North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5
Geotechnical Report

Sonoma Valley County Sanitation District
Wastewater Treatment Plant
22333 8th Street East

Sonoma, California

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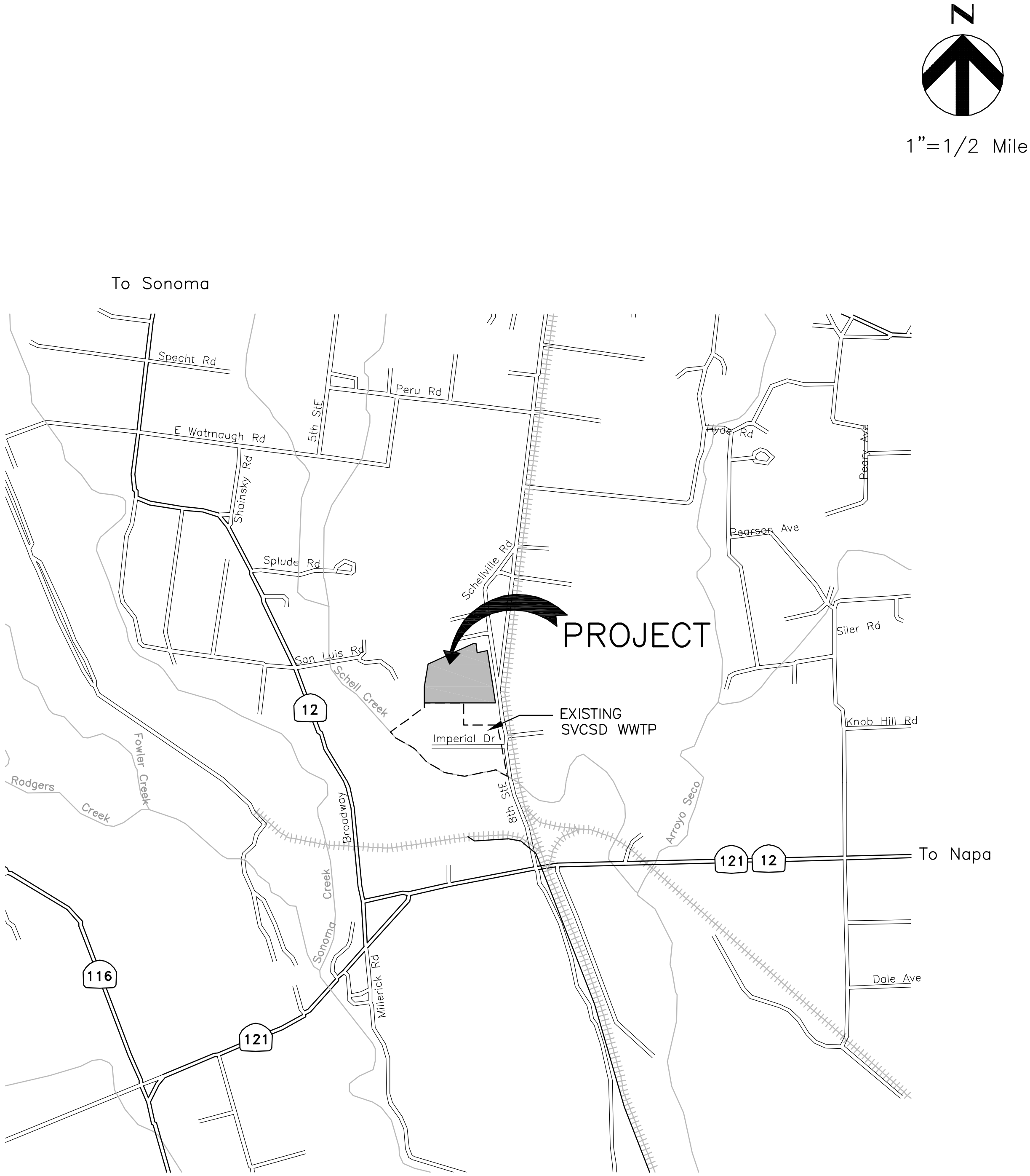
1.0 Project Description

The Sonoma Valley County Sanitation District is planning to construct a new tertiary effluent reservoir north of the existing Sonoma Valley Wastewater Treatment Plant (WWTP) facility. The current WWTP and proposed tertiary effluent reservoir project site are shown on the Vicinity Map, Figure 1.

The proposed tertiary effluent reservoir will consist of a lined pond that will retain up to approximately 100 acre-feet of treated water on the western portion of the site. The reservoir will be lined with a 60-mil High Density Polyethylene (HDPE) liner and consist of 3 horizontal to 1 vertical (3H:1V) waterside slopes and 2H:1V landside slopes, a crown at Elevation 34 feet (National Geodetic Vertical Datum of 1929, NGVD29), and a crown width of 16 feet. The reservoir embankments will be approximately 600 feet long in the east-west direction and 500 to 700 feet in the north-south direction. The bottom elevation of the reservoir will vary from about Elevation 15 feet in the southeast corner to about Elevation 17 feet in the northwest corner. Cuts up to 9 feet will be necessary to construct the reservoir.

The pond will have a maximum depth of 15 feet of water with 2 feet of freeboard and a design water surface elevation (DWSE) of 32 feet. The DWSE will be maintained at 32 feet with the standpipe. The standpipe will serve as an overflow structure, with the top of the standpipe at Elevation 32 feet. A recycled water pumping station is proposed in the southwest corner of the reservoir with a base at Elevation 13 feet. The discharge piping for the pumping station will connect to a 14” Recycled Water pipeline on the landside of the reservoir. The foundation for the discharge piping is proposed at Elevation 34.5 feet and will be built on the reservoir crown and a portion of the waterside reservoir slope.



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VICINITY MAP

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Sonoma Valley Effluent Reservoir R5

Date
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Figure
1

2.0 Site Conditions

The project site is located at 22333 8th Street East and is bounded by the Sonoma Valley WWTP to the south, vineyards to the west and north, and 8th Street East and Schellville Road to the east. The project site is bounded by a fence along the perimeter and several trees along the southern boundary. There is an access road from 8th Street East that runs along the southern boundary of the project site. There is a drainage path which runs in the north-south direction approximately 200 feet west of Schellville Road and approximately 100 feet east of the proposed easternmost embankment landside toe. The western portion of the project site is currently used as a grape vineyard and the remainder of the site consists of grasses.

The existing ground surface on the western side of the project site is about Elevation 27 feet and slopes downward at an approximate 70H:1V slope toward the drainage path at about Elevation 15 feet. The existing ground surface slopes up from the drainage path to Schellville Road at an approximate 30H:1V slope with the elevation of Schellville Road at approximately Elevation 23 feet.

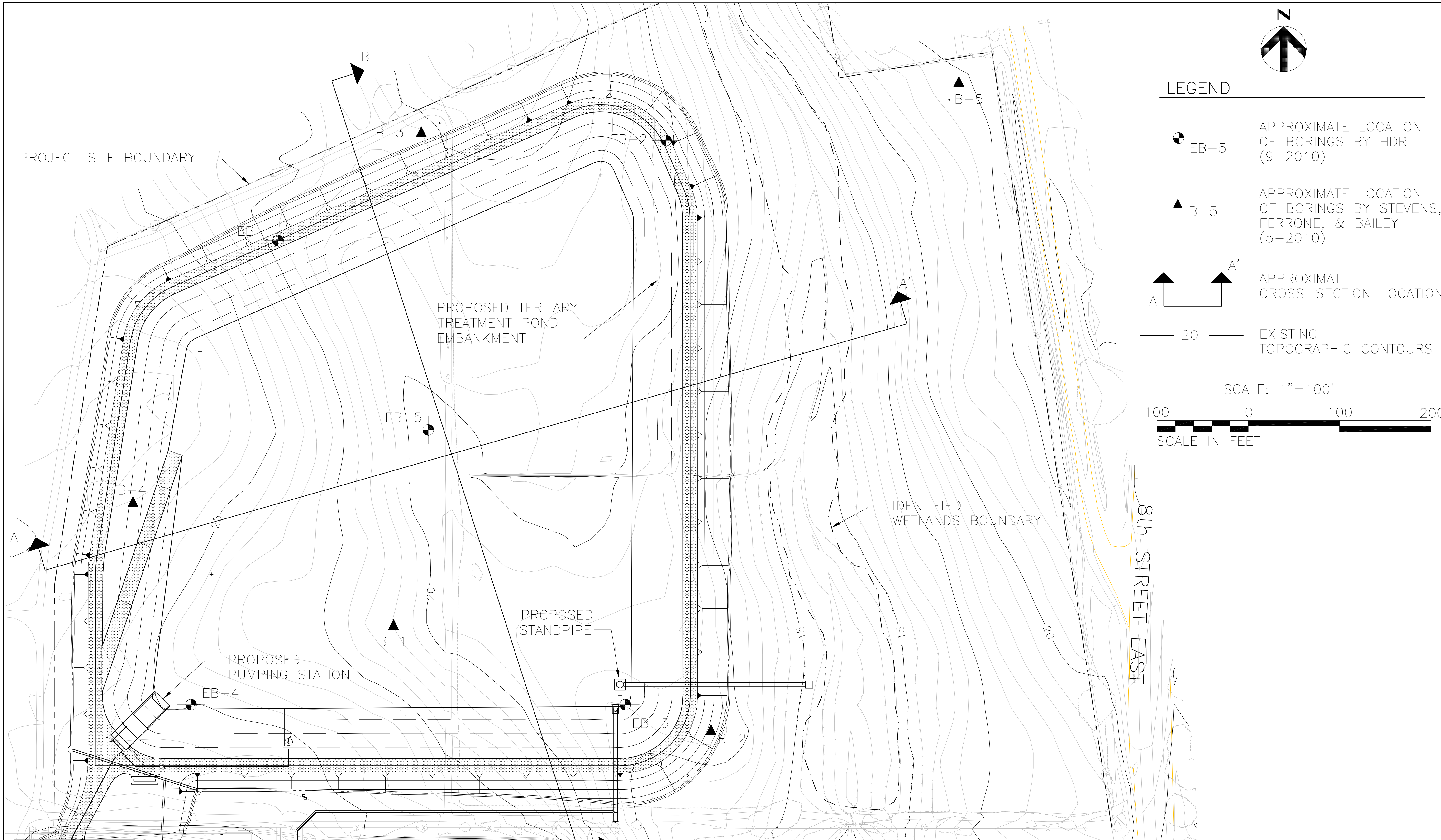
3.0 Site Characterization

Subsurface exploration was performed by drilling five borings in September 2010. The borings were drilled at each corner and in the middle of the proposed tertiary effluent reservoir to a maximum depth of 101½ feet below ground surface (bgs). The borings were drilled with a combination of auger and rotary drilling methods. Previous borings by Stevens, Ferrone, and Bailey Engineering Company, Inc. (SFB) to depths of 24½ to 41½ feet bgs in April 2010 were also considered for our subsurface characterization. The locations of the borings performed by HDR and previous borings by SFB are presented on the Boring Location Map, Figure 2.

Based on the data from our subsurface exploration and review of data by others, the existing subsurface consists of firm to very stiff clay (low to high plasticity) down to about Elevation 16 to 19 feet. The surface clay material was underlain by a medium dense to very dense clayey gravel to about Elevation 18 to 7 feet and medium dense to very dense silty sand and poorly-graded sand to a maximum of about Elevation 0 feet, then alternating layers of stiff clay and dense sand to the maximum depth explored of about Elevation -81 feet. The materials reviewed in the borings by SFB are in general agreement with the stratification encountered in our borings. The logs of our borings are presented in Appendix A and the logs of the previous borings by SFB are presented in Appendix C.

Groundwater was not established during our subsurface exploration due to the use of rotary drilling methods. However, SFB measured the groundwater in each boring and converted Boring B-2 to a piezometer during their field investigation. SFB measured the groundwater between about Elevation 16 to 23 feet in April 2010 during their field investigation. During our field investigation, groundwater was measured in the piezometer at 12 feet bgs (Elevation 4.5 feet) on September 7, 2010.

Laboratory testing was performed on selected samples obtained from our borings. Testing included moisture content, dry density, Atterberg Limits, sieve analysis, 200 wash, direct shear, and consolidation. The results of the laboratory testing are presented in Appendix B. The laboratory testing performed by SFB is noted on their logs and included in Appendix C.



EXISTING SONOMA WWTP FACILITY

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BORING LOCATION MAP

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Figure
2

4.0 Geotechnical Analysis and Results

The proposed embankment geometry and DWSE, stated above, was used in conjunction with topographic data, and geotechnical data provided in previous reports and obtained in our current subsurface and laboratory investigations.

4.1 Seepage Analyses

4.1.1 Seepage Models

Seepage analyses were completed to determine if the proposed configuration and embankment fill material will result in either underseepage or through seepage when the tertiary effluent reservoir is at the DWSE and the liner does not exist. Seepage analyses were performed with the DWSE at Elevation 32 feet, a landside slope of 2H:1V and waterside slope of 3H:1V. Due to the proposed standpipe outlet at Elevation 32 feet, seepage analyses were not performed for a water surface elevation (WSE) at the crown of the embankment.

Two cross-sections (A-A' in the east-west direction and B-B' in the north-south direction) were chosen to evaluate the likely range of topographic and subsurface conditions at the site. The locations of the cross-sections are shown on Figure 2 and the modeled cross-sections are shown are Figures D-1 and D-3 in Appendix D. HDR analyzed one model in each direction (east-west and north-south) for the side of the embankment with the most permeable material, resulting in two total models. The subsurface information for each model was derived considering the borings presented in Table 1 and the proposed embankment geometry and cuts described above.

Table 1. Subsurface Information Considered

Cross-Section	HDR Borings	SFB Borings
A-A'	EB-3, EB-4, EB-5	B-1, B-2, B-4
B-B'	EB-1, EB-4, EB-5	B-1, B-3

Hydraulic conductivity (also referred to as permeability) values selected for use in our seepage analyses were based upon classification information. The classification information was used in conjunction with the recommended permeability values for seepage analyses of levees presented in various reports prepared by URS for the DWR Urban Levee Program. The parameters used in our seepage analyses are summarized in Table 2 below and presented with more detail in Appendix D. The anisotropy ratio of vertical hydraulic conductivity over horizontal hydraulic conductivity for all materials was set to 0.25.

Table 2. Representative Horizontal Hydraulic Conductivities

Material	Horizontal Hydraulic Conductivity (cm/sec)
Compacted Clay Embankment	1×10^{-6}
GC	1×10^{-3}
SM	5×10^{-4}
CL/CH	1×10^{-6}

The seepage models extended to about the middle of the proposed tertiary effluent reservoir on the waterside and 400 feet from the reservoir embankment centerline on the landside. Where topographic and/or subsurface data was not available, a horizontal continuation of the ground surface and/or subsurface layering was assumed. The seepage models, illustrating topography and stratigraphy, are attached in Appendix D as Figures D-1 and D-3.

The finite element computer program used to model seepage was SEEP/W, Version 7.17. The boundary conditions for the models were as follows:

- Fixed-head boundary conditions set to the DSWE was used along the boundary nodes of the waterside reservoir embankment slope, pond bottom, and the waterside vertical edge of the model.
- Nodes along the bottom of the model were set to have no flow condition, corresponding to the presence of a low permeability aquiclude at this elevation.
- Nodes on the landside vertical edge were set to have no flow conditions. This boundary was set far away from the levee itself.
- Nodes on the landside reservoir embankment slope and the landside ground surface were modeled as potential seepage surfaces.

Seepage results from SEEP/W were reviewed for consistency and to confirm geometry, stratigraphy, and geotechnical parameters were modeled correctly.

4.1.2 Seepage Evaluation Criteria

The levee embankment seepage criteria presented in the EM 1110-2-1913 prepared by the USACE was used to evaluate the underseepage and through seepage for the tertiary effluent reservoir embankment. A maximum allowable seepage gradient of 0.5 (and a minimum Factor of Safety of 1.6 for soils with a saturated unit weight (γ_{sat}) less than 112 pounds per cubic foot, pcf) at the exterior toe of slope has been used as the benchmark to require mitigation for a given DWSE. As noted previously, a seepage analyses for a WSE at the embankment crown was not preformed. In addition, the seepage models conservatively assume the pond liner does not exist.

The levee embankment criteria provide by the USACE requires that the maximum allowable seepage gradient at the bottom of an empty ditch up to 150 feet from the exterior toe of slope be less than 0.8.

4.1.3 Seepage Results

The seepage analyses results of the proposed tertiary effluent reservoir embankment and existing subsurface conditions are presented graphically in Appendix D and are summarized in Table 3.

Average exit gradients are noted as i_{ave} which is the total head drop *in the vertical direction* across the subsurface landside blanket divided by the blanket thickness. This gradient value indicates potential piping or a blowout type failure through a low permeability blanket and is frequently referenced in typical levee design/evaluation manuals.

In addition, the average exit gradient, i_{ave}, was measured at the bottom of the drainage path for Cross-Section A-A' since the drainage path is within 150 feet of the proposed exterior toe of slope.

Table 3. Seepage Analysis Results – Proposed Pond Embankment

Cross-Section	Condition	DWSE	
		i_{ave}	FS
A-A'	Toe, Surface Layer	0.37	2.7
	Bottom of Drainage Path, Surface Layer	0.06	>2.0
B-B'	Toe, Surface Layer	0.47	2.1

Based on the results of our analyses of the existing conditions considering the DWSE, resulting average exit gradients over 0.5 and 0.8 at the exterior toe of the slope and at the drainage path, respectively, were not established.

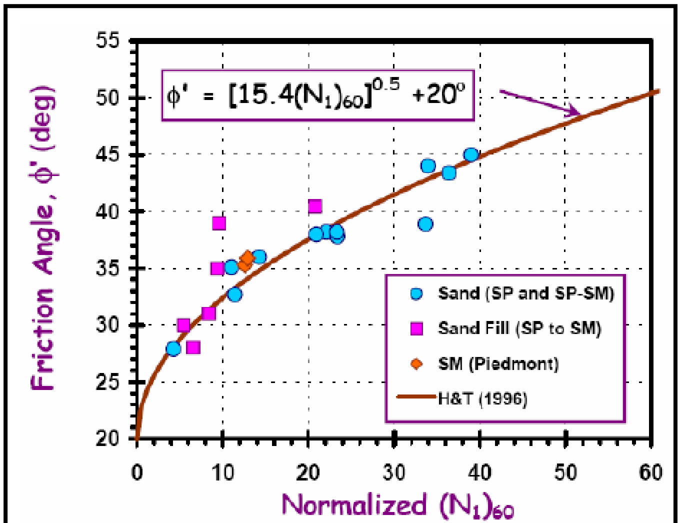
4.2 Slope Stability Analyses

4.2.1 Slope Stability Models

Slope stability analyses were performed to determine if the proposed geometry and embankment fill material would remain stable after construction. Embankment stability analyses were performed using the same stratigraphy and models used for the seepage analyses.

Unit weight values selected for use in our slope stability analyses were based upon laboratory test results and classification information. The effective shear strengths for use in or slope stability analyses were determined by using the available standard penetration test (SPT) blow counts provided in the boring logs and correlations between the equivalent blow count $(N_1)_{60}$, and Plasticity Index (PI). SPT blow counts presented on the boring logs were corrected to $(N_1)_{60}$ using correction factors recommended in the *Soil Liquefaction During Earthquakes* (Idriss and Boulanger, 2008).

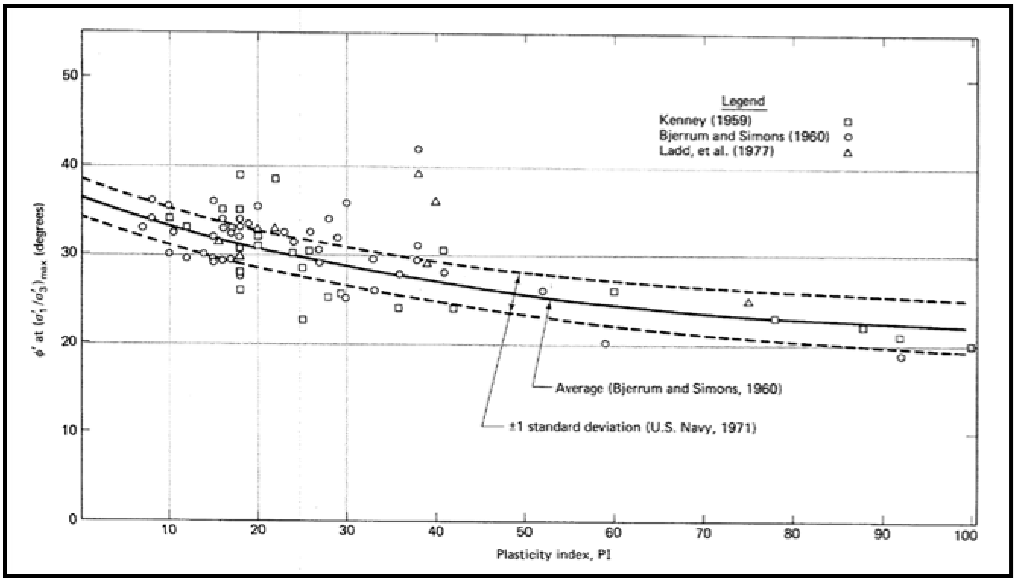
For sandy soils, effective friction angles (ϕ') were estimated using $(N_1)_{60}$ values following guidance found in Appendix C of the *Guidance Document for Geotechnical Analyses, Urban Levee Geotechnical Evaluations Program, Revision 6* (URS 2008) established by Hatanakata and Uchida (1996), shown in Graph 1. Effective cohesion was set to zero.



Peak Friction Angle of Sands from SPT Resistance
(adapted from Hatanakata & Uchida, 1996; Figure from FHWA NHI, 2002).

Graph 1. Effective Friction Angle of Sand Based on SPT Resistance

For the clay soils encountered, effective strength parameters were estimated using relationships established by Bjerrum and Simons (1960), Ladd et. al (1977), and others, shown in Graph 2. These relationships are largely based on the PI, which was obtained on select samples and presented on our boring logs. If the PI was not known, it was assumed to be 20, which yielded an ϕ' of 31 degrees. Based on our direct shear laboratory tests, the effective cohesion values were set to be 200 pounds per square foot (psf) for the reservoir embankment and 50 psf for the in-situ clay layers.



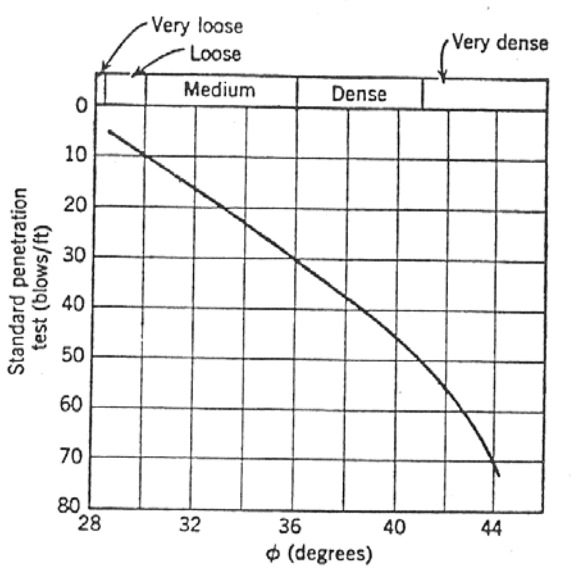
Graph 2. Effective Friction Angle of Normally Consolidated Clay Based on Plasticity Index

Table 4 summarizes the effective strength parameters used in our slope stability analyses. Due to the generally conservative nature of the parameters chosen, sensitivity analyses with varying parameters or geometry was not performed. The slope stability models, illustrating topography and stratigraphy, are attached in Appendix E as Figures E-1 and E-5.

Table 4. Representative Effective Strength Parameters

Material	Effective Strength Parameters	
	φ'	c' (psf)
Compacted Clay Embankment	28°	200
GC	40°	0
SM	36°	0
CL	30°	50

For sandy soils, total friction angles (ϕ_T) were estimated using SPT blow counts following guidance established by Peck, Hanson, and Thornburn (1953), shown in Graph 3. Total cohesion was set to zero.



Graph 3. Total Friction Angle of Sand Based on SPT Resistance

For the clay soils encountered, undrained strength parameters were estimated using SPT blow counts, pocket penetrometer and torvane shear values obtained during the field investigation.

Table 5 summarizes the undrained strength parameters used in our slope stability analyses. Due to the generally conservative nature of the parameters chosen, sensitivity analyses with varying parameters or geometry was not preformed. The slope stability models, illustrating topography and stratigraphy, are attached in Appendix E as Figures E-1 and E-8.

Table 5. Representative Undrained Strength Parameters

Material	Total Strength Parameters	
	ϕ_T	c (psf)
Compacted Clay Embankment	N/A	2,000
GC	36°	0
SM	32°	0
CL	N/A	2,500

The limit equilibrium computer program SLOPE/W, also part of the GeoStudio Version 7.17 software package, was used. The following cases were analyzed:

- End-of-Construction
- Rapid Drawdown
- Steady State (Static)
- Pseudo-static

Slope Stability results from SLOPE/W were reviewed for consistency and to confirm geometry, stratigraphy, and geotechnical parameters were modeled correctly.

4.2.2 Slope Stability Evaluation Criteria

The levee embankment slope stability criteria provided in the EM 1110-2-1902 by the USACE were used to evaluate the end of construction, rapid drawdown, and steady state cases for the tertiary effluent reservoir embankment. The required minimum factors of safety are:

- End of Construction 1.3
- Rapid Drawdown 1.0 to 1.2
- Steady State (Static) 1.4
- Pseudo-static 1.0

4.2.3 Slope Stability Results

The end of construction model uses the undrained soil strength values presented in Table 5 and no water in the reservoir. The rapid drawdown model uses the effective soil strength values from Table 4 and the piezometric surface from the seepage model. The steady state model uses the effective soil strength values presented in Table 4 and the DWSE of Elevation 32 feet. The pseudo-static model uses the undrained soil strength values presented in Table 5 for the fine-grained soils and the effective soil strength values from Table 4 for the coarse-grained soils. In addition, a horizontal seismic coefficient of 0.23g was applied to the pseudo-static model. This value corresponds to $^{1}/_{2}$ of the Peak Ground Acceleration (PGA) expected at the project site based on the recommendations in Hynes-Griffen and Franklin (1984). More discussion of the PGA is presented in Section 4.9 below.

The slope stability analyses results of the proposed tertiary effluent reservoir embankment and existing subsurface conditions are presented graphically in Appendix E and are summarized in Table 6.

Table 6. Slope Stability Analyses – Proposed Pond Embankment

Cross-Section	Condition	FS
A-A'	End of Construction (landside)	4.22
	End of Construction (waterside)	4.12
	Rapid Drawdown	1.98
	Steady State (Static)	1.91
	Pseudo-static (landside)	1.67
	Pseudo-static (waterside)	2.38
B-B'	End of Construction (landside)	4.28
	End of Construction (waterside)	4.72
	Rapid Drawdown	2.17
	Steady State (Static)	1.84
	Pseudo-static (landside)	1.78
	Pseudo-static (waterside)	2.60

As shown in Table 6, the results meet the project requirements for end of construction, rapid drawdown, steady state (static), and pseudo-static slope stability for the DWSE for the proposed tertiary effluent reservoir embankment.

4.3 Settlement Analyses

4.3.1 Settlement Parameters

Foundation settlement due to reservoir embankment construction was evaluated using a simplified soil stratigraphy developed from the cross-sections mentioned above. Consolidation characteristics, such as compression index, recompression index, Over Consolidation Ratio (OCR), and maximum past pressure, were obtained from the consolidation laboratory test and are presented in Table 7. The settlement calculation is presented in Appendix F.

Table 7. Representative Consolidation Parameters

Material	Consolidation Characteristics			
	$C_{c\varepsilon}$	$C_{r\varepsilon}$	Maximum Past Pressure, σ'_p (psf)	OCR
CL (~Elevation 30 feet)	0.08	0.01	5,200	2.2

4.3.2 Settlement Results

Settlement of the existing underlying clay layers could potentially occur as the tertiary effluent reservoir embankment is built and load is applied to the existing subsurface soils. However, the expected total and differential settlement is small (< ½") and is not expected to impact the embankment or require special design measures.

4.4 Liquefaction Analyses

4.4.1 Liquefaction Parameters

A liquefaction analyses was performed using the information obtained during the subsurface exploration. The ground motion parameters for the project site were obtained from the USGS 2002 Interactive Deaggregations website (http://eqint.cr.usgs.gov/deaggint/2002/). The approximate latitude and longitude coordinates of the project site were entered to obtain the governing fault and PGA for the project site where there is a 10 percent probability of exceedance in 50 years event. For the project site, the PGA expected is 0.45g.

The sample depth, blow count, estimated unit weight, and soil type were entered into a spreadsheet developed following the guidelines from Idriss and Boulanger (2008). For the soil layers that were susceptible to liquefaction, the liquefaction induced settlement was estimated using the procedures by Tokimatsu and Seed (1987). The liquefaction analyses spreadsheets are presented in Appendix G.

4.4.2 Liquefaction Results

The project site is located within an area of high seismic exposure and strong ground shaking can be expected over the life of the proposed tertiary effluent reservoir. Liquefaction is expected to occur in the coarse-grained sand layer around Elevation -10 to -15 feet. Based on the boring logs, the coarse-grained layers expected to liquefy are relatively thin (3 to 5 feet). Therefore, liquefaction induced settlement is expected to be less than ½" at the project site and special design measures are not required.

5.0 Conclusions and Recommendations

Since the results of our seepage analyses indicate average exit gradients for the more permeable soil strata do not exceed the maximum exit gradient criteria values and are above minimum FS values, underseepage and through seepage are not considered to affect the proposed tertiary effluent reservoir embankment.

The results of our slope stability analyses met the project requirements for end of construction, rapid drawdown, steady state (static), and pseudo-static slope stability for the DWSE. Therefore, slope instability of the proposed tertiary effluent reservoir embankment is not expected after construction is complete.

The results of our settlement analyses show minimal settlement of the existing underlying clay material is expected due to the construction of the tertiary effluent reservoir embankment. The results of our liquefaction analyses show liquefaction is expected to occur in the coarse-grained sand layer encountered at about Elevation -10 to -15 feet. However, the liquefaction induced settlement is expected to be minimal. After a seismic event, the tertiary effluent reservoir embankment should be surveyed for deformation and repaired as needed. Special design measures are not necessary regarding settlement and liquefaction.

Both seepage and slope stability models were developed assuming use of on-site soil to construct the proposed embankment. As mentioned previously, cuts up to 9 feet are expected in areas of higher elevation (western portion of the site). Based on our field investigation and previous investigations by others, we anticipate the excavated material will consist of clay with varying plasticity.

5.1 Earthwork

5.1.1 Site Preparation

Excavation of existing soil material is expected to be readily achieved using typical heavy-duty grading equipment. All debris and organic matter should be removed from the site prior to grading. Based on the project information, excavation is expected to extend to about Elevation 17 feet in the northwest portion of the reservoir and about Elevation 15 feet in the southeast portion of the reservoir. The excavation should extend horizontally 5 feet beyond the exterior and interior toes of slope.

In order to remove the surficial clay layer and reduce the average exit gradients, the excavation should extend to the top of the gravel layer (typically encountered to about Elevation 15 feet during our subsurface investigation). In addition, an inspection trench should be excavated below the bottom of the reservoir embankment excavation to confirm the absence of clay material. The inspection trench should be 12 feet wide and extend to 5 feet below the base of the excavation (about Elevation 12 to 10) and should not be within 10 feet of a vertical excavation. The inspection trench can be backfilled with compacted granular material, if it is encountered, or the surficial clay material. Our geotechnical representative should be present during the excavation of the inspection trench and preparation of the embankment foundation.

5.1.2 Fill Material

Type 1 fill material, whether on-site or import, should meet the following criteria:

- Liquid Limit (LL) is less than or equal to 45
- Plasticity Index (PI) is greater than or equal to 8 and less than or equal to 25
- Fines content (Passing the no. 200 sieve) is greater than or equal to 20% and less than or equal to 80%
- Maximum particle size is less than or equal to 2 inches

Type 2 fill material, should meet the following criteria:

- Liquid Limit (LL) can be greater than 45
- Plasticity Index (PI) is greater than or equal to 8 and less than or equal to 40
- Fines content (Passing the no. 200 sieve) is greater than or equal to 20% and less than or equal to 80%
- Maximum particle size is less than or equal to 2 inches

Type 1 fill material and can be used throughout the embankment. Type 2 fill material should only be used in the core of the embankment and have at least 3 feet of Type 1 fill material cover. Based on the information obtained and reviewed, we estimate about 50 percent of the material in the proposed cut is Type 2 fill material, and limited to being used as core material. Visual classification in the field by our geotechnical representative should be used to verify the suitability of the excavated material. In addition, an Atterberg limits laboratory test (ASTM D4318) should be performed for every 1,000 cubic yards of material excavated to verify the visual field classification.

5.1.3 Temporary Slopes

Temporary construction slopes deeper than 5 feet should be no steeper than 1H:1V and should be designed in accordance with OSHA requirements. Vertical slopes not exceeding 5 feet may be used adjacent to the property line and in the inspection trench, if needed. Shoring should also be designed in accordance with OSHA requirements, if used.

5.1.4 Permanent Slopes

Permanent waterside and landside slopes of the tertiary effluent reservoir embankment should not be constructed steeper than 3H:1V and 2H:1V, respectively. In addition, the embankment material is potentially erodible and erosion protection should be used on the slopes. Regular inspection and maintenance of the slopes and pond liner should be performed.

5.1.5 Compaction

Where the tertiary effluent reservoir embankment will be constructed, the subgrade should be scarified to a depth of 12 inches, moisture conditioned as necessary and compacted to 97 percent of the maximum density per American Society of Testing and Materials (ASTM) D698, with a moisture content between -1 and +3 percent of the optimum. The tertiary effluent reservoir embankment should be compacted to 97 percent of the maximum density per ASTM D698, with a moisture content between -1 and +3 percent of the optimum. Fill material should be placed in loose lifts, not exceeding 8 inches.

Where structures or slabs-on-grade will be constructed on fill material, the subgrade should be compacted to 100 percent of the maximum density per ASTM D698, with a moisture content between -1 and +3 percent of the optimum.

Where pipelines or trenches will be constructed within the reservoir embankment prism, the backfill should be compacted to 97 percent of the maximum density per ASTM D698, with a moisture content between -1 and +3 percent of the optimum.

Where pipelines or trenches will be constructed outside the reservoir embankment prism, the backfill should be compacted to 90 percent of the maximum density per ASTM D1557. Within 3 feet of finished grade under roadways, the subgrade should be compacted to 95 percent of the maximum density per ASTM D1557.

5.1.6 Volume Change

Based on the soils encountered in our borings and the previous borings by others, and the results of our laboratory tests, we anticipate volume shrinkage of approximately 10 to 15 percent for soils that are removed during grading and compacted to 97 percent relative compaction per ASTM D698 and 90 percent relative compaction per ASTM D1557. This volume shrinkage estimate should be used for planning purposes only and the grading contractor should arrive at their own conclusions.

5.1.7 Design Changes

If the configuration of the proposed tertiary effluent reservoir embankment and excavation changes from what is shown on the plans or recommended herein, HDR should be consulted for concurrence and potential supplemental analyses. In addition, HDR should be given the opportunity to review the plans and specifications prior to construction.

5.2 Foundation

5.2.1 Foundation Support

The pump station should be supported on spread footings bearing on either undistributed native soils or compacted fills. Footings should be at least 12 inches wide and founded at least 24 inches below lowest adjacent finished grade.

The footings should be designed for an allowable bearing pressure of 2,000 pounds per square foot (psf) due to dead loads, 3,000 psf due to dead plus live loads, and 4,000 psf for all loads, including wind and seismic. These allowable bearing pressures are net values; therefore, the weight of the footing can be neglected for design purposes. At least 10 feet of soil cover, measured laterally from the face of the footing to the face of reservoir embankment slopes, should be provided in order to generate the full vertical resistance. Deepening of footings on or near slopes may be necessary to acquire the full vertical resistance.

