.61	1.009	18677.57
56	7.33	6.52	-132.55	-114.76	1.009	18737.32
57	7.45	6.50	-132.49	-114.91	1.009	18799.46
58	7.59	6.47	-132.42	-115.08	1.009	18864.03
59	7.73	6.44	-132.35	-115.25	1.009	18924.85
60	7.87	6.41	-132.28	-115.43	1.009	18987.12
61	8.03	6.38	-132.20	-115.62	1.009	19051.46
62	8.19	6.35	-132.12	-115.83	1.009	19117.85
63	8.36	6.31	-132.03	-116.04	1.009	19186.28
64	8.55	6.28	-131.94	-116.26	1.009	19256.68
65	8.74	6.24	-131.85	-116.50	1.009	19329.01
66	8.94	28.20	-32551.52	-60435.52	1.000	74.44
67	8.94	6.20	-131.75	-116.74	1.009	19403.64
68	9.15	28.16	-32551.42	-60541.03	1.000	162.45
69	9.15	6.16	-131.64	-117.00	1.009	19479.54
70	9.37	28.11	-32551.30	-60652.12	1.000	253.85
71	9.37	6.12	-131.53	-117.28	1.009	19557.04
72	9.60	28.07	-32551.19	-60769.10	1.000	348.68
73	9.60	6.07	-131.41	-117.57	1.010	19635.96
74	9.85	28.02	-32551.06	-60892.32	1.000	447.02
75	9.85	6.02	-131.29	-117.87	1.010	19716.10
76	10.11	27.97	-32550.93	-61022.11	1.000	548.89
77	10.11	5.97	-131.16	-118.19	1.010	19801.07
78	10.38	27.92	-32550.80	-61158.86	1.000	654.33
79	10.38	5.92	-131.02	-118.53	1.010	19896.49

Output Data

Wall Height = 65.00
Wall Slope = 30.13

Circle Number	Circle X-Intercept	Circle Base Angle	Circle X-Center	Circle Y-Center	Moment Ratio	Force Req'd/ Unit Wall Length
80	10.67	27.86	-32550.65	-61302.95	1.000	763.35
81	10.67	5.86	-130.88	-118.88	1.010	19995.57
82	10.97	27.80	-32550.50	-61454.83	1.000	875.95
83	10.97	5.80	-130.73	-119.26	1.001	18418.28
84	11.29	27.74	-32550.34	-61614.93	1.000	992.10
85	11.29	5.74	-130.57	-119.65	1.001	18508.90
86	11.63	27.68	-32550.17	-61783.74	1.000	1111.75
87	11.63	5.68	-130.40	-120.07	1.001	18599.79
88	11.99	27.61	-32549.99	-61961.78	1.000	1234.84
89	11.99	5.61	-130.22	-120.51	1.002	18690.43
90	12.36	27.54	-32549.81	-62149.58	1.000	1361.24
91	12.36	5.54	-130.03	-120.97	1.002	18780.09
92	12.76	27.46	-32549.61	-62347.73	1.000	1490.82
93	12.76	5.46	-129.83	-121.46	1.002	18868.24
94	13.18	27.38	-32549.40	-62556.87	1.000	1623.40
95	13.18	5.38	-129.63	-121.98	1.002	18953.92
96	13.62	27.30	-32549.18	-62777.65	1.000	1758.73
97	13.62	5.30	-129.40	-122.52	1.002	19036.11
98	14.09	27.21	-32548.95	-63010.79	1.000	1896.52
99	14.09	5.22	-129.17	-123.10	1.003	19096.91
100	14.58	27.12	-32548.70	-63257.07	1.000	2036.42
101	14.58	5.13	-128.93	-123.71	1.003	19137.54
102	15.13	27.03	-32557.38	-63534.83	1.000	2178.36
103	15.13	5.03	-128.67	-124.40	1.003	19184.81
104	15.88	26.93	-32606.54	-63907.31	1.000	2323.64
105	15.88	4.93	-128.42	-125.37	1.003	19175.09
106	16.67	26.82	-32658.69	-64302.41	1.000	2470.69
107	16.67	4.82	-128.15	-126.40	1.004	19145.71
108	17.51	26.71	-32714.03	-64721.75	1.000	2618.92
109	17.51	4.71	-127.87	-127.49	1.004	19116.89
110	18.40	26.60	-32772.81	-65167.08	1.000	2767.68
111	18.40	4.60	-127.57	-128.65	1.004	19074.92
112	19.35	26.47	-32835.27	-65640.33	1.000	2916.14
113	19.35	4.48	-127.26	-129.88	1.005	19026.64
114	20.35	26.35	-32901.69	-66143.59	1.000	3063.17
115	20.35	4.35	-126.92	-131.19	1.002	18102.03
116	21.42	26.21	-32972.37	-66679.14	1.000	3208.03
117	21.42	4.21	-126.56	-132.58	1.003	18003.29
118	22.56	26.07	-33047.65	-67249.52	1.000	3349.18
119	22.56	4.07	-126.17	-134.06	1.003	17870.96
120	23.78	25.92	-33127.89	-67857.48	1.000	3485.07
121	23.78	3.92	-125.77	-135.64	1.004	17853.85
122	25.08	25.77	-33213.50	-68506.10	1.000	3613.85
123	25.08	3.77	-125.33	-137.33	1.005	17804.09
124	26.46	25.60	-33304.91	-69198.73	1.000	3733.38
125	26.46	3.61	-124.87	-139.13	1.005	17680.07
126	27.94	25.43	-33402.63	-69939.11	1.000	3841.12
127	27.94	3.43	-124.37	-141.06	1.006	17409.90
128	29.53	25.25	-33507.20	-70731.40	1.000	3934.17
129	29.53	3.25	-123.84	-143.12	1.006	16876.74
130	31.22	25.06	-33619.23	-71580.23	1.000	4009.09
131	31.22	3.07	-123.27	-145.33	1.007	16300.01
132	33.04	24.87	-33739.41	-72490.77	1.000	4061.88
133	33.04	2.87	-122.65	-147.69	1.007	15654.83
134	35.00	24.66	-33868.49	-73468.80	1.000	4087.85
135	35.00	2.66	-122.00	-150.24	1.008	14654.08


Static FS CEMEX North CKD Perm Shotctete Wall
-20
-10
0
10
20
30
40
50
60
70
80
-120
-100
-80
-60
-40
-20
0
20
40

Static FS CEMEX North CKD Perm Shotctete Wall

General Data	
File Indentifier	CEMEX.GNI
Unit weight of water	62.4
Base depth for analysis	65.0
Seismic Coefficient	0.0
Minimum Base Exit Angle	-15.0
X Search limit (left)	5.0
X Search limit (right)	35.0
Number of slip circles	250
No. of slip circle exits	100

LRFD and Safety Factor Data	
Analysis Mode: (L)RFD or (S)LD (specify L or S)	S
SLD Safety and Strength Factors (mode S only)	
FS for Soil Cohesion	1
FS for Soil Friction	1
Strength Factor for Head Strength	0.67
Strength Factor for Nail Tendon Strength	0.55
Strength Factor for Nail Pullout Resistance	0.5
LRFD Load Factors (mode L only)	
LF for Unit Weight of Water	1
LF for Unit Weight of Soil	1.2
LF for Surcharge Loads	1.2
LF for Seismic Loads	1
LRFD Resistance Factors (mode L only)	
RF for Soil Cohesion	0.7
RF for Soil Friction Angle	0.7
RF for Head Strength	0.8
RF for Nail Pullout Resistance	0.7
RF for Nail Tendon Strength	0.9

PIEZOMETRIC DATA	X-Value	Piez. Level
Point 1		
Point 2		
Point 3		
Point 4		
Point 5		
Point 6		
Point 7		
Point 8		
Point 9		
Point 10		

Nodal Data

Node No	X-Value	Y-Value	Node No	X-Value	Y-Value	Node No	X-Value	Y-Value
1	-112	65	16			31		
2	0	0	17			32		
3	15	0	18			33		
4	65	-6.65	19			34		
5			20			35		
6			21			36		
7			22			37		
8			23			38		
9			24			39		
10			25			40		
11			26			41		
12			27			42		
13			28			43		
14			29			44		
15			30			45		

Wall Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID	Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID
1	1	2	1	1	11				
2					12				
3					13				
4					14				
5					15				
6					16				
7					17				
8					18				
9					19				
10					20				

Surface Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Seg. No.	Node 1	Node 2	Soil ID
1	2	3	1	11			
2	3	4	1	12			
3				13			
4				14			
5				15			
6				16			
7				17			
8				18			
9				19			
10				20			

Internal Segment Data

Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID	Seg. No.	Node 1	Node 2	Soil ID	Pullout Res. ID
1					11				
2					12				
3					13				
4					14				
5					15				
6					16				
7					17				
8					18				
9					19				
10					20				

Soil Strength & Pullout Resist. Data

Material ID No.	c	ø	Unit Weight	Pullout Res.
1	50	38	115	9500
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				

Surcharge Pressure Data

Load No	X-value	Vert.	Horiz.
1	15	125	0
2			
3			
4			
5			
6			
7			
8			
9			
10			

Nail Data	Nail Depth	Nail Length	Tendon Strength	Head Strength	Fixed Nail?
Nail Row 1	2	34	59300	15000	
Nail Row 2	8	34	59300	15000	
Nail Row 3	14	34	59300	15000	
Nail Row 4	20	34	59300	15000	
Nail Row 5	26	34	59300	15000	
Nail Row 6	32	34	59300	15000	
Nail Row 7	38	29	59300	15000	
Nail Row 8	44	24	59300	15000	
Nail Row 9	50	17	59300	15000	
Nail Row 10	56	15	59300	15000	
Nail Row 11	62	15	59300	15000	
Nail Row 12					
Nail Row 13					
Nail Row 14					
Nail Row 15					
Horiz. Spacing	6				
Nail Declination	15				

Global Stability

Minimum global safety factor = 2.010 for circle no. 200

Output Data

Wall Height = 65.00
Wall Slope = 30.13

Circle Number	Circle X-Intercept	Circle Base Angle	Circle X-Center	Circle Y-Center	Moment Ratio	Factor of Safety
1	5.28	28.94	-32553.35	-58605.53	This slip circle requires zero soil streng	
2	5.28	6.94	-133.58	-112.23	1.005	3.28
3	5.01	29.00	-32553.48	-58471.68	This slip circle requires zero soil streng	
4	5.01	7.00	-133.71	-111.90	1.005	3.31
5	5.02	28.99	-32553.48	-58476.09	This slip circle requires zero soil streng	
6	5.02	7.00	-133.71	-111.91	1.005	3.31
7	5.03	28.99	-32553.48	-58480.72	This slip circle requires zero soil streng	
8	5.03	6.99	-133.70	-111.92	1.005	3.31
9	5.04	28.99	-32553.47	-58485.59	This slip circle requires zero soil streng	
10	5.04	6.99	-133.70	-111.93	1.005	3.31
11	5.05	28.99	-32553.47	-58490.70	This slip circle requires zero soil streng	
12	5.05	6.99	-133.69	-111.94	1.005	3.31
13	5.06	28.99	-32553.46	-58496.06	This slip circle requires zero soil streng	
14	5.06	6.99	-133.69	-111.96	1.005	3.31
15	5.07	28.98	-32553.46	-58501.69	This slip circle requires zero soil streng	
16	5.07	6.98	-133.68	-111.97	1.005	3.30
17	5.08	28.98	-32553.45	-58507.61	This slip circle requires zero soil streng	
18	5.08	6.98	-133.67	-111.99	1.005	3.30
19	5.09	28.98	-32553.44	-58513.82	This slip circle requires zero soil streng	
20	5.09	6.98	-133.67	-112.00	1.005	3.30
21	5.11	28.98	-32553.44	-58520.34	This slip circle requires zero soil streng	
22	5.11	6.98	-133.66	-112.02	1.005	3.30
23	5.12	28.97	-32553.43	-58527.20	This slip circle requires zero soil streng	
24	5.12	6.97	-133.65	-112.03	1.005	3.30
25	5.13	28.97	-32553.42	-58534.39	This slip circle requires zero soil streng	
26	5.13	6.97	-133.65	-112.05	1.005	3.30
27	5.15	28.97	-32553.41	-58541.95	This slip circle requires zero soil streng	
28	5.15	6.97	-133.64	-112.07	1.005	3.29
29	5.16	28.96	-32553.41	-58549.89	This slip circle requires zero soil streng	
30	5.16	6.96	-133.63	-112.09	1.005	3.29
31	5.18	28.96	-32553.40	-58558.22	This slip circle requires zero soil streng	
32	5.18	6.96	-133.62	-112.11	1.005	3.29
33	5.20	28.96	-32553.39	-58566.97	This slip circle requires zero soil streng	
34	5.20	6.96	-133.62	-112.13	1.005	3.29
35	5.22	28.95	-32553.38	-58576.17	This slip circle requires zero soil streng	
36	5.22	6.95	-133.61	-112.15	1.005	3.29
37	5.24	28.95	-32553.37	[illegible]	This slip circle requires zero soil streng	
38	5.24	6.95	-133.60	-112.18	1.005	3.28
39	5.26	28.94	-32553.36	-58595.96	This slip circle requires zero soil streng	
40	5.26	6.95	-133.59	-112.20	1.005	3.28
41	5.28	28.94	-32553.35	-58606.61	This slip circle requires zero soil streng	
42	5.28	6.94	-133.58	-112.23	1.005	3.28
43	5.30	28.93	-32553.34	-58617.80	This slip circle requires zero soil streng	
44	5.30	6.94	-133.56	-112.26	1.005	3.28
45	5.32	28.93	-32553.33	-58629.55	This slip circle requires zero soil streng	
46	5.32	6.93	-133.55	-112.29	1.005	3.27
47	5.35	28.92	-32553.31	-58641.89	This slip circle requires zero soil streng	
48	5.35	6.93	-133.54	-112.32	1.005	3.27
49	5.37	28.92	-32553.30	-58654.85	This slip circle requires zero soil streng	
50	5.37	6.92	-133.53	-112.35	1.005	3.27
51	5.40	28.91	-32553.29	-58668.46	This slip circle requires zero soil streng	
52	5.40	6.92	-133.51	-112.38	1.005	3.26
53	5.43	28.91	-32553.27	-58682.77	This slip circle requires zero soil streng	
54	5.43	6.91	-133.50	-112.42	1.005	3.26

Output Data

Wall Height = 65.00
Wall Slope = 30.13

Circle Number	Circle X-Intercept	Circle Base Angle	Circle X-Center	Circle Y-Center	Moment Ratio	Factor of Safety
55	5.46	28.90	-32553.26	-58697.79	This slip circle requires zero soil streng	
56	5.46	6.90	-133.48	-112.45	1.005	3.26
57	5.49	28.90	-32553.24	-58713.57	This slip circle requires zero soil streng	
58	5.49	6.90	-133.47	-112.49	1.005	3.25
59	5.53	28.89	-32553.23	-58730.14	This slip circle requires zero soil streng	
60	5.53	6.89	-133.45	-112.53	1.005	3.25
61	5.56	28.88	-32553.21	-58747.55	This slip circle requires zero soil streng	
62	5.56	6.88	-133.43	-112.58	1.005	3.24
63	5.60	28.87	-32553.19	-58765.84	This slip circle requires zero soil streng	
64	5.60	6.88	-133.42	-112.62	1.005	3.24
65	5.64	28.87	-32553.17	-58785.05	This slip circle requires zero soil streng	
66	5.64	6.87	-133.40	-112.67	1.005	3.23
67	5.68	28.86	-32553.15	-58805.24	This slip circle requires zero soil streng	
68	5.68	6.86	-133.38	-112.72	1.005	3.23
69	5.72	28.85	-32553.13	-58826.45	This slip circle requires zero soil streng	
70	5.72	6.85	-133.36	-112.77	1.005	3.23
71	5.76	28.84	-32553.11	-58848.72	This slip circle requires zero soil streng	
72	5.76	6.84	-133.33	-112.83	1.005	3.22
73	5.81	28.83	-32553.08	-58872.13	This slip circle requires zero soil streng	
74	5.81	6.83	-133.31	-112.89	1.005	3.21
75	5.86	28.82	-32553.06	-58896.72	This slip circle requires zero soil streng	
76	5.86	6.82	-133.29	-112.95	1.005	3.21
77	5.91	28.81	-32553.03	-58922.56	This slip circle requires zero soil streng	
78	5.91	6.81	-133.26	-113.01	1.005	3.22
79	5.96	28.80	-32553.01	-58949.71	This slip circle requires zero soil streng	
80	5.96	6.80	-133.23	-113.08	1.005	3.21
81	6.02	28.79	-32552.98	-58978.24	This slip circle requires zero soil streng	
82	6.02	6.79	-133.20	-113.15	1.005	3.20
83	6.08	28.77	-32552.95	-59008.21	This slip circle requires zero soil streng	
84	6.08	6.78	-133.17	-113.22	1.005	3.20
85	6.14	28.76	-32552.92	-59039.71	This slip circle requires zero soil streng	
86	6.14	6.76	-133.14	-113.30	1.005	3.19
87	6.21	28.75	-32552.88	-59072.82	This slip circle requires zero soil streng	
88	6.21	6.75	-133.11	-113.38	1.005	3.18
89	6.28	28.73	-32552.85	-59107.61	This slip circle requires zero soil streng	
90	6.28	6.73	-133.07	-113.47	1.005	3.17
91	6.35	28.72	-32552.81	-59144.17	This slip circle requires zero soil streng	
92	6.35	6.72	-133.04	-113.56	1.005	3.17
93	6.43	28.70	-32552.77	-59182.60	This slip circle requires zero soil streng	
94	6.43	6.70	-133.00	-113.65	1.005	3.16
95	6.51	28.69	-32552.73	-59222.99	This slip circle requires zero soil streng	
96	6.51	6.69	-132.96	-113.75	1.005	3.15
97	6.60	28.67	-32552.69	-59265.44	This slip circle requires zero soil streng	
98	6.60	6.67	-132.92	-113.86	1.005	3.14
99	6.69	28.65	-32552.65	-59310.07	This slip circle requires zero soil streng	
100	6.69	6.65	-132.87	-113.97	1.005	3.13
101	6.78	28.63	-32552.60	-59356.99	This slip circle requires zero soil streng	
102	6.78	6.63	-132.83	-114.08	1.005	3.12
103	6.88	28.61	-32552.55	-59406.31	This slip circle requires zero soil streng	
104	6.88	6.61	-132.78	-114.20	1.005	3.11
105	6.98	28.59	-32552.50	-59458.17	This slip circle requires zero soil streng	
106	6.98	6.59	-132.72	-114.33	1.005	3.10
107	7.09	28.57	-32552.44	-59512.70	This slip circle requires zero soil streng	
108	7.09	6.57	-132.67	-114.47	1.005	3.09
109	7.21	28.55	-32552.39	-59570.03	This slip circle requires zero soil streng	
110	7.21	6.55	-132.61	-114.61	1.005	3.08
111	7.33	28.52	-32552.33	-59630.32	This slip circle requires zero soil streng	
112	7.33	6.52	-132.55	-114.76	1.005	3.06
113	7.45	28.50	-32552.26	-59693.73	This slip circle requires zero soil streng	