Where footings are located adjacent to utility trenches or excavations, the foundation bearing surface should bear below and imaginary 1.5H:1V place extending upward from the bottom edge of the adjacent utility trench or base excavation. Alternatively, the foundation reinforcing could be increased to span the area defined above assuming no soil support is provided.

Wetting prior to construction of the foundations should close any visible cracks in the bottoms of the footing excavations. An HDR geotechnical representative should observe the footing excavations prior to placing reinforcing steel or concrete to check that footings are founded on the appropriate materials.

Lateral load resistance for the proposed footings and pump station walls can be developed by friction between the foundation bottom and the supporting subgrade. A friction coefficient of 0.3 is considered applicable. As an alternative, a passive resistance equal to an equivalent fluid weighing 300 pcf acting against the vertical face of the foundations could be used; however the upper 1 foot should be ignored in the passive resistance design. If foundations are poured neat against the soil, the friction and passive resistance can be used in combination. The portion of the footing located within 10 feet (as measured laterally) of the nearest slope face should be ignored in the passive resistance design.

5.2.2 Pumping Station Walls

The pumping station walls should be designed to resist both lateral earth pressures and any additional lateral loads caused by surcharging. We recommend that an active condition (unrestrained walls) without drainage be designed to resist an equivalent fluid pressure of 85 pounds per cubic foot (pcf). An at-rest condition (restrained walls) without drainage should be designed to resist an equivalent fluid pressure of 95 pcf. Both cases assume a level backfill. Walls with inclined backfill should be designed for an additional equivalent fluid pressure of 1 pcf for every 2 degrees of slope inclination. Walls subjected to surcharge loads should be designed for an additional uniform lateral pressure equal to 1/3 or ½ the anticipated surcharge load for unrestrained or restrained walls, respectively.

Retaining walls should be supported on spread footing foundations designed in accordance with the recommendations presented previously in Section 5.2.1.

6.0 Limitations

Site exploration and testing characterizes subsurface conditions only at the locations where the explorations or tests are performed; actual subsurface conditions between explorations or tests may be different than those described in this report. Variations of subsurface conditions from those analyzed or characterized in this report are not uncommon and may become evident during construction. In addition, changes in the condition of the site can occur over time as a result of either natural processes (such as earthquakes, flooding, or changes in ground water levels) or human activity (such as construction adjacent to the site, dumping of fill, or excavating). If changes to the site's surface or subsurface conditions occur since the performance of the field work described in this report, or if differing subsurface conditions are encountered, we should be contacted immediately to evaluate the differing conditions to assess if the opinions, conclusions, and recommendations provided in this report are still applicable or should be amended.

This report is a design document that has been prepared in accordance with generally accepted geotechnical engineering practices for the exclusive use of the Sonoma Valley County Sanitation District and their consultants for specific application to the proposed tertiary effluent reservoir at the Sonoma WWTP project in Sonoma, California. The conclusions and recommendations contained in this report are solely professional opinions. It is the responsibility of the Sonoma Valley County Sanitation District to transmit the information and recommendations of this report to those designing and constructing the project. We will not be responsible for the misinterpretation of the information provided in this report.

In the event that there are any changes in the nature, design or location of the project, as described in this report, or if any future additions or expansions are planned, the conclusions and recommendations contained in this report shall not be considered valid unless we are contacted in writing, the project changes are reviewed by us, and the conclusions and recommendations presented in this report are modified or verified in writing. The opinions, conclusions, and recommendations contained in this report are based upon the description of the project as presented in the introduction section of this report.

7.0 Reference Documents

1. "*Seepage Analysis and Control for Dams*," Engineer Manual, EM 1110-2-1901, United States Army Corps of Engineers, 30 September 1986; 30 April 1993 (Change 1).
2. "*Laboratory Investigations and Testing*," Engineer Regulation, ER 1110-1-8100, United States Army Corps of Engineers, 31 December 1997.
3. "*Design and Construction of Levees*," Engineer Manual, EM 1110-2-1913, United States Army Corps of Engineers, 30 April 2000.
4. "*Geotechnical Investigations*," Engineer Manual, EM 1110-1-1804, United States Army Corps of Engineers, 1 January 2001.
5. "*Design Guidance for Levee Underseepage*," Engineer Technical Letter, ETL 1110-2-569, United States Army Corps of Engineers, 1 May 2005.
6. *"Soil Liquefaction During Earthquakes*."Idriss, I. M., and Boulanger, R. W., Monograph MNO-12, Earthquake Engineering Research Institute, Oakland, CA, 2008.
7. *"Evaluation of Settlement in sand due to earthquake shaking*." Tokimatsu, K. and Seed, H.B. Journal of Geotechnical Engineering, ASCE, Vol. 113 (8): 861-878, 1987.
8. *"Rationalizing the seismic coeffeicent method*." Hynes-Griffen, M.E. and Franklin, A.G. Rep. No. GL-84-13, United States Army Corps of Engineers Waterways Experiment Station, 1984.
9. "*Empirical correlation between penetration resistance and effective friction of sandy soil*." Hatanaka, M. and Uchida, A. Soils & Foundations, Vol. 36 (4), Japanese Geotechnical Society. (1996).
10. "*Comparison of Shear Strength Characteristics of Normally Consolidated Clays*." Bjerrum, L. and Simons, N.E. Proceedings of the ASCE Research Conference on Shear Strength of Cohesive Soils. 1960.
11. Peck, R. B., Hanson, W. E., and Thornburn, T. H. 1974. *Foundation Engineering*, Wiley, NY.

APPENDIX A

SUBSURFACE EXPLORATION

Subsurface Exploration

Our field investigation for the Sonoma Valley WWTP tertiary effluent reservoir consisted of a surface reconnaissance and a subsurface exploration program using a truck-mounted Diedrich D-120 drill rig equipped with continuous flight, hollow stem augers and rotary drilling equipment. Five 6-inch diameter exploratory borings were drilled between September 7 and 10, 2010, to a maximum depth of 101½ feet. The locations of the current exploratory borings by HDR and the previous borings by others are shown on the Boring Location Map, Figure 2. Our representative continuously logged the soils encountered in the borings in the field. The soils descriptions on our boring logs are in general accordance with the Unified Soil Classification System (ASTM D2487). The logs of the borings as well as a boring legend (Figure A-1) are included as part of this appendix.

Borings by others were drilled at or near the tertiary effluent reservoir site in April 2010 to a maximum depth of 41½ feet. The boring logs by others are included in Appendix C.

Representative samples were obtained from our exploratory borings at selected depths appropriate to the investigation and field classified in general accordance with ASTM 2488. Relatively undisturbed samples were obtained using a 3-inch O.D. (Modified California) split barrel sampler with liners, and disturbed samples were obtained using the 2-inch O.D. (Standard Penetration Test, SPT) split spoon sampler. Samples obtained in liners in the Modified California Sampler were capped to retain moisture. Samples obtained in the SPT sampler were placed in sealed "ziplock" baggies. All samples were transmitted to our facilities for evaluation and appropriate testing. Both sampler types are indicated in the "Sampler" column of the boring logs as designated in Figure A-1.

Resistance blow counts were obtained in our borings with the samplers by dropping a 140-pound, automatic hammer through a 30-inch free fall. The sampler was driven 18 inches, or a shorter distance where hard resistance was encountered, and the number of blows were recorded for each 6 inches of penetration. The diagonally-stacked blows recorded on the boring logs represent the individual blows for each 6 inches of driving. The blows per foot is accumulated number of blows that were required to drive the last 12 inches, or the number of inches indicated where hard resistance was encountered. The blow counts recorded on the boring logs are equivalent SPT blow counts and have been corrected for sampler size and hammer energy, but have not been corrected for overburden, silt content, or other factors.

A hammer efficiency test was not performed as part of the subsurface investigation. Therefore, the hammer efficiency was assumed at 90%. This efficiency is 150% ($C_E = 1.5$) of an ideal 60% efficient cathead and rope hammer system. Therefore, in order to determine the corrected field blow count, N_{60}, the field blows were multiplied by 1.5 for samples. N_{60} values are presented on the boring logs.

The borings were backfilled with a neat cement grout, in accordance with the Sonoma County Environmental Health Department guidelines.

The elevations discussed in this report and shown on the boring logs were estimated from the topographic map from the Sonoma County Sanitation District. The elevations are referenced to the National Geodetic Vertical Datum of 1929, NGVD29. A summary of the boring vertical data is presented in Table A-1 below.

The latitude and longitude of the boring locations was not estimated during the subsurface exploration.

The attached HDR boring logs and related information show our interpretation of the subsurface conditions at the dates and locations indicated.

Table A-1. Boring Data

Boring	Surface Elevation, NGVD29 (ft)	Depth (ft)
EB-1	25.0	56.5
EB-2	20.5	101.5
EB-3	17.5	61.5
EB-4	25.0	61.5
EB-5	19.5	41.5

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

MATERIAL TYPES	CRITERIA FOR ASSIGNING SOIL GROUP NAMES			GROUP SYMBOL	SOIL GROUP NAMES & LEGEND
COARSE-GRAINED SOILS >50% RETAINED ON NO. 200 SIEVE	GRAVELS >50% OF COARSE FRACTION RETAINED ON NO 4. SIEVE	CLEAN GRAVELS <5% FINES	$C_u \geq 4$ AND $1 \leq C_c \leq 3$	GW	WELL-GRADED GRAVEL
			$C_u < 4$ AND/OR $1 > C_c > 3$	GP	POORLY-GRADED GRAVEL
		GRAVELS WITH FINES >12% FINES	FINES CLASSIFY AS ML OR MH	GM	SILTY GRAVEL
			FINES CLASSIFY AS CL OR CH	GC	CLAYEY GRAVEL
	SANDS >50% OF COARSE FRACTION PASSES NO 4. SIEVE	CLEAN SANDS <5% FINES	$C_u \geq 6$ AND $1 \leq C_c \leq 3$	SW	WELL-GRADED SAND
			$C_u < 6$ AND/OR $1 > C_c > 3$	SP	POORLY-GRADED SAND
		SANDS AND FINES >12% FINES	FINES CLASSIFY AS ML OR MH	SM	SILTY SAND
			FINES CLASSIFY AS CL OR CH	SC	CLAYEY SAND
FINE-GRAINED SOILS >50% PASSES NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT<50	INORGANIC	PI>7 AND PLOTS>"A" LINE	CL	LEAN CLAY
			PI>4 AND PLOTS<"A" LINE	ML	SILT
		ORGANIC	LL (oven dried)/LL (not dried)<0.75	OL	ORGANIC CLAY OR SILT
	SILTS AND CLAYS LIQUID LIMIT>50	INORGANIC	PI PLOTS >"A" LINE	CH	FAT CLAY
			PI PLOTS <"A" LINE	MH	ELASTIC SILT
		ORGANIC	LL (oven dried)/LL (not dried)<0.75	OH	ORGANIC CLAY OR SILT
HIGHLY ORGANIC SOILS		PRIMARILY ORGANIC MATTER, DARK IN COLOR, AND ORGANIC ODOR		PT	PEAT

OTHER SYMBOLS

MATERIALS
- Asphalt
- Aggregate Base
- Boulders & Cobbles
- Fill
- Topsoil

WELL
- Concrete Grout/Fill
- Bentonite/Grout Seal
- Sand Pack + Solid Pipe
- Sand Pack + Slotted Pipe

SAMPLERS
- SPT (2" OD)
- Modified California (3" OD)
- California (2.5" OD)
- Shelby Tube
- Pitcher Barrel
- HQ Core

INITIAL WATER LEVEL MEASUREMENT(WITH DATE)

STABILIZED WATER LEVEL MEASUREMENT(WITH DATE)

GRAIN SIZES

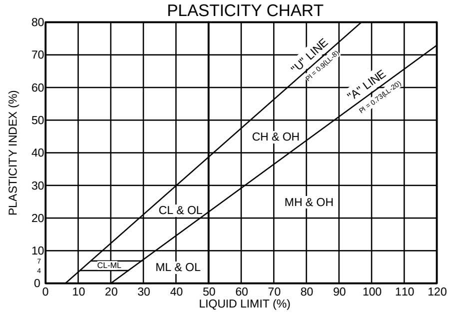
U.S. STANDARD SIEVE	200	40	10	4	3/4"	3"	12"
SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

PENETRATION RESISTANCE

SAND & GRAVEL		SILT & CLAY		
RELATIVE DENSITY	BLOWS/FOOT*	CONSISTENCY	BLOWS/FOOT*	UNC. COMP. STRENGTH (KSF)
VERY LOOSE	0 - 3	VERY SOFT	0 - 1	0 - 1/2
LOOSE	4 - 9	SOFT	2 - 4	1/2 - 1
MEDIUM DENSE	10 - 29	FIRM	5 - 8	1 - 2
DENSE	30 - 50	STIFF	9 - 15	2 - 4
VERY DENSE	OVER 50	VERY STIFF	15 - 30	4 - 8
		HARD	OVER 30	OVER 8

* NUMBER OF BLOWS OF 140 LB HAMMER FALLING 30 INCHES TO DRIVE A 2 INCH O.D. (1-3/8 INCH I.D.) SPLIT-BARREL SAMPLER THE LAST 12 INCHES OF AN 18-INCH DRIVE (ASTM-1586 STANDARD PENETRATION TEST).

PLASTICITY CHART



NOTES

BGS	BELOW GROUND SURFACE
c	COHESION
CD	CONSOLIDATED DRAINED TRIAXIAL
CN	CONSOLIDATION
CR	CORROSIVITY
CU	CONSOLIDATED UNDRAINED TRIAXIAL
DS	DIRECT SHEAR
EI	EXPANSION INDEX
LL	LIQUID LIMIT
N_{60}	BLOW COUNT, Corrected for Hammer Energy Only
PI	PLASTICITY INDEX
PR	PERMEABILITY
RV	R-VALUE
SA	SIEVE ANALYSIS
-200	% PASSING NO. 200 SIEVE
TC	CYCLIC TRIAXIAL
UC	UNCONFINED COMPRESSION
UU	UNCONSOLIDATED UNDRAINED TRIAXIAL

INCREASING VISUAL MOISTURE CONTENT

SATURATED
WET
MOIST
DAMP
DRY

COMPONENT PERCENTAGE

PRIMARY	>50%
SECONDARY (-y)	30 - 50%
WITH	15 - 30%
TRACE	0 - 15%

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Boring Legend

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date: JAN 2011

Figure: A-1

LOGGED BY: **Kimberly Brown** DATE: START **9/8/10** END **9/9/10**

STATION & OFFSET: **N/A,** LATITUDE: **38.2550** LONGITUDE: **-122.4450** O.G. ELEV.: **25.0 ft**

DRILL RIG: **Diedrich D-120** DRILLING COMPANY: **Andy Elbon/Taber Consultants**

DRILL METHOD: **Auger, Rotary** BIT DIAMETER: **6"** GROUNDWATER DATA: DEPTH: DEPTH:

CASING TIP DEPTH: **5.0 ft** HAMMER: **Automatic** NOT ENCOUNTERED ☐ TIME: TIME:

CHECKED BY: **Chris Trumbull** DATE: **10/20/10** NOT ESTABLISHED ☒ DATE: DATE:

SAMPLE DEPTH (ft)	SAMPLE NO./ CORE RUN	FIELD BLOWS/6 IN (N_{60})	POCKET PEN (ksf)	TORVANE (ksf)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	OTHER TESTS	DEPTH (ft) / ELEVATION (ft)	DESCRIPTION	REMARKS
0.0–1.5	1	8, 12, 15 (27)			96	6	AT	0 / 25	Dark Brown, CLAY (CL), low plasticity clay, trace subangular coarse gravel, very stiff, dry	
2.5–4.0	2	12, 5, 12 (26)							Dark Brown, Gravelly SAND (SW-SC), fine- to coarse-grained sand, subangular fine gravel, trace low plasticity clay, medium dense, dry	
5.0–6.5	3	10, 17, 12 (29)						5 / 20	moist	
7.5–9.0	4	11, 13, 26 (39)							dense	
10.0–11.5	5	5, 15, 16 (47)					SA	10 / 15		
12.5–14.0	6	10, 15, 18 (33)	>9.0	6.0	95	28			Brown, CLAY (CL), low plasticity, hard, moist	Switch to Mud Rotary
15.0–16.5	7	6, 8, 10 (18)	7.0	4.0				15 / 10	trace fine-grained sand, very stiff	
17.5–19.0	8	4, 5, 6 (11)					-200		Brown, SAND with Silt (SM), fine-grained sand, low plasticity silt, medium dense, moist	
20.0–21.5	9b	6, 7, 9 (16)			82	36		20 / 5		
									Dark Brown, SAND with Gravel (SP), fine- to medium-grained snad, subangular fine gravel, very dense, wet	
25.0–26.5	10	27, 30, 21 (51)			106	20	SA	25 / 0		
								30 / -5		

HDR

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Boring Log

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date: JAN 2011

Boring: EB-1

SAMPLE DEPTH (ft)	SAMPLER	SAMPLE NO./ CORE RUN	FIELD BLOWS/6 IN (N_{60})	POCKET PEN (ksf)	TORVANE (ksf)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	OTHER TESTS	DEPTH (ft)	ELEVATION (ft)	MATERIAL GRAPHIC	DESCRIPTION	REMARKS
30.0–31.5		11	10 14 27 (41)									Brown, Silty SAND (SM), fine-grained sand, low plasticity silt, trace subrounded fine gravel, dense, moist, orange mottles *(continued)*	
												Brown, SAND with Silt (SP-SM), medium-grained sand, low plasticty silt, trace subrounded fine gravel, medium dense, wet	
35.0–36.5		12b 12c	6 8 3 (17)						35	-10			35
												Dark Gray, CLAY (CL), low plasticity, very stiff, moist	
40.0–41.5		13	4 8 15 (23)					AT	40	-15		trace subangular fine gravel	40
												Dark Brown, SAND (SW-SC), medium- to coarse-grained sand, trace low plasticity clay and subangular fine gravel, very dense, wet	
45.0–46.5		14	19 21 23 (67)					SA	45	-20			45
50.0–51.5		15b 15c	15 17 15 (32)	3.0 3.0	4.0 3.0				50	-25			50
												Dark Gray, CLAY (CL), low plasticity, hard, moist	
												Dark Gray, Sandy CLAY (CL), low plasticity clay, fine-grained sand, very stiff, moist	
55.0–56.5		16	6 8 11 (19)						55	-30			55

Boring terminated at 56.5' below ground surface

Boring backfilled with cement grout

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Boring Log

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date: JAN 2011

Boring: EB-1

LOGGED BY: **Kimberly Brown** DATE: START **9/8/10** END **9/8/10**

STATION & OFFSET: **N/A,** LATITUDE: **38.2550** LONGITUDE: **-122.4430** O.G. ELEV.: **20.5 ft**

DRILL RIG: **Diedrich D-120** DRILLING COMPANY: **Andy Elbon/Taber Consultants**

DRILL METHOD: **Auger, Rotary** BIT DIAMETER: **6"** GROUNDWATER DATA: DEPTH: DEPTH:

CASING TIP DEPTH: **5.0 ft** HAMMER: **Automatic** NOT ENCOUNTERED ☐ TIME: TIME:

CHECKED BY: **Chris Trumbull** DATE: **10/20/10** NOT ESTABLISHED ☒ DATE: DATE:

SAMPLE DEPTH (ft)	SAMPLE NO./ CORE RUN	FIELD BLOWS/6 IN (N_{60})	POCKET PEN (ksf)	TORVANE (ksf)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	OTHER TESTS	DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	REMARKS
0.0–1.5	1	5, 10, 10 (20)	>9.0						20	Brown, CLAY (CL) with sand, low plasticity clay, fine-grained sand, very stiff, dry	
2.5–4.0	2	8, 8, 15 (23)	>9.0		106	18	AT				
										Brown, Silty SAND (SM), fine- to medium-grained sand, low plasticity silt, trace subangular to subrounded fine gravel, dense, moist	
5.0–6.5	3b 3c	12, 20, 28 (48)	>9.0 9.0		90	28	-200	5	15		
7.5–9.0	4b 4c	8, 19, 38 (57)	>9.0		107	20	DS			very dense	
10.0–11.5	5	7, 7, 9 (25)						10	10	medium dense	
12.5–14.0	6	8, 7, 8 (15)					-200			no gravel	Switch to Mud Rotary
15.0–16.5	7	3, 4, 5 (14)						15	5		
17.5–19.0	8	4, 6, 7 (13)								Dark Brown, SAND (SP-SM), fine- to medium-grained sand, trace low plasticity silt and subangular fine gravel, medium dense, wet	No Recovery
20.0–21.5	9	10, 8, 14 (33)					SA	20	0	dense	
25.0–26.5	10	13, 19, 16 (53)						25	-5	very dense	
								30			

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Boring Log

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date: JAN 2011

Boring: EB-2

SAMPLE DEPTH (ft)	SAMPLER	SAMPLE NO./ CORE RUN	FIELD BLOWS/6 IN (N_{60})	POCKET PEN (ksf)	TORVANE (ksf)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	OTHER TESTS	DEPTH (ft)	ELEVATION (ft)	MATERIAL GRAPHIC	DESCRIPTION	REMARKS
30.0 31.5		11b 11c	12 6 7 (13)	3.0	2.0			CN		-10		Dark Gray, CLAY (CL), low plasticity clay, trace fine-grained sand, stiff, moist *(continued)*	
35.0 36.5		12b 12c	6 7 8 (15)	4.0 2.0	3.0				35	-15			35
40.0 41.5		13b 13c	8 9 13 (22)	2.0	3.0	88	29	AT	40	-20		very stiff	40
												Dark Gray, SAND (SP), medium- to coarse-grained sand, trace subangular fine gravel, very dense, wet	
45.0 46.5		14b 14c	16 38 50/6"					SA	45	-25			45
50.0 51.5		15	7 19 26 (68)						50	-30			50
												Dark Gray, CLAY with Sand (CL), low plasticity clay, fine-grained sand, stiff, moist	
55.0 56.5		16	12 4 6 (15)						55	-35			55
60.0 61.5		17b 17c	5 8 15 (23)	4.0 5.0	2.0 4.0	85	35	AT	60	-40		very stiff	60

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Boring Log

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Boring
EB-2

SAMPLE DEPTH (ft)	SAMPLER	SAMPLE NO./ CORE RUN	FIELD BLOWS/6 IN (N_{60})	POCKET PEN (ksf)	TORVANE (ksf)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	OTHER TESTS	DEPTH (ft)	ELEVATION (ft)	MATERIAL GRAPHIC	DESCRIPTION	REMARKS
65.0–66.5		18b 18c	5 9 13 (22)	4.0 3.0	1.0 2.0				65	-45		Dark Gray, CLAY with Sand (CL), low plasticity clay, fine-grained sand, stiff, moist *(continued)*	65
70.0–71.0		19	5 50/5"						70	-50			70
												Dark Brown, Silty SAND (SM), fine-grained sand, low plasticity silt, very dense, wet	
												Brown, CLAY (CL), low plasticity clay, trace fine-grained sand, hard, moist	
75.0–76.5		20	6 10 14 (36)						75	-55			75
80.0–81.5		21b 21c	10 16 28 (44)	>9.0	4.0	88	34		80	-60			80
												Brown, Silty SAND with gravel (SM), medium-grained sand, low plasticity silt, subangular fine gravel, dense, wet	
85.0–86.5		22b 22c	8 12 25 (37)	7.0 >9.0					85	-65			85
90.0–91.0		23	23 50/6"						90	-70		very dense	90
95.0–96.5		24	15 32 50/5"						95	-75			95
												Light Brown, CLAY (CL), low plasticity clay, trace subangular fine gravel, very stiff, moist	

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Boring Log

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Boring
EB-2

SAMPLE DEPTH (ft)	SAMPLER	SAMPLE NO./ CORE RUN	FIELD BLOWS/6 IN (N_{60})	POCKET PEN (ksf)	TORVANE (ksf)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	OTHER TESTS	DEPTH (ft)	ELEVATION (ft)	MATERIAL GRAPHIC	DESCRIPTION	REMARKS
100.0 101.5		25	16 7 9 (25)						100	-80		Light Brown, CLAY (CL), low plasticity clay, trace subangular fine gravel, very stiff, moist *(continued)*	100

Boring terminated at 101.5' eblow ground surface

Boring backfilled with cement grout

LOGGED BY: **Kimberly Brown** DATE: START **9/10/10** END **9/10/10**

STATION & OFFSET: **N/A,** LATITUDE: **38.2540** LONGITUDE: **-122.4430** O.G. ELEV.: **17.5 ft**

DRILL RIG: **Diedrich D-120** DRILLING COMPANY: **Andy Elbon/Taber Consultants**

DRILL METHOD: **Auger, Rotary** BIT DIAMETER: **6"** GROUNDWATER DATA: DEPTH: DEPTH:

CASING TIP DEPTH: **5.0 ft** HAMMER: **Automatic** NOT ENCOUNTERED ☐ TIME: TIME:

CHECKED BY: **Chris Trumbull** DATE: **10/20/10** NOT ESTABLISHED ☒ DATE: DATE:

SAMPLE DEPTH (ft)	SAMPLER	SAMPLE NO./ CORE RUN	FIELD BLOWS/6 IN (N_{60})	POCKET PEN (ksf)	TORVANE (ksf)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	OTHER TESTS
0.0–1.5	X	1	6, 15, 15 (30)	>9.0	8.0			
2.5–4.0	X	2b, 2c	4, 8, 23 (31)	8.0	7.0	78	33	SA
5.0–6.5	X	3	11, 12, 13 (25)	8.0		83	36	
7.5–9.0	X	4	5, 8, 8 (16)	5.0	6.0			
10.0–11.5	X	5	3, 3, 4 (7)			93	31	DS
12.5–13.5	X	6	15, 50/6"					
15.0–16.5		7	10, 6, 36 (63)					SA
17.5–19.0		8b, 8c	13, 20, 10 (45)					
20.0–21.5		9	8, 8, 8 (24)					
25.0–26.5	X	10	8, 7, 15 (22)	5.0	5.0	93	30	

DEPTH (ft): 5, 10, 15, 20, 25, 30

ELEVATION (ft): 15, 10, 5, 0, -5, -10

DESCRIPTION

Brown, SAND with Silt and Gravel (SM), fine-grained sand, low plasticity silt, subangular fine gravel, dense, dry

Light Brown, Sandy SILT (ML), low plasticity silt, fine-grained sand, very stiff, dry

Light Brown, Silty SAND (SM), fine-grained sand, low plasticity silt, medium dense, damp

loose

Brown, SAND with Silt (SP-SM), medium to coarse-grained sand, low plasticity silt, trace subrounded fine gravel, very dense, wet

Brown, Gravel with Sand (GW), subrounded to subangular fine to corase gravel, coarse-grained sand, very dense, wet

Brown, CLAY (CL), low plasticity, hard, moist

very stiff

Brown, Silty SAND (SM), fine-grained sand, low plasticity silt, medium dense, moist

Brown, CLAY (CL), low plasticity, very stiff, moist

REMARKS

Switch to Mud Rotary

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Boring Log

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date: JAN 2011

Boring: EB-3

SAMPLE DEPTH (ft)	SAMPLER	SAMPLE NO./ CORE RUN	FIELD BLOWS/6 IN (N_{60})	POCKET PEN (ksf)	TORVANE (ksf)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	OTHER TESTS	DEPTH (ft)	ELEVATION (ft)	MATERIAL GRAPHIC	DESCRIPTION	REMARKS
30.0–31.5	X	11	7 9 7 (16)	6.0	5.0			AT				Brown, CLAY (CL), low plasticity, very stiff, moist *(continued)*	
										-15		Black, Silty SAND (SM), fine-grained sand, low plasticity silt, medium dense, wet	
35.0–36.5	X	12	6 7 7 (14)						35				35
										-20		Dark Gray, Sandy CLAY (CL), low plasticity clay, fine-grained sand, very stiff, wet	
40.0–41.5	X	13	13 10 12 (22)						40				40
										-25			
45.0–46.5	X	14	3 2 3 (5)						45			firm	45
										-30			
50.0–51.5	X	15	12 16 30 (46)			95	29		50			hard	50
										-35			
55.0–56.5	X	16	5 6 8 (14)						55				55
										-40		Dark Gray, Silty SAND (SM), fine-grained sand, low plasticity silt, medium dense, wet	
60.0–61.5	X	17	6 9 15 (24)						60				60
												Dark Gray, Clayey GRAVEL (GC), subangular fine gravel, low plasticity clay, medium dense, wet	

Boring terminated at 61.5' below ground surface

Boring backfilled with cement grout

HDR

ONE COMPANY | *Many Solutions*

Boring Log

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Boring
EB-3

LOGGED BY: Kimberly Brown | DATE: START 9/9/10 END 9/9/10

STATION & OFFSET: N/A, | LATITUDE: 38.2540 | LONGITUDE: -122.4450 | O.G. ELEV.: 25.0 ft

DRILL RIG: Diedrich D-120 | DRILLING COMPANY: Andy Elbon/Taber Consultants

DRILL METHOD: Auger, Rotary | BIT DIAMETER: 6" | GROUNDWATER DATA: DEPTH: DEPTH:

CASING TIP DEPTH: 5.0 ft | HAMMER: Automatic | NOT ENCOUNTERED ☐ TIME: TIME:

CHECKED BY: Chris Trumbull | DATE: 10/20/10 | NOT ESTABLISHED ☒ DATE: DATE:

SAMPLE DEPTH (ft)	SAMPLER	SAMPLE NO./ CORE RUN	FIELD BLOWS/6 IN (N_{60})	POCKET PEN (ksf)	TORVANE (ksf)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	OTHER TESTS	DEPTH (ft)	ELEVATION (ft)	MATERIAL GRAPHIC	DESCRIPTION	REMARKS
0.0–1.5	X	1	4 4 4 (8)	5.0	3.0	94	11	AT				Dark Brown, CLAY (CL), low plasticity, trace subrounded fine gravel, firm, dry	
2.5–4.0	X	2b 2c	4 8 39 (47)	3.0 >9.0		97	20	SA				Brown, SAND with Clay and Gravel (SW-SC), fine- to medium-grained sand, low plasticity clay, subangular fine gravel, dense, dry	
5.0–6.5	X	3b 3c	27 39 45 (84)	>9.0					5	20			
7.5–9.0	X	4	7 7 10 (17)	4.0	4.0							Brown, CLAY (CL/CH), low to high plasticity, very stiff, moist	
10.0–11.5	X	5	6 10 15 (25)	7.0	6.0	90	31	AT	10	15			
12.5–14.0	X	6	9 15 20 (35)	8.0	7.0							hard	Switch to Mud Rotary
15.0–16.5	X	7	6 9 10 (19)	7.0	4.0				15	10		very stiff	
17.5–19.0	X	8	6 10 13 (23)	8.0	7.0								
20.0–21.5	X	9	8 12 11 (23)	8.0	6.0				20	5			
25.0–26.5	X	10	4 3 6 (9)	3.0	3.0	95	29		25	0		stiff	
									30	-5			

HDR ONE COMPANY | *Many Solutions*

Boring Log

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date: JAN 2011

Boring: EB-4

SAMPLE DEPTH (ft)	SAMPLER	SAMPLE NO./ CORE RUN	FIELD BLOWS/6 IN (N_{60})	POCKET PEN (ksf)	TORVANE (ksf)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	OTHER TESTS	DEPTH (ft)	ELEVATION (ft)	MATERIAL GRAPHIC	DESCRIPTION	REMARKS
30.0–31.5		11	9 8 9 (17)	6.0	8.0							Brown, CLAY (CL/CH), low to high plasticity, very stiff, moist *(continued)* very stiff	
35.0–36.5		12	7 13 14 (27)	8.0	4.0	95	29	AT	35	-10			35
40.0–41.5		13	5 9 12 (21)	7.0	6.0				40	-15		Black, CLAY with Sand (CL), low plasticity clay, fine-grained sand, very stiff, wet	40
45.0–45.5		14	50/6"						45	-20		Black, SAND (SW-SC), fine- to medium-grained sand, trace low plasticity clay and subangular fine gravel, very dense, wet	45
50.0–51.5		15	15 30 27 (86)						50	-25			50
55.0–56.5		16	9 19 40 (89)					SA	55	-30			55
60.0–61.5		17	18 25 23 (73)						60	-35			60

Boring terminated at 61.5' below ground surface

Boring backfilled with cement grout

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Boring Log

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Boring
EB-4

LOGGED BY: **Kimberly Brown** DATE: START **9/10/10** END **9/10/10**

STATION & OFFSET: **N/A,** LATITUDE: **38.2540** LONGITUDE: **-122.4440** O.G. ELEV.: **19.5 ft**

DRILL RIG: **Diedrich D-120** DRILLING COMPANY: **Andy Elbon/Taber Consultants**

DRILL METHOD: **Auger, Rotary** BIT DIAMETER: **6"** GROUNDWATER DATA: DEPTH: ____ DEPTH: ____

CASING TIP DEPTH: **5.0 ft** HAMMER: **Automatic** NOT ENCOUNTERED ☐ TIME: ____ TIME: ____

CHECKED BY: **Chris Trumbull** DATE: **10/20/10** NOT ESTABLISHED ☒ DATE: ____ DATE: ____

SAMPLE DEPTH (ft)	SAMPLER	SAMPLE NO./ CORE RUN	FIELD BLOWS/6 IN (N_{60})	POCKET PEN (ksf)	TORVANE (ksf)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	OTHER TESTS
0.0–1.5	X	1	5, 8, 8 (16)	8.0				
2.5–4.0	X	2	4, 6, 22 (28)	7.0	7.0	91	29	-200
5.0–6.5	X	3	9, 16, 24 (40)	>9.0				
7.5–9.0	X	4	6, 16, 22 (38)	>9.0				
10.0–11.5	X	5	5, 7, 15 (22)	9.0	8.0	89	32	AT
12.5–14.0	X	6	6, 8, 11 (19)	7.0	5.0			
15.0–16.5	X	7	6, 8, 8 (16)	3.0	4.0			
17.5–19.0	X	8	4, 4, 4 (8)	1.0	2.0	83	35	-200
20.0–21.5	X	9	6, 8, 10 (18)	6.0	8.0			
25.0–26.5	X	10	2, 6, 8 (14)	4.0	4.0			

DEPTH (ft)	ELEVATION (ft)	DESCRIPTION	REMARKS
0	19.5	Dark Brown, Gravelly CLAY (CH), high plasticity clay, subangular fine gravel, very stiff dry	
5	15	hard	
10	10	very stiff	
12			Switch to Mud Rotary
14.5	5	Brown, CLAY (CL), low plasticity, very stiff, moist	
17.5		firm, wet	
19	0	Olive Brown, Silty CLAY (CL-ML), low plasticity, very stiff, moist	
25	-5	stiff	
28	-10	Dark Gray, CLAY (CH), high plasticity, stiff, moist	
30			

HDR FOLSOM BORING LOG TERTIARY TREATMENT POND SONOMA WWTP.GPJ FOLSOM.GDT 1/19/11

HDR
ONE COMPANY | *Many Solutions*

Boring Log

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date: JAN 2011

Boring: EB-5

SAMPLE DEPTH (ft)	SAMPLER	SAMPLE NO./ CORE RUN	FIELD BLOWS/6 IN (N_{60})	POCKET PEN (ksf)	TORVANE (ksf)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	OTHER TESTS	DEPTH (ft)	ELEVATION (ft)	MATERIAL GRAPHIC	DESCRIPTION	REMARKS
30.0–31.5	X	11	4 6 8 (14)	6.0	7.0							Dark Gray, CLAY (CH), high plasticity, stiff, moist *(continued)*	
										-15			
35.0–36.5	X	12	3 3 4 (7)	1.0	3.0	70	54	AT	35			firm	35
										-20			
40.0–41.5	X	13	4 4 5 (9)						40			bark in sample	40
												Dark Gray, Silty SAND (SM), fine-grained sand, low plasticity silt, loose, wet	

Boring terminated at 41.5' below ground surface

Boring backfilled with cement grout

HDR FOLSOM BORING LOG TERTIARY TREATMENT POND SONOMA WWTP.GPJ FOLSOM.GDT 1/19/11

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Boring Log

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Boring
EB-5

APPENDIX B

LABORATORY TESTING

Laboratory Testing

Our laboratory testing program consisted of performing testing on select samples to assist in soil classification and to determine geotechnical parameters and index values for use in our design and analyses. All laboratory testing was subcontracted to and performed by Taber Consultants and Sierra Testing Laboratories, Inc. The tests performed are summarized below:

Table B-1. Laboratory Testing Performed

Test	Standard
Moisture Content	ASTM D2216
Dry Density	ASTM D2837
Atterberg Limits	ASTM D4318
Sieve Analysis	ASTM D422
200 Wash	ASTM D1140
Direct Shear	ASTM D3080
Consolidation	ASTM D2435

A summary of the laboratory testing performed is presented in the attached Table B-2. Specific test results, organized by boring are also attached to this appendix. Test results and/or indicators are presented on the boring logs at the appropriate samples depths.

Boring	Sample No.	Depth	Percent Passing by Weight											Atterberg		Water Cont (%)	Dry Dens (pcf)	Un Conf (psf)	Direct Shear		Triaxial Shear		Perm (cm/sec)	Description
			Gravel (Sieve size)				Sand (Sieve No.)						Fines											
			3"	1½"	¾"	⅜"	4	10	20	40	50	100	200	LL	PI				c (psf)	ϕ (deg)	c (psf)	ϕ (deg)		
EB-1	1	1												25	10	6	96							CL
EB-1	5	10.5			93	72	57	38	23	15			7											SW-SC
EB-1	6	13.5														28	95							CL
EB-1	8	18.5											35											SM
EB-1	9b	20.5														36	82							SM
EB-1	10	26			95	87	80	74	63	32			5			20	106							SP
EB-1	13	41												49	25									CL
EB-1	14	45.5				98	86	61	37	20			7											SW-SC
EB-2	2	3.5												23	8	18	106							CL
EB-2	3b	5.5											36			28	90							SM
EB-2	4c	8.5			95	89	86	83	79	69			48			20	107		500	45				SM
EB-2	6	13.5					100	99	99	96			40											SM
EB-2	9	20.5			100	96	93	88	77	61			6											SP-SM
EB-2	11c	31																						CL
EB-2	13c	41												32	13	29	88							CL
EB-2	14c	46			100	97	91	77	57	32			4											SP
EB-2	17c	61												42	21	35	85							CL
EB-2	21c	81														34	88							CL

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Summary of Laboratory Testing

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Figure
B-1

Boring	Sample No.	Depth	Percent Passing by Weight											Atterberg		Water Cont (%)	Dry Dens (pcf)	Un Conf (psf)	Direct Shear		Triaxial Shear		Perm (cm/sec)	Description
			Gravel (Sieve size)				Sand (Sieve No.)						Fines											
			3"	1½"	¾"	⅜"	4	10	20	40	50	100	200	LL	PI				c (psf)	ϕ (deg)	c (psf)	ϕ (deg)		
EB-3	2c	3.5			100		74	57		41			27			33	78							SM
EB-3	3	6														36	83							ML
EB-3	5	11														31	93		250	36				SM
EB-3	7	15.5		100	78	48	27	15	10	7			3											GW
EB-3	10	26														30	93							SM
EB-3	11	31												42	21									CL
EB-3	15	51														29	95							CL
EB-4	1	1												24	11	11	94							CL
EB-4	2c	3.5				100	96	92		74			47			20	97							SW-SC
EB-4	5	11												48	24	31	90							CL/CH
EB-4	10	26														29	95							CL/CH
EB-4	12	36												34	13	29	95							CL/CH
EB-4	16	55.5			100	93	88	82	72	51			10											SW-SC
EB-5	2	3.5											68			29	91							CH
EB-5	5	11												56	28	32	89							CH
EB-5	8	18.5											81			35	83							CL
EB-5	12	36												59	33	54	70							CL

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Summary of Laboratory Testing

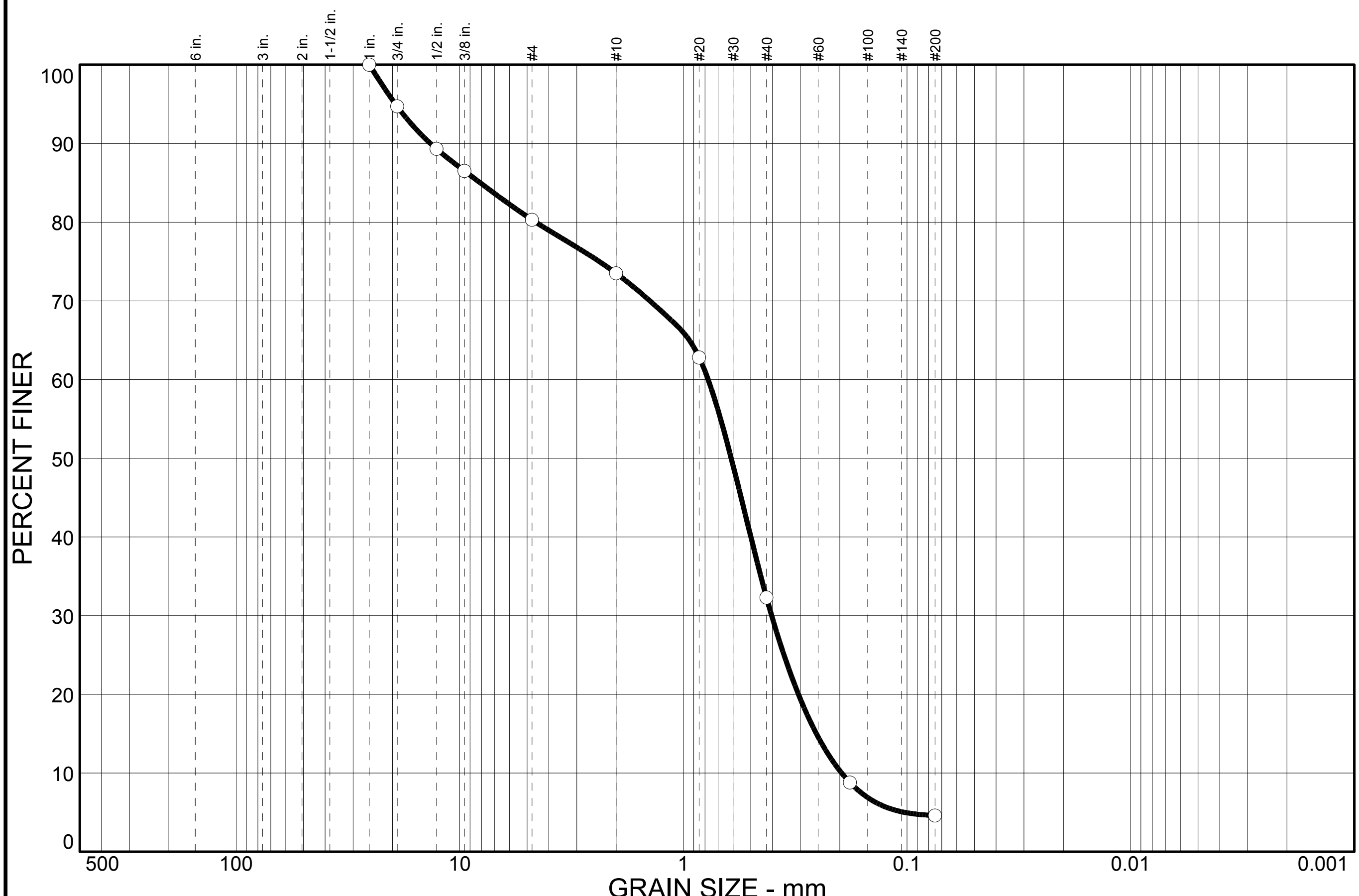
North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Figure
B-2

LAB TEST SUMMARY TERTIARY TREATMENT POND SONOMA WWTP.GPJ FOLSOM.GDT 1/18/11

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	5.3	14.4	6.8	41.2	27.7	4.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
.75 in.	94.7		
.5 in.	89.3		
.375 in.	86.5		
#4	80.3		
#10	73.5		
#20	62.8		
#40	32.3		
#80	8.8		
#200	4.6		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 8.10 D_{60}= 0.775 D_{50}= 0.612
D_{30}= 0.403 D_{15}= 0.254 D_{10}= 0.196
C_u= 3.95 C_c= 1.07

Classification

USCS= AASHTO=

Remarks

Total dry weight of sample tested=753grams.

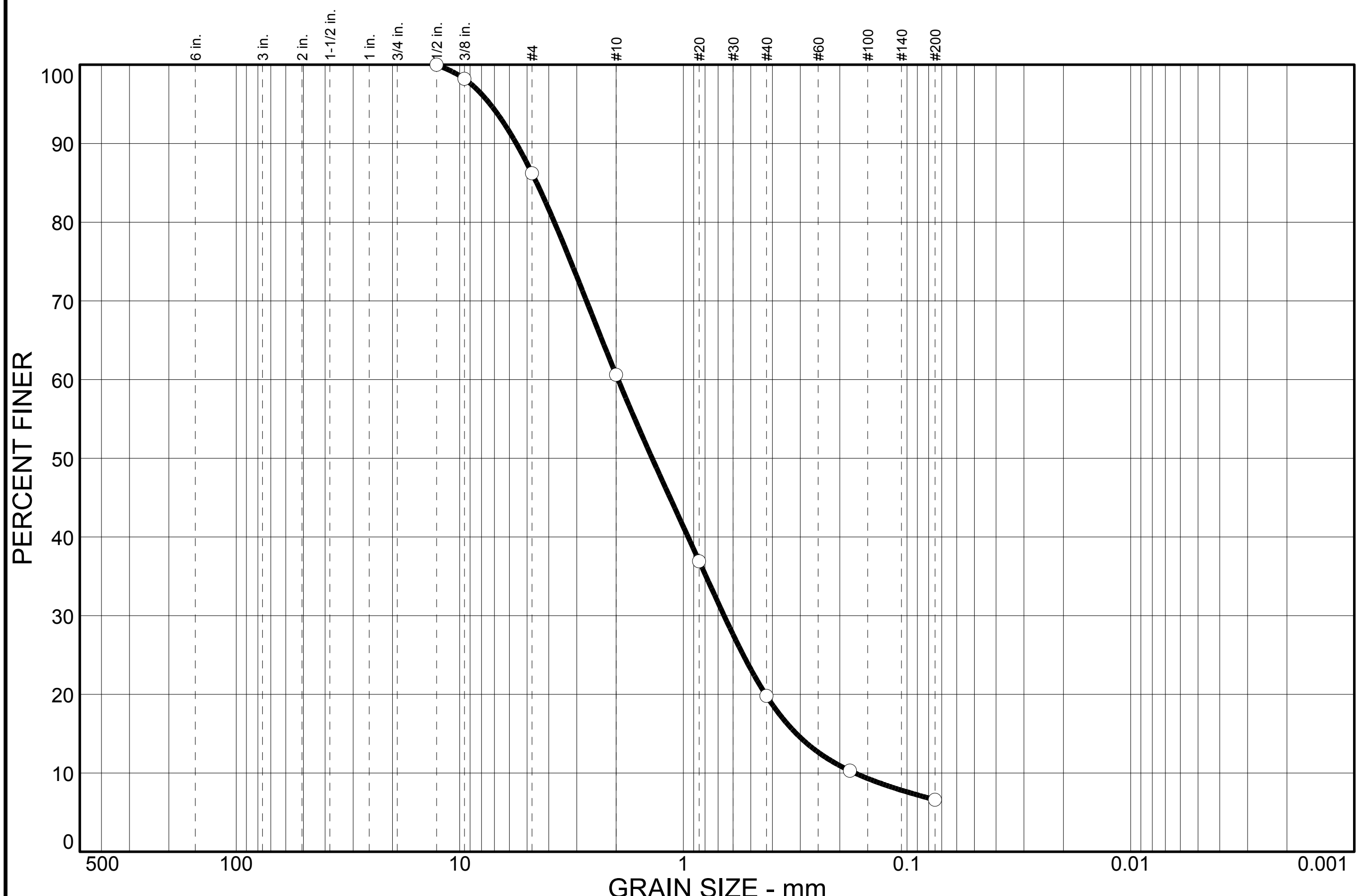
Sample No.: EB-1/10 **Source of Sample:** **Date:** 9-27-2010
Location: **Elev./Depth:** 26.0'-26.5'

Taber
Since 1954

Client: HDR
Project: Sonoma County Water Agency / #144993

Project No: 2010/0198 **Figure** B-3

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	13.8	25.6	40.8	13.2	6.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	98.2		
#4	86.2		
#10	60.6		
#20	36.9		
#40	19.8		
#80	10.3		
#200	6.6		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 4.53 D_{60}= 1.96 D_{50}= 1.38
D_{30}= 0.658 D_{15}= 0.312 D_{10}= 0.171
C_u= 11.48 C_c= 1.29

Classification

USCS= AASHTO=

Remarks

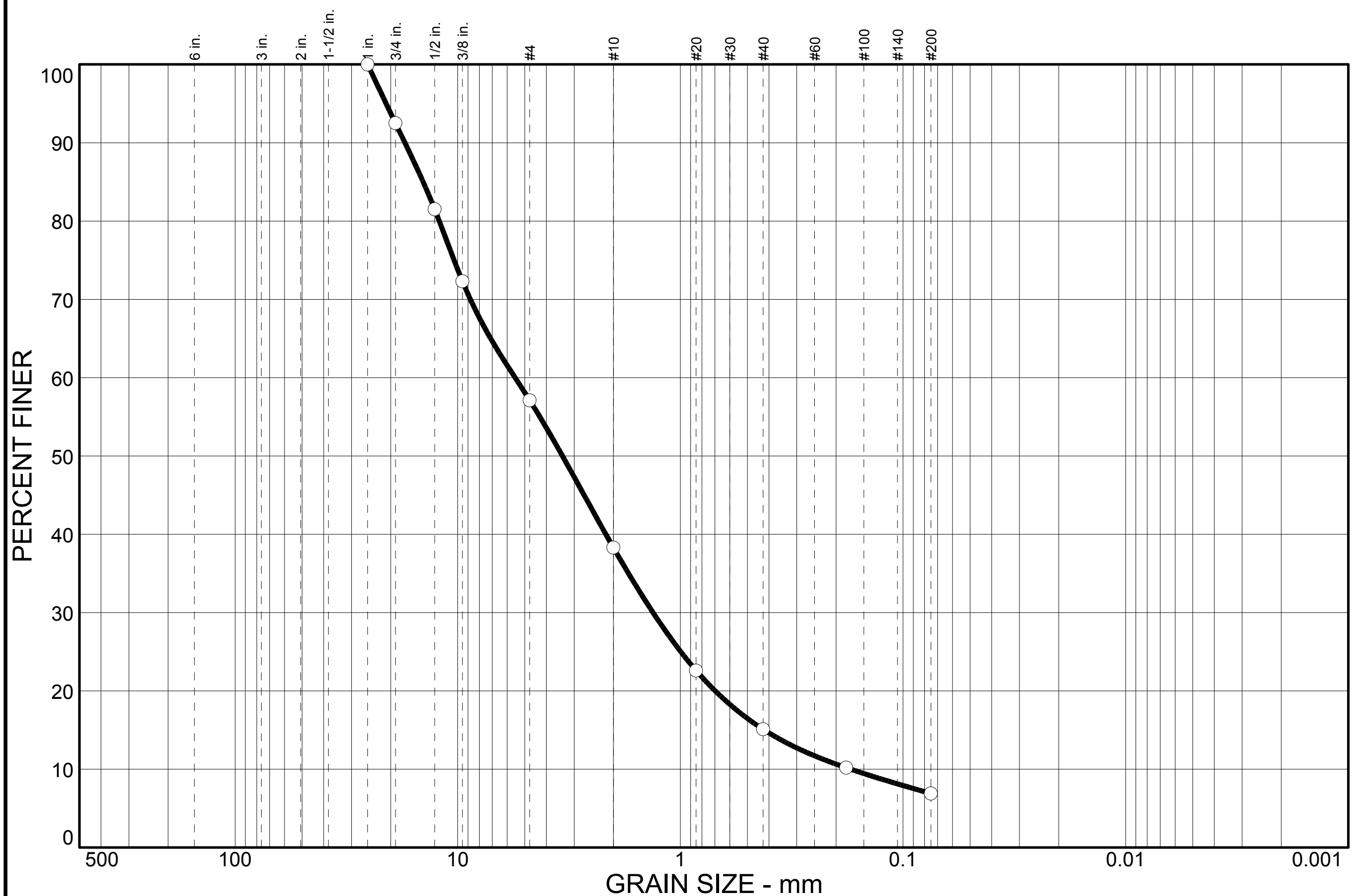
Total dry weight of sample tested=571grams.

Sample No.: EB-1/14 **Source of Sample:** **Date:** 9-27-2010
Location: **Elev./Depth:** 45.5'-46.5'

Taber
Since 1954

Client: HDR
Project: Sonoma County Water Agency / #144993
Project No: 2010/0198 **Figure** B-4

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	7.5	35.4	18.8	23.2	8.2	6.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
.75 in.	92.5		
.5 in.	81.5		
.375 in.	72.3		
#4	57.1		
#10	38.3		
#20	22.6		
#40	15.1		
#80	10.2		
#200	6.9		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 14.3 D_{60}= 5.53 D_{50}= 3.39
D_{30}= 1.33 D_{15}= 0.420 D_{10}= 0.172
C_u= 32.19 C_c= 1.86

Classification

USCS= AASHTO=

Remarks

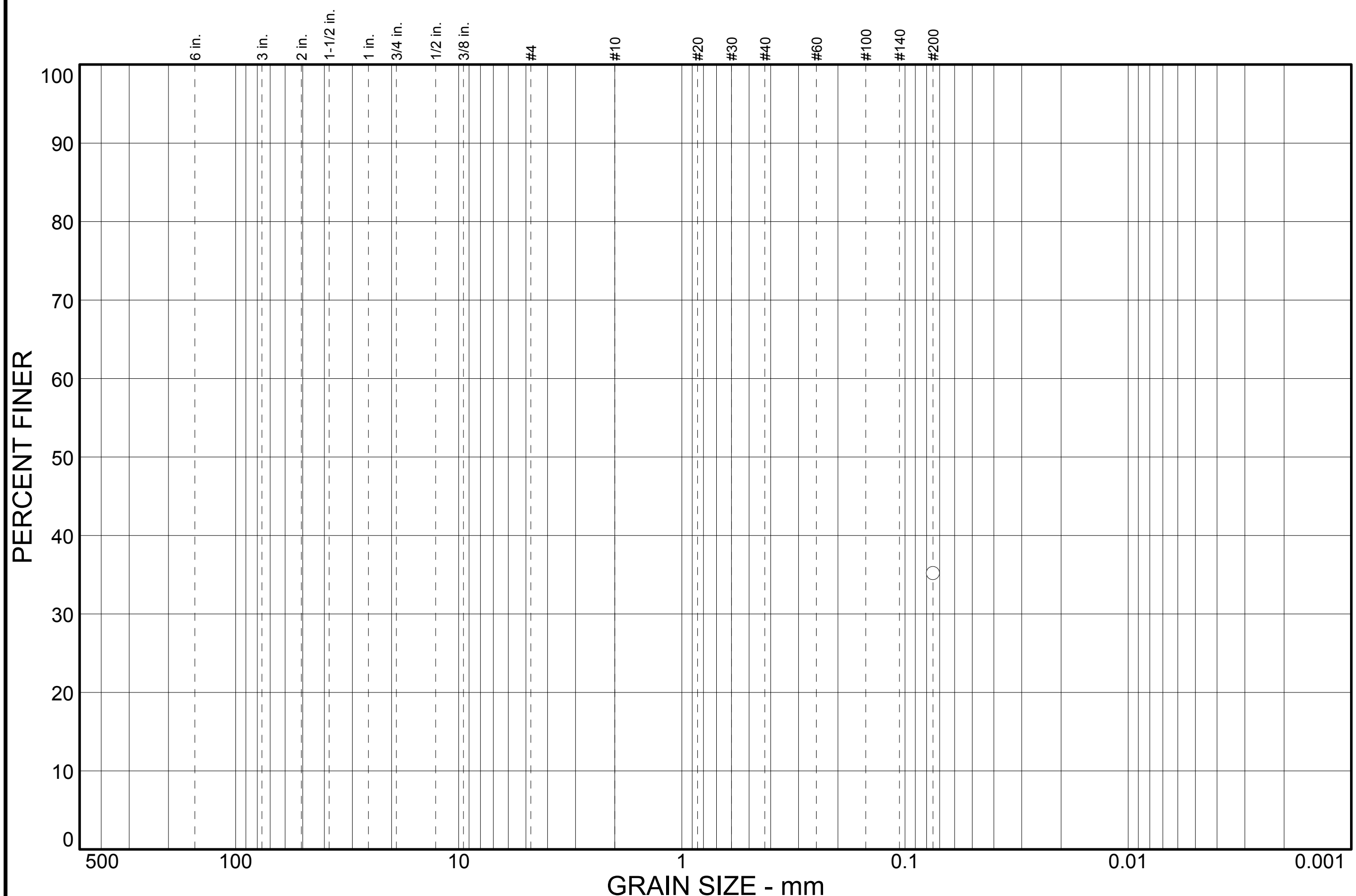
Total dry weight of sample tested=393grams.

Sample No.: EB-1/5 **Source of Sample:** **Date:** 9-27-2010
Location: **Elev./Depth:** 10.5'-11.0'

Taber
Since 1954

Client: HDR
Project: Sonoma County Water Agency / #144993
Project No: 2010/0198 **Figure** B-5

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
						35.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	35.2		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

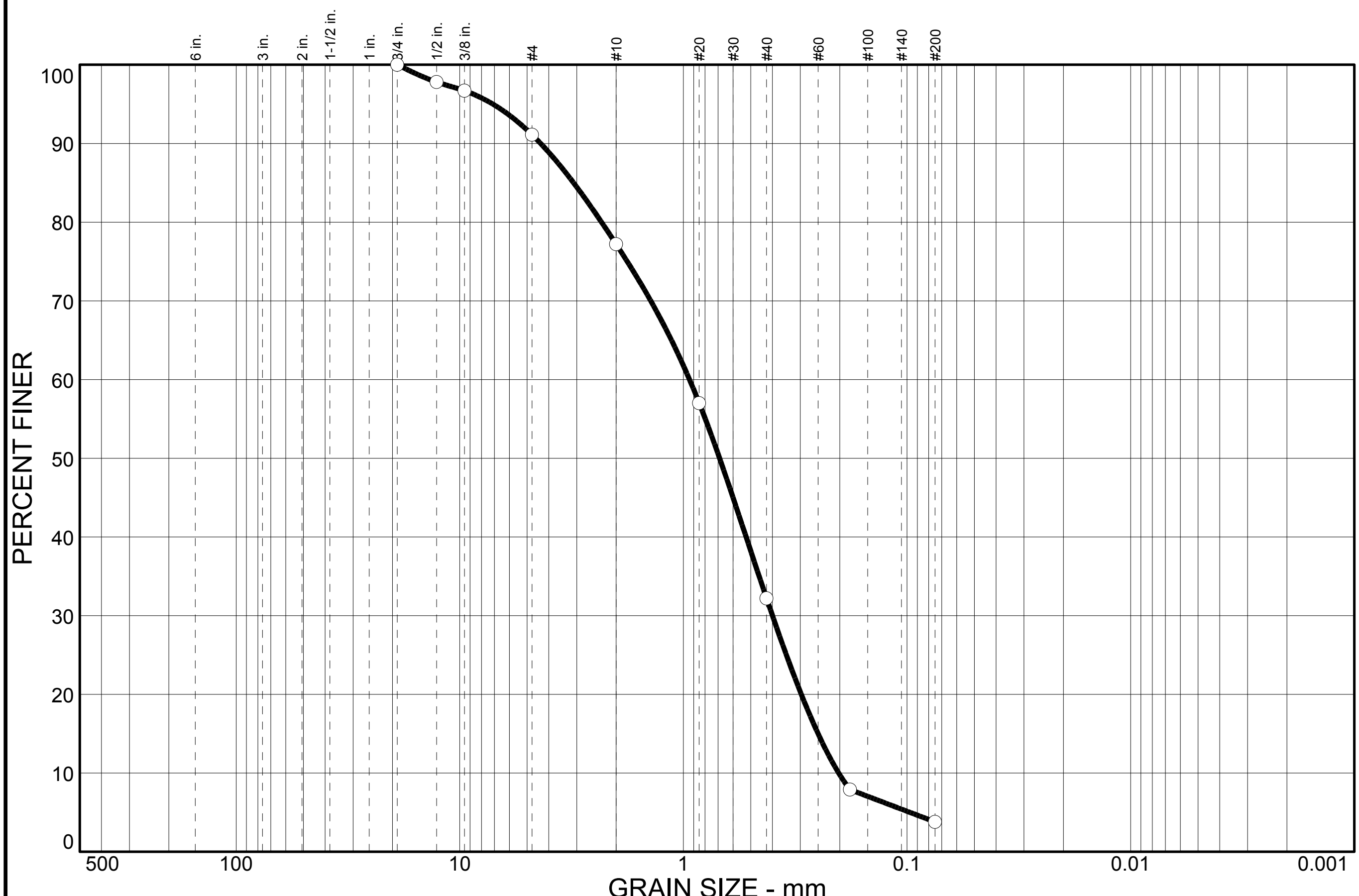
Total dry weight of sample tested=262grams.

Sample No.: EB-1/8 **Source of Sample:** **Date:** 9-27-2010
Location: **Elev./Depth:** 18.5'-19.0'

Taber Since 1954

Client: HDR
Project: Sonoma County Water Agency / #144993
Project No: 2010/0198 **Figure** B-6

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	8.9	13.9	45.0	28.4	3.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	97.8		
.375 in.	96.7		
#4	91.1		
#10	77.2		
#20	57.0		
#40	32.2		
#80	7.9		
#200	3.8		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 3.10 D_{60}= 0.939 D_{50}= 0.689
D_{30}= 0.400 D_{15}= 0.250 D_{10}= 0.202
C_u= 4.65 C_c= 0.84

Classification

USCS= AASHTO=

Remarks

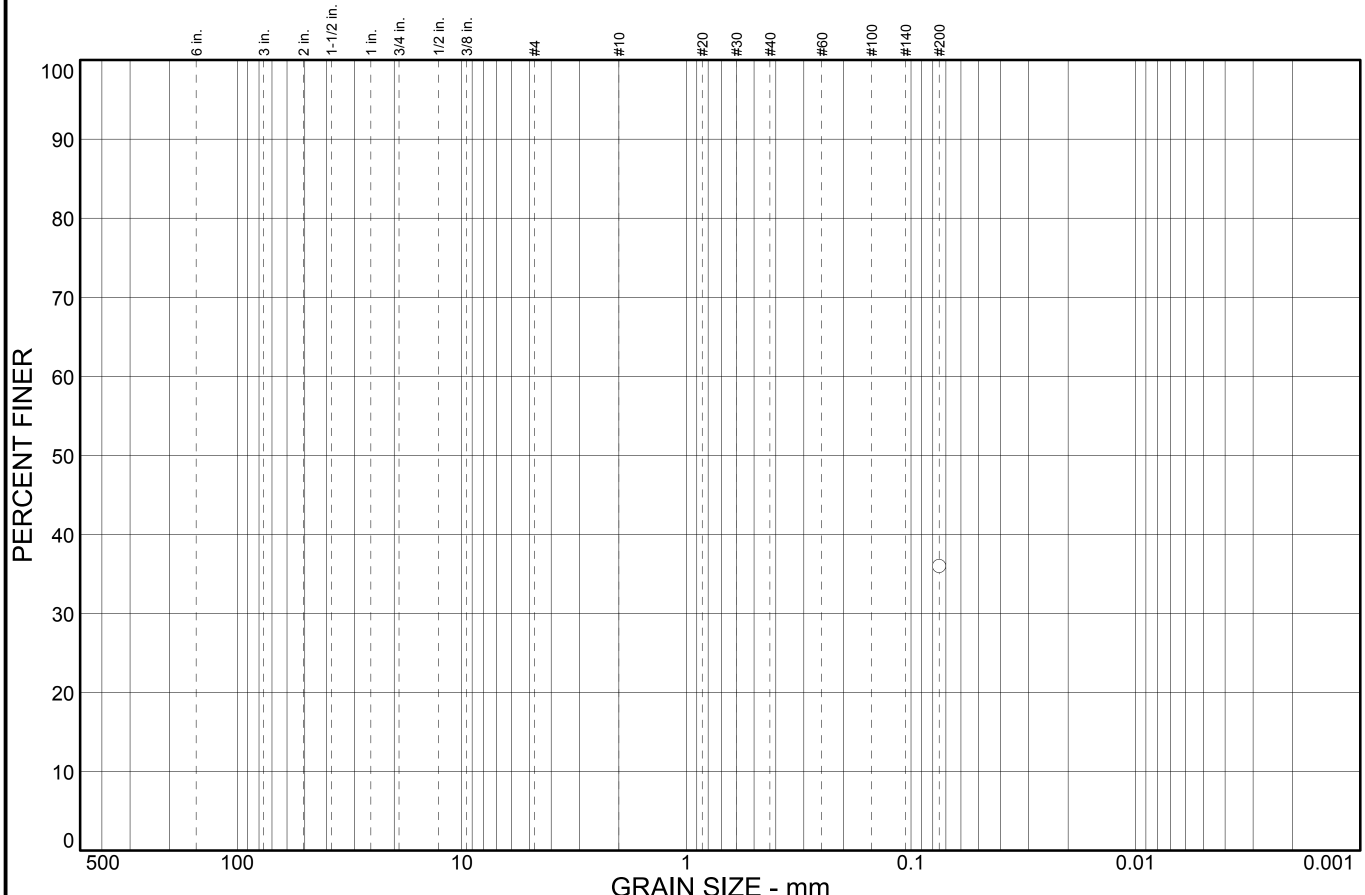
Total dry weight of sample tested=751grams.

Sample No.: EB-2/14c **Source of Sample:** **Date:** 9-27-2010
Location: **Elev./Depth:** 46.0'-46.5'

Taber
Since 1954

Client: HDR
Project: Sonoma County Water Agency / #144993
Project No: 2010/0198 **Figure** B-7

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
						36.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	36.0		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

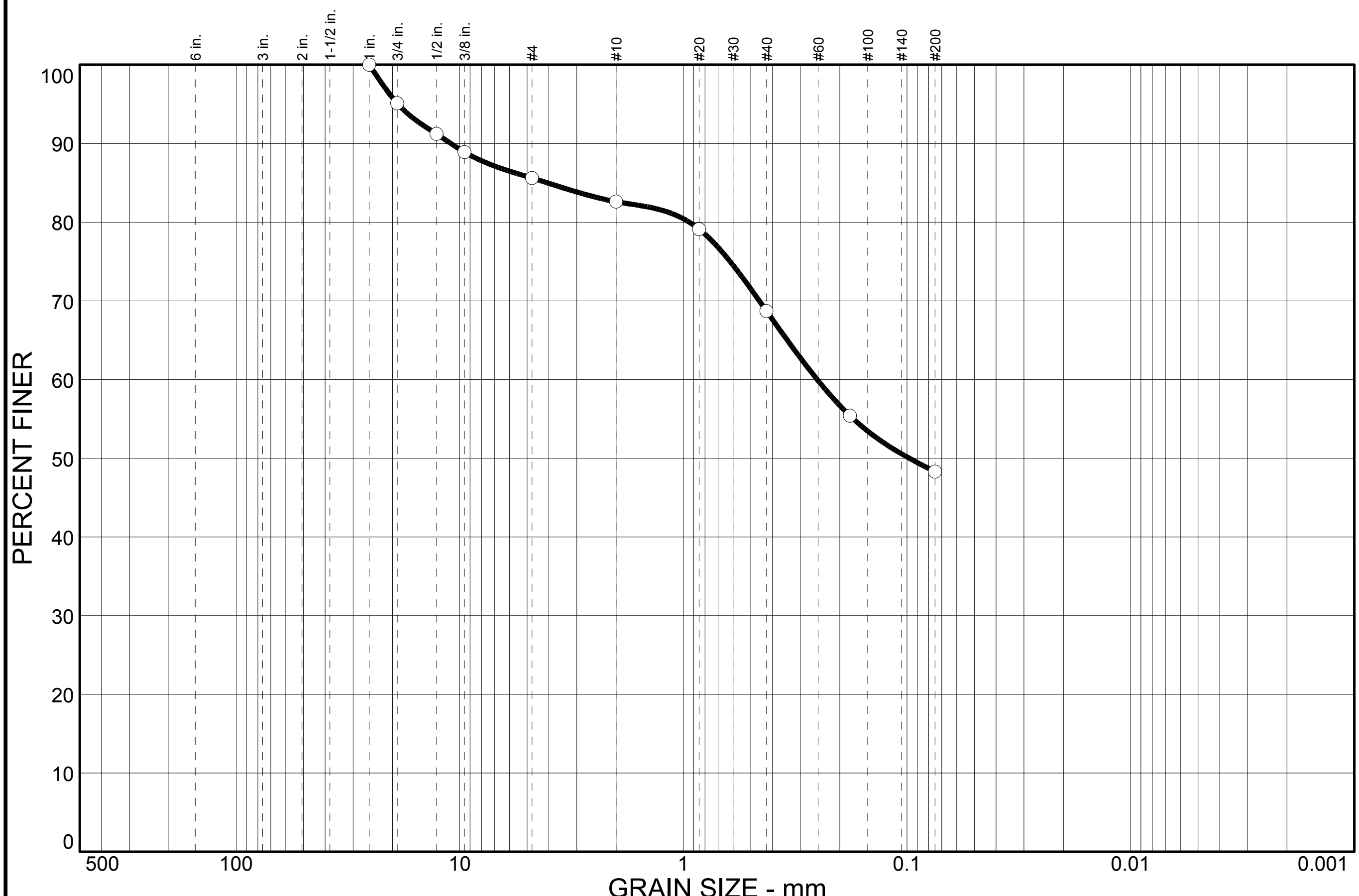
Total dry weight of sample=635grams.

Sample No.: EB-2/3b **Source of Sample:** **Date:** 9-27-2010
Location: **Elev./Depth:** 5.5'-6.0'

Taber Since 1954

Client: HDR
Project: Sonoma County Water Agency / #144993
Project No: 2010/0198 **Figure** B-8

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	4.9	9.5	3.0	13.9	20.4	48.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
.75 in.	95.1		
.5 in.	91.2		
.375 in.	88.9		
#4	85.6		
#10	82.6		
#20	79.1		
#40	68.7		
#80	55.4		
#200	48.3		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 4.06 D_{60}= 0.252 D_{50}= 0.0977
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Total dry weight of sample tested=1,272grams.