Output Data

Wall Height = 65.00
Wall Slope = 30.13

Circle Number	Circle X-Intercept	Circle Base Angle	Circle X-Center	Circle Y-Center	Moment Ratio	Factor of Safety
114	7.45	6.50	-132.49	-114.91	1.005	3.05
115	7.59	28.47	-32552.20	-59760.42	This slip circle requires zero soil streng	
116	7.59	6.47	-132.42	-115.08	1.005	3.04
117	7.73	28.44	-32552.13	-59830.57	This slip circle requires zero soil streng	
118	7.73	6.44	-132.35	-115.25	1.005	3.03
119	7.87	28.41	-32552.05	-59904.36	This slip circle requires zero soil streng	
120	7.87	6.41	-132.28	-115.43	1.005	3.01
121	8.03	28.38	-32551.97	-59982.00	This slip circle requires zero soil streng	
122	8.03	6.38	-132.20	-115.62	1.005	3.00
123	8.19	28.35	-32551.89	-60063.68	This slip circle requires zero soil streng	
124	8.19	6.35	-132.12	-115.83	1.005	2.99
125	8.36	28.31	-32551.81	-60149.64	This slip circle requires zero soil streng	
126	8.36	6.31	-132.03	-116.04	1.005	2.97
127	8.55	28.28	-32551.72	-60240.09	This slip circle requires zero soil streng	
128	8.55	6.28	-131.94	-116.26	1.005	2.96
129	8.74	28.24	-32551.62	-60335.30	This slip circle requires zero soil streng	
130	8.74	6.24	-131.85	-116.50	1.004	2.94
131	8.94	28.20	-32551.52	-60435.52	This slip circle requires zero soil streng	
132	8.94	6.20	-131.75	-116.74	1.004	2.93
133	9.15	28.16	-32551.42	-60541.03	This slip circle requires zero soil streng	
134	9.15	6.16	-131.64	-117.00	1.004	2.91
135	9.37	28.11	-32551.30	-60652.12	This slip circle requires zero soil streng	
136	9.37	6.12	-131.53	-117.28	1.004	2.89
137	9.60	28.07	-32551.19	-60769.10	This slip circle requires zero soil streng	
138	9.60	6.07	-131.41	-117.57	1.004	2.87
139	9.85	28.02	-32551.06	-60892.32	This slip circle requires zero soil streng	
140	9.85	6.02	-131.29	-117.87	1.004	2.85
141	10.11	27.97	-32550.93	-61022.11	This slip circle requires zero soil streng	
142	10.11	5.97	-131.16	-118.19	1.004	2.83
143	10.38	27.92	-32550.80	-61158.86	This slip circle requires zero soil streng	
144	10.38	5.92	-131.02	-118.53	1.004	2.81
145	10.67	27.86	-32550.65	-61302.95	This slip circle requires zero soil streng	
146	10.67	5.86	-130.88	-118.88	1.004	2.79
147	10.97	27.80	-32550.50	-61454.83	This slip circle requires zero soil streng	
148	10.97	5.80	-130.73	-119.26	1.004	2.76
149	11.29	27.74	-32550.34	-61614.93	This slip circle requires zero soil streng	
150	11.29	5.74	-130.57	-119.65	1.004	2.74
151	11.63	27.68	-32550.17	-61783.74	This slip circle requires zero soil streng	
152	11.63	5.68	-130.40	-120.07	1.004	2.72
153	11.99	27.61	-32549.99	-61961.78	This slip circle requires zero soil streng	
154	11.99	5.61	-130.22	-120.51	1.004	2.69
155	12.36	27.54	-32549.81	-62149.58	This slip circle requires zero soil streng	
156	12.36	5.54	-130.03	-120.97	1.004	2.67
157	12.76	27.46	-32549.61	-62347.73	This slip circle requires zero soil streng	
158	12.76	5.46	-129.83	-121.46	1.004	2.65
159	13.18	27.38	-32549.40	-62556.87	This slip circle requires zero soil streng	
160	13.18	5.38	-129.63	-121.98	1.004	2.62
161	13.62	27.30	-32549.18	-62777.65	This slip circle requires zero soil streng	
162	13.62	5.30	-129.40	-122.52	1.004	2.60
163	14.09	27.21	-32548.95	-63010.79	This slip circle requires zero soil streng	
164	14.09	5.22	-129.17	-123.10	1.004	2.57
165	14.58	27.12	-32548.70	-63257.07	This slip circle requires zero soil streng	
166	14.58	5.13	-128.93	-123.71	1.004	2.55
167	15.13	27.03	-32557.38	-63534.83	This slip circle requires zero soil streng	
168	15.13	5.03	-128.67	-124.40	1.004	2.53
169	15.88	26.93	-32606.54	-63907.31	This slip circle requires zero soil streng	
170	15.88	4.93	-128.42	-125.37	1.004	2.51
171	16.67	26.82	-32658.69	-64302.41	This slip circle requires zero soil streng	
172	16.67	4.82	-128.15	-126.40	1.004	2.49

Output Data

Wall Height = 65.00
Wall Slope = 30.13

Circle Number	Circle X-Intercept	Circle Base Angle	Circle X-Center	Circle Y-Center	Moment Ratio	Factor of Safety
173	17.51	26.71	-32714.03	-64721.75	This slip circle requires zero soil streng	
174	17.51	4.71	-127.87	-127.49	1.004	2.48
175	18.40	26.60	-32772.81	-65167.08	This slip circle requires zero soil streng	
176	18.40	4.60	-127.57	-128.65	1.004	2.47
177	19.35	26.47	-32835.27	-65640.33	This slip circle requires zero soil streng	
178	19.35	4.48	-127.26	-129.88	1.004	2.45
179	20.35	26.35	-32901.69	-66143.59	This slip circle requires zero soil streng	
180	20.35	4.35	-126.92	-131.19	1.004	2.43
181	21.42	26.21	-32972.37	-66679.14	This slip circle requires zero soil streng	
182	21.42	4.21	-126.56	-132.58	1.004	2.40
183	22.56	26.07	-33047.65	-67249.52	This slip circle requires zero soil streng	
184	22.56	4.07	-126.17	-134.06	1.004	2.37
185	23.78	25.92	-33127.89	-67857.48	This slip circle requires zero soil streng	
186	23.78	3.92	-125.77	-135.64	1.004	2.32
187	25.08	25.77	-33213.50	-68506.10	This slip circle requires zero soil streng	
188	25.08	3.77	-125.33	-137.33	1.004	2.28
189	26.46	25.60	-33304.91	-69198.73	This slip circle requires zero soil streng	
190	26.46	3.61	-124.87	-139.13	1.004	2.23
191	27.94	25.43	-33402.63	-69939.11	This slip circle requires zero soil streng	
192	27.94	3.43	-124.37	-141.06	1.004	2.19
193	29.53	25.25	-33507.20	-70731.40	1.000	115.17
194	29.53	3.25	-123.84	-143.12	1.004	2.15
195	31.22	25.06	-33619.23	-71580.23	1.000	46.79
196	31.22	3.07	-123.27	-145.33	1.003	2.11
197	33.04	24.87	-33739.41	-72490.77	1.000	29.49
198	33.04	2.87	-122.65	-147.69	1.003	2.06
199	35.00	24.66	-33868.49	-73468.80	1.000	21.61
200	35.00	2.66	-122.00	-150.24	1.003	2.01

North CKD Final Design for CEMEX
Soil Nailed Wall
Flexural Strength Calculations

FLEXURE

Soil Nail Wall Facing Analysis		Updated 10/05	
Geometry & Miscellaneous Input Data		**A**	**B**
Vertical Nail Spacing, S_V (ft)		6.00	6.00
Horizontal Nail Spacing, S_H (ft)		6.00	6.00
Facing Thickness, t_F (in)		6.00	5.00
Facing Usuage (Temporary, Permanent)		Permanent	Permanent
Nail Pattern (Rectangular, Staggered)		Rectangular	Rectangular
Resistance Factor for Facing Flexure, ϕ_F	(LRFD)	1.00	1.00
Vertical Bearing Bar Continuity Factor (0 = Cutoff, 1 = Continuous)		0.00	0.00
Continuity Factor For All Positive Moment Steel (0 = Cutoff, 1 = Continuous)		1.00	1.00
Reinforcement Details			
Steel Depth, d (in)	cover to soil face	3.00	2.50
Area of a Main Vertical Bar/Wire, A_{MV1} (in^2)	2x.029=.058	0.058	0.029
Main Vertical Bar/Wire Spacing, s_{MV} (in)		4.0	4.0
Area of Vertical Bearing Bar Reinforcement, A_{VB} (in^2)	2 X .20 = 2 #4	0.40	0.40
Area of a Main Horizontal Bar/Wire, A_{MH1} (in^2)	2x.029=.058	0.058	0.029
Main Horizontal Waler Bar/Wire Spacing, s_{MH} (in)		4.0	4.0
Area of Waler Bar Reinforcement, A_{WB} (in^2)	2 X .20 = 2 #4	0.40	0.40
Material Properties			
Concrete Compressive Strength, f'_C (ksi)		4.0	4.0
Main Reinforcement Yield Stress, F_Y (ksi)		60.0	60.0
Waler/Vertical Bearing Bar Reinforcement Yield Stress, F_Y (ksi)		60.0	60.0
Facing Flexure Nailhead Capacity Calculations			
Facing Flexure Factor, C_F		2.00	2.00
Gross Reinforcement Ratio, Negative Moment, Vertical Direction, ρ_{NV}		0.33%	0.26%
Gross Reinforcement Ratio, Positive Moment, Vertical Direction, ρ_{PV}		0.24%	0.15%
Gross Reinforcement Ratio, Negative Moment, Horizontal Direction, ρ_{NH}		0.33%	0.26%
Gross Reinforcement Ratio, Positive Moment, Horizontal Direction, ρ_{PH}		0.33%	0.26%
Negative Unit Moment Capacity in Vertical Direction, m^-_V (k-ft/ft)		3.397	1.834
Positive Unit Moment Capacity in Vertical Direction, m^+_V (k-ft/ft)		2.499	1.060
Negative Unit Moment Capacity in Horizontal Direction, m^-_H (k-ft/ft)		3.397	1.834
Positive Unit Moment Capacity in Horizontal Direction, m^+_H (k-ft/ft)		3.397	1.834
Nominal Nail Head Strength in Vertical Direction, $T_{FN,V}$ (k)		94.3	46.3
Nominal Nail Head Strength in Horizontal Direction, $T_{FN,H}$ (k)		108.7	58.7
Design Nail Head Strength, ϕT_{FN} (k)		**94.3**	**46.3**

PUNCHING

Soil Nail Wall Facing Analysis & Design Version 2.0 - 01/99

Geometric and Material Parameters	A	B
Vertical Nail Spacing, S_V (ft)	6.00	6.00
Horizontal Nail Spacing, S_H (ft)	6.00	6.00
Facing Thickness, t_F (in)	6.00	5.00
Connection Type (Bearing, Headed Stud)	Bearing	Bearing
Facing Usuage (Temporary, Permanent)	Permanent	Permanent
Resistance Factor for Facing Punching Shear, ϕ_S	1.00	1.00
Plate Width, b_{PL} (in)	8.00	8.00
Plate Thickness, t_{PL} (in)	0.75	0.75
Permanent Cover to Plate on Soil Side, C_{PL} (in)	6.00	5.00
Headed Stud Embedment Length, L_{HS} (in)	0.00	0.00
Headed Stud Spacing, S_{HS} (in)	0.00	0.00
Grout Column Diameter, D_{GC} (in)	6.00	6.00
Concrete Compressive Strength, f'_C (ksi)	4.00	4.0

Calculations		
Nail Head Pressure Increase Factor for Punching Shear, C_S	2.50	2.50
Equivalent Cone Depth, h_C (in)	6.00	5.00
Equivalent Top Cone Diameter, D''_C (in)	8.00	8.00
Cone Bottom Diameter, D_C (in)	20.00	18.00
Effective Cone Diameter, D'_C (in)	14.00	13.00
Cone Bottom Area, A_C (in^2)	314.2	254.5
Grout Column Area, A_{GC} (in^2)	28.3	28.3
Shear Stress Area, A_V (in^2)	263.9	204.2
Nominal Punching Shear Stress, v_N (psi)	253.0	253.0
Nominal Punching Shear Strength of Facing, V_N (k)	66.8	51.7
Strength Ratio From Pressure Concentration, T_{FN}/V_N	1.16	1.12
Design Nail Head Strength, $\phi_S T_{FN}$ (k)	**77.5**	**58.0**

Flexural Strength Calculations

Soil Nail Wall Facing Analysis & Design	Version 1.10 - 08/05/96

Geometric and Material Parameters	
Headed Stud Diameter, D_{HS} (in)	0.500
Headed Stud Head Diameter, D_H (in)	1.000
Headed Stud Head Thickness, t_H (in)	0.312
Resistance Factor for Headed Stud Tension, ϕ_{HS}	1.00
Headed Stud Ultimate Stress, F_U (ksi)	60.0

Calculations	
Total Headed Stud Tension Area, A_{HS} (in^2)	0.785
Design Headed Stud Strength, $\phi_{HS}T_{FN}$ (k)	47.1

ATTACHMENT C-4

SEISMIC EVALUATION AND DETERMINATION OF PEAK GROUND ACCELERATION (ANCHOR QEA, 2018)

720 Olive Way, Suite 1900
Seattle, Washington 98101
206.287.9130

Memorandum

July 27, 2018

To: Wayne Adams, P.E., Adams Resource Consultants

From: Michael Whelan, P.E., and Casey Janisch, Anchor QEA

cc: John Laplante, P.E., Anchor QEA

Re: Seismic Evaluation and Determination of Peak Ground Acceleration (PGA) for North Cement Kiln Dust (CKD) Area, CEMEX Davenport Facility

In support of completing the Closure Plan for the North Cement Kiln Dust (CKD) Area at the CEMEX Davenport Cement Plant (site), Anchor QEA has conducted an evaluation of appropriate seismic design factors, including determination of an expected peak ground acceleration at the site, and the application of a pseudostatic coefficient for representation of seismic loading.

California's Code of Regulations (CCR) Title 27 for Environmental Protection and Class II waste management units (CCR Title 27, Section 21750.f.5) mandates the determination of an expected peak ground acceleration (PGA) at the site, associated with the maximum credible earthquake (MCE). Furthermore, the determination of PGA is required to consider regional and local seismic conditions and faulting and is required to be done using an identified procedure or publication.

Seismic Characteristics of Davenport and Surrounding Region

The site is located in Davenport, California, on the central coast of California about 12 miles northwest of Santa Cruz and the northern end of Monterey Bay. The region is characterized by numerous known fault zones, all of which are manifestations of the northwest-southeast trending strike-slip contact between the North American and Pacific tectonic plates.

The closest mapped active fault zone - the San Gregorio fault - is located approximately 3 miles west (offshore) of Davenport. Regionally, the most dominant and widespread being the historically active strike-slip San Andreas fault zone, along with the affiliated Zayante-Vergeles and Butano faults, all of which range from 10 to 16 miles northeast of Davenport. Slip rates along these faults vary, with the most historically active area being the main San Andreas fault itself; numerous smaller seismic events (with magnitudes ranging from 0.8 to 4.0) were noted over the course of one month in 1998 along the Zayante-Vergeles, on a segment previously considered inactive (Gallardo et al, 2004). The Ben Lomond fault zone, located approximately 8 miles east, appears to have remained largely inactive in the Holocene epoch.

Historic earthquakes experienced at Santa Cruz and the region (from Earthquake Track; www.earthquaketrack.com/us-ca-santa-cruz) have occurred along the San Gregorio and San Andreas fault systems, including the following:

- The 2014 South Napa earthquake (magnitude 6.0) centered north of San Pablo Bay, approximately 100 miles from Davenport
- The 1989 Loma Prieta earthquake (magnitude 6.9) centered in the Santa Cruz Mountains, about 13 miles northeast of Davenport
- Two earthquakes in 1926 originating in nearby Monterey Bay (magnitude 6.1)
- The 1906 San Francisco Earthquake (magnitude 8.3)

The seismic regime surrounding Davenport, Santa Cruz, Monterey Bay, and the Santa Cruz Mountains, as summarized above, clearly has the potential to contribute significant seismic activity to the project site. A full seismic analysis was therefore performed to determine the Maximum Credible Earthquake (MCE) that could be reasonably expected.

Determination of Peak Ground Acceleration Corresponding to Maximum Credible Earthquake

The United States Geological Survey (USGS) compiles site-specific earthquake records across the United States and globally, including records from the events listed above, under its National Seismic Hazard Mapping Project (USHMP; USGS 2014). This data compilation is used in concert with established seismic analysis methodologies by design committees including the Building Seismic Safety Committee, the American Society of Civil Engineers (ASCE), and the International Code Council, for inclusion in building codes, risk assessments, and other public policy applications. The analytical procedures that are codified through this approach represent the USHMP's assessment of best-available data, models, and methods for site-specific seismic hazard assessments throughout the country.