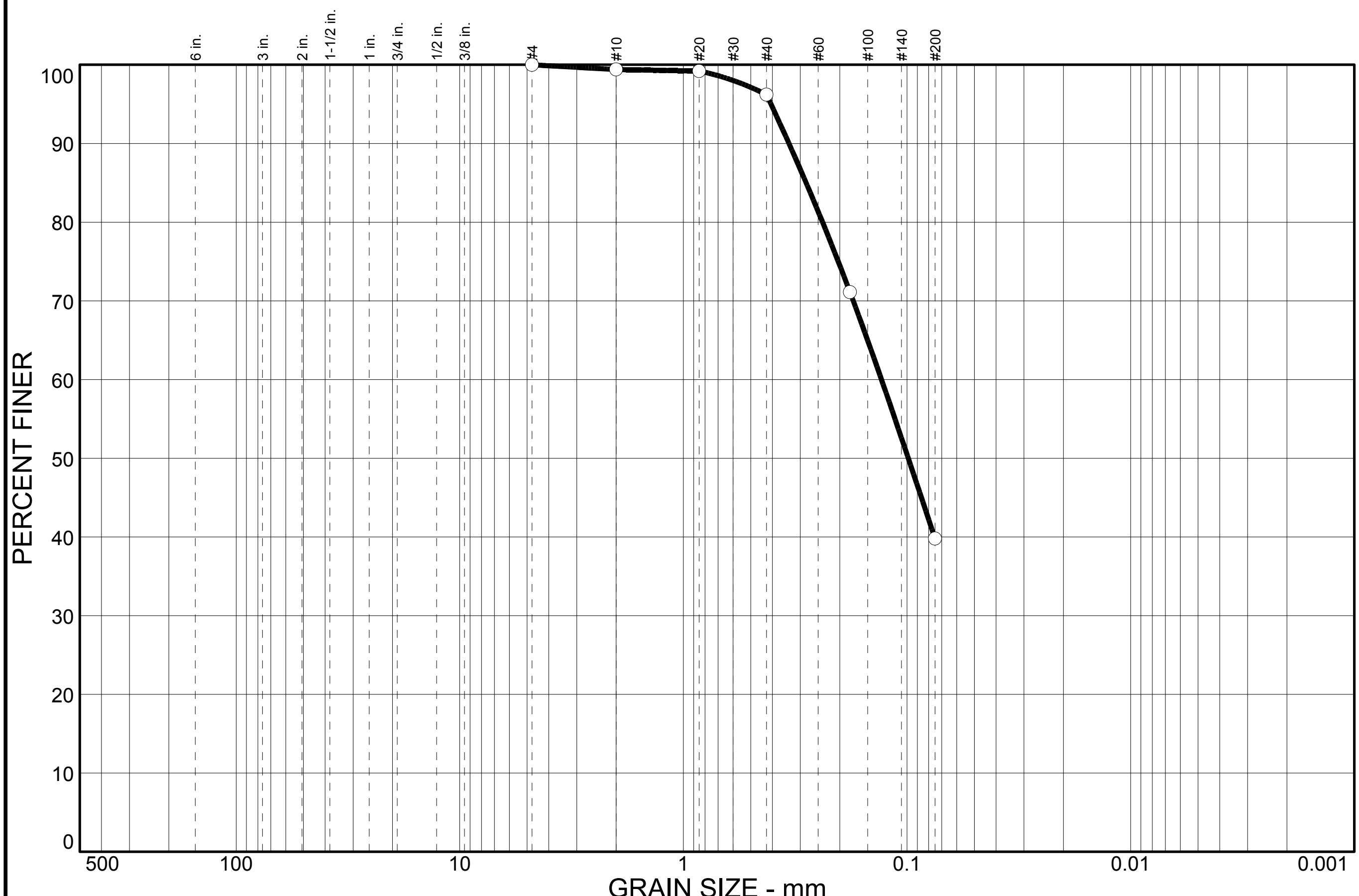
Sample No.: EB-2/4c **Source of Sample:** **Date:** 9-27-2010
Location: **Elev./Depth:** 8.5'-9.0'

Taber Since 1954

Client: HDR
Project: Sonoma County Water Agency / #144993

Project No: 2010/0198 **Figure** B-9

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.6	3.2	56.4	39.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.4		
#20	99.2		
#40	96.2		
#80	71.1		
#200	39.8		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.283 D_{60}= 0.130 D_{50}= 0.0988
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Total dry weight of sample tested=192grams.

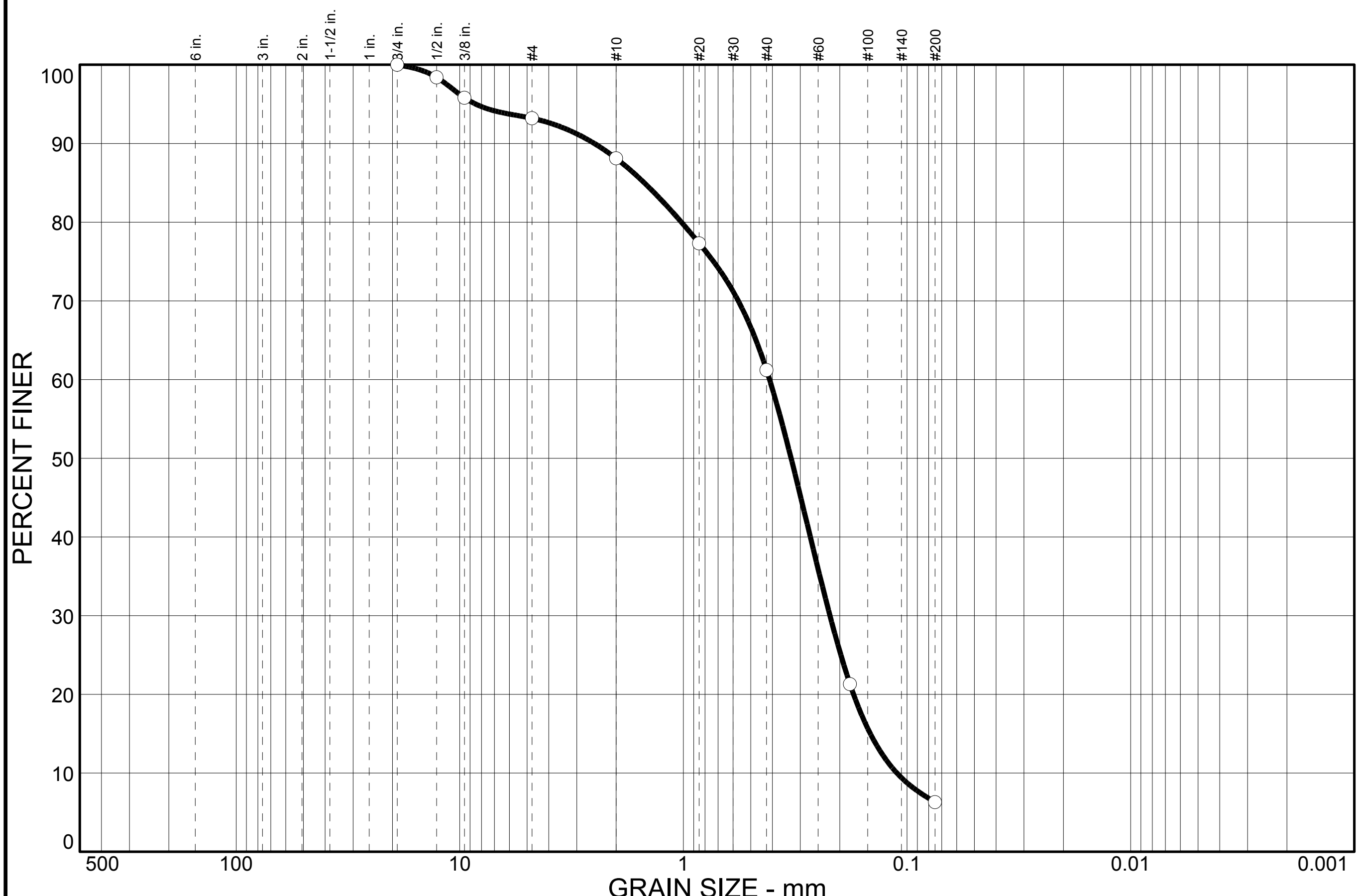
Sample No.: EB-2/6 **Source of Sample:** **Date:** 9-27-2010
Location: **Elev./Depth:** 13.5'-14.0'

Taber Since 1954

Client: HDR
Project: Sonoma County Water Agency / #144993

Project No: 2010/0198 **Figure** B-10

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	6.8	5.1	26.9	54.9	6.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	98.4		
.375 in.	95.8		
#4	93.2		
#10	88.1		
#20	77.3		
#40	61.2		
#80	21.3		
#200	6.3		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 1.50 D_{60}= 0.412 D_{50}= 0.330
D_{30}= 0.221 D_{15}= 0.146 D_{10}= 0.111
C_u= 3.71 C_c= 1.07

Classification

USCS= AASHTO=

Remarks

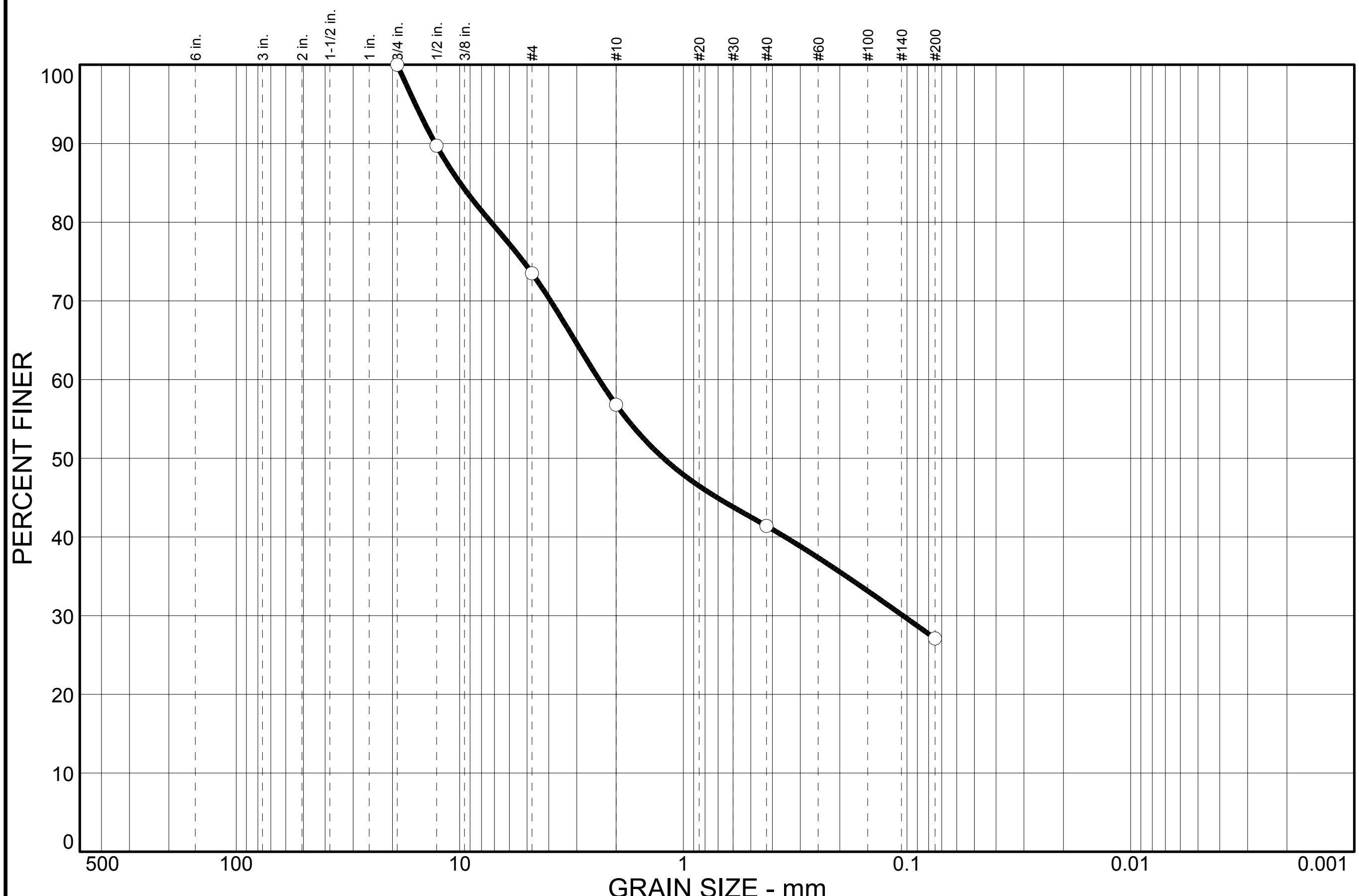
Total dry weight of sample tested=493grams.

Sample No.: EB-2/9 **Source of Sample:** **Date:** 9-27-2010
Location: **Elev./Depth:** 20.5'-21.5'

Taber
Since 1954

Client: HDR
Project: Sonoma County Water Agency / #144993
Project No: 2010/0198 **Figure** B-11

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	26.5	16.7	15.4	14.3	27.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	89.7		
#4	73.5		
#10	56.8		
#40	41.4		
#200	27.1		

* (no specification provided)

Material Description

*Note: Sample comprised of cemented fines that are readily reduced in particle size with moderate impact and should not be construed as sand or gravel. Grain size is subject to considerable variation.

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 9.98 D_{60}= 2.38 D_{50}= 1.23
D_{30}= 0.104 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

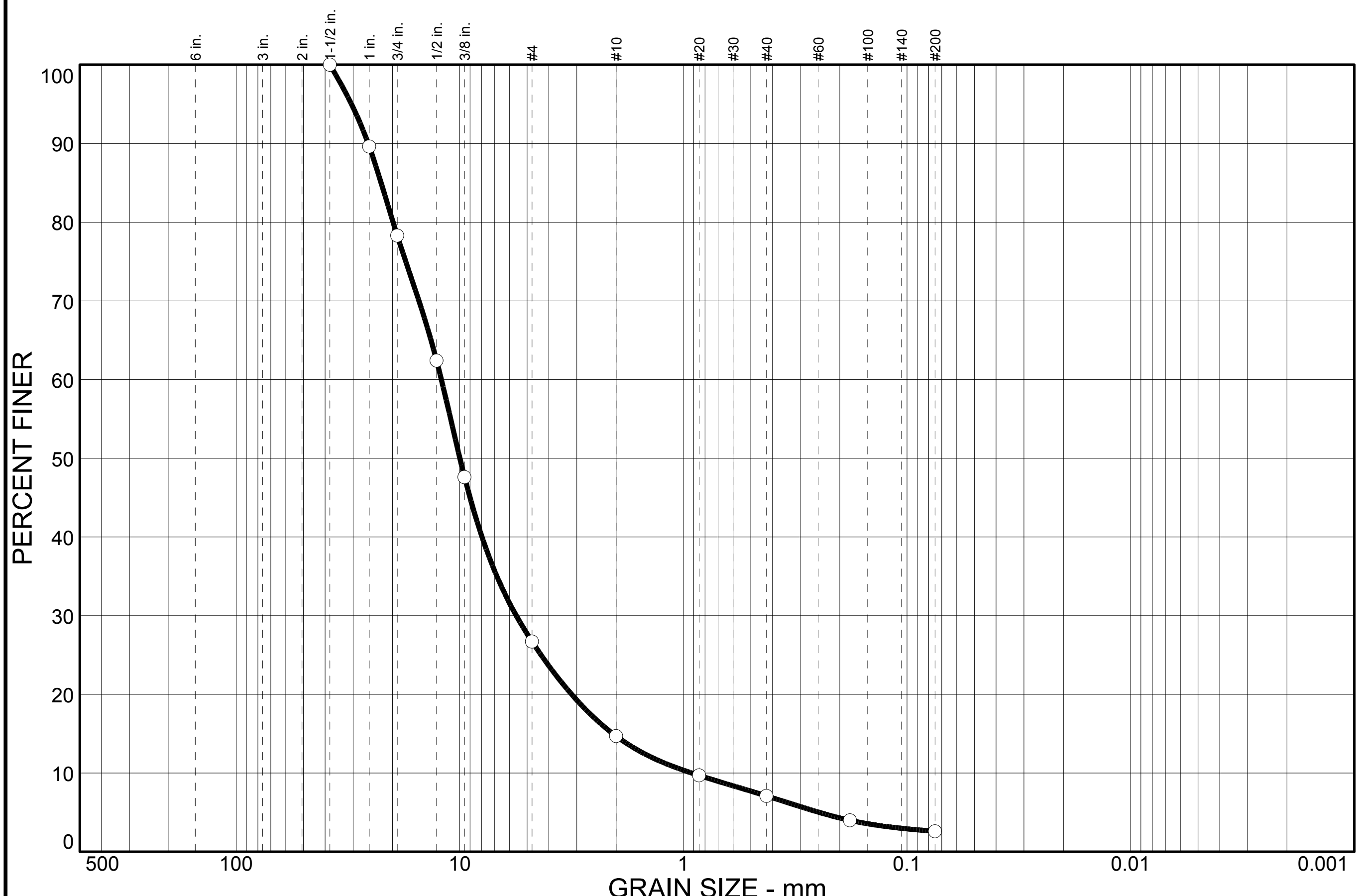
Total dry weight of sample tested=538grams.

Sample No.: EB-3/2c **Source of Sample:** **Date:** 9-27-2010
Location: **Elev./Depth:** 3.5'-4.0'

Taber Since 1954

Client: HDR
Project: Sonoma County Water Agency / #144993
Project No: 2010/0198 **Figure** B-12

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	21.7	51.6	12.0	7.6	4.5	2.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	89.6		
.75 in.	78.3		
.5 in.	62.4		
.375 in.	47.6		
#4	26.7		
#10	14.7		
#20	9.7		
#40	7.1		
#80	4.0		
#200	2.6		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 22.5 D_{60}= 12.1 D_{50}= 10.00
D_{30}= 5.59 D_{15}= 2.07 D_{10}= 0.916
C_u= 13.20 C_c= 2.82

Classification

USCS= AASHTO=

Remarks

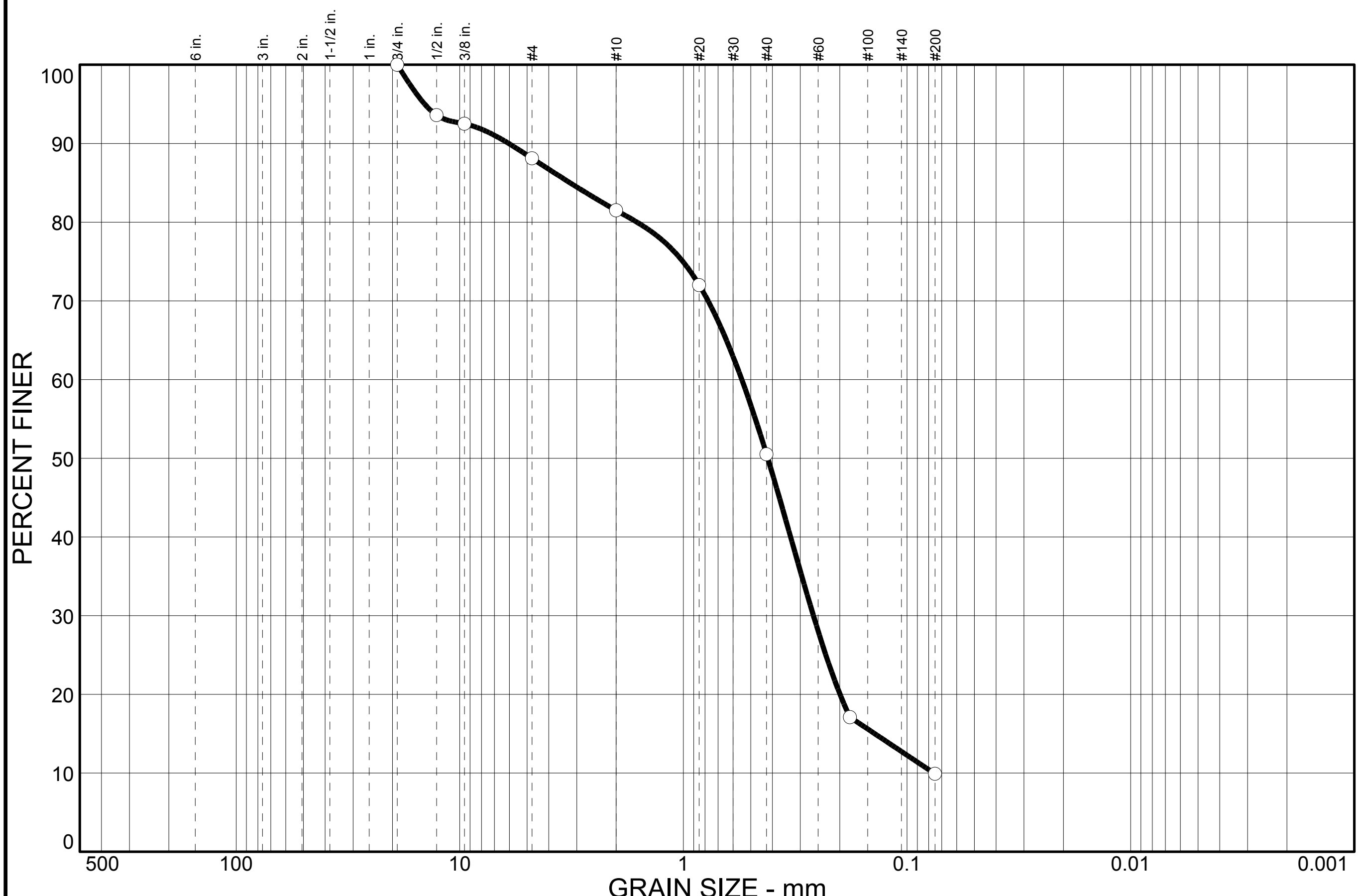
Total dry weight of sample tested=332grams.

Sample No.: EB-3/7 **Source of Sample:** **Date:** 9-27-2010
Location: **Elev./Depth:** 15.5'-16.5'

Taber
Since 1954

Client: HDR
Project: Sonoma County Water Agency / #144993
Project No: 2010/0198 **Figure** B-13

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	11.9	6.6	31.0	40.6	9.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	93.6		
.375 in.	92.5		
#4	88.1		
#10	81.5		
#20	72.0		
#40	50.5		
#80	17.1		
#200	9.9		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 3.21 D_{60}= 0.548 D_{50}= 0.420
D_{30}= 0.262 D_{15}= 0.139 D_{10}= 0.0759
C_u= 7.22 C_c= 1.65

Classification

USCS= AASHTO=

Remarks

Total dry weight of sample tested=350grams.

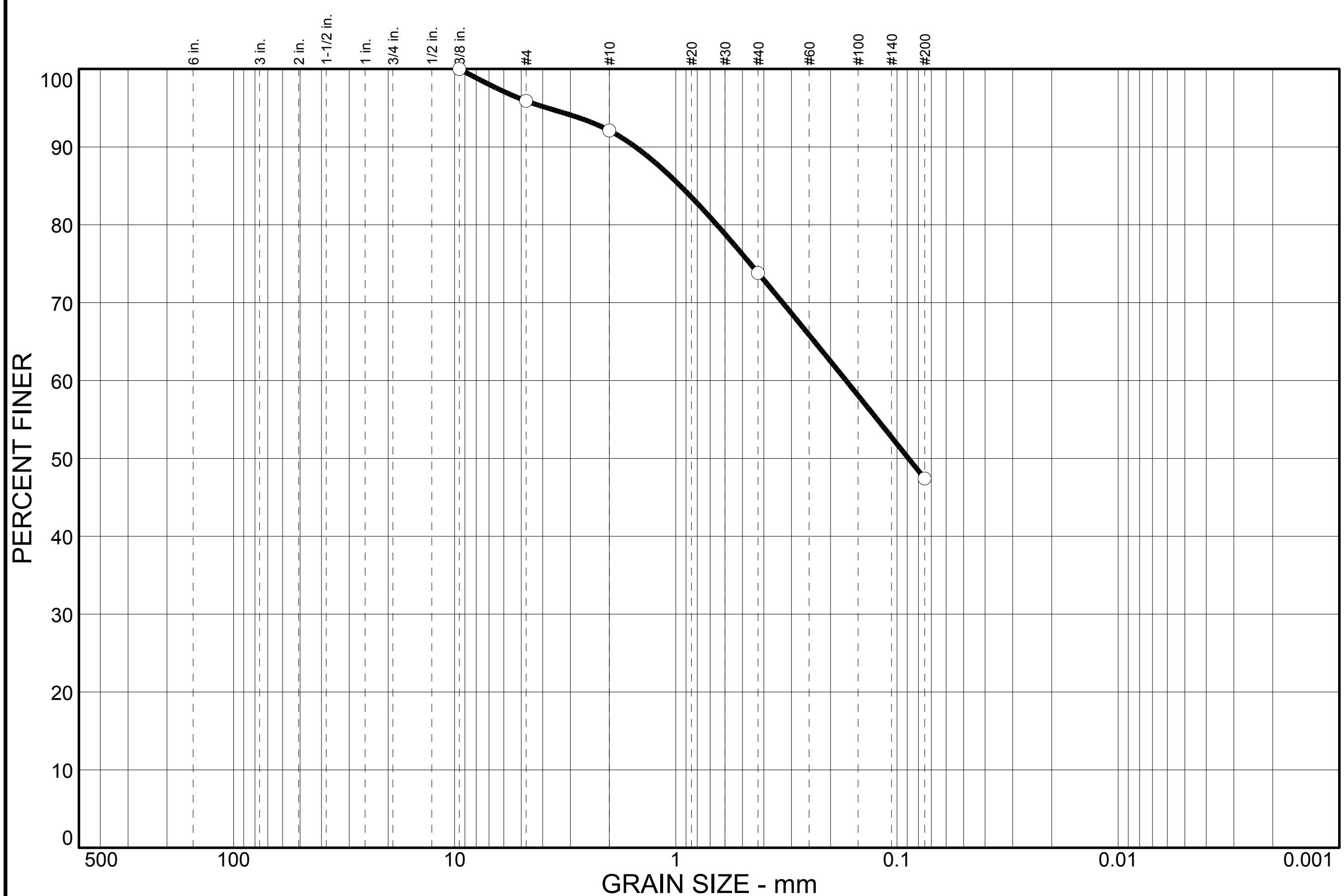
Sample No.: EB-4/16 **Source of Sample:** **Date:** 9-27-2010
Location: **Elev./Depth:** 55.5'-56.5'

Taber
Since 1954

Client: HDR
Project: Sonoma County Water Agency / #144993

Project No: 2010/0198 **Figure** B-14

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	4.1	3.8	18.3	26.4	47.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	95.9		
#10	92.1		
#40	73.8		
#200	47.4		

* (no specification provided)

Material Description

*Note: Sample comprised of cemented fines that are readily reduced in particle size with moderate impact and should not be construed as sand or gravel. Grain size is subject to considerable variation.

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.955 D_{60}= 0.170 D_{50}= 0.0888
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

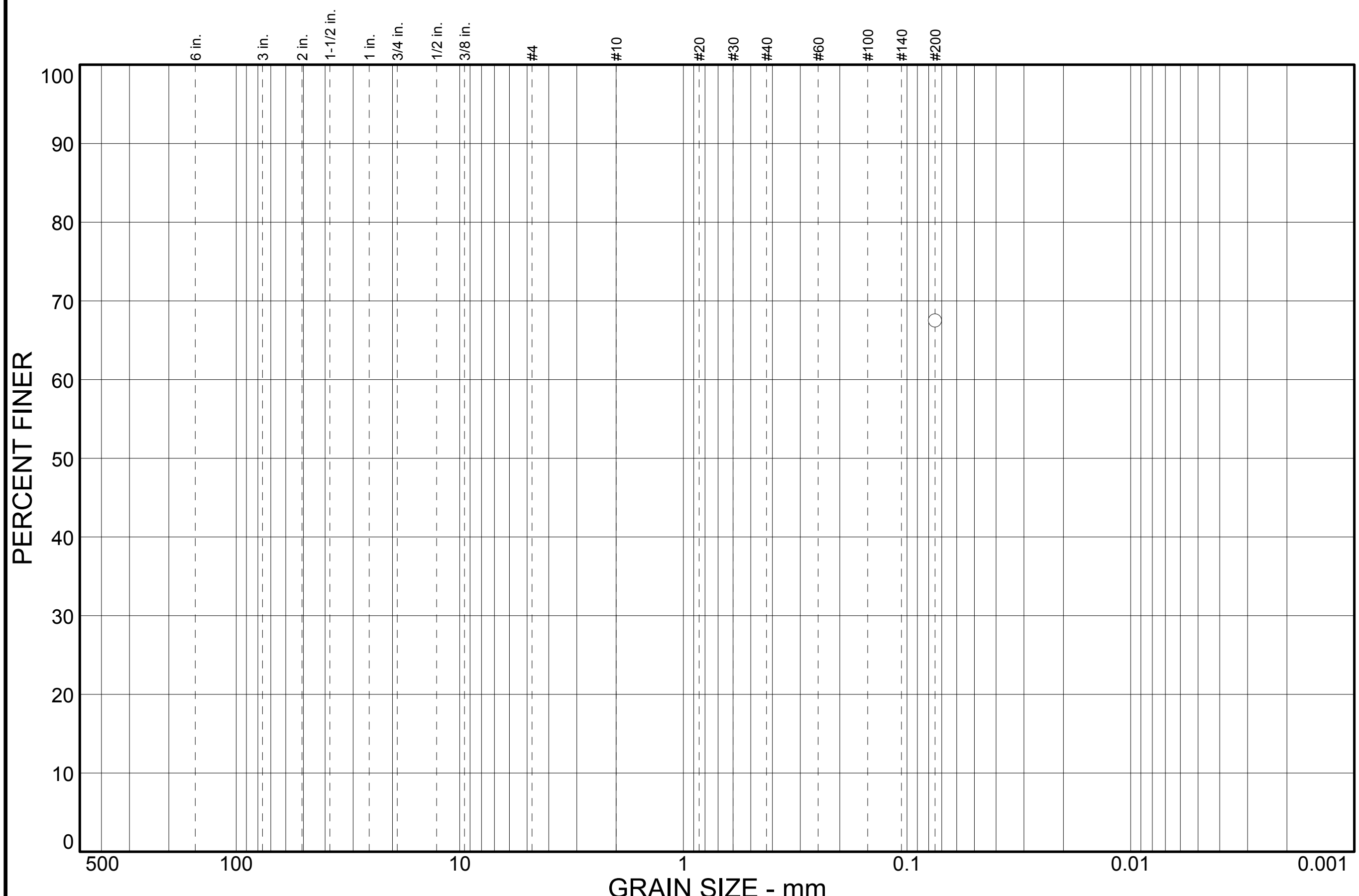
Total dry weight of sample tested=292grams.

Sample No.: EB-4/2c **Source of Sample:** **Date:** 9-27-2010
Location: **Elev./Depth:** 3.5'-4.0'

Taber
Since 1954

Client: HDR
Project: Sonoma County Water Agency / #144993
Project No: 2010/0198 **Figure** B-15

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
						67.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	67.5		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

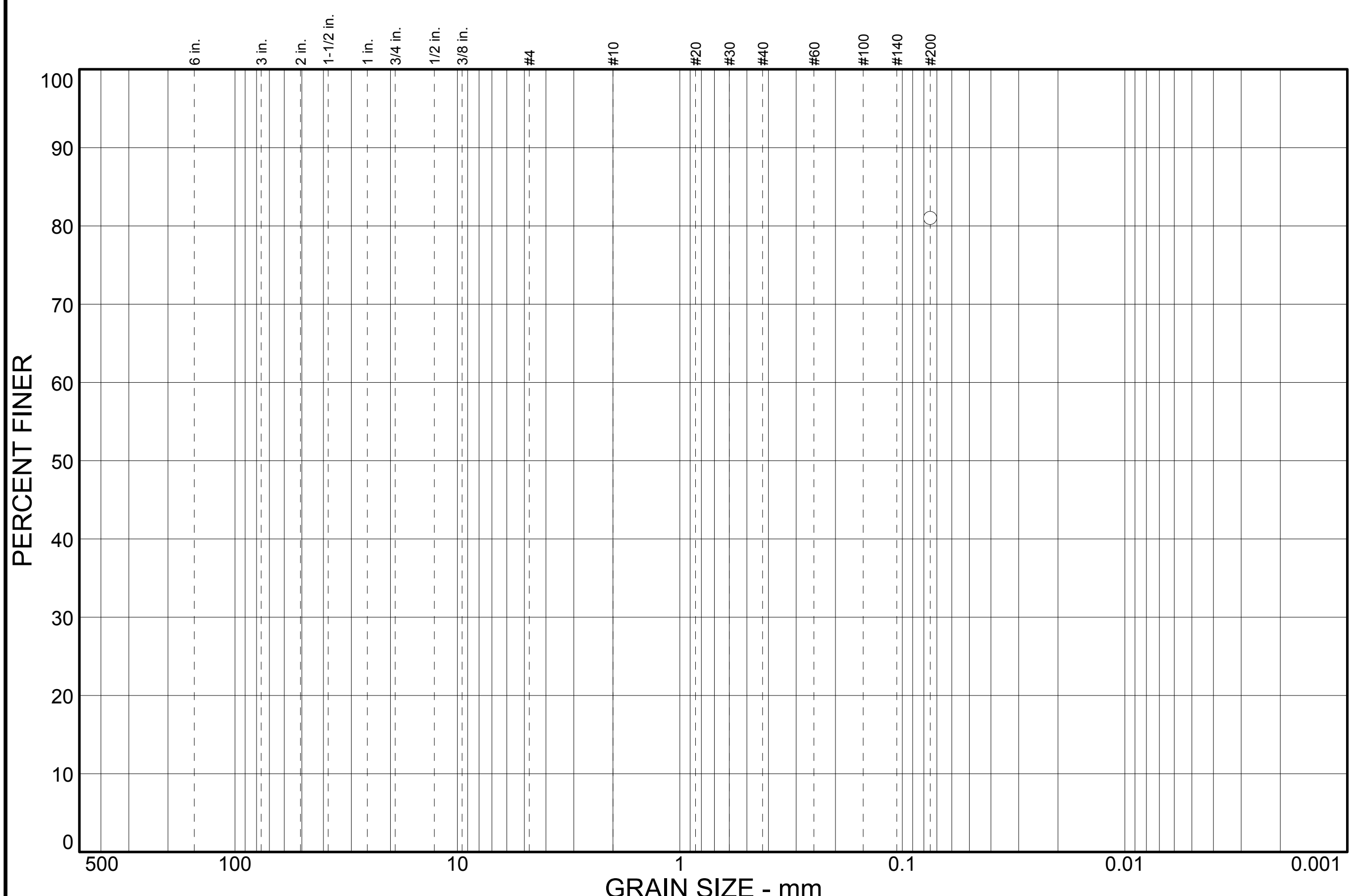
Total dry weight of sample tested=642grams.

Sample No.: EB-5/2 **Source of Sample:** **Date:** 9-27-2010
Location: **Elev./Depth:** 3.5'-4.0'

Taber Since 1954

Client: HDR
Project: Sonoma County Water Agency / #144993
Project No: 2010/0198 **Figure** B-16

Particle Size Distribution Report



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
						81.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	81.0		

* (no specification provided)

Material Description

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

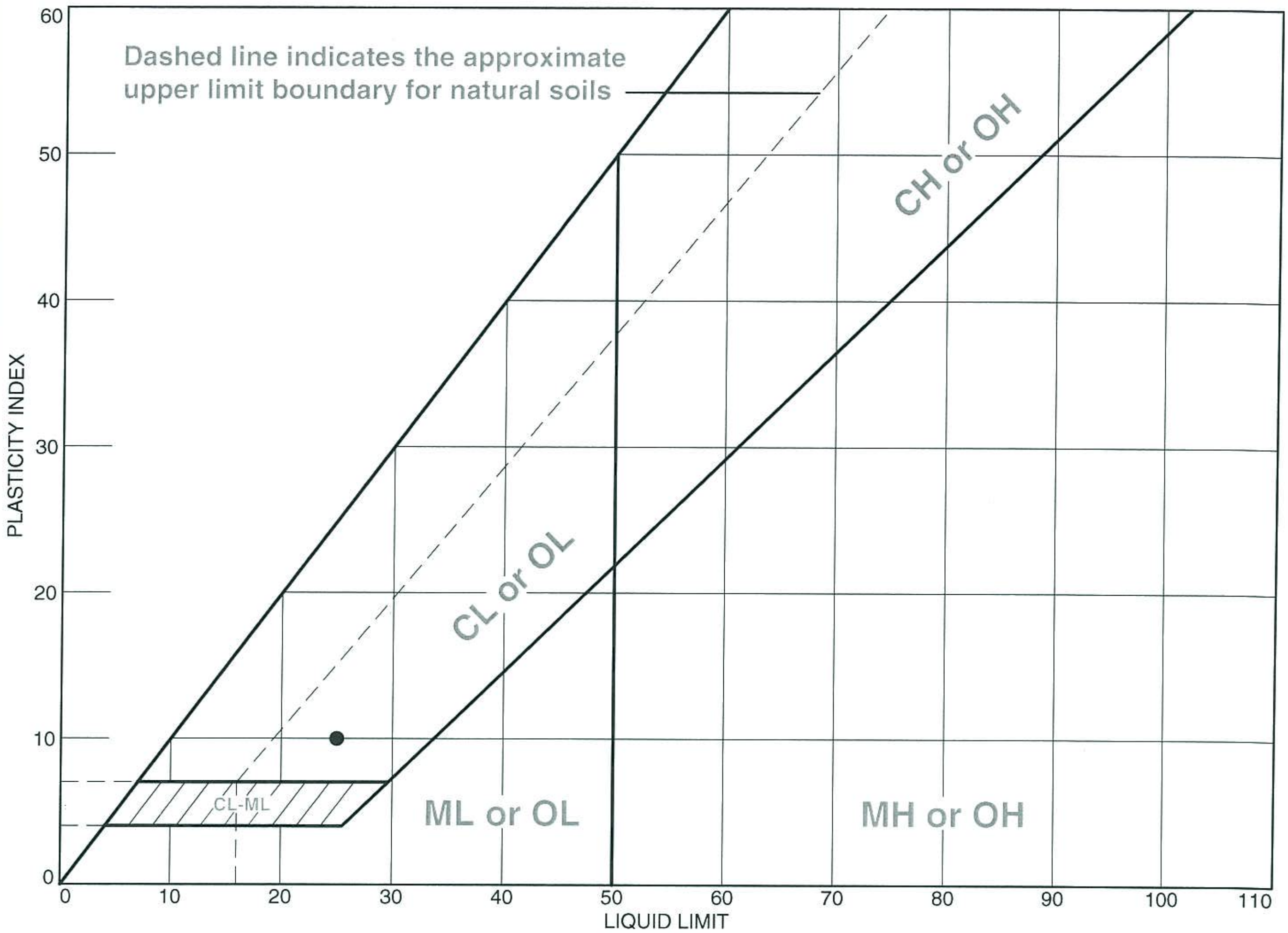
Total dry weight of sample tested=574grams.

Sample No.: EB-5/8 **Source of Sample:** **Date:** 9-27-2010
Location: **Elev./Depth:** 18.5'-19.0'

Taber Since 1954

Client: HDR
Project: Sonoma County Water Agency / #144993
Project No: 2010/0198 **Figure** B-17

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		25	15	10			

Project No. 10-265 **Client:** Taber Construction

Project: Sonoma County Water Agency #2010/0198

● **Location:** EB-1/1 **Depth:** 1-1.5 **Sample Number:** S25204

Remarks:

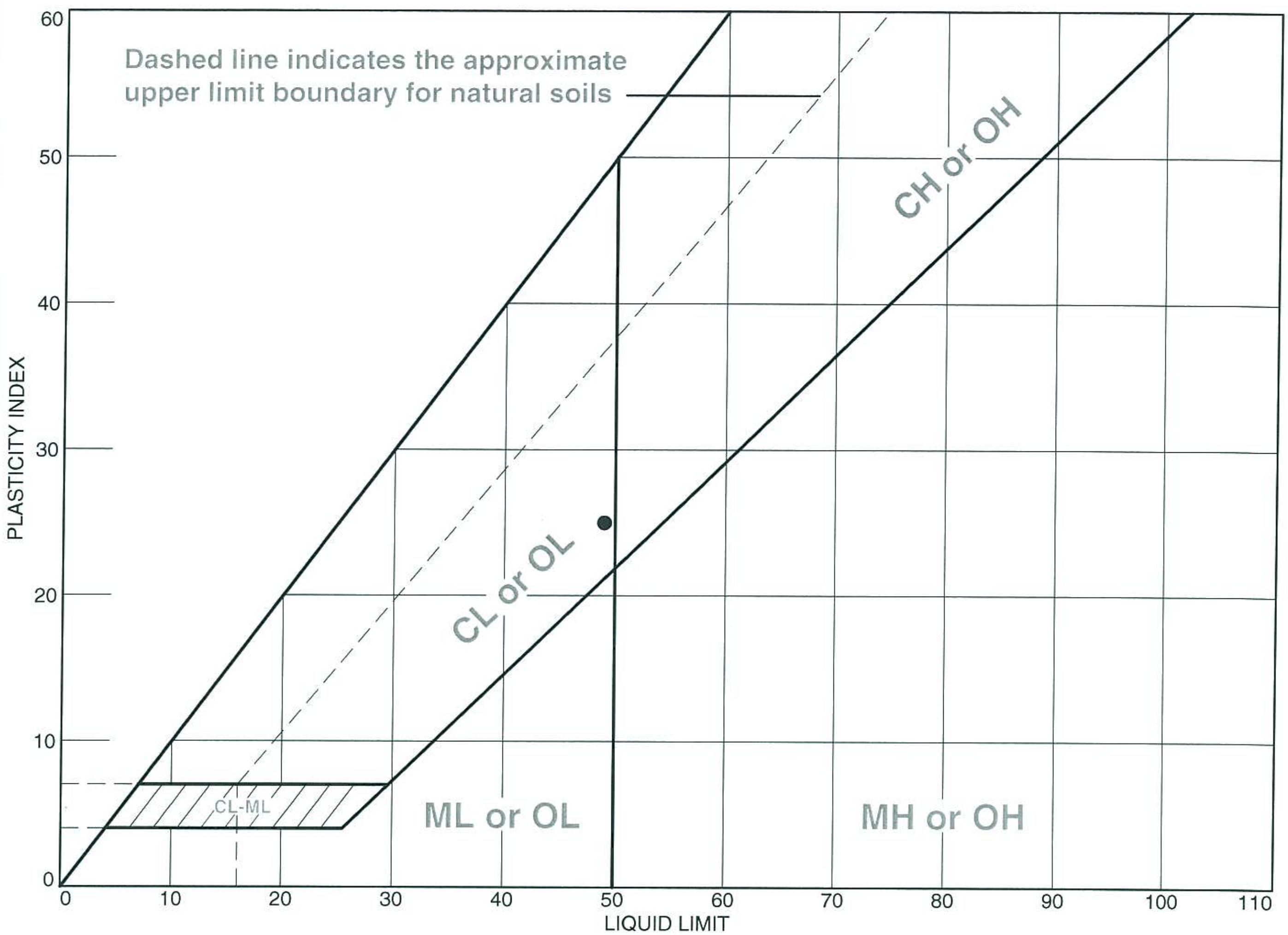
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure B-18

Tested By: rl **Checked By:** mn

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		49	24	25			

Project No. 10-265 **Client:** Taber Construction

Project: Sonoma County Water Agency #2010/0198

● **Location:** EB-1/13 **Depth:** 41-41.5 **Sample Number:** S25205

Remarks:

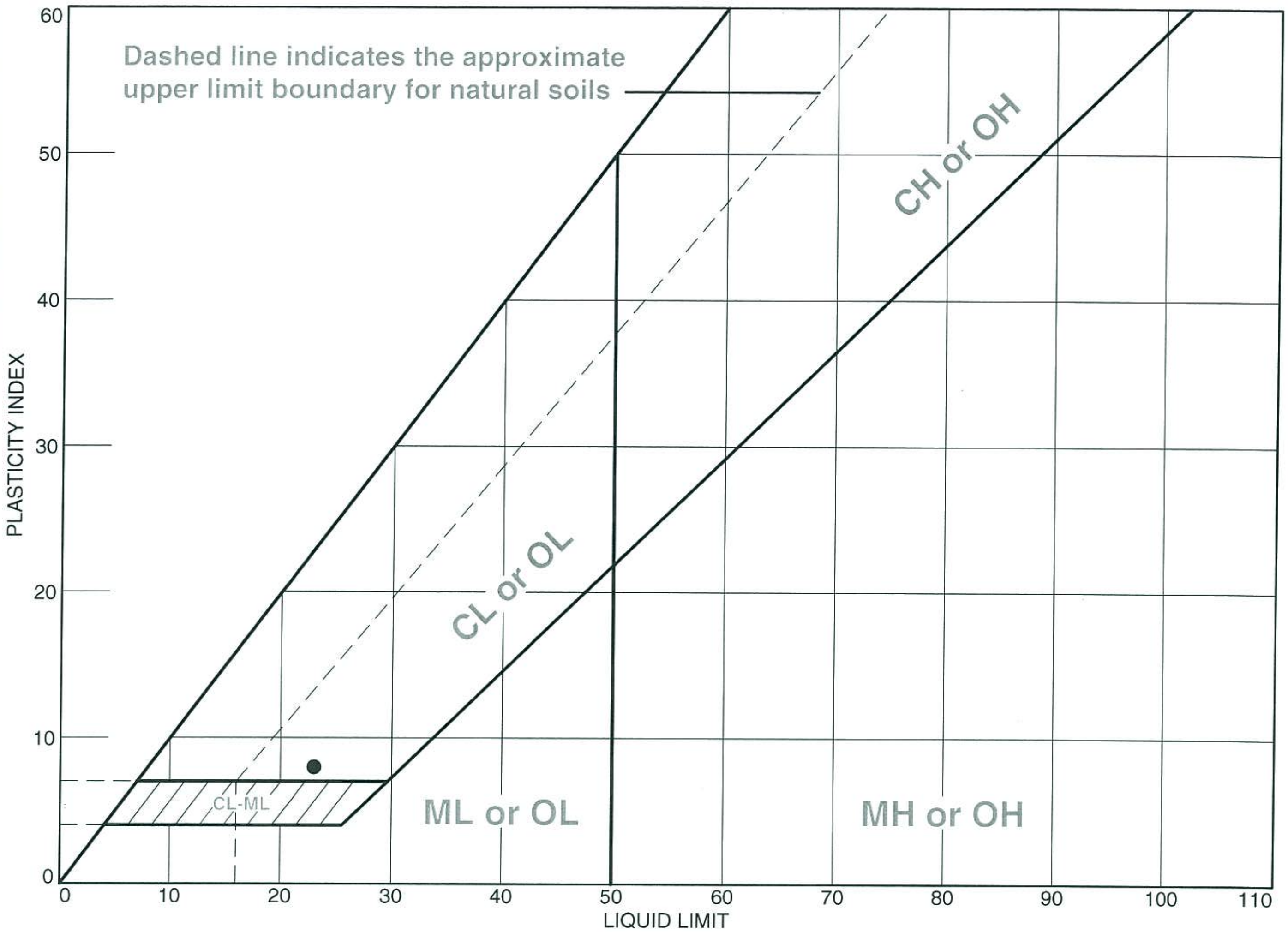
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure B-19

Tested By: ef **Checked By:** mn

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		23	15	8			

Project No. 10-265 **Client:** Taber Construction

Project: Sonoma County Water Agency #2010/0198

● **Location:** EB-2/2 **Depth:** 3.5-4.0 **Sample Number:** S25206

Remarks:

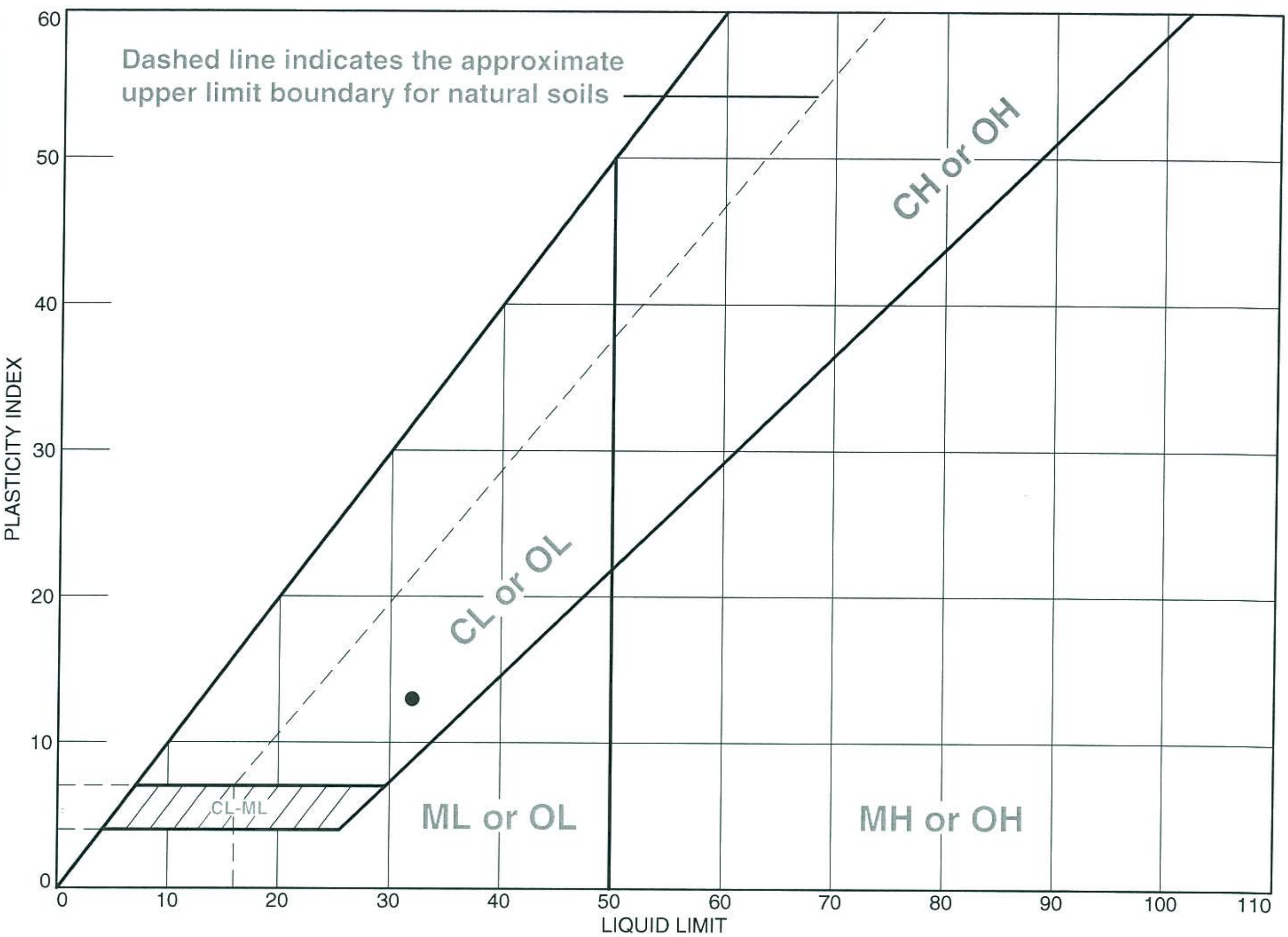
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure B-20

Tested By: ef **Checked By:** mn

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		32	19	13			

Project No. 10-265 **Client:** Taber Construction

Project: Sonoma County Water Agency #2010/0198

● **Location:** EB-2/13C **Depth:** 41-41.5 **Sample Number:** S25207

Remarks:

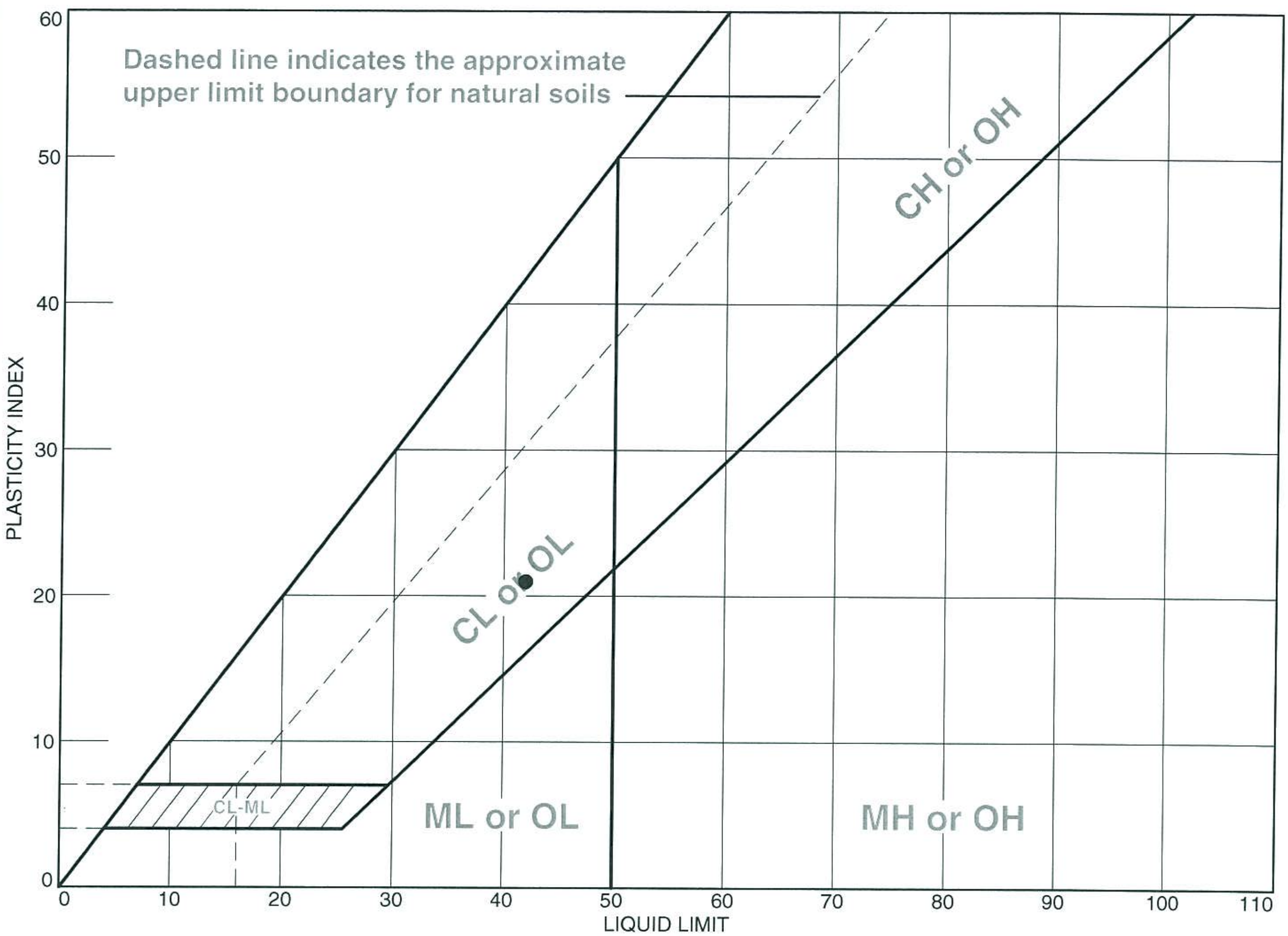
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure B-21

Tested By: ef **Checked By:** mn

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		42	21	21			

Project No. 10-265 **Client:** Taber Construction

Project: Sonoma County Water Agency #2010/0198

● **Location:** EB-2/17C **Depth:** 61-61.5 **Sample Number:** S25208

Remarks:

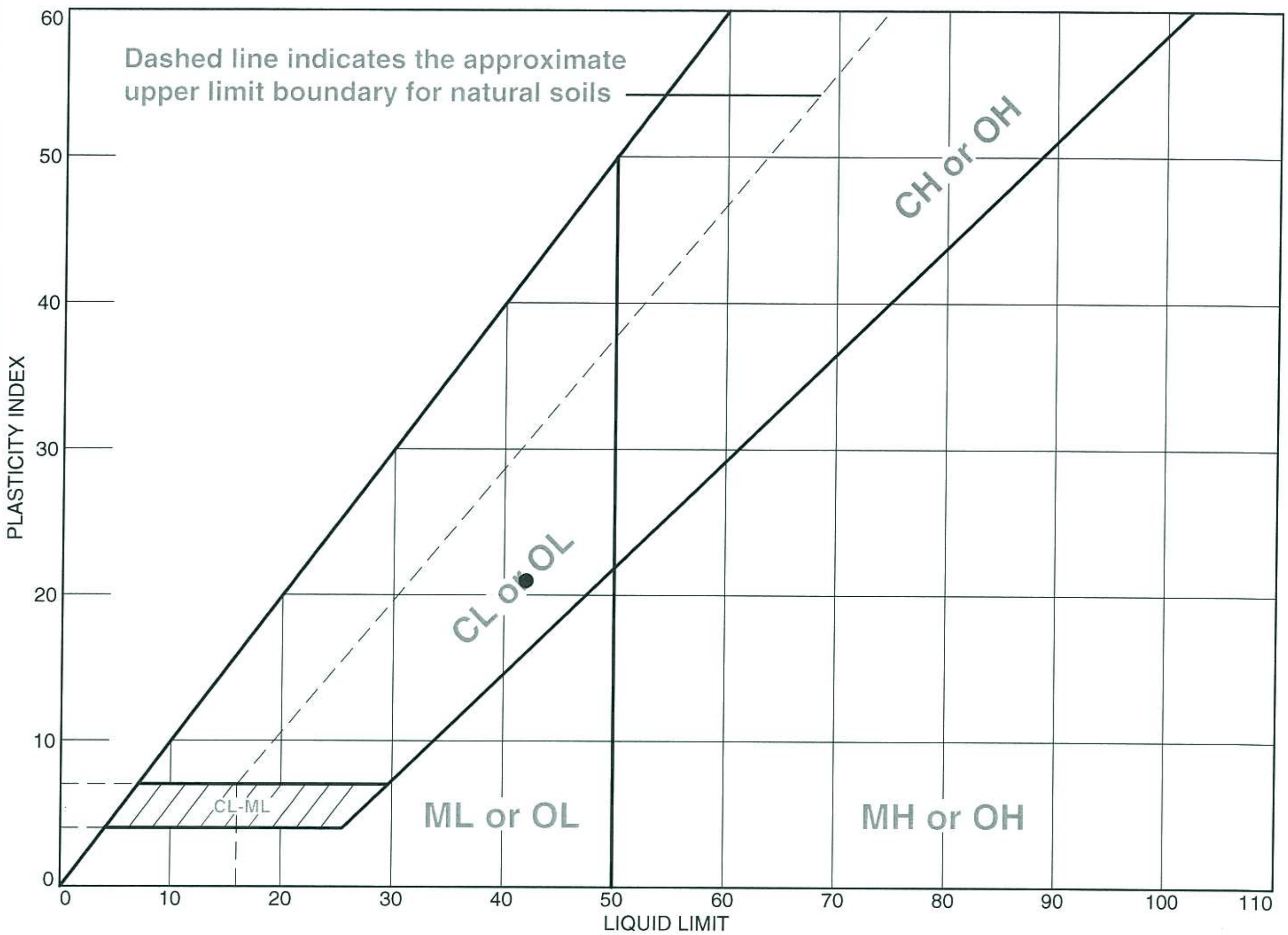
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure B-22

Tested By: rh **Checked By:** mn

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		42	21	21			

Project No. 10-265 **Client:** Taber Construction

Project: Sonoma County Water Agency #2010/0198

● **Location:** EB-3/11 **Depth:** 31-31.5 **Sample Number:** S25209

Remarks:

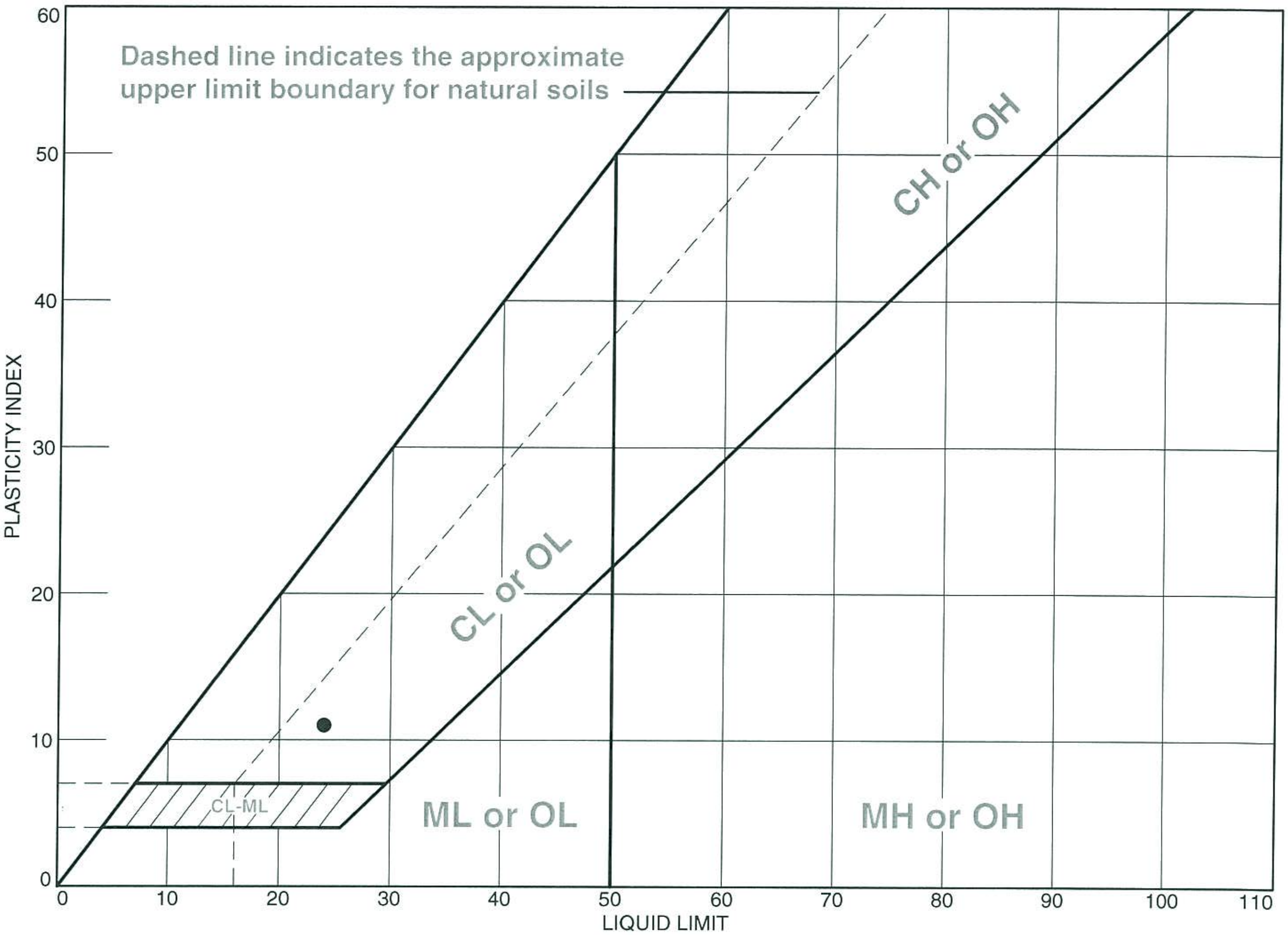
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure B-23

Tested By: rl **Checked By:** mn

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		24	13	11			

Project No. 10-265 **Client:** Taber Construction

Project: Sonoma County Water Agency #2010/0198

● **Location:** EB-4/1 **Depth:** 1-1.5 **Sample Number:** S25210

Remarks:

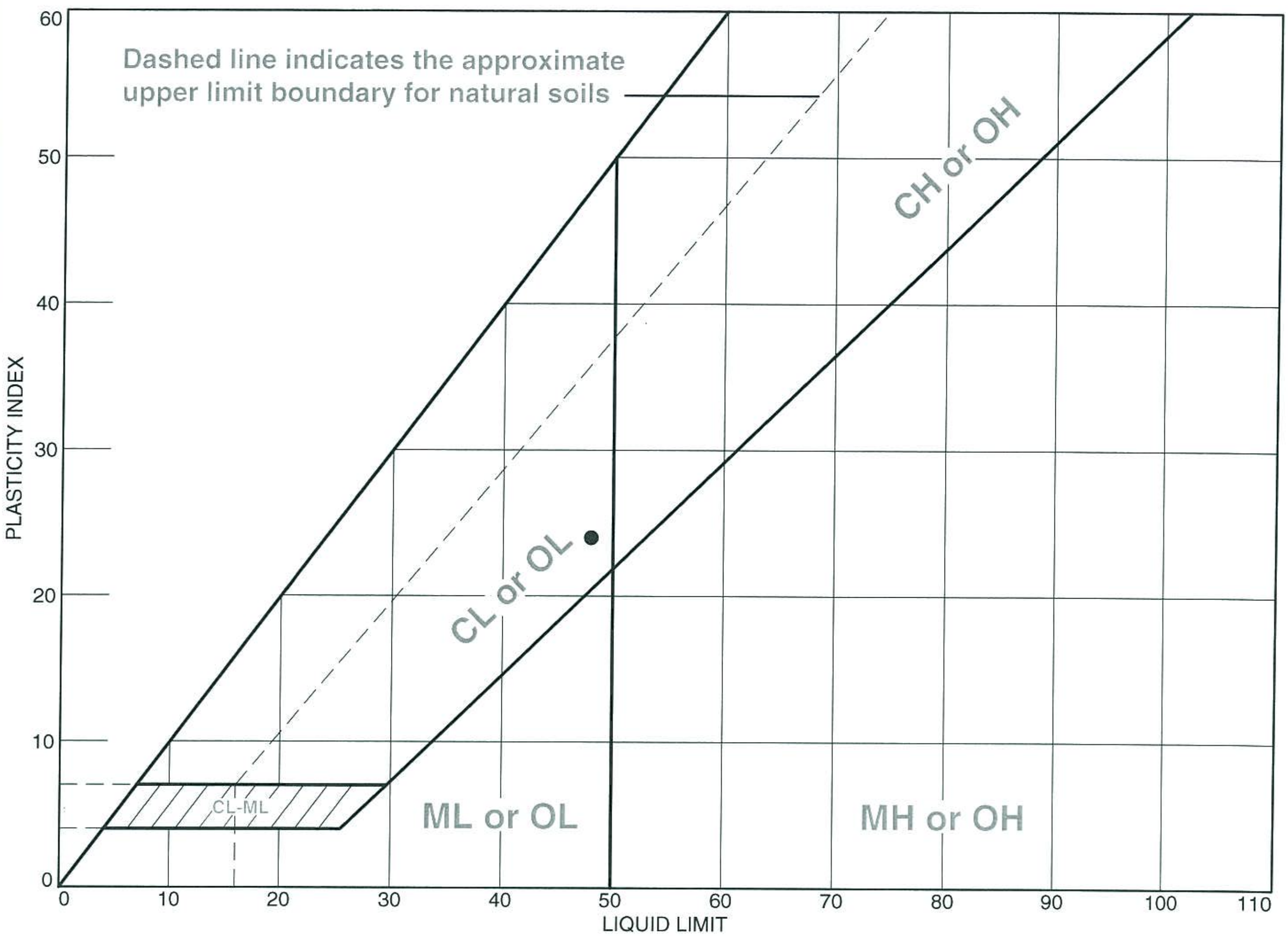
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure B-24

Tested By: rl **Checked By:** mn

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		48	24	24			

Project No. 10-265 **Client:** Taber Construction

Project: Sonoma County Water Agency

#2010/0198

● **Location:** EB-4/5 **Depth:** 11-11.5 **Sample Number:** S25211

Remarks:

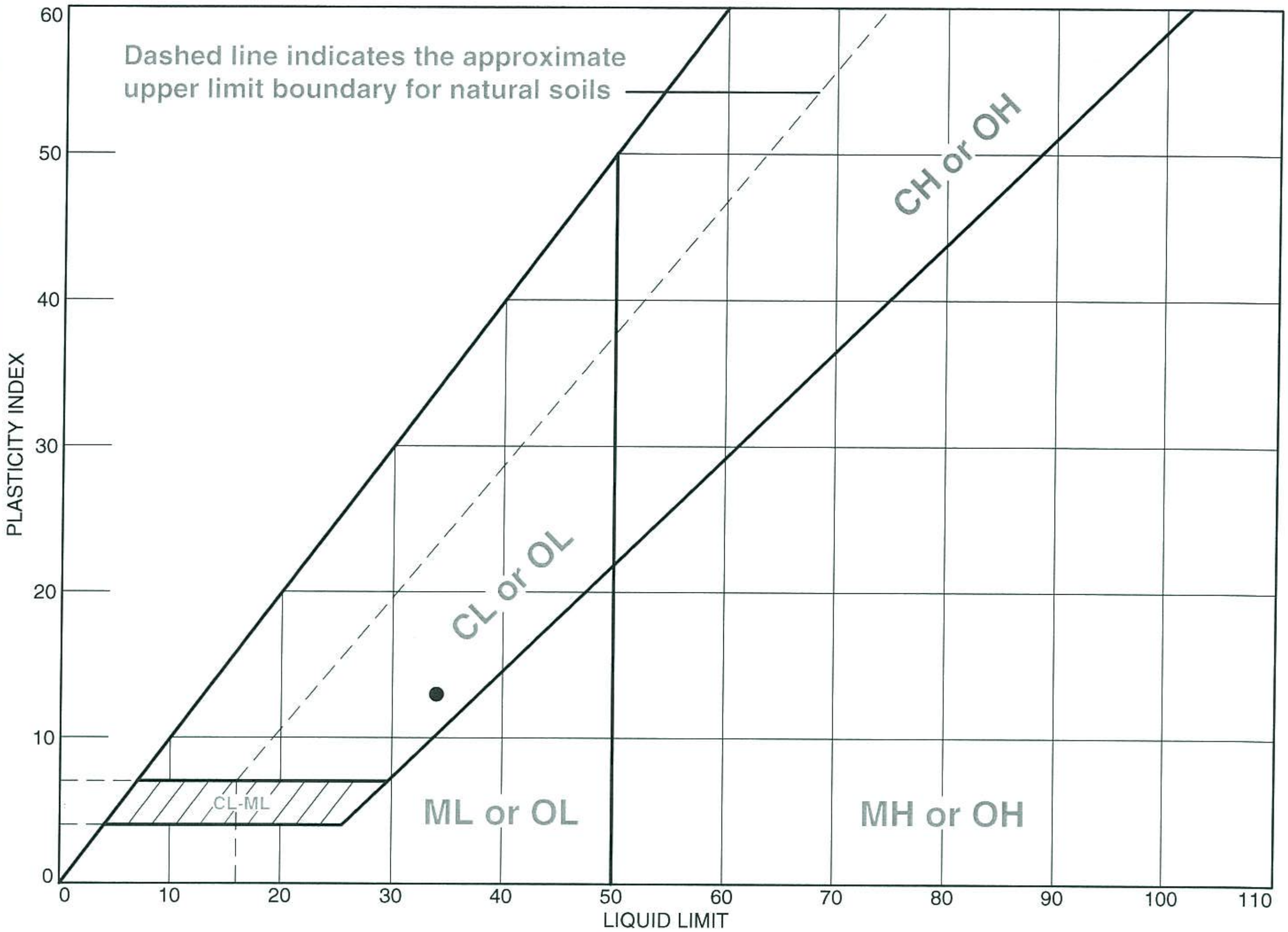
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure B-25

Tested By: rh **Checked By:** mn

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		34	21	13			

Project No. 10-265 **Client:** Taber Construction

Project: Sonoma County Water Agency #2010/0198

● **Location:** EB-4/12 **Depth:** 36-36.5 **Sample Number:** S25212

Remarks:

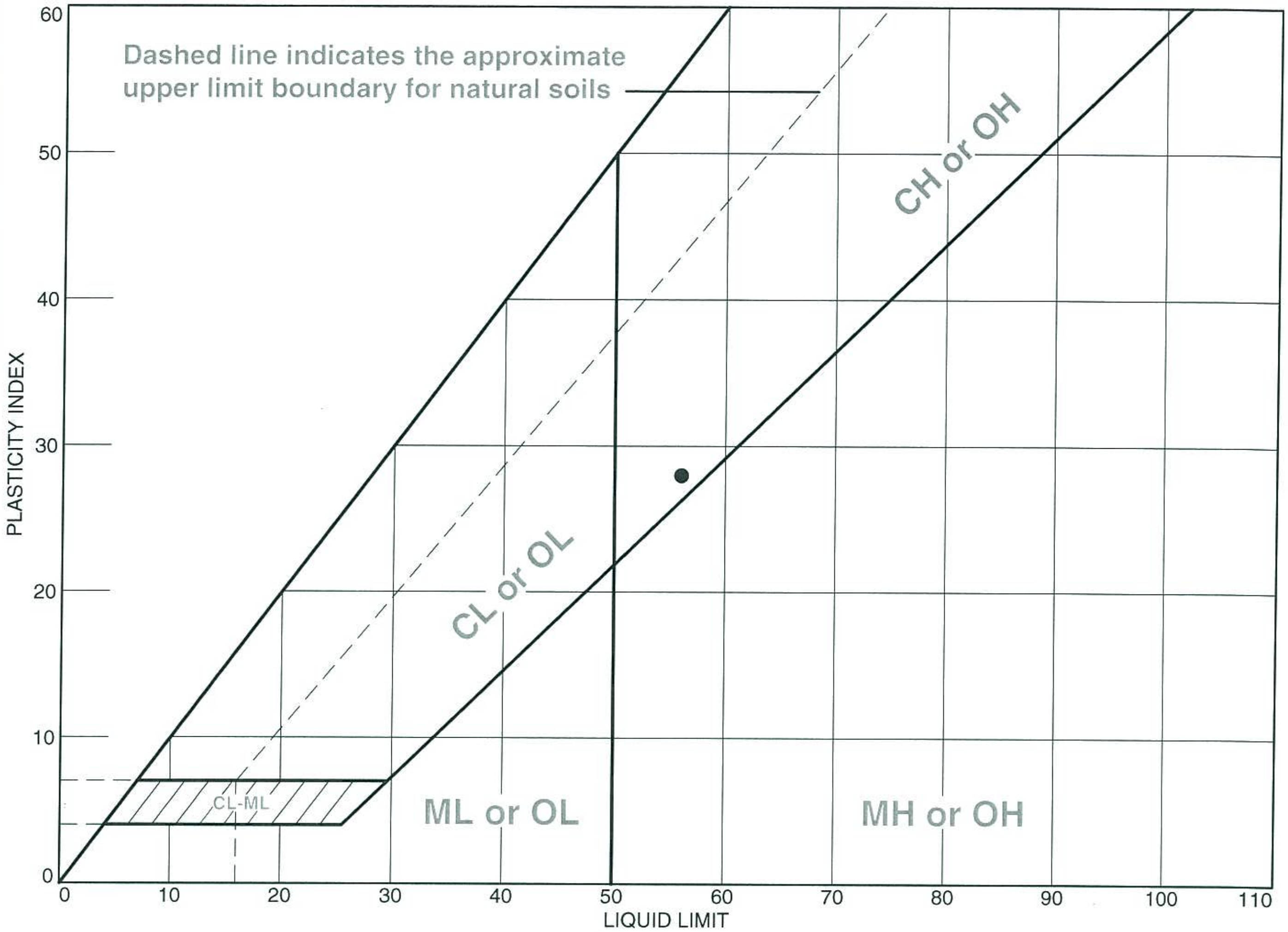
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure B-26

Tested By: rl **Checked By:** mn

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		56	28	28			

Project No. 10-265 **Client:** Taber Construction

Project: Sonoma County Water Agency

#2010/0198

● **Location:** EB-5/5 **Depth:** 11-11.5 **Sample Number:** S25213

Remarks:

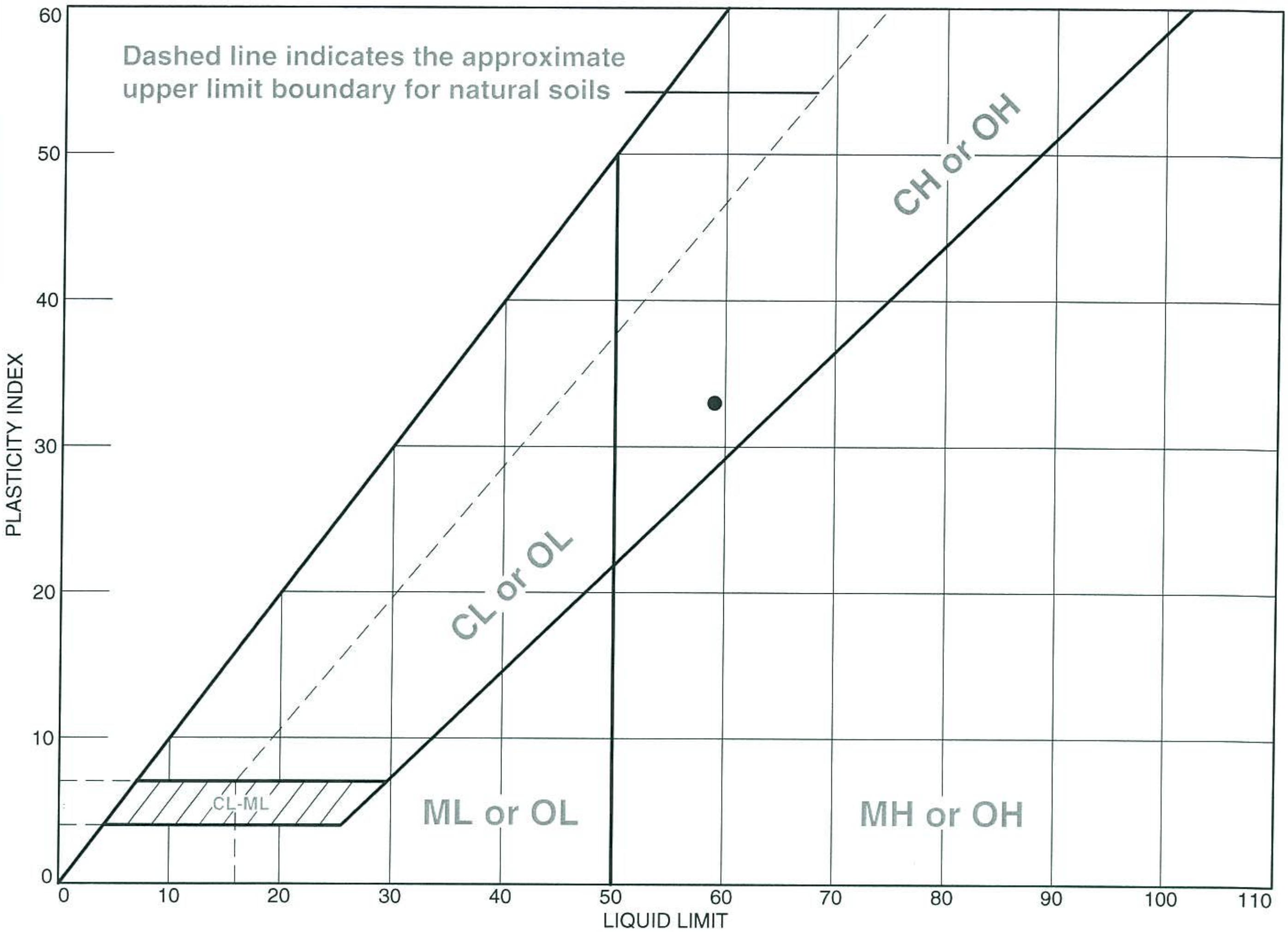
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure B-27

Tested By: rh **Checked By:** mn

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		59	26	33			

Project No. 10-265 **Client:** Taber Construction

Project: Sonoma County Water Agency
#2010/0198

● **Location:** EB-5/12 **Depth:** 36-36.5 **Sample Number:** S25214

Remarks:

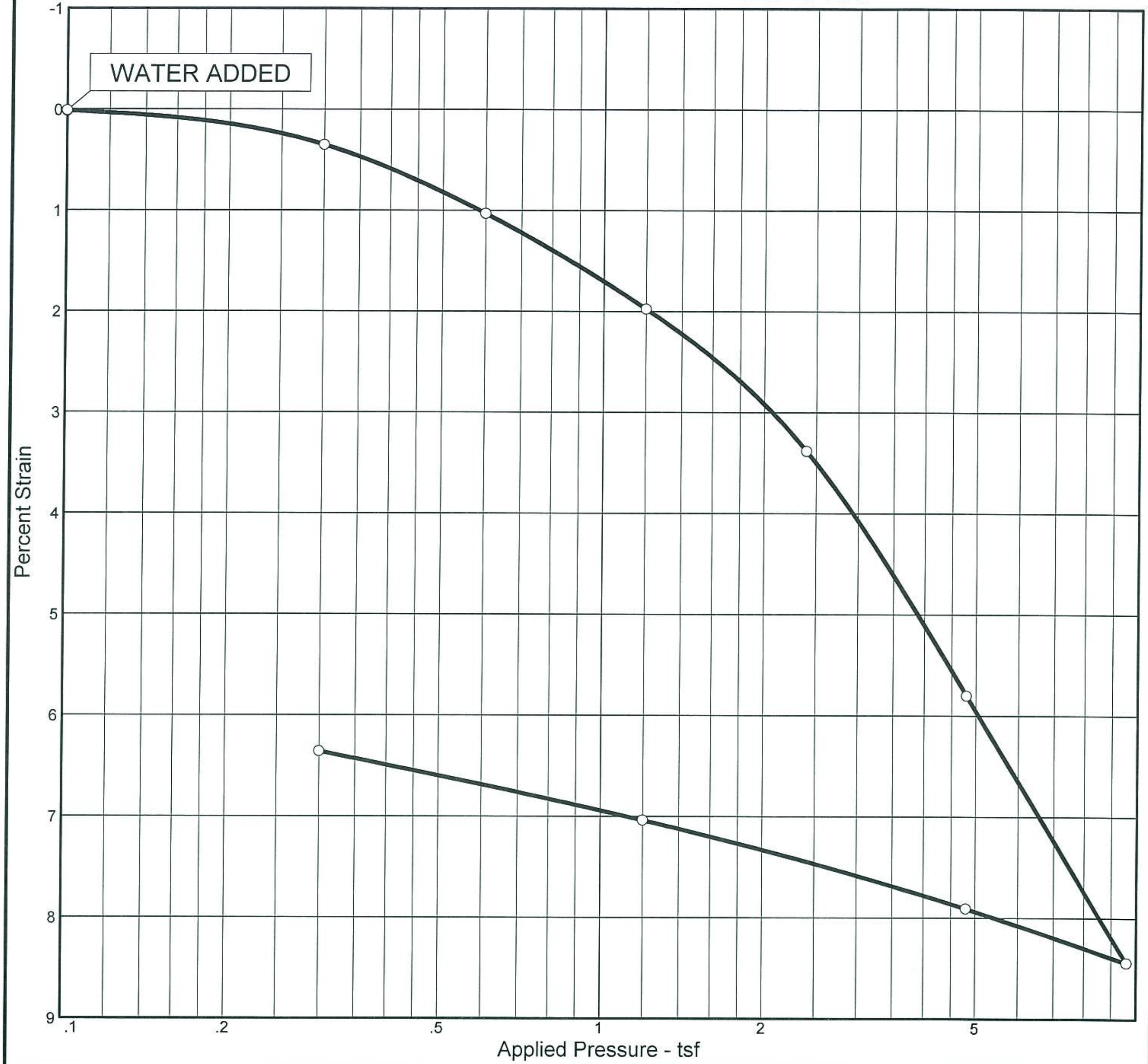
SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure B-28

Tested By: rh **Checked By:** mn

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_s	Swell Press. (tsf)	Swell %	e_o
Sat.	Moist.											
99.1 %	49.7 %	71.6			2.70		2.61	0.21	0.03	0.10		1.353

MATERIAL DESCRIPTION	USCS	AASHTO

Project No. 10-265 **Client:** Taber Construction

Project: Sonoma County Water Agency #2010/0198

Location: EB-2

Remarks:

SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure B-29

2010/0198
#144993 / SCWA

SUMMARY OF DIRECT SHEAR TESTS

			Peak Values		Ultimate Values	
Boring/Sample Number	**Test Condition**	**Normal Stress** (psf)	**Shear Stress** (psf)	**Displacement** (inches)	**Shear Stress** (psf)	**Displacement** (inches)
EB-2/4c	3	600	1208	.110	1145	.240
"	"	1200	1534	.140	1471	.240
"	"	2400	2972	.150	2227	.240
EB-3/5	3	500	617	.090	454	.240
"	"	1000	998	.100	736	.240
"	"	2000	1733	.120	1334	.240

All samples sheared – specimen test condition as noted – in standard circular shear box under strain control = 0.025 inches per minute.

Test Condition Notation
1. Natural Moisture Content, Unconsolidated
2. Submerged, Unconsolidated
3. Saturated, Consolidated at Test Load
4. Remolded to 90%± Relative Compaction (ASTM D1557)

SURCHARGE VOLUME CHANGE TESTS

(2 .4" Diameter by 1" Thick Specimen, 24-hr Saturation at Indicated Surcharge)

		INITIAL VALUES			
Boring/Sample Number	**Surcharge (psf)**	**Dry Density (pcf)**	**Moisture (%)**	**Final Moisture (%)**	**Compression (-) Expansion (+) %**
EB-2/4c	600	106	19.7	20.7	(-) 0.5
"	1200	107	19.7	21.1	(-) 0.7
"	2400	107	19.7	20.3	(-) 1.4
EB-3/5	500	95	30.6	30.2	(-) 0.9
"	1000	96	30.6	29.3	(-) 2.5
"	2000	97	30.6	29.4	(-) 2.7

APPENDIX C

SUBSURFACE EXPLORATION BY OTHERS

Subsurface Exploration by Others

Subsurface exploration was performed by Stevens, Ferrone & Bailey Engineering Company, Inc. in April 2010 at the proposed tertiary effluent reservoir. The borings are summarized below and the boring logs and limited laboratory test results are attached to this appendix. The boring locations are presented on the Boring Location Map, Figure 2.

Table C-1. Borings by SFB

Boring	Date Drilled	Depth (ft)
B-1	4/9/10	41.5
B-2	4/12/10	26.0
B-3	4/12/10	24.5
B-4	4/14/10	26.5
B-5	4/14/10	26.5

DRILL RIG CME 850, HSA	SURFACE ELEVATION ---	LOGGED BY TC
DEPTH TO GROUND WATER 3 feet	BORING DIAMETER 8-inch	DATE DRILLED 04/09/10

DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	DEPTH (FEET)	SAMPLER	SPT N-VALUE	WATER CONTENT (%)	DRY DENSITY (PCF)	UNC. COMP. (KSF)	OTHER TESTS
CLAY (CH), dark grayish brown, silty, some sand(fine-grained), damp to moist.	firm		0						LL = 58, PI = 39
GRAVEL (GC), mottled gray yellowish brown, fine to coarse, subangular to subrounded, sandy(fine- to coarse-grained), clayey, with silt, moist. Same large rock fragments.	medium dense		5		16	20	107		See Figure B-1 for Gradation Test Results
CLAY (CL), brown, silty, some gravel(fine, subangular to subrounded), damp.	stiff								
	very stiff		10		26	25	101		
			15		20				
1" thick gray fine- to coarse-grained sand (SP-SM) some silt at 21'.			20		25				Passing # 200 Sieve = 28%
SAND (SM), gray, fine- to medium-grained, with to silty, moist to wet.	medium dense								
Clayey, wet.			25		29				
CLAY (CL), brown, silty, some sand(fine-grained), damp.	very stiff								
CLAY (CH), dark bluish gray, silty, some sand(fine- to medium-grained), damp.	very stiff		30		21				

Depth to ground water indicated at 3 feet (▼).

Stevens, Ferrone & Bailey Engineering Company, Inc.
1600 Willow Pass Court
Concord, CA 94520
Telephone: 925-688-1001
Fax: 925-688-1005

EXPLORATORY BORING LOG

SVCSD STORAGE PONDS
Sonoma, CA

PROJECT NO.	DATE	BORING NO.
496-1	May 2010	B-1

DRILL RIG CME 850, HSA	SURFACE ELEVATION ---	LOGGED BY TC
DEPTH TO GROUND WATER 3 feet	BORING DIAMETER 8-inch	DATE DRILLED 04/09/10

DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	DEPTH (FEET)	SAMPLER	SPT N-VALUE	WATER CONTENT (%)	DRY DENSITY (PCF)	UNC. COMP. (KSF)	OTHER TESTS
CLAY (CH), Continued, damp.	very stiff		35		24				
SILT (ML), dark bluish gray, clayey, with silt(fine-grained), damp.	very stiff		40		22				
Bottom of Boring = 41.5 feet Notes: Stratification is approximate, variations must be expected. Blowcounts converted to SPT N-values. See Report for additional details.			45						
			50						
			55						
			60						
			65						

EXPLORATORY BORING LOG 496-1.GPJ STEVENS FERRONE BAILEY.GDT 5/10/10

Stevens, Ferrone & Bailey Engineering Company, Inc.
1600 Willow Pass Court
Concord, CA 94520
Telephone: 925-688-1001
Fax: 925-688-1005

EXPLORATORY BORING LOG

SVCSD STORAGE PONDS
Sonoma, CA

PROJECT NO.	DATE	BORING NO.
496-1	May 2010	B-1

DRILL RIG CME 850, HSA	SURFACE ELEVATION ---	LOGGED BY NSK
DEPTH TO GROUND WATER 1 feet	BORING DIAMETER 8-inch	DATE DRILLED 04/12/10

DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	DEPTH (FEET)	SAMPLER	SPT N-VALUE	WATER CONTENT (%)	DRY DENSITY (PCF)	UNC. COMP. (KSF)	OTHER TESTS
CLAY (CH), dark grayish brown, silty, some sand(fine- to medium-grained), moist.	soft		0 ▼	X	3				
GRAVEL (GC), mottled reddish orange brown, fine to coarse, subangular to subrounded, clayey, sandy(fine- to coarse-grained), some silt, moist.	medium dense		5	X	22				
SAND (SM), brown with dark gray mottles, fine- to medium-grained, some silt, some clay, trace gravel, moist.	medium dense		10	X	16				See Figure B-1 for Gradation Test Results
Gravelly at 12.5' to 13'.									
			15	X	17				
CLAY (CL), brown, silty, with sand(fine-grained), damp.	hard		20	X	34				
	very stiff		25	X	27				
Bottom of Boring = 26 feet Notes: Stratification is approximate, variations must be expected. Blowcounts converted to SPT N-values. See Report for additional details.			30						

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EXPLORATORY BORING LOG

SVCSD STORAGE PONDS
Sonoma, CA

PROJECT NO.	DATE	BORING NO.
496-1	May 2010	B-2

DRILL RIG CME 850, HSA	SURFACE ELEVATION ---	LOGGED BY NSK
DEPTH TO GROUND WATER 1.5 feet	BORING DIAMETER 8-inch	DATE DRILLED 04/12/10

DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	DEPTH (FEET)	SAMPLER	SPT N-VALUE	WATER CONTENT (%)	DRY DENSITY (PCF)	UNC. COMP. (KSF)	OTHER TESTS
SILT (ML), gray clayey, some sand(fine-grained), wet.	very soft		0	X	0				
Gravels at 2.5' to 3'.									
CLAY (CL), brown, sandy(fine-grained), damp to moist.	hard								
No recovery at 4.5' to 6'.			5	X	91				
				X	33				
Very sandy at 7.5'.									
SAND (SM), grayish brown, fine-grained, silty, damp.	medium dense								
			10	X	21				
Gravels at 12.5'.									
Fine- to coarse-grained at 15', damp.	loose		15	X	9				Passing # 200 Sieve = 19%
	very dense		20	X	65				
Fine- to coarse-grained at 21'. Gravelly at 21.5'.									
Boring converted to piezometer.									
Bottom of Boring = 24.5 feet Notes: Stratification is approximate, variations must be expected. Blowcounts converted to SPT N-values. See Report for additional details.			25						
			30						

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EXPLORATORY BORING LOG

SVCSD STORAGE PONDS
Sonoma, CA

PROJECT NO.	DATE	BORING NO.
496-1	May 2010	B-3

DRILL RIG CME 850, HSA	SURFACE ELEVATION ---	LOGGED BY NSK
DEPTH TO GROUND WATER 4 feet	BORING DIAMETER 8-inch	DATE DRILLED 04/14/10

DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	DEPTH (FEET)	SAMPLER	SPT N-VALUE	WATER CONTENT (%)	DRY DENSITY (PCF)	UNC. COMP. (KSF)	OTHER TESTS
CLAY (CH), dark brown, some silt, moist.	firm		0						
Hard pan layer at 3' to 4'.	stiff								
Sandy(fine- to medium-grained), with gravel.			▼						
			5	X	50/6"				
GRAVEL (GC), dark gray brown, fine to coarse, subangular to subrounded, clayey, some sand(fine- to coarse-grained), moist.	very dense								
CLAY (CL), mottled grayish brown, silty, some sand(fine-grained), damp.	stiff								
No recovery at 10' to 11.5'.			10	X	8				
Some gravel at 13'.									
	hard		15	X	38				
	very stiff		20	X	25				
			25	X	26				
Bottom of Boring = 26.5 feet Notes: Stratification is approximate, variations must be expected. Blowcounts converted to SPT N-values. See Report for additional details.									
			30						

EXPLORATORY BORING LOG 496-1.GPJ STEVENS FERRONE BAILEY.GDT 5/10/10

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EXPLORATORY BORING LOG

SVCSD STORAGE PONDS
Sonoma, CA

PROJECT NO.	DATE	BORING NO.
496-1	May 2010	B-4

DRILL RIG CME 850, HSA	SURFACE ELEVATION ---	LOGGED BY NSK
DEPTH TO GROUND WATER 4 feet	BORING DIAMETER 8-inch	DATE DRILLED 04/14/10

DESCRIPTION AND REMARKS	CONSIST	SOIL TYPE	DEPTH (FEET)	SAMPLER	SPT N-VALUE	WATER CONTENT (%)	DRY DENSITY (PCF)	UNC. COMP. (KSF)	OTHER TESTS
CLAY (CH), dark brown, silty, some sand(fine-grained), moist.	firm		0 (▼ groundwater at 4)						
SAND (SC), dark gray brown, fine- to coarse-grained, clayey, some gravel, wet.	medium dense		5	X	14				Passing # 200 Sieve = 20 %
GRAVEL (GC), mottled dark gray brown, fine to coarse, subangular to subrounded, clayey, with sand(fine- to coarse-grained), wet.	medium dense		10	X	24				
CLAY (CL), mottled gray brown, silty, damp.	very stiff		15	X	42				
GRAVEL (GC), gray brown, fine to coarse, subangular to subrounded, clayey, with sand(fine- to coarse-grained), moist.	dense								
SILT (ML), gray brown, with sand(fine-grained), some clay, moist.	stiff		20	X	14				Passing # 200 Sieve = 25%
SAND (SM), brown, fine- to medium-grained, with silt and clay, moist.	medium dense								
SILT (ML), brown, clayey, some sand(fine- to coarse-grained), moist.	hard		25	X	35				
Bottom of Boring = 26.5 feet Notes: Stratification is approximate, variations must be expected. Blowcounts converted to SPT N-values. See Report for additional details.			30						

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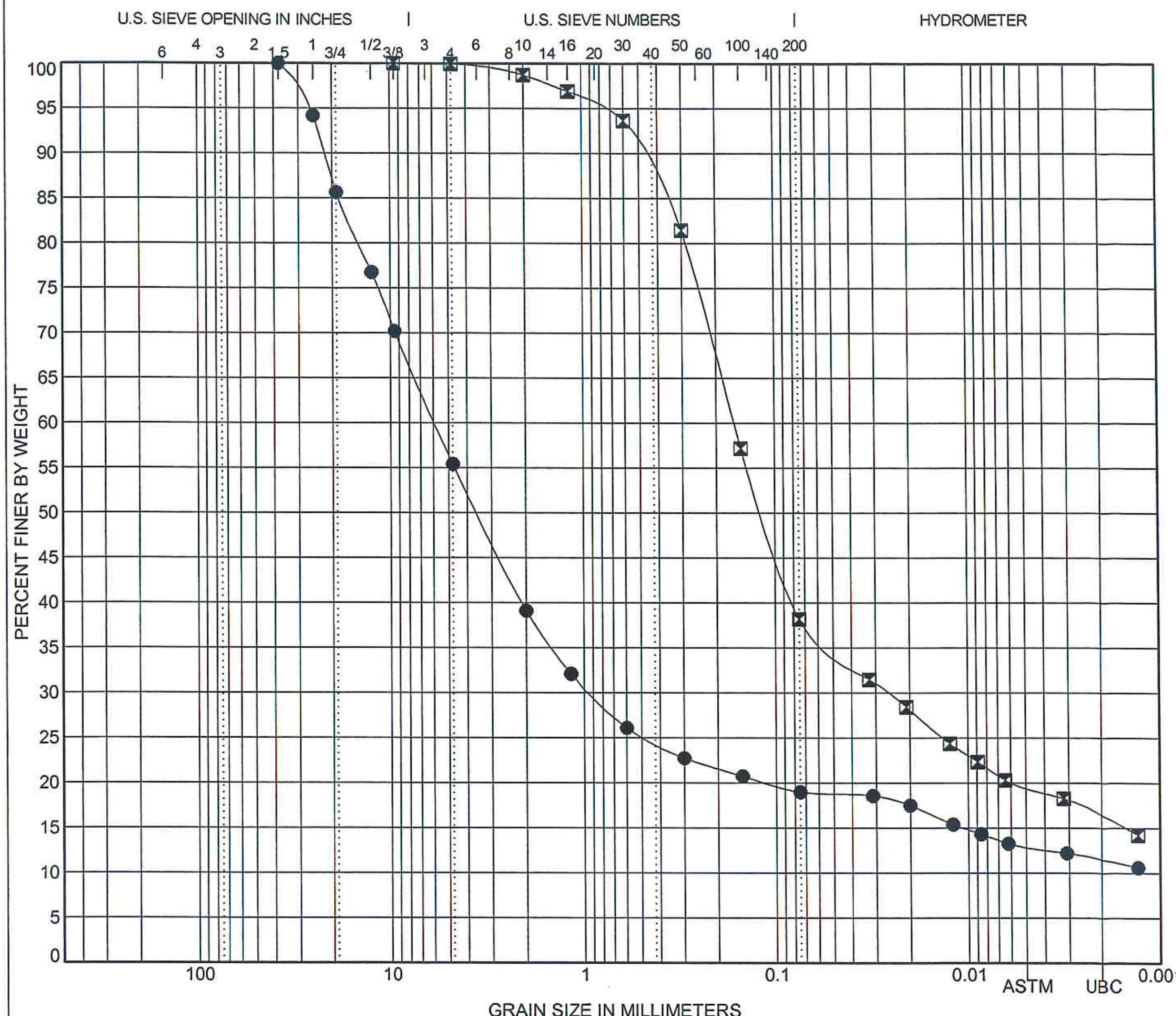
EXPLORATORY BORING LOG

SVCSD STORAGE PONDS
Sonoma, CA

PROJECT NO.	DATE	BORING NO.
496-1	May 2010	B-5



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Location	Depth (ft)	Classification	LL	PL	PI	Cc	Cu
●	**B-1**	**6.0**	**Dark brown gravelly SAND with clay some silt (SC)**					
⊠	**B-2**	**10.5**	**Gray brown clayey SAND with silt (SC/SM)**					

	Location	Depth (ft)	D100	D60	D30	D10	%Gravel	%Sand	ASTM %Silt	ASTM %Clay	UBC %-200<0.002mm
●	**B-1**	**6.0**	**37.5**	**5.888**	**0.932**		**44.6**	**36.4**	**6.0**	**12.9**	**60.1**
⊠	**B-2**	**10.5**	**9.5**	**0.163**	**0.026**		**0.1**	**61.7**	**18.6**	**19.6**	**42.3**

SIEVE 496-1.GPJ US_LAB.GDT 5/10/10

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GRAIN SIZE DISTRIBUTION

SVCSD STORAGE PONDS
Sonoma, CA

PROJECT NO.	DATE	FIGURE NO.
496-1	**May 2010**	**B-1**

APPENDIX D

SEEPAGE ANALYSES RESULTS

Seepage Analyses Attachments

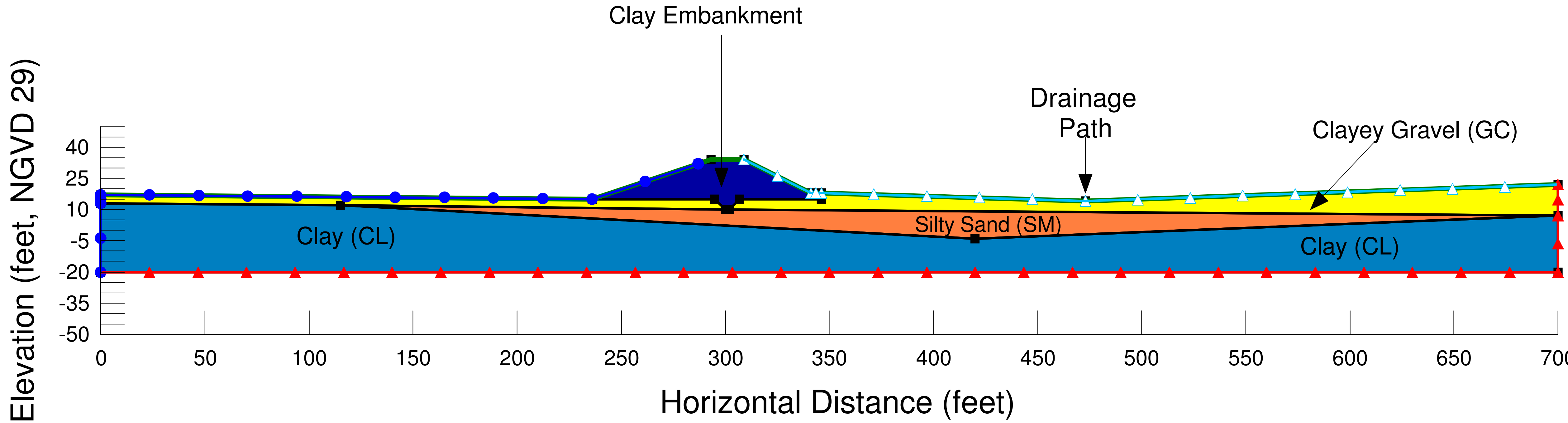
The attached figures illustrate the results of our seepage analyses of existing subsurface conditions with the proposed tertiary effluent reservoir embankment geometry. A summary of the figures included is presented in Table D-1 below. Note that the DWSE was modeled at Elevation 32 feet.

Table D-1. Seepage Analyses – Existing Conditions

Cross-Section	Condition	Figure No.
A-A’	Model Stratigraphy	D-1
	DWSE	D-2
B-B’	Model Stratigraphy	D-3
	DWSE	D-4

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5
DWSE = 32ft
Cross Section A-A' (East)
Last Edited By: Brown, Kimberly
Date: 11/4/2010 Time: 10:49:06 AM
Sonoma_WWTP_A-A_East.gsz

Name: Clay Embankment (CL/CH) K-Function: kh = 0.0028 ft/day (1x10^-6 cm/sec) Vol. WC. Function: Clay K-Ratio: 0.25
Name: Clayey Gravel (GC) K-Function: kh = 2.83 ft/day (1x10^-3 cm/sec) Vol. WC. Function: Gravel K-Ratio: 0.25
Name: Silty Sand (SM) K-Function: kh = 1.417 ft/day (5x10^-4 cm/sec) Vol. WC. Function: Silty Sand K-Ratio: 0.25
Name: Clay (CL/CH) K-Function: kh = 0.0028 ft/day (1x10^-6 cm/sec) Vol. WC. Function: Clay K-Ratio: 0.25



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Cross Section A-A' (EAST)
Model Stratigraphy

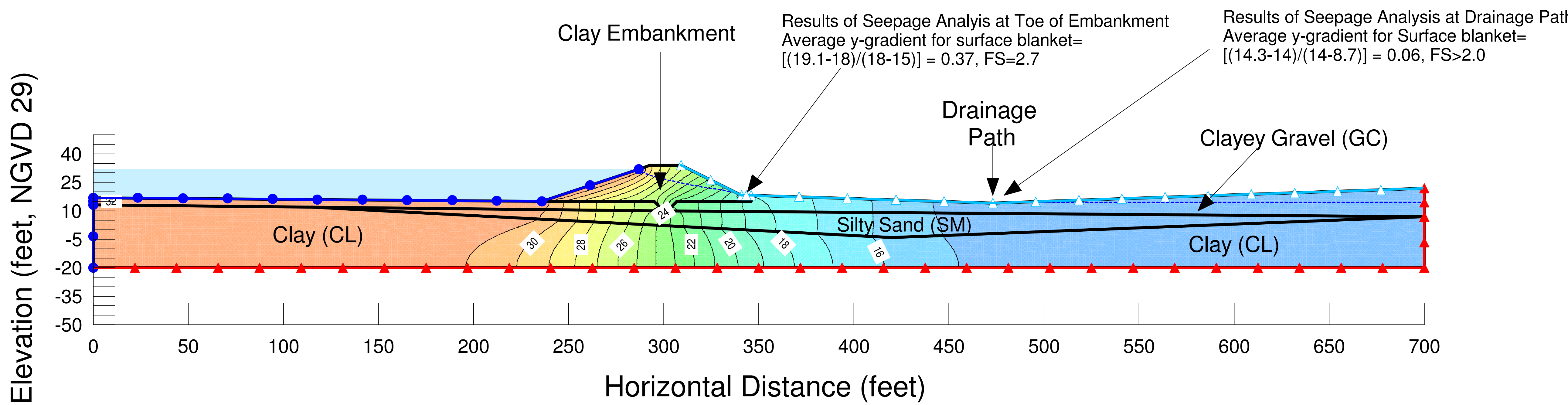
North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Figure
D-1

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5
DWSE = 32ft
Cross Section A-A' (East)
Last Edited By: Brown, Kimberly
Date: 11/4/2010 Time: 10:49:06 AM
Sonoma_WWTP_A-A_East.gsz

Name: Clay Embankment (CL/CH) K-Function: kh = 0.0028 ft/day (1x10^-6 cm/sec) Vol. WC. Function: Clay K-Ratio: 0.25
Name: Clayey Gravel (GC) K-Function: kh = 2.83 ft/day (1x10^-3 cm/sec) Vol. WC. Function: Gravel K-Ratio: 0.25
Name: Silty Sand (SM) K-Function: kh = 1.417 ft/day (5x10^-4 cm/sec) Vol. WC. Function: Silty Sand K-Ratio: 0.25
Name: Clay (CL/CH) K-Function: kh = 0.0028 ft/day (1x10^-6 cm/sec) Vol. WC. Function: Clay K-Ratio: 0.25



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Cross Section A-A' (EAST)
Seepage Results

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
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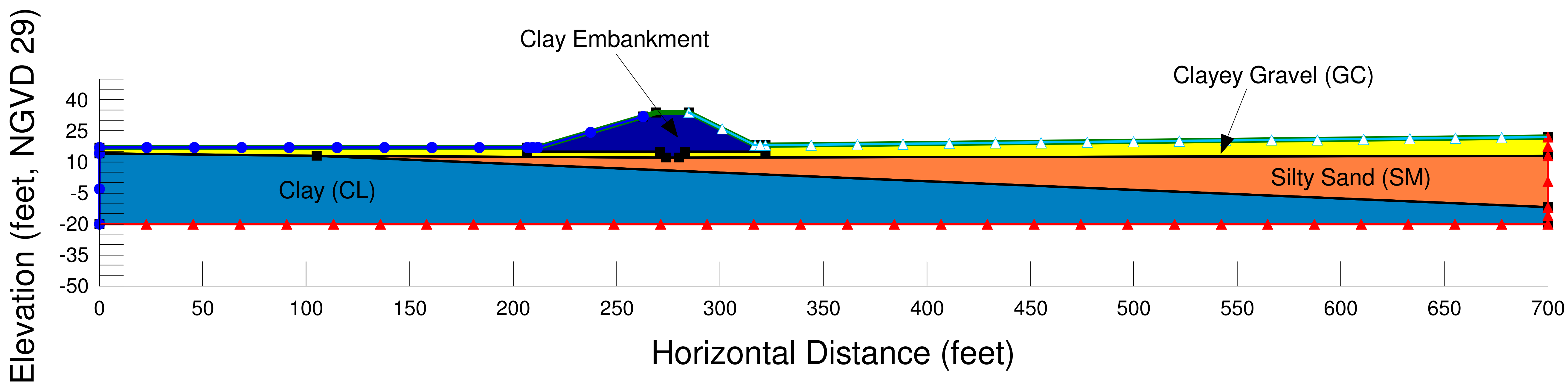
Figure
D-2