Anchor QEA's seismic evaluation for the site was conducted using analytical procedures documented by ASCE in their Standard Document 7-16, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* (ASCE 2016), as made publicly available through the ASCE's Hazard Assessment Tool (ASCE 2017). The Hazard Tool incorporates up-to-date seismic analysis and mapping provided by the USHMP, available online from USGS (2018). Using this information, it provides a site-specific design response spectrum for a Maximum Considered Earthquake (MCE), defined as the "most severe earthquake effects considered by this standard determined for the orientation that results in the largest maximum response to horizontal ground motions", per ASCE design guidance (ASCE 2016, Section 11).

The Hazard Tool in fact applies a "risk targeted" form of the MCE ground acceleration (MCE_r); this element was added to seismic engineering codes after 2012 in order to provide a more consistent level of seismic performance in national earthquake design (NEHRP 2012). In some areas, such as the San Francisco and Santa Cruz areas, the risk-targeted MCE acceleration is equal to, or slightly higher than, the MCE that would be derived without targeted risk incorporated. Therefore, the definitions of MCE and MCE_r used by ASCE Standard 7-16 and the Hazard Tool are consistent with the Title 27 definition of Maximum Credible Earthquake: "the maximum earthquake that appears capable of occurring under the presently known geologic framework". Furthermore, since the Hazard Assessment Tool incorporates the seismic history of the vicinity and geologic province (through its integration of USHMP seismic records) and known earthquake records and the proximity of major faults, it represents a seismic evaluation procedure that is fully consistent with the design intent of CCR Title 27.

Design earthquake ground motions (spectral response parameters) are further developed as two-thirds of the corresponding MCE ground motions, per ASCE (2016). For inputs to the Hazard Assessment Tool, the site soil classification was determined, based on recently completed site investigations, to be a Class C for very dense soils having an average Standard Penetration Test blow count greater than 50. In addition, an Occupancy Category of I was selected, representing structures with no human occupancy (ASCE 2016)..

Attachment 1 provides the output from the Hazard Assessment Tool's estimated seismic response of the site. Using the design response spectrum, and application of Equation 1 (below), the applicable PGA for site design use was determined to be **0.566g**.

Equation 1

$$\mathrm{PGA} = 0.4 * S_{DS}$$

$$\mathrm{PGA} = 0.4 * 1.416\ g$$

$$\mathrm{PGA} = 0.566\ g$$

where:

PGA	=	peak ground acceleration
S_{DS}	=	design earthquake spectral response acceleration parameter at short period
g	=	acceleration due to gravity

Application of Peak Ground Acceleration to Slope Stability Analyses

No site-specific, reduction or amplification factors were applied to the selected PGA because the selection of Site Class inherently accounts for site-specific soil conditions; instead, the full value of 0.566g was assumed to apply. Because the PGA represents the peak acceleration, and actual accelerations in the soil mass occur as transient and continually changing (both in magnitude and direction) forces, standard seismic analysis using limit equilibrium methods includes translating the peak ground acceleration into an equivalent, constantly-acting, horizontal force also known as a pseudo-static coefficient. An overview of established literature regarding the selection of a pseudo-static coefficient is provided by California Geological Survey (2008) and others; Seed (1979) originally suggested that pseudo-static coefficients of 0.1 to 0.15 were appropriate values, depending on the magnitude of the seismic event. For this work, recognizing more recent research and standard engineering practice, the pseudo-static coefficient was calculated as one-half (0.5) of the PGA to convert the PGA to a horizontal force in the limit-equilibrium analyses. This results in a pseudo-static coefficient of **0.283g**.

References

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USGS, 2018. Online earthquake hazard maps and design ground motions. Available at https://earthquake.usgs.gov/designmaps.

Attachments

Attachment 1 ASCE 7 Hazards Report

Attachment 1

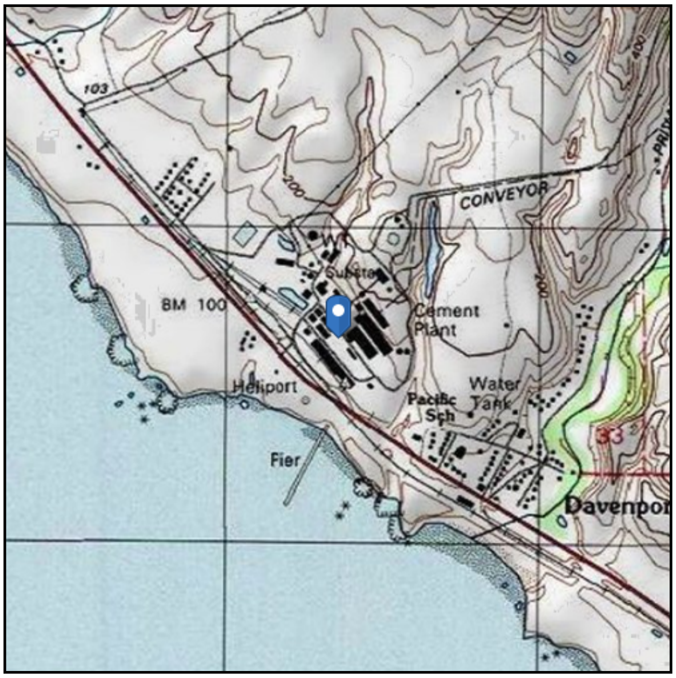
ASCE 7 Hazards Report

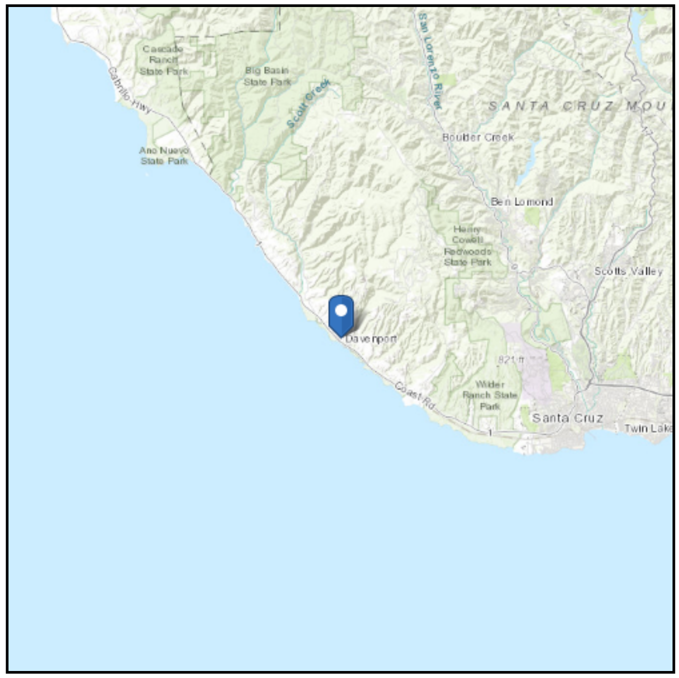
ASCE 7 Hazards Report

Address:
No Address at This Location

Standard: ASCE/SEI 7-16
Risk Category: I
Soil Class: C - Very Dense Soil and Soft Rock

Elevation: 101.94 ft (NAVD 88)
Latitude: 37.015
Longitude: -122.199





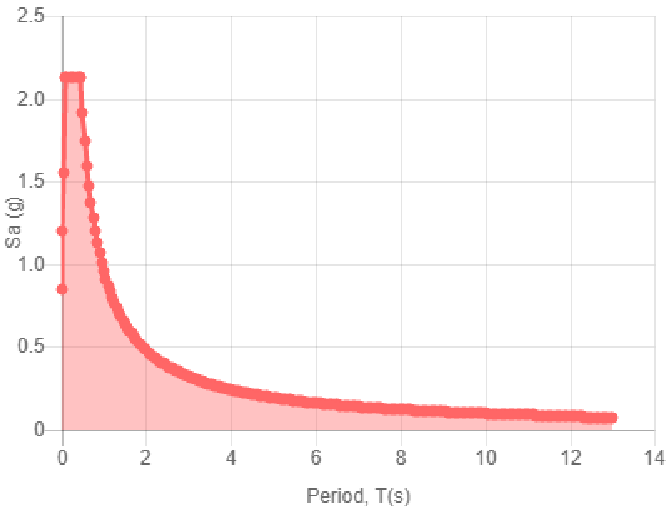
Seismic

Site Soil Class: C - Very Dense Soil and Soft Rock

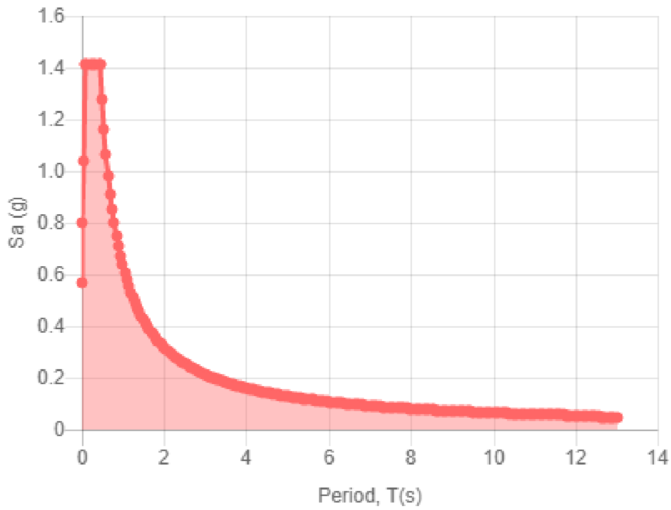
Results:

S_S:	1.77
S_1:	0.684
S_{MS}:	2.125
S_{M1}:	0.957
S_{DS}:	1.416
S_{D1}:	0.638

MCEr Spectrum



Design Response Spectrum



Data Source: [USGS Seismic Design Maps]

Date Accessed: Thu Mar 01 2018

The ASCE 7 Hazard Tool is provided for your convenience, for informational purposes only, and is provided "as is" and without warranties of any kind. The location data included herein has been obtained from information developed, produced, and maintained by third party providers; or has been extrapolated from maps incorporated in the ASCE 7 standard. While ASCE has made every effort to use data obtained from reliable sources or methodologies, ASCE does not make any representations or warranties as to the accuracy, completeness, reliability, currency, or quality of any data provided herein. Any third-party links provided by this Tool should not be construed as an endorsement, affiliation, relationship, or sponsorship of such third-party content by or from ASCE.

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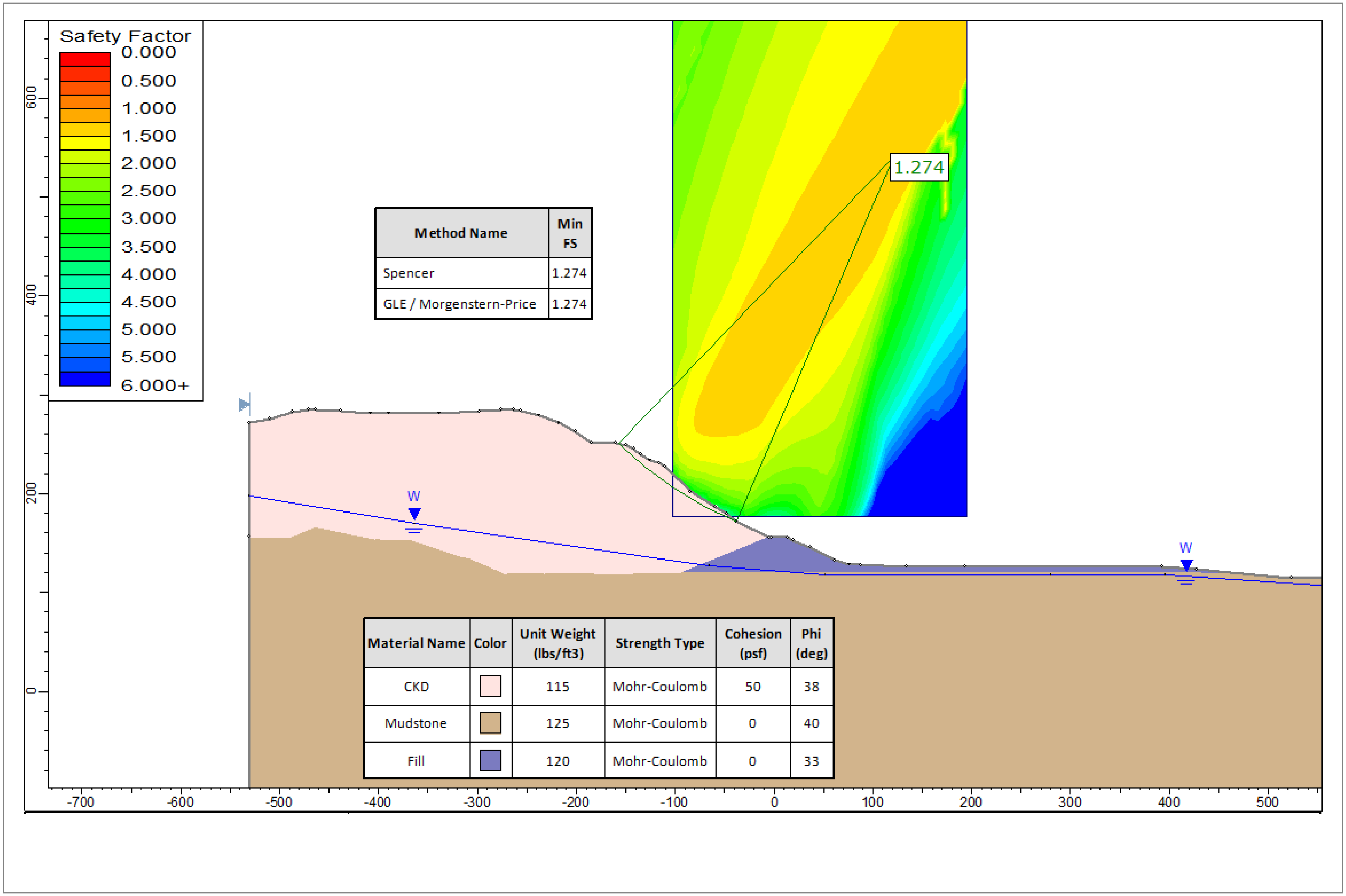
ATTACHMENT C-5

SLOPE STABILITY ANALYSIS RESULTS



Method Name	Min FS
Spencer	1.274
GLE / Morgenstern-Price	1.274

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
CKD		115	Mohr-Coulomb	50	38
Mudstone		125	Mohr-Coulomb	0	40
Fill		120	Mohr-Coulomb	0	33

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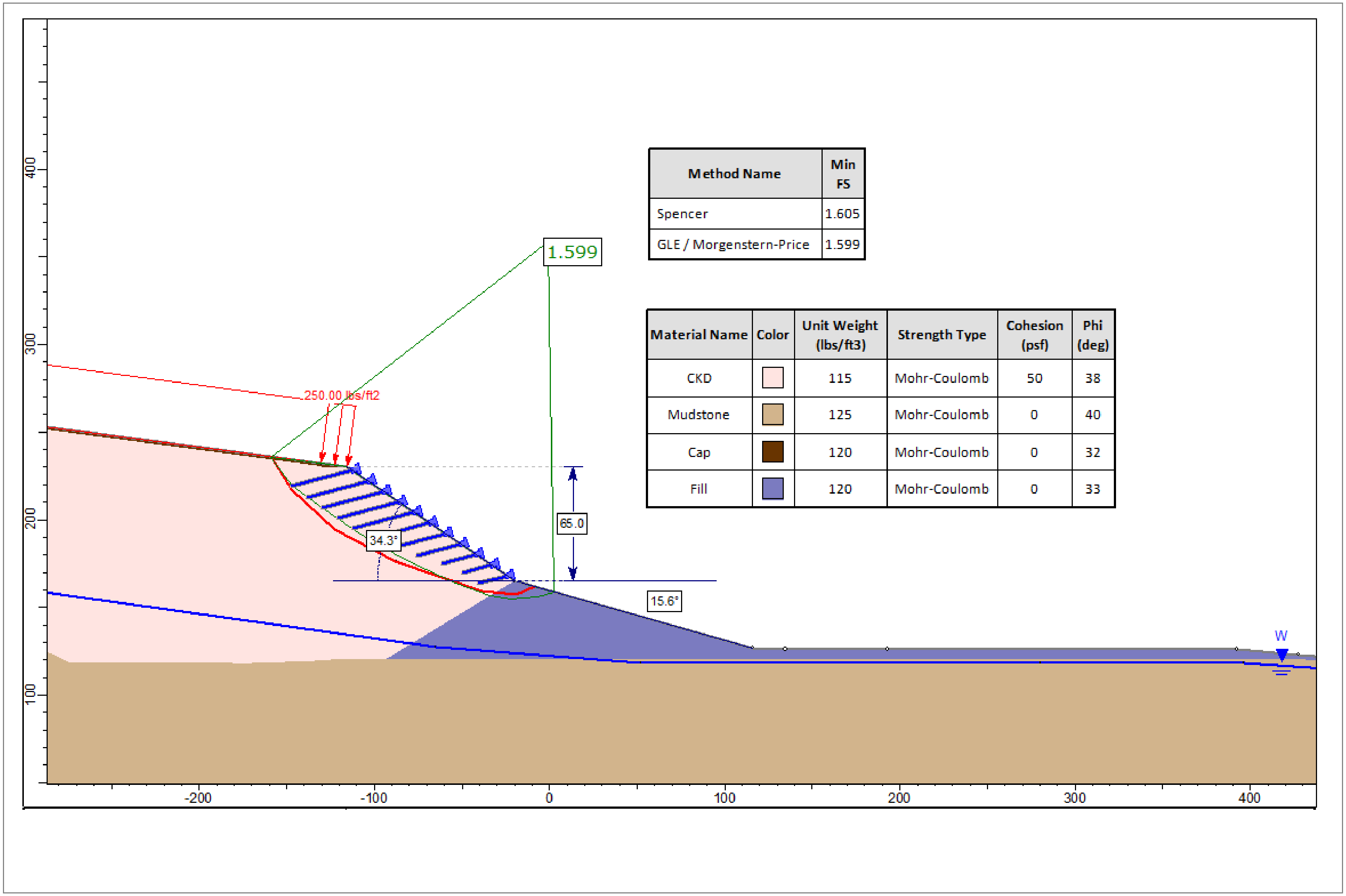
Figure C-5.1
Existing Condition – Static Analysis
Final Geotechnical Design
CEMEX Davenport North CDK Area