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5
DSWE = 32 ft
Cross Section B-B' (North)
Last Edited By: Brown, Kimberly
Date: 11/4/2010 Time: 11:07:12 AM
Sonoma_WWTP_B-B_North.gsz

Name: Clay Embankment (CL/CH) K-Function: kh = 0.0028 ft/day (1x10^-6 cm/sec) Vol. WC. Function: Clay K-Ratio: 0.25
Name: Clayey Gravel (GC) K-Function: kh = 2.83 ft/day (1x10^-2 cm/sec) Vol. WC. Function: Gravel K-Ratio: 0.25
Name: Silty Sand (SM) K-Function: kh = 1.417 ft/day (5x10^-4 cm/sec) Vol. WC. Function: Silty Sand K-Ratio: 0.25
Name: Clay (CL/CH) K-Function: kh = 0.0028 ft/day (1x10^-6 cm/sec) Vol. WC. Function: Clay K-Ratio: 0.25



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Cross Section B-B' (NORTH)
Model Stratigraphy

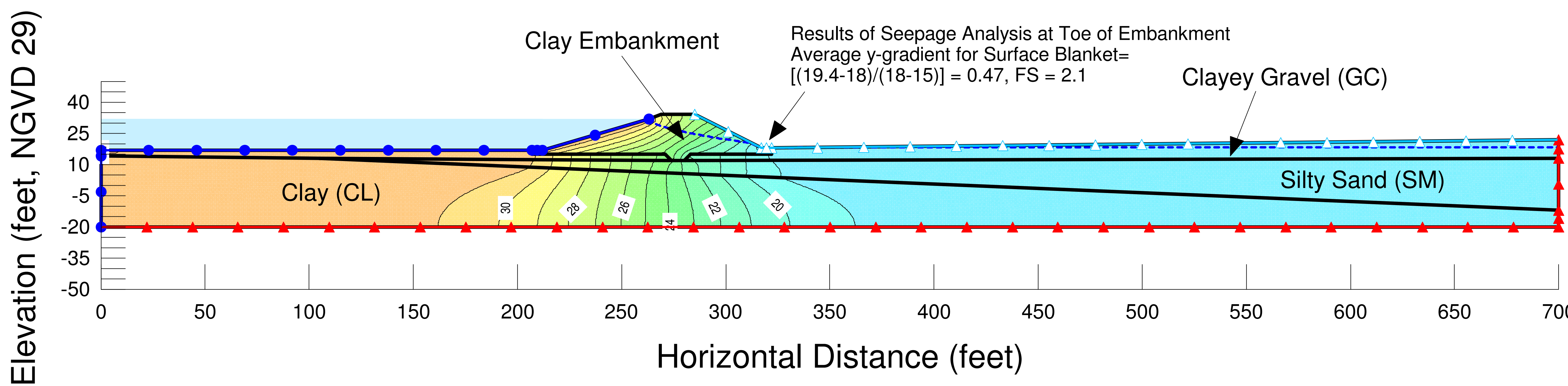
North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Figure
D-3

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5
DSWE = 32 ft
Cross Section B-B' (North)
Last Edited By: Brown, Kimberly
Date: 11/4/2010 Time: 11:07:12 AM
Sonoma_WWTP_B-B_North.gsz

Name	K-Function	Vol. WC. Function	K-Ratio
Name: Clay Embankment (CL/CH)	K-Function: kh = 0.0028 ft/day (1x10^-6 cm/sec)	Vol. WC. Function: Clay	K-Ratio: 0.25
Name: Clayey Gravel (GC)	K-Function: kh = 2.83 ft/day (1x10^-2 cm/sec)	Vol. WC. Function: Gravel	K-Ratio: 0.25
Name: Silty Sand (SM)	K-Function: kh = 1.417 ft/day (5x10^-4 cm/sec)	Vol. WC. Function: Silty Sand	K-Ratio: 0.25
Name: Clay (CL/CH)	K-Function: kh = 0.0028 ft/day (1x10^-6 cm/sec)	Vol. WC. Function: Clay	K-Ratio: 0.25



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Cross Section B-B' (NORTH)
Seepage Results

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Figure
D-4

APPENDIX E

SLOPE STABILITY ANALYSES RESULTS

Slope Stability Analyses Attachments

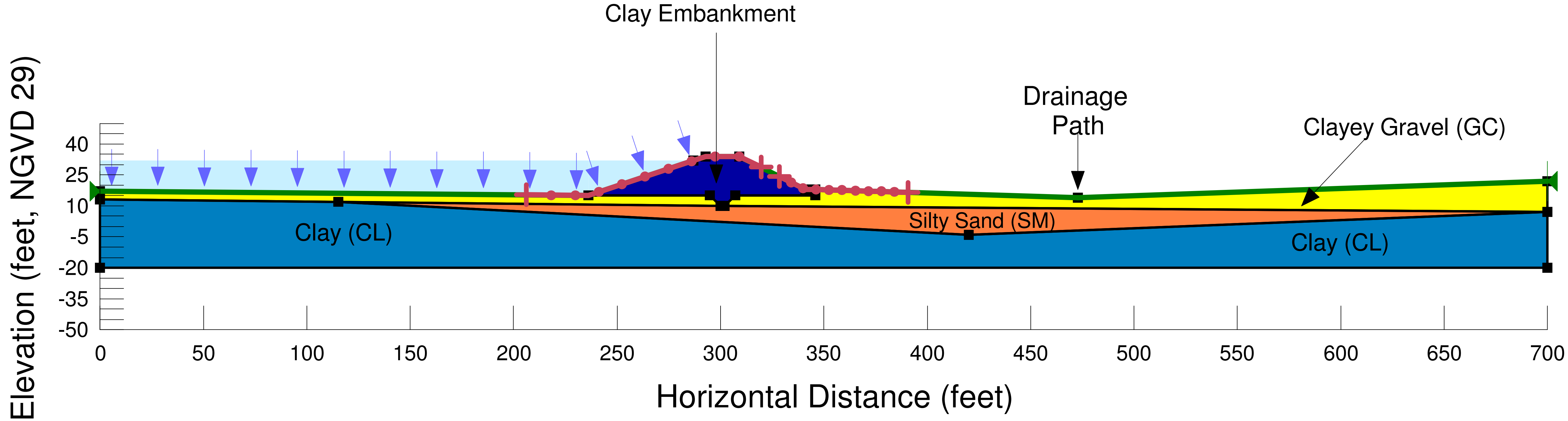
The attached figures illustrate the results of our slope stability analyses of existing subsurface conditions with the proposed tertiary effluent reservoir embankment geometry. A summary of the figures included is presented in Table E-1 below. Note that the DWSE was modeled at Elevation 32 feet.

Table E-1. Slope Stability Analyses – Existing Conditions

Cross-Section	Condition	Figure No.
A-A'	Model Stratigraphy	E-1
	End of Construction (landside)	E-2
	End of Construction (waterside)	E-3
	Rapid Drawdown	E-4
	Steady State (Static)	E-5
	Pseudo-static (landside)	E-6
	Pseudo-static (waterside)	E-7
B-B'	Model Stratigraphy	E-8
	End of Construction (landside)	E-9
	End of Construction (waterside)	E-10
	Rapid Drawdown	E-11
	Steady State (Static)	E-12
	Pseudo-static (landside)	E-13
	Pseudo-static (waterside)	E-14

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5
DWSE = 32 ft
Steady State (Static)
Cross Section A-A' (East)
Last Edited By: Brown, Kimberly
Date: 11/4/2010 Time: 10:49:06 AM
Sonoma_WWTP_A-A_East.gsz

Name: Clay Embankment (CL/CH) Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 200 psf Phi: 28 ° Phi-B: 0 °
Name: Clayey Gravel (GC) Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 40 ° Phi-B: 0 °
Name: Silty Sand (SM) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 36 ° Phi-B: 0 °
Name: Clay (CL/CH) Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 50 psf Phi: 30 ° Phi-B: 0 °



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Cross Section A-A' (EAST)
Model Stratigraphy

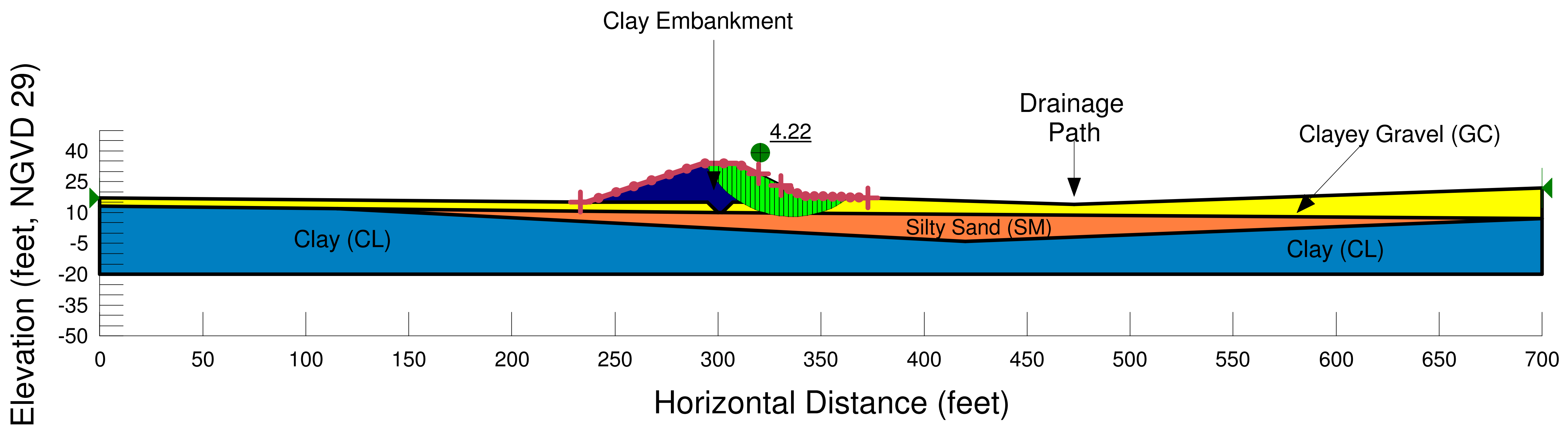
North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Figure
E-1

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5
End of Construction (Landside)
Cross Section A-A' (East)
Last Edited By: Brown, Kimberly
Date: 11/4/2010 Time: 10:49:06 AM
Sonoma_WWTP_A-A_East.gsz

Name: Clay Embankment (CL/CH) Undrained Model: Undrained (Phi=0) Unit Weight: 125 pcf Cohesion: 2000 psf
Name: Clayey Gravel (GC) Undrained Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 36 ° Phi-B: 0 °
Name: Silty Sand (SM) Undrained Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 32 ° Phi-B: 0 °
Name: Clay (CL/CH) Undrained Model: Undrained (Phi=0) Unit Weight: 115 pcf Cohesion: 2500 psf



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Cross Section A-A' (EAST)
End of Construction (Landside)

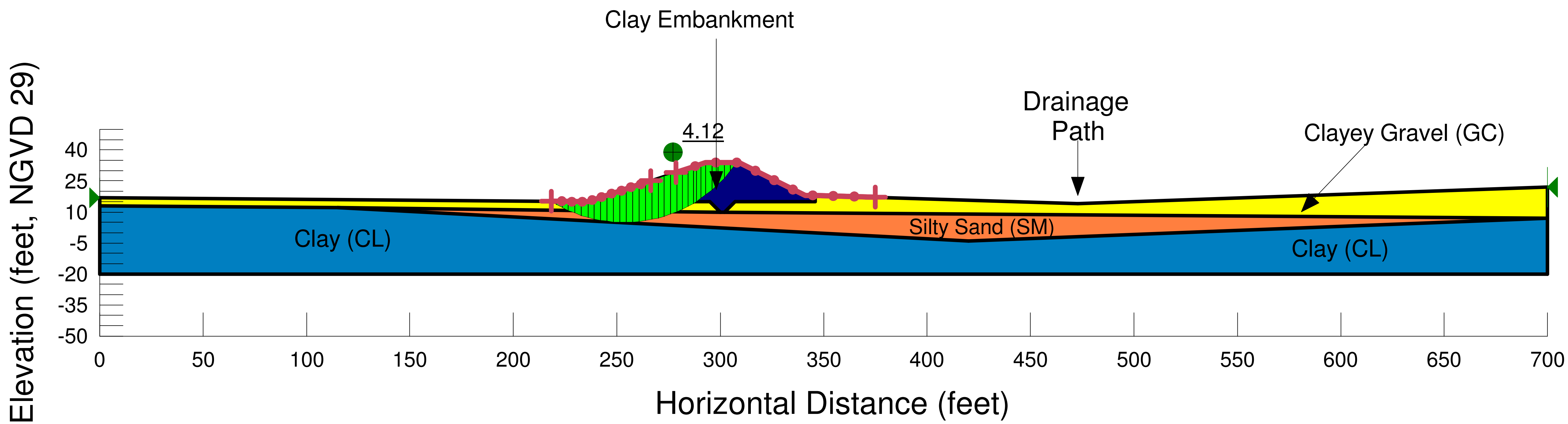
North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Figure
E-2

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5
End of Construction (Waterside)
Cross Section A-A' (East)
Last Edited By: Brown, Kimberly
Date: 11/4/2010 Time: 10:49:06 AM
Sonoma_WWTP_A-A_East.gsz

Name: Clay Embankment (CL/CH) Undrained   Model: Undrained (Phi=0)   Unit Weight: 125 pcf   Cohesion: 2000 psf
Name: Clayey Gravel (GC) Undrained   Model: Mohr-Coulomb   Unit Weight: 122 pcf   Cohesion: 0 psf   Phi: 36 °   Phi-B: 0 °
Name: Silty Sand (SM) Undrained   Model: Mohr-Coulomb   Unit Weight: 120 pcf   Cohesion: 0 psf   Phi: 32 °   Phi-B: 0 °
Name: Clay (CL/CH) Undrained   Model: Undrained (Phi=0)   Unit Weight: 115 pcf   Cohesion: 2500 psf



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Cross Section A-A' (EAST)
End of Construction (Waterside)

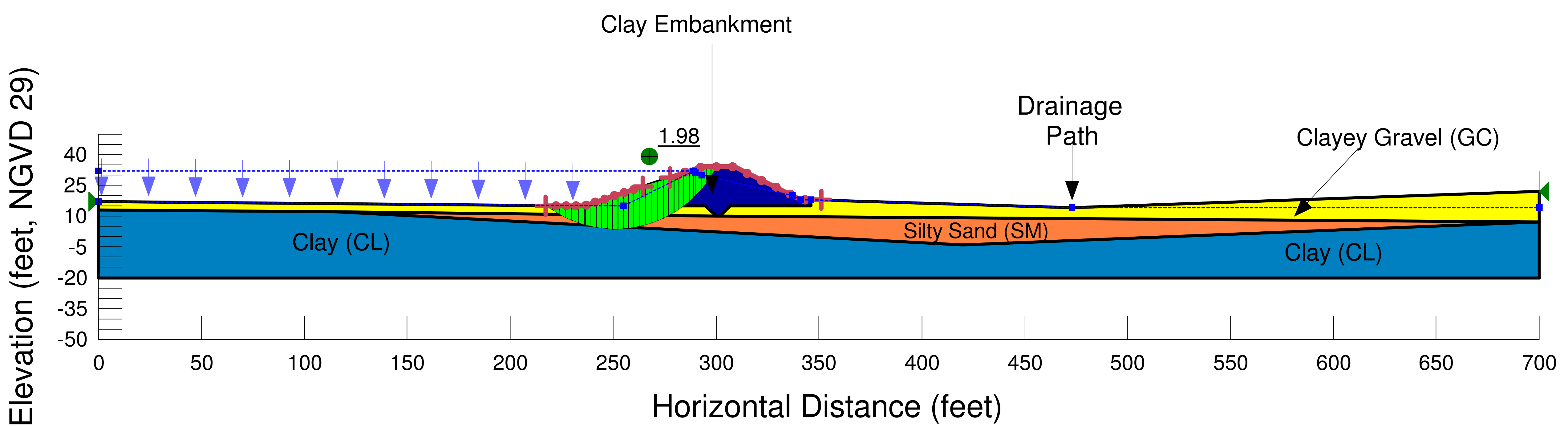
North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Figure
E-3

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5
Rapid Drawdown
Cross Section A-A' (East)
Last Edited By: Brown, Kimberly
Date: 11/4/2010 Time: 10:49:06 AM
Sonoma_WWTP_A-A_East.gsz

Name: Clay Embankment (CL/CH) Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 200 psf Phi: 28 ° Phi-B: 0 ° Drawdown Total Cohesion: 1500 psf Drawdown Total Phi: 0 ° Piezometric Line: 1 Piezometric Line After Drawdown: 2
Name: Clayey Gravel (GC) Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 40 ° Phi-B: 0 ° Drawdown Total Cohesion: 0 psf Drawdown Total Phi: 42 ° Piezometric Line: 1 Piezometric Line After Drawdown: 2
Name: Silty Sand (SM) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 36 ° Phi-B: 0 ° Drawdown Total Cohesion: 0 psf Drawdown Total Phi: 36 ° Piezometric Line: 1 Piezometric Line After Drawdown: 2
Name: Clay (CL/CH) Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 50 psf Phi: 30 ° Phi-B: 0 ° Drawdown Total Cohesion: 2000 psf Drawdown Total Phi: 0 ° Piezometric Line: 1 Piezometric Line After Drawdown: 2



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Cross Section A-A' (EAST)
Rapid Drawdown

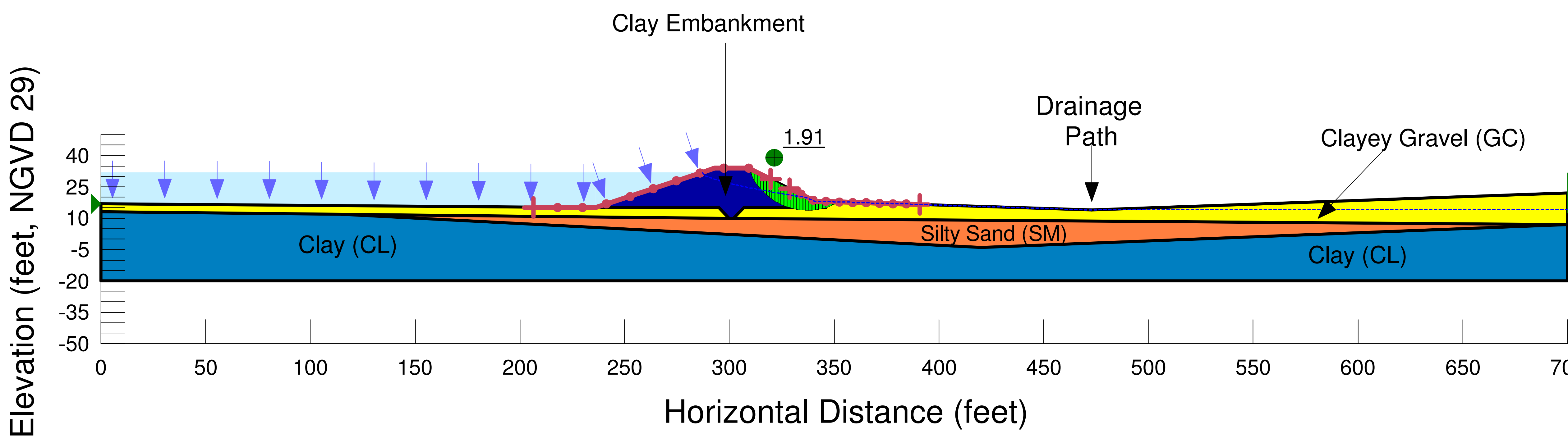
North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Figure
E-4

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5
Steady State (Static)
DWSE = 32 ft
Cross Section A-A' (East)
Last Edited By: Brown, Kimberly
Date: 11/4/2010 Time: 10:49:06 AM
Sonoma_WWTP_A-A_East.gsz

Name: Clay Embankment (CL/CH) Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 200 psf Phi: 28 ° Phi-B: 0 °
Name: Clayey Gravel (GC) Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 40 ° Phi-B: 0 °
Name: Silty Sand (SM) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 36 ° Phi-B: 0 °
Name: Clay (CL/CH) Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 50 psf Phi: 30 ° Phi-B: 0 °



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Cross Section A-A' (EAST)
Steady State (Static)

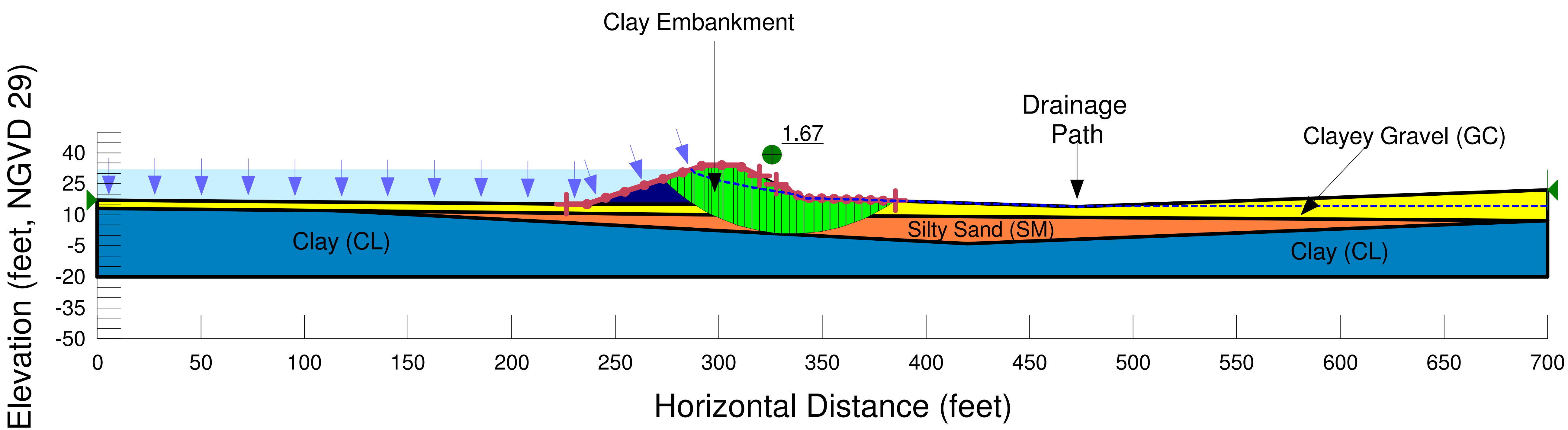
North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Figure
E-5

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5
Pseudostatic (Landside)
DWSE = 32 ft
Cross Section A-A' (East)
Last Edited By: Brown, Kimberly
Date: 11/4/2010 Time: 10:49:06 AM
Sonoma_WWTP_A-A_East.gsz

Name: Clayey Gravel (GC) Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 40 ° Phi-B: 0 °
Name: Silty Sand (SM) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 36 ° Phi-B: 0 °
Name: Clay Embankment (CL/CH) Undrained Model: Undrained (Phi=0) Unit Weight: 125 pcf Cohesion: 2000 psf
Name: Clay (CL/CH) Undrained Model: Undrained (Phi=0) Unit Weight: 115 pcf Cohesion: 2500 psf



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Cross Section A-A' (EAST)
Pseudostatic (Landside)

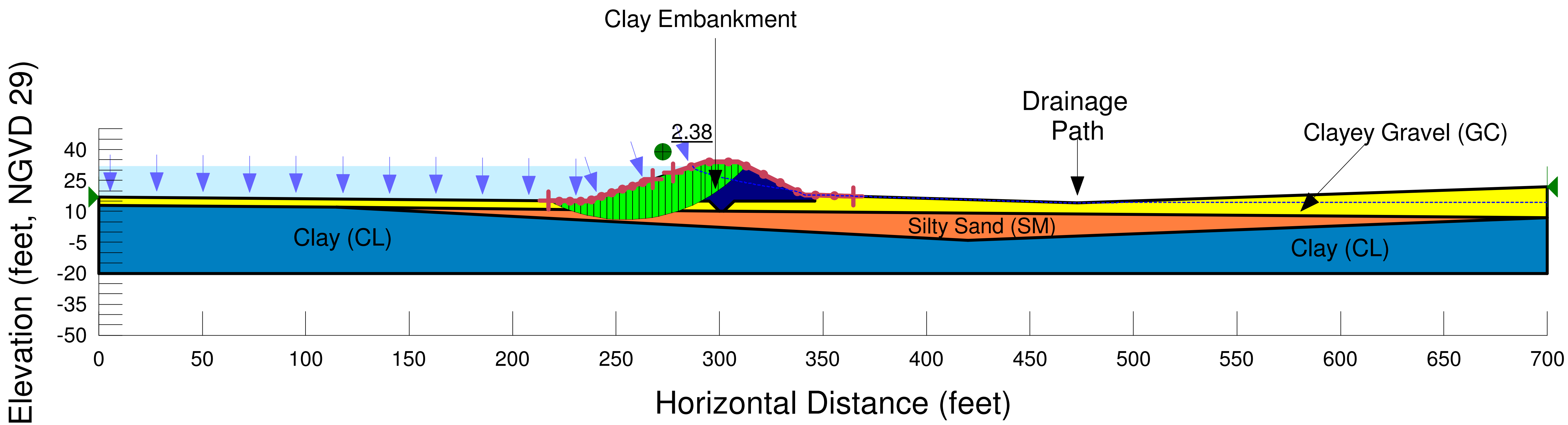
North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Figure
E-6

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5
Pseudostatic (Waterside)
DWSE = 32 ft
Cross Section A-A' (East)
Last Edited By: Brown, Kimberly
Date: 11/4/2010 Time: 10:49:06 AM
Sonoma_WWTP_A-A_East.gsz

Name: Clayey Gravel (GC) Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 40 ° Phi-B: 0 °
Name: Silty Sand (SM) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 36 ° Phi-B: 0 °
Name: Clay Embankment (CL/CH) Undrained Model: Undrained (Phi=0) Unit Weight: 125 pcf Cohesion: 2000 psf
Name: Clay (CL/CH) Undrained Model: Undrained (Phi=0) Unit Weight: 115 pcf Cohesion: 2500 psf



HDR Engineering, Inc.

CREATED BY	K. BROWN
REVIEWED BY	A. QUINTRALL
DRAWN BY	V. ANDERSON
PROJECT NUMBER	009240-144993

Cross Section A-A' (EAST)
Pseudostatic (Waterside)

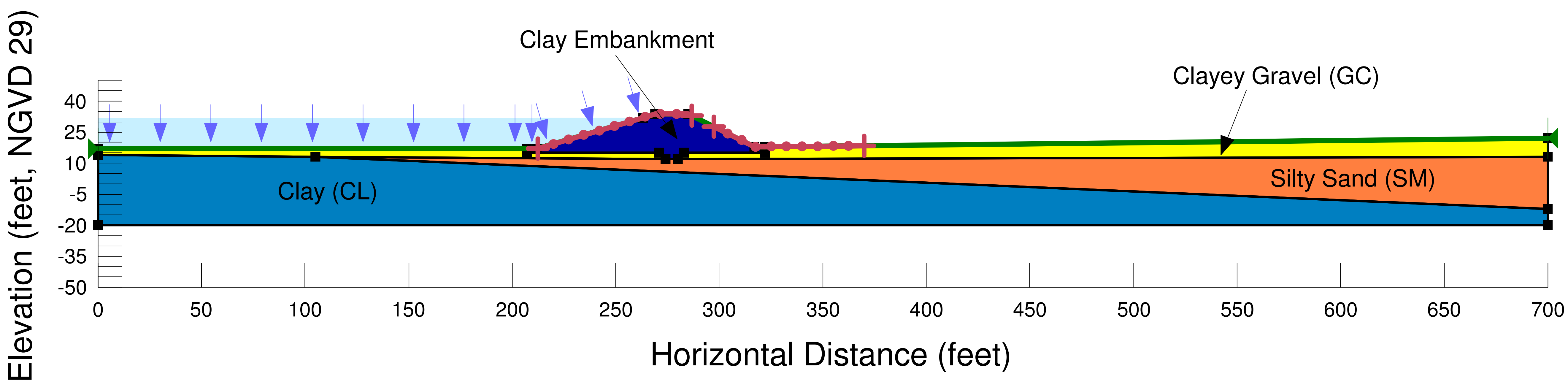
North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Figure
E-7

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5
DWSE = 32 ft
Steady State (Static)
Cross Section B-B' (North)
Last Edited By: Brown, Kimberly
Date: 11/4/2010 Time: 11:07:12 AM
Sonoma_WWTP_B-B_North.gsz

Name: Clay Embankment (CL/CH) Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 200 psf Phi: 28 ° Phi-B: 0 °
Name: Clayey Gravel (GC) Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 40 ° Phi-B: 0 °
Name: Silty Sand (SM) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 36 ° Phi-B: 0 °
Name: Clay (CL/CH) Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 50 psf Phi: 30 ° Phi-B: 0 °



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REVIEWED BY	A. QUINTRALL
DRAWN BY	V. ANDERSON
PROJECT NUMBER	009240–144993

Cross Section B-B' (NORTH)
Model Stratigraphy

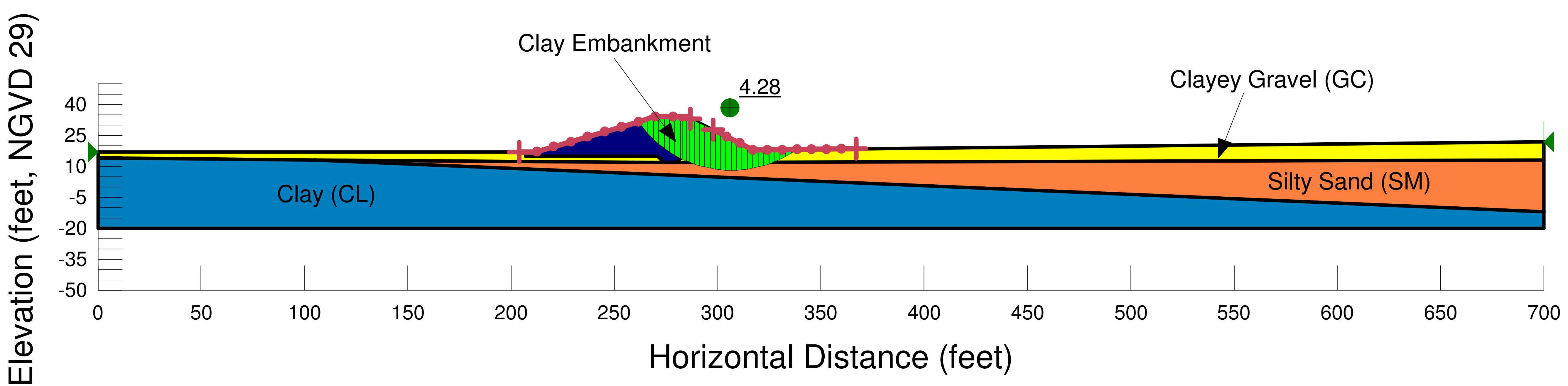
North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Figure
E-8

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5
End of Construction (Landside)
Cross Section B-B' (North)
Last Edited By: Brown, Kimberly
Date: 11/4/2010 Time: 11:07:12 AM
Sonoma_WWTP_B-B_North.gsz

Name: Clay Embankment (CL/CH) Undrained Model: Undrained (Phi=0) Unit Weight: 125 pcf Cohesion: 2000 psf
Name: Clayey Gravel (GC) Undrained Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 36 ° Phi-B: 0 °
Name: Silty Sand (SM) Undrained Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 32 ° Phi-B: 0 °
Name: Clay (CL/CH) Undrained Model: Undrained (Phi=0) Unit Weight: 115 pcf Cohesion: 2500 psf



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PROJECT NUMBER	009240-144993

Cross Section B-B' (NORTH)
End of Construction (Landside)

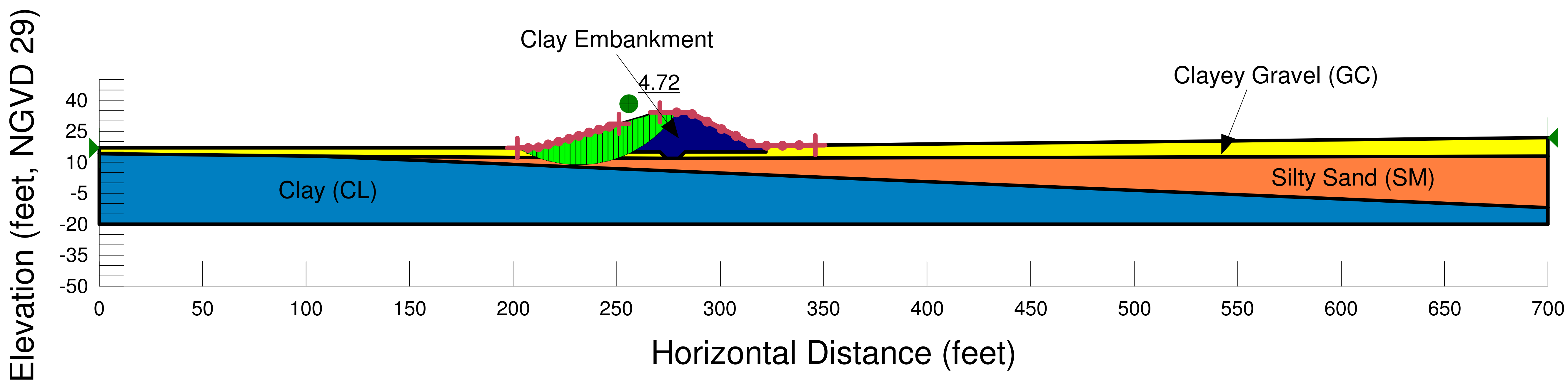
North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Figure
E-9

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5
End of Construction (Waterside)
Cross Section B-B' (North)
Last Edited By: Brown, Kimberly
Date: 11/4/2010 Time: 11:07:12 AM
Sonoma_WWTP_B-B_North.gsz

Name: Clay Embankment (CL/CH) Undrained Model: Undrained (Phi=0) Unit Weight: 125 pcf Cohesion: 2000 psf
Name: Clayey Gravel (GC) Undrained Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 36 ° Phi-B: 0 °
Name: Silty Sand (SM) Undrained Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 32 ° Phi-B: 0 °
Name: Clay (CL/CH) Undrained Model: Undrained (Phi=0) Unit Weight: 115 pcf Cohesion: 2500 psf



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DRAWN BY	V. ANDERSON
PROJECT NUMBER	009240–144993

Cross Section B-B' (NORTH)
End of Construction (Waterside)

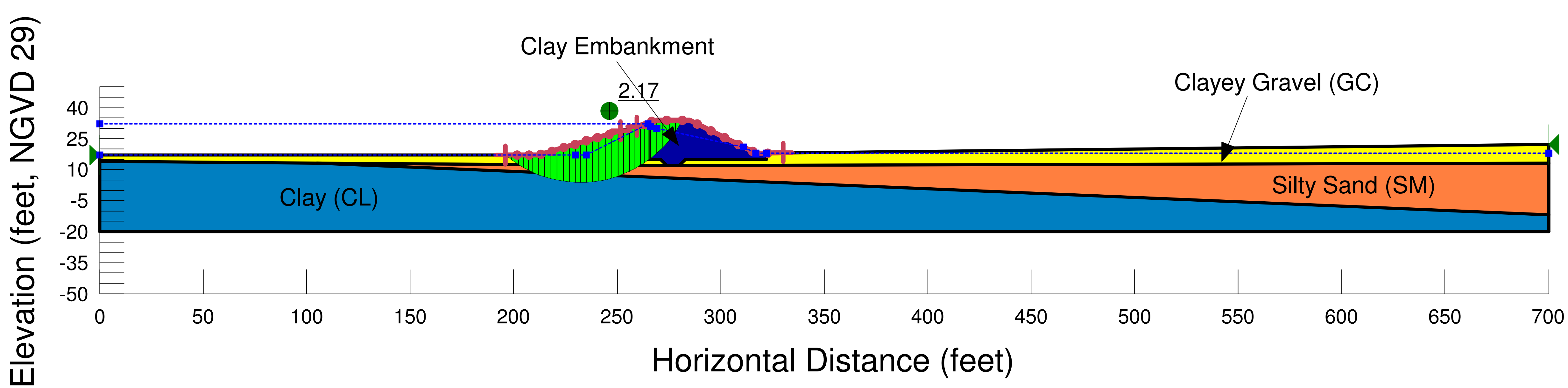
North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Figure
E-10