Method Name	Min FS
Spencer	1.605
GLE / Morgenstern-Price	1.599

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
CKD		115	Mohr-Coulomb	50	38
Mudstone		125	Mohr-Coulomb	0	40
Cap		120	Mohr-Coulomb	0	32
Fill		120	Mohr-Coulomb	0	33

Filepath: \\socal2\disneyland\PROJECTS\Cemex_dba_RMC_Pacific\Davenport_CKD_Closure (181732-01.01)\Deliverables\Stability Analysis\Appendix C_Geotech Report\Figures\Figure C-5.2.docx

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Figure C-5.2
Constructed Soil Nail Wall – Static Analysis
Final Geotechnical Design
CEMEX Davenport North CDK Area

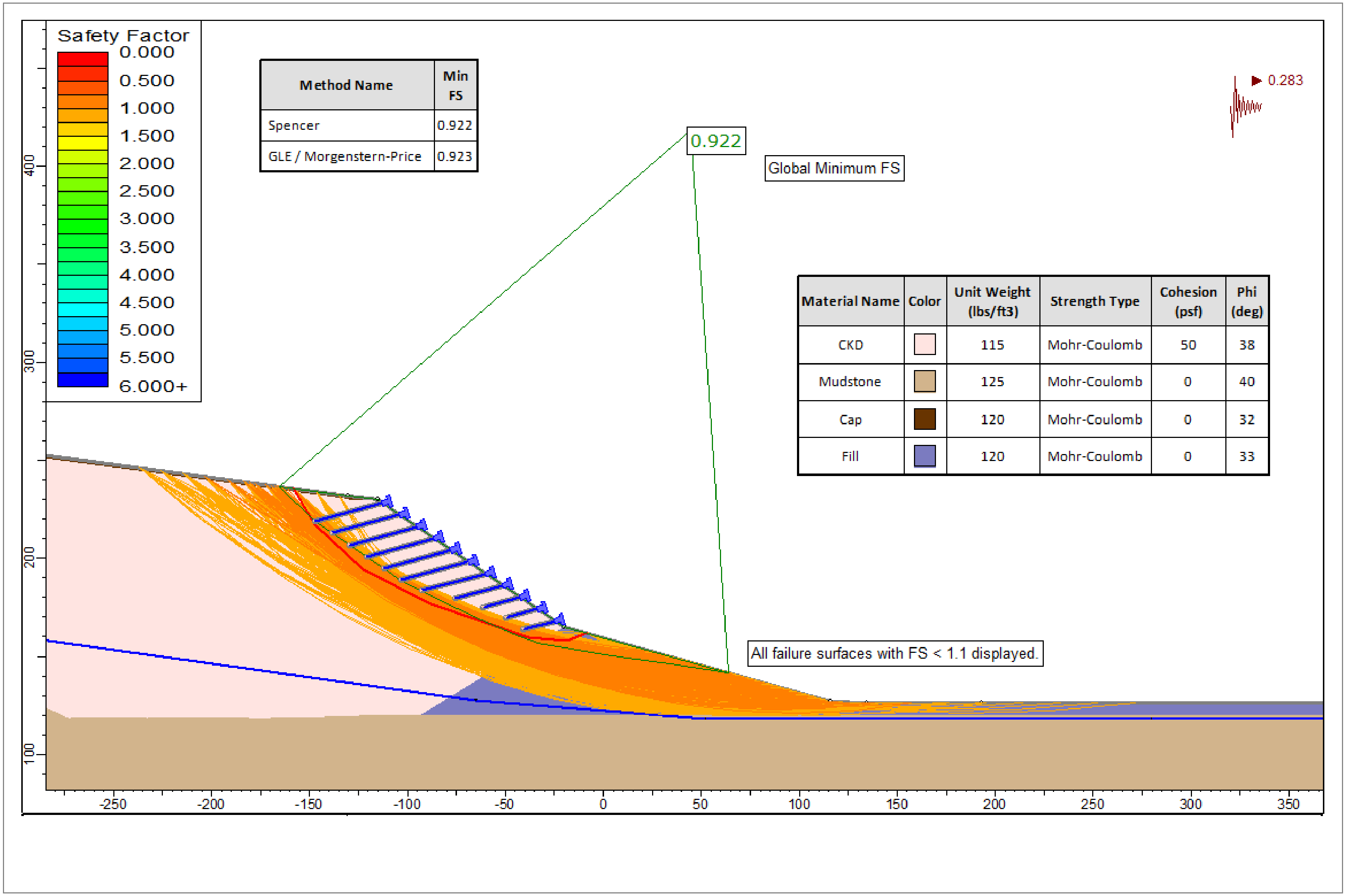

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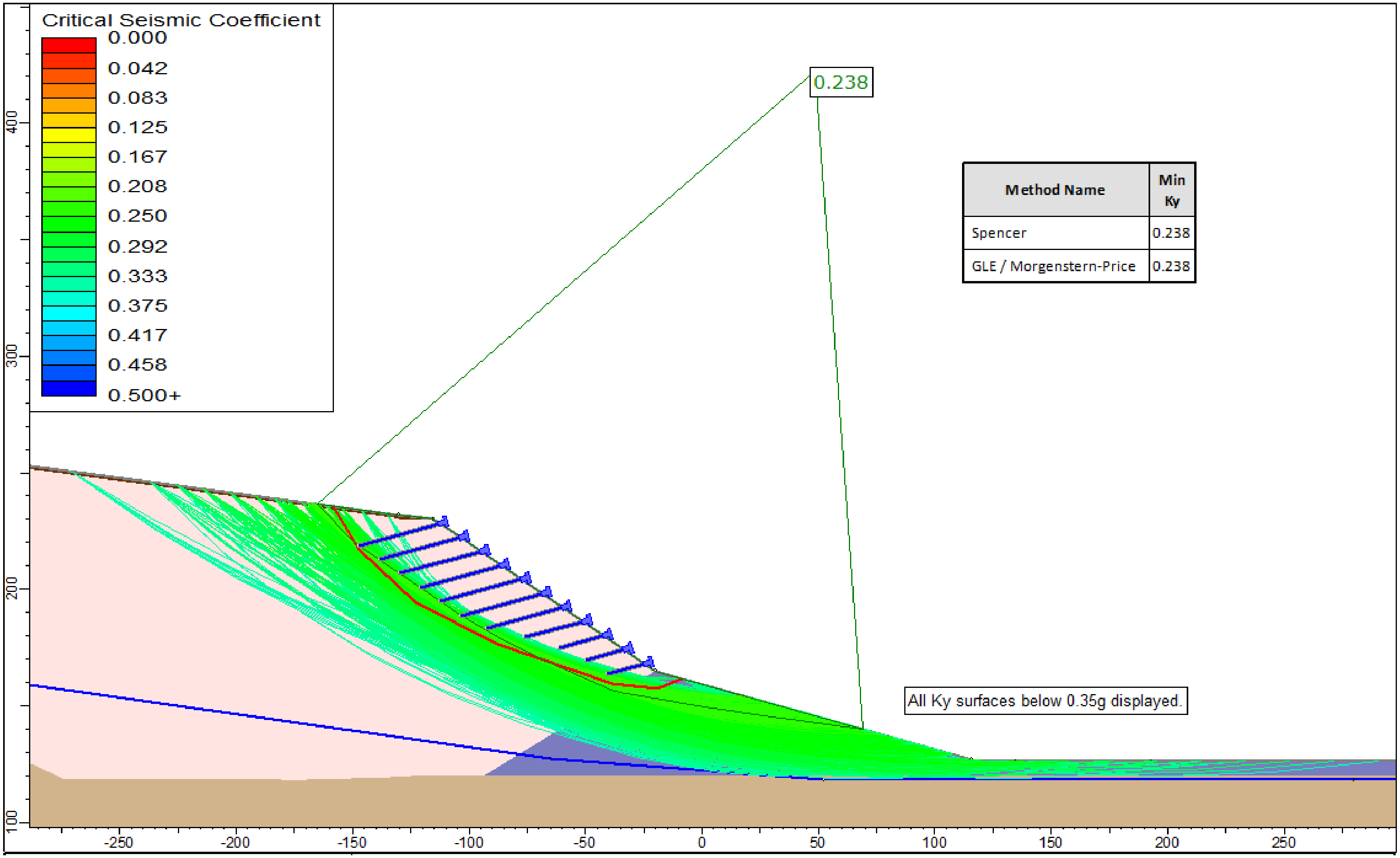
Figure C-5.3
Constructed Soil Nail Wall – Seismic Analysis
Final Geotechnical Design
CEMEX Davenport North CDK Area



Method Name	Min Ky
Spencer	0.238
GLE / Morgenstern-Price	0.238

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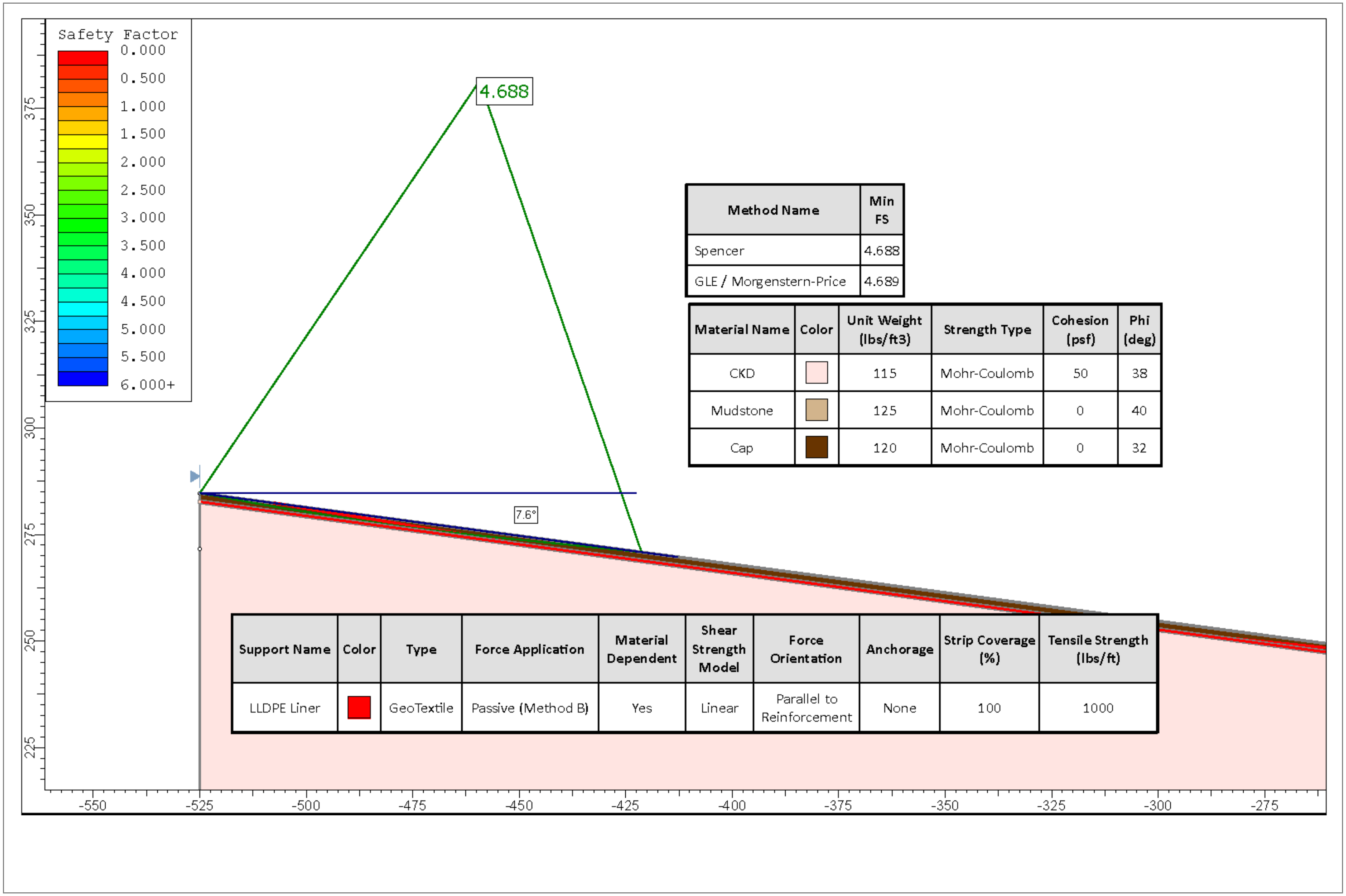
Figure C-5.4
Constructed Soil Nail Wall – Critical Seismic Coefficient
Final Geotechnical Design
CEMEX Davenport North CDK Area



Method Name	Min FS
Spencer	4.688
GLE / Morgenstern-Price	4.689

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
CKD		115	Mohr-Coulomb	50	38
Mudstone		125	Mohr-Coulomb	0	40
Cap		120	Mohr-Coulomb	0	32

Support Name	Color	Type	Force Application	Material Dependent	Shear Strength Model	Force Orientation	Anchorage	Strip Coverage (%)	Tensile Strength (lbs/ft)
LLDPE Liner		GeoTextile	Passive (Method B)	Yes	Linear	Parallel to Reinforcement	None	100	1000

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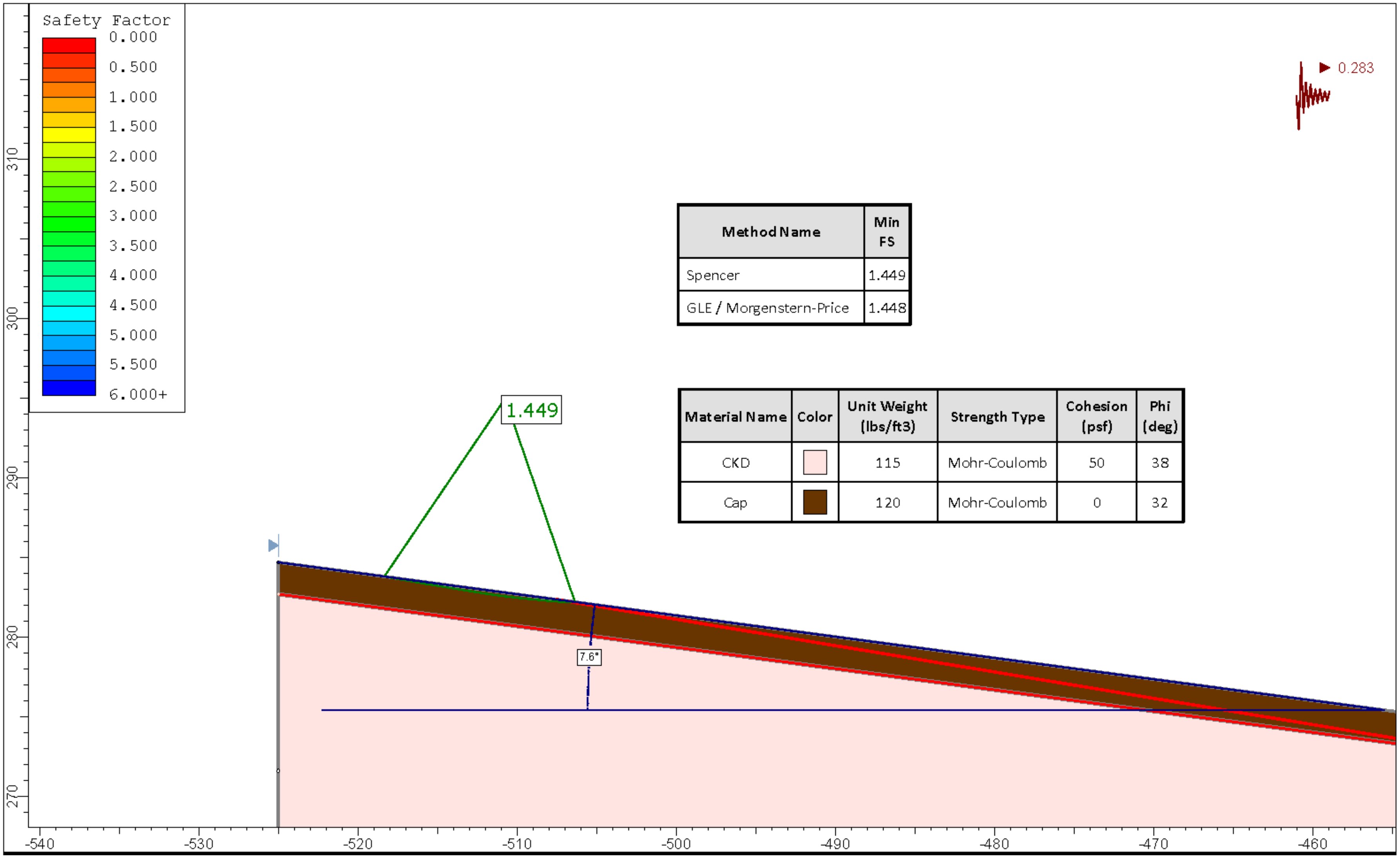
Figure C-5.5
Constructed CKD Cover – Static Analysis
Final Geotechnical Design
CEMEX Davenport North CDK Area



Method Name	Min FS
Spencer	1.449
GLE / Morgenstern-Price	1.448

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
CKD		115	Mohr-Coulomb	50	38
Cap		120	Mohr-Coulomb	0	32

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Figure C-5.6
Constructed CKD Cover – Seismic Analysis
Final Geotechnical Design
CEMEX Davenport North CDK Area