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5
Rapid Drawdown
Cross Section B-B' (North)
Last Edited By: Brown, Kimberly
Date: 11/4/2010 Time: 11:07:12 AM
Sonoma_WWTP_B-B_North.gsz

Name: Clay Embankment (CL/CH) Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 200 psf Phi: 28 ° Phi-B: 0 ° Drawdown Total Cohesion: 1500 psf Drawdown Total Phi: 0 ° Piezometric Line: 1 Piezometric Line After Drawdown: 2
Name: Clayey Gravel (GC) Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 40 ° Phi-B: 0 ° Drawdown Total Cohesion: 0 psf Drawdown Total Phi: 42 ° Piezometric Line: 1 Piezometric Line After Drawdown: 2
Name: Silty Sand (SM) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 36 ° Phi-B: 0 ° Drawdown Total Cohesion: 0 psf Drawdown Total Phi: 36 ° Piezometric Line: 1 Piezometric Line After Drawdown: 2
Name: Clay (CL/CH) Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 50 psf Phi: 30 ° Phi-B: 0 ° Drawdown Total Cohesion: 2000 psf Drawdown Total Phi: 0 ° Piezometric Line: 1 Piezometric Line After Drawdown: 2



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REVIEWED BY	A. QUINTRALL
DRAWN BY	V. ANDERSON
PROJECT NUMBER	009240-144993

Cross Section B-B' (NORTH)
Rapid Drawdown

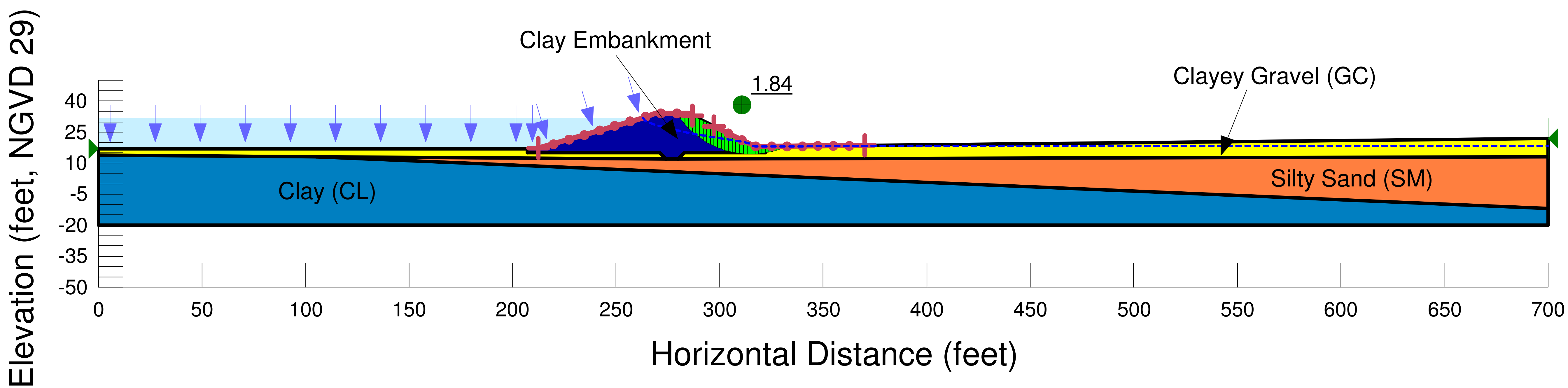
North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Figure
E-11

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5
Steady State (Static)
DWSE = 32 ft
Cross Section B-B' (North)
Last Edited By: Brown, Kimberly
Date: 11/4/2010 Time: 11:07:12 AM
Sonoma_WWTP_B-B_North.gsz

Name: Clay Embankment (CL/CH) Model: Mohr-Coulomb Unit Weight: 125 pcf Cohesion: 200 psf Phi: 28 ° Phi-B: 0 °
Name: Clayey Gravel (GC) Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 40 ° Phi-B: 0 °
Name: Silty Sand (SM) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 36 ° Phi-B: 0 °
Name: Clay (CL/CH) Model: Mohr-Coulomb Unit Weight: 115 pcf Cohesion: 50 psf Phi: 30 ° Phi-B: 0 °



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DRAWN BY	V. ANDERSON
PROJECT NUMBER	009240-144993

Cross Section B-B' (NORTH)
Steady State (Static)

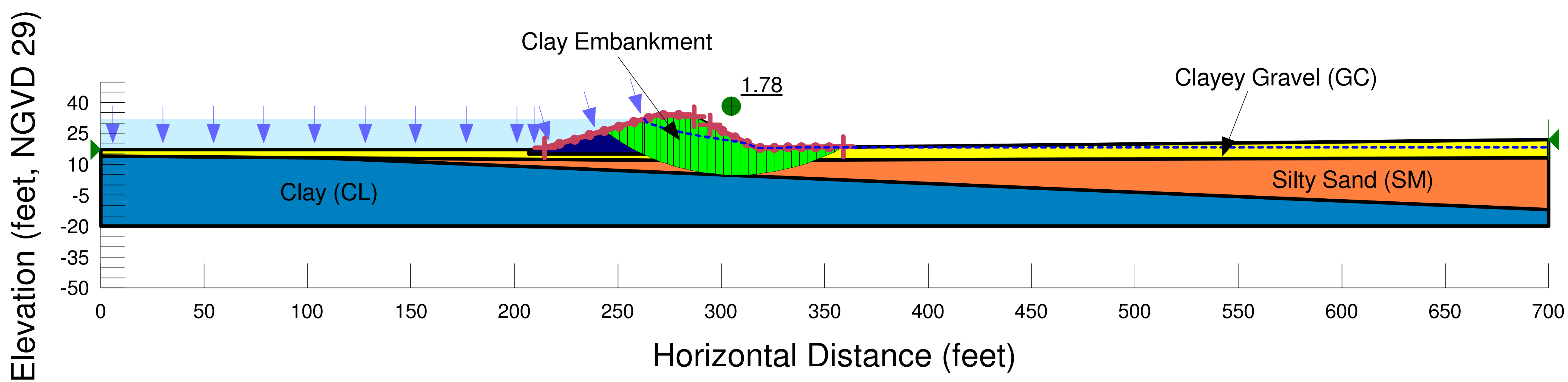
North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Figure
E-12

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5
Pseudostatic (Landside)
DWSE = 32 ft
Cross Section B-B' (North)
Last Edited By: Brown, Kimberly
Date: 11/4/2010 Time: 11:07:12 AM
Sonoma_WWTP_B-B_North.gsz

Name: Clayey Gravel (GC) Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 40 ° Phi-B: 0 °
Name: Silty Sand (SM) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 36 ° Phi-B: 0 °
Name: Clay Embankment (CL/CH) Undrained Model: Undrained (Phi=0) Unit Weight: 125 pcf Cohesion: 2000 psf
Name: Clay (CL/CH) Undrained Model: Undrained (Phi=0) Unit Weight: 115 pcf Cohesion: 2500 psf



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REVIEWED BY	A. QUINTRALL
DRAWN BY	V. ANDERSON
PROJECT NUMBER	009240-144993

Cross Section B-B' (NORTH)
Pseudostatic (Landside)

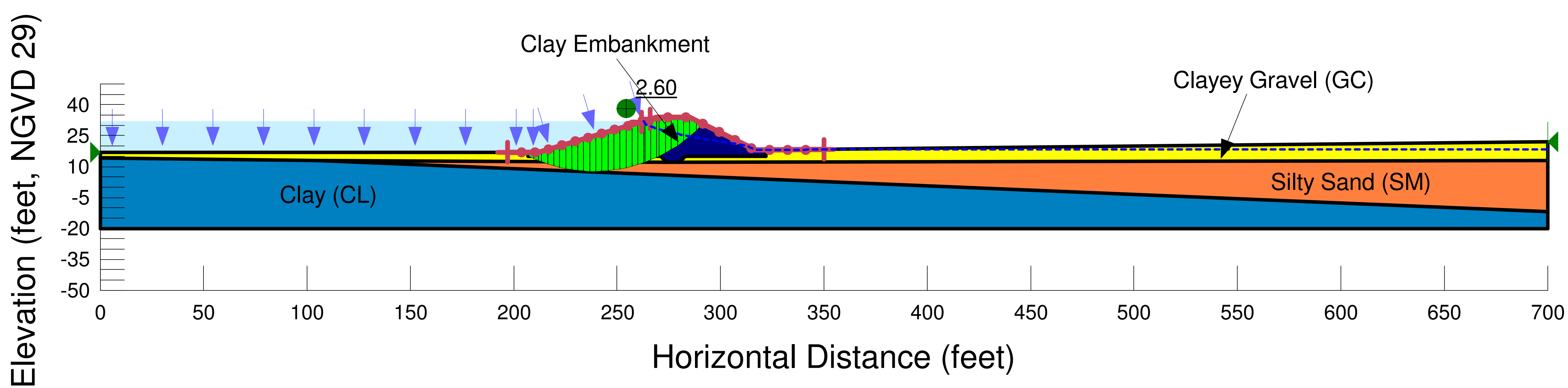
North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Figure
E-13

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5
Pseudostatic (Waterside)
DWSE = 32 ft
Cross Section B-B' (North)
Last Edited By: Brown, Kimberly
Date: 11/4/2010 Time: 11:07:12 AM
Sonoma_WWTP_B-B_North.gsz

Name: Clayey Gravel (GC) Model: Mohr-Coulomb Unit Weight: 122 pcf Cohesion: 0 psf Phi: 40 ° Phi-B: 0 °
Name: Silty Sand (SM) Model: Mohr-Coulomb Unit Weight: 120 pcf Cohesion: 0 psf Phi: 36 ° Phi-B: 0 °
Name: Clay Embankment (CL/CH) Undrained Model: Undrained (Phi=0) Unit Weight: 125 pcf Cohesion: 2000 psf
Name: Clay (CL/CH) Undrained Model: Undrained (Phi=0) Unit Weight: 115 pcf Cohesion: 2500 psf



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REVIEWED BY	A. QUINTRALL
DRAWN BY	V. ANDERSON
PROJECT NUMBER	009240-144993

Cross Section B-B' (NORTH)
Pseudostatic (Waterside)

North Bay Water Reuse Program
Sonoma Valley Effluent Reservoir R5

Date
JAN 2011

Figure
E-14

APPENDIX F

SETTLEMENT ANALYSES RESULTS

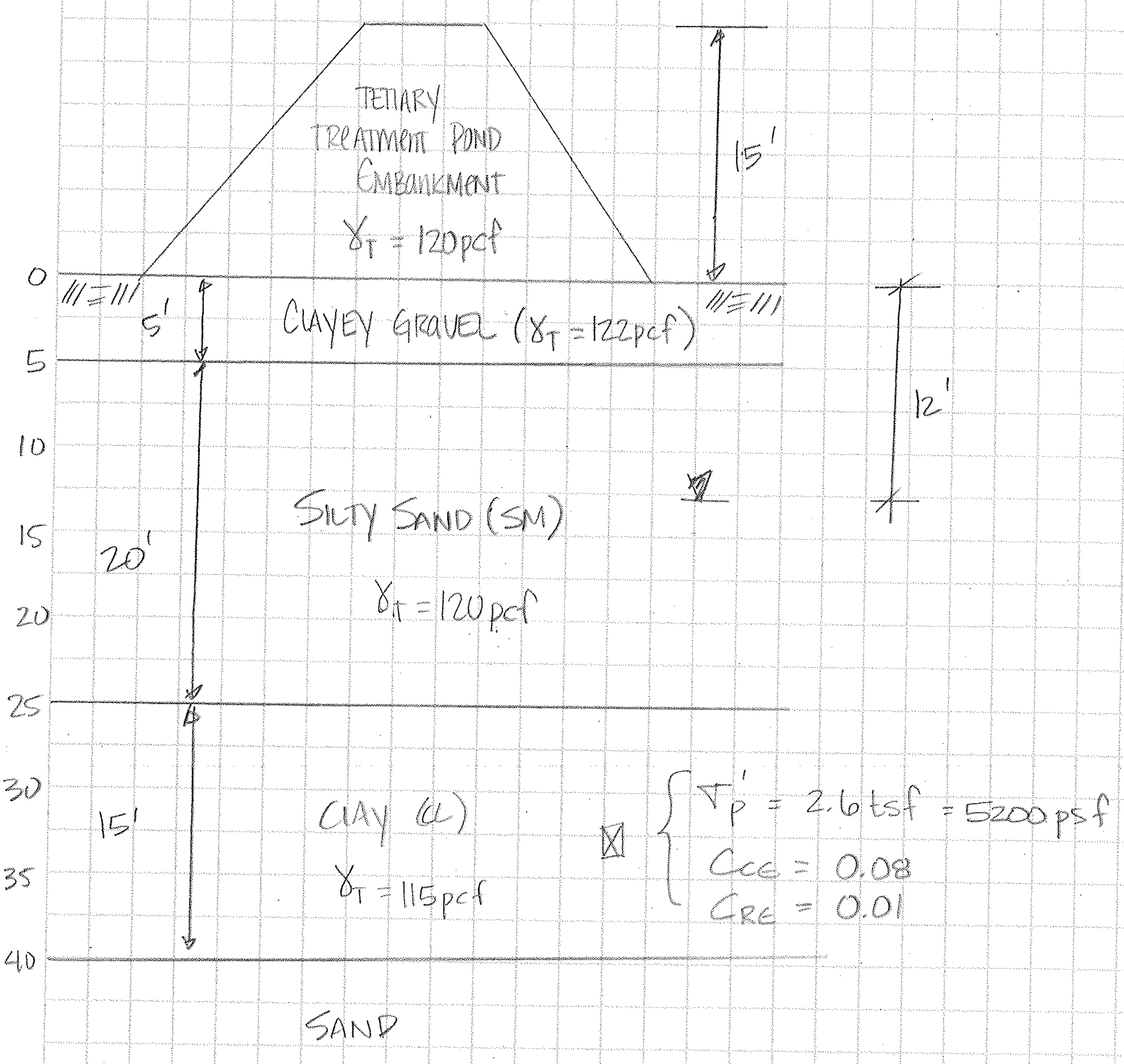
Settlement Analyses Attachments

The attached figures illustrate the results of our settlement analyses of existing subsurface conditions and the proposed tertiary effluent reservoir geometry.

HDR | ONE COMPANY *Many Solutions®*

Project: SONOMA WWTP		Computed: KIB		Date: 10/11/10	
Subject: SETTLEMENT CALC.		Checked: TAQ		Date: 10/14/10	
Task:		Page: 1		of: 3	
Job #: 144993		No:			

IDEALIZED SOIL PROFILE:



VERTICAL EFFECTIVE STRESS:

$$\sigma_{vo}' = (122\text{ pcf})(5') + (120\text{ pcf})(7') + (120 - 62.4\text{ pcf})(13') + (115 - 62.4\text{ pcf})(7.5') = 2593.3\text{ psf}$$

Increase in Vertical Effective Stress

$\Delta\sigma_v = (120\text{pcf})(15') = 1800 \text{ psf}$

Consolidation Type

$\sigma_{vo}' = 2593.3 \text{ psf}$

$\Delta\sigma_v = 1800 \text{ psf}$

$\sigma_{vo}' + \Delta\sigma_v = 4393.3 \text{ psf}$

$\sigma_p' = 5200 \text{ psf}$

$\sigma_{vo}' + \Delta\sigma_v < \sigma_p'$, USC

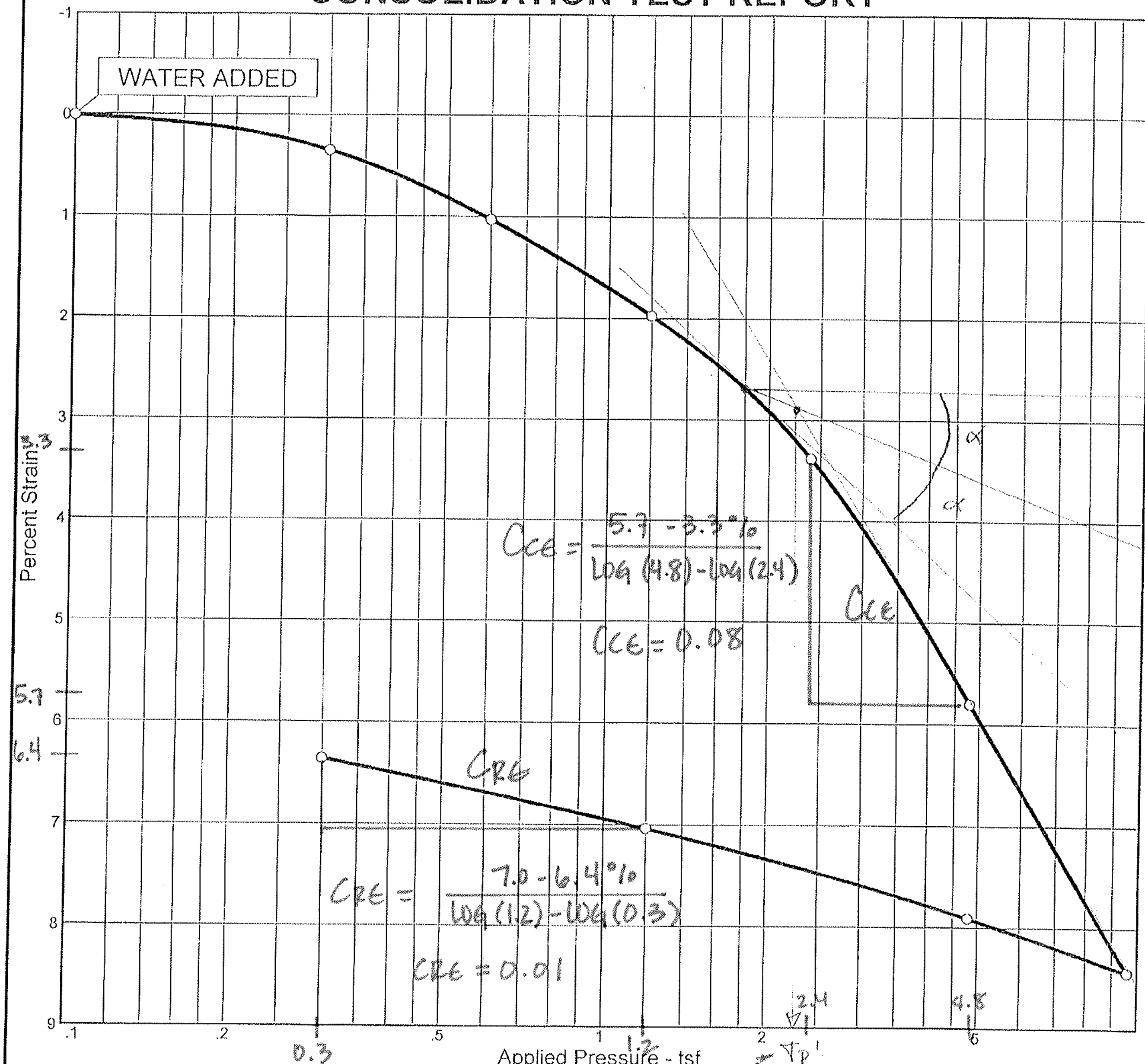
$\delta_p = C_{r\varepsilon} H_o \log\left(\frac{\sigma_{vo}' + \Delta\sigma_v}{\sigma_{vo}'}\right)$

Settlement

$\delta_p = 0.01(15')\log\left(\frac{4393.3 \text{ psf}}{2593.3 \text{ psf}}\right) = 0.03' = \underline{0.41''}$

SONOMA WWTP - Settlement
KIB 10/11/10

CONSOLIDATION TEST REPORT



Natural Sat.	Natural Moist.	Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_s	Swell Press. (tsf)	Swell %	e_o
99.1 %	49.7 %	71.6			2.70		2.61	0.21	0.03	0.10		1.353

MATERIAL DESCRIPTION	USCS	AASHTO
$0.03 / 1+e_o = 0.01$ ✓		

Project No. 10-265 **Client:** Taber Construction

Project: Sonoma County Water Agency #2010/0198

Location: EB-2

Remarks:

$0.21 / 1+e_o = 0.09$ ✓

SIERRA TESTING LABS, INC.

El Dorado Hills, CA

Figure

APPENDIX G

LIQUEFACTION ANALYSES RESULTS

Liquefaction Analyses Attachments

The attached figures illustrate the results of our liquefaction analyses of existing subsurface conditions using the recommended methods presented in Idriss and Boulanger, 2008.

EB-1

Job No.	144993

Project	Sonoma WWTP - Tertiary Pond	Computed	KIB	Date	10/10/2010
Task		Checked	TAQ	Date	10/15/2010

General Parameters

Return Period	475	yrs
PGA	0.4553	g
M	6.48	
$d_{water\ table}$	12	ft
γ_w	62.4	pcf
$\phi_{borehole}$	6	in
Rod Extension	3	ft
Hammer Type	Automatic Triphammer	
Energy Ratio (ER)	90	%
Use C_S	No	
Weight of Hammer	140	lbs
Height of Drop	30	in

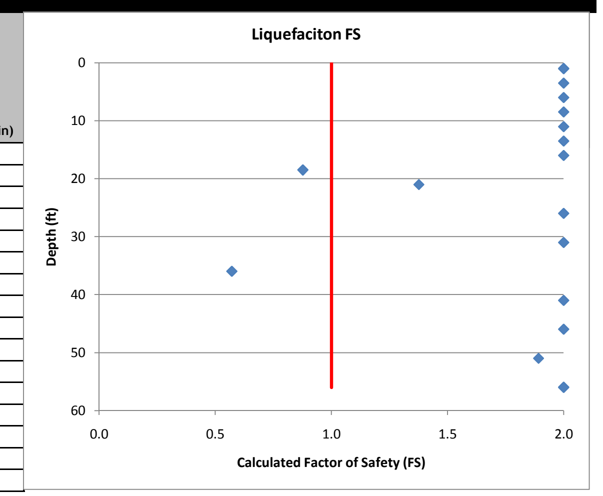
http://eqint.cr.usgs.gov/deaggint/2002/

Blow Count Correction

Sample Number	Depth to Middle of Sample (ft)	N	Soil Type from Boring Log (USCS)		Sampler Type	Sampler Lined?	Outside Diameter (in)	Inside Diameter (in)	Flag "Clay" "Unsaturated" "Unreliable"	FC (%)	γ_t (pcf)	γ_{sat} (pcf)	γ_b (pcf)	C_E	C_B	C_R	C_S	C_D	N_{60}	σ_{vc} (psf)	σ'_{vc} (psf)	C_N	$(N_1)_{60}$	$(\Delta N_1)_{60}$ (fines)	$(N_1)_{60-cs}$
1	1.0	27	CL	Lean Clay	MC	No	3.0	2.500	Clay		102	102	39.6	1.5	1.15	0.75	1.00	0.77	26.8	102.0	102.0	1.70	45.5	N/A	N/A
2	3.5	17	SW-SM	Well Graded Sand with Silt	SPT	No	2.0	1.375	None	7	125	125	62.6	1.5	1.15	0.75	1.00	1.00	22.0	437.5	437.5	1.70	37.4	0.1	37.5
3	6.0	29	SW-SM	Well Graded Sand with Silt	MC	No	3.0	2.500	None	7	125	125	62.6	1.5	1.15	0.75	1.00	0.77	28.8	750.0	750.0	1.68	48.3	0.1	48.5
4	8.5	39	SW-SM	Well Graded Sand with Silt	MC	No	3.0	2.500	None	7	125	125	62.6	1.5	1.15	0.80	1.00	0.77	41.3	1062.5	1062.5	1.41	58.3	0.1	58.4
5	11.0	31	SW-SM	Well Graded Sand with Silt	SPT	No	2.0	1.375	None	7	125	125	62.6	1.5	1.15	0.85	1.00	1.00	45.5	1375.0	1375.0	1.24	56.4	0.1	56.5
6	13.5	33	CL	Lean Clay	MC	No	3.0	2.500	Clay		122	122	59.6	1.5	1.15	0.85	1.00	0.77	37.1	1647.0	1553.4	1.17	43.3	N/A	N/A
7	16.0	18	CL	Lean Clay	MC	No	3.0	2.500	Clay		122	122	59.6	1.5	1.15	0.85	1.00	0.77	20.2	1952.0	1702.4	1.11	22.6	N/A	N/A
8	18.5	11	SM	Silty Sand	MC	No	3.0	2.500	None	35	112	112	49.6	1.5	1.15	0.95	1.00	0.77	13.8	2072.0	1666.4	1.13	15.6	5.5	21.1
9	21.0	16	SM	Silty Sand	MC	No	3.0	2.500	None	35	112	112	49.6	1.5	1.15	0.95	1.00	0.77	20.1	2352.0	1790.4	1.09	21.9	5.5	27.4
10	26.0	51	SP	Poorly Graded Sand	MC	No	3.0	2.500	None	5	127	127	64.6	1.5	1.15	0.95	1.00	0.77	64.1	3302.0	2428.4	0.93	59.8	0.0	59.8
11	31.0	41	SM	Silty Sand	MC	No	3.0	2.500	None	35	112	112	49.6	1.5	1.15	1.00	1.00	0.77	54.2	3472.0	2286.4	0.96	52.2	5.5	57.7
12	36.0	11	SP-SM	Poorly Graded Sand with Silt	SPT	No	2.0	1.375	None	5	127	127	64.6	1.5	1.15	1.00	1.00	1.00	19.0	4572.0	3074.4	0.83	15.7	0.0	15.7
13	41.0	23	CL	Lean Clay	MC	No	3.0	2.500	Clay		115	115	52.6	1.5	1.15	1.00	1.00	0.77	30.4	4715.0	2905.4	0.85	26.0	N/A	N/A
14	46.0	44	SP-SC	Sand with Clay	SPT	No	2.0	1.375	None	7	125	125	62.6	1.5	1.15	1.00	1.00	1.00	75.9	5750.0	3628.4	0.76	58.0	0.1	58.1
15	51.0	32	SP-SC	Sand with Clay	MC	No	3.0	2.500	None	7	125	125	62.6	1.5	1.15	1.00	1.00	0.77	42.3	6375.0	3941.4	0.73	31.0	0.1	31.2
16	56.0	19	CL	Lean Clay	MC	No	3.0	2.500	Clay		115	115	52.6	1.5	1.15	1.00	1.00	0.77	25.1	6440.0	3694.4	0.76	19.0	N/A	N/A

Liquefaction Analysis

Sample Number	Depth to Middle of Sample (ft)	$(N_1)_{60-cs}$	r_d	MSF for sand	K_σ for sand	CSR (M=7.5 & σ'vc=1 ATM)	CRR (M=7.5 & σ'vc=1 ATM)	FS	Volumetric Strain, εv (%)	Layer Thickness (ft)	Liquefaction Settlement, s_{liq} (in)
1	1.0	N/A	1.00	1.31	1.10	0.21	2.00	2.00	N/A	1.0	N/A
2	3.5	37.5	0.99	1.31	1.10	0.20	2.00	2.00	N/A	2.5	N/A
3	6.0	48.5	0.98	1.31	1.10	0.20	2.00	2.00	N/A	2.5	N/A
4	8.5	58.4	0.97	1.31	1.10	0.20	2.00	2.00	N/A	2.5	N/A
5	11.0	56.5	0.96	1.31	1.10	0.20	2.00	2.00	N/A	2.5	N/A
6	13.5	N/A	0.95	1.31	1.09	0.21	2.00	2.00	N/A	2.5	N/A
7	16.0	N/A	0.93	1.31	1.06	0.23	2.00	2.00	N/A	2.5	N/A
8	18.5	21.1	0.92	1.31	1.03	0.25	0.22	0.88	1.0	2.5	0.21
9	21.0	27.4	0.90	1.31	1.03	0.26	0.36	1.38	N/A	2.5	N/A
10	26.0	59.8	0.87	1.31	0.96	0.28	2.00	2.00	N/A	5.0	N/A
11	31.0	57.7	0.84	1.31	0.98	0.30	2.00	2.00	N/A	5.0	N/A
12	36.0	15.7	0.81	1.31	0.96	0.28	0.16	0.57	1.8	5.0	0.75
13	41.0	N/A	0.77	1.31	0.91	0.31	2.00	2.00	N/A	5.0	N/A
14	46.0	58.1	0.74	1.31	0.84	0.32	2.00	2.00	N/A	5.0	N/A
15	51.0	31.2	0.71	1.31	0.87	0.30	0.57	1.89	N/A	5.0	N/A
16	56.0	N/A	0.68	1.31	0.84	0.32	2.00	2.00	N/A	5.0	N/A
											0.96



Notes:

1) Factor of Safety against liquefaction limited to 2.0

EB-2

General Parameters		
Return Period	475	yrs
PGA	0.4553	g
M	6.48	
$d_{water\ table}$	12	ft
γ_w	62.4	pcf
$\phi_{borehole}$	6	in
Rod Extension	3	ft
Hammer Type	Automatic Triphammer	
Energy Ratio (ER)	90	%
Use C_S	No	
Weight of Hammer	140	lbs
Height of Drop	30	in

http://eqint.cr.usgs.gov/deaggint/2002/

Job No.	144993

HDR

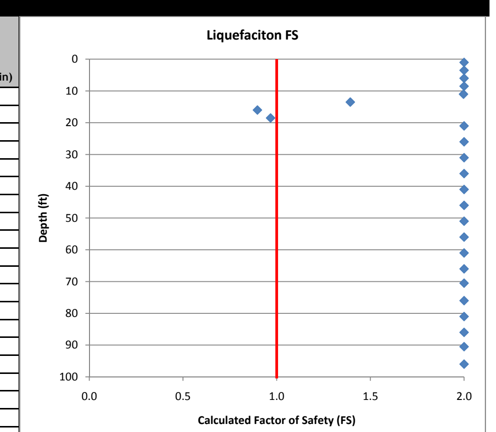
Project	Sonoma WWTP - Tertiary Pond	Computed	KIB	Date	#########
Task		Checked	TAQ	Date	#########

Blow Count Correction

Sample Number	Depth to Middle of Sample (ft)	N	Soil Type from Boring Log (USCS)		Sampler Type	Sampler Lined?	Outside Diameter (in)	Inside Diameter (in)	Flag "Clay" "Unsaturated" "Unreliable"	FC (%)	γ_t (pcf)	γ_{sat} (pcf)	γ_b (pcf)	C_E	C_B	C_R	C_S	C_D	N_{60}	σ_{vc} (psf)	σ'_{vc} (psf)	C_N	$(N_1)_{60}$	$(\Delta N_1)_{60}$ (fines)	$(N_1)_{60-cs}$
1	1.0	20	CL	Lean Clay	MC	No	3.0	2.500	Clay		125	125	62.6	1.5	1.15	0.75	1.00	0.77	19.8	125.0	125.0	1.70	33.7	N/A	N/A
2	3.5	23	CL	Lean Clay	MC	No	3.0	2.500	Clay		125	125	62.6	1.5	1.15	0.75	1.00	0.77	22.8	437.5	437.5	1.70	38.8	N/A	N/A
3	6.0	48	SM	Silty Sand	MC	No	3.0	2.500	None	35	115	115	52.6	1.5	1.15	0.75	1.00	0.77	47.6	690.0	690.0	1.70	81.0	5.5	86.5
4	8.5	57	SM	Silty Sand	MC	No	3.0	2.500	None	35	115	115	52.6	1.5	1.15	0.80	1.00	0.77	60.3	977.5	977.5	1.47	88.8	5.5	94.3
5	11.0	16	SM	Silty Sand	MC	No	3.0	2.500	None	40	120	120	57.6	1.5	1.15	0.85	1.00	0.77	18.0	1320.0	1320.0	1.27	22.8	5.6	28.4
6	13.5	15	SM	Silty Sand	MC	No	3.0	2.500	None	40	120	120	57.6	1.5	1.15	0.85	1.00	0.77	16.9	1620.0	1526.4	1.18	19.9	5.6	25.4
7	16.0	9	SM	Silty Sand	SPT	No	2.0	1.375	None	40	120	120	57.6	1.5	1.15	0.85	1.00	1.00	13.2	1920.0	1670.4	1.13	14.9	5.6	20.4
8	18.5	13	SP-SM	Poorly Graded Sand with Silt	SPT	No	2.0	1.375	None	6	125	125	62.6	1.5	1.15	0.95	1.00	1.00	21.3	2312.5	1906.9	1.05	22.4	0.0	22.5
9	21.0	22	SP-SM	Poorly Graded Sand with Silt	SPT	No	2.0	1.375	None	6	125	125	62.6	1.5	1.15	0.95	1.00	1.00	36.1	2625.0	2063.4	1.01	36.5	0.0	36.5
10	26.0	35	SP-SM	Poorly Graded Sand with Silt	SPT	No	2.0	1.375	None	6	125	125	62.6	1.5	1.15	0.95	1.00	1.00	57.4	3250.0	2376.4	0.94	54.1	0.0	54.2
11	31.0	13	CL	Lean Clay	MC	No	3.0	2.500	Clay		115	115	52.6	1.5	1.15	1.00	1.00	0.77	17.2	3565.0	2379.4	0.94	16.2	N/A	N/A
12	36.0	15	CL	Lean Clay	MC	No	3.0	2.500	Clay		115	115	52.6	1.5	1.15	1.00	1.00	0.77	19.8	4140.0	2642.4	0.89	17.8	N/A	N/A
13	41.0	22	CL	Lean Clay	MC	No	3.0	2.500	Clay		115	115	52.6	1.5	1.15	1.00	1.00	0.77	29.1	4715.0	2905.4	0.85	24.8	N/A	N/A
14	46.0	88	SP	Poorly Graded Sand	MC	No	3.0	2.500	None	4	125	125	62.6	1.5	1.15	1.00	1.00	0.77	116.4	5750.0	3628.4	0.76	88.9	0.0	88.9
15	51.0	45	SP	Poorly Graded Sand	SPT	No	2.0	1.375	None	4	125	125	62.6	1.5	1.15	1.00	1.00	1.00	77.6	6375.0	3941.4	0.73	56.9	0.0	56.9
16	56.0	10	CL	Lean Clay	SPT	No	2.0	1.375	Clay		115	115	52.6	1.5	1.15	1.00	1.00	1.00	17.3	6440.0	3694.4	0.76	13.1	N/A	N/A
17	61.0	23	CL	Lean Clay	MC	No	3.0	2.500	Clay		115	115	52.6	1.5	1.15	1.00	1.00	0.77	30.4	7015.0	3957.4	0.73	22.3	N/A	N/A
18	66.0	22	CL	Lean Clay	MC	No	3.0	2.500	Clay		115	115	52.6	1.5	1.15	1.00	1.00	0.77	29.1	7590.0	4220.4	0.71	20.6	N/A	N/A
19	70.5	120	CL	Lean Clay	MC	No	3.0	2.500	Clay		115	115	52.6	1.5	1.15	1.00	1.00	0.77	158.8	8107.5	4457.1	0.69	109.4	N/A	N/A
20	76.0	24	CL	Lean Clay	SPT	No	2.0	1.375	Clay		118	118	55.6	1.5	1.15	1.00	1.00	1.00	41.4	8968.0	4974.4	0.65	27.0	N/A	N/A
21	81.0	44	CL	Lean Clay	MC	No	3.0	2.500	Clay		118	118	55.6	1.5	1.15	1.00	1.00	0.77	58.2	9558.0	5252.4	0.63	37.0	N/A	N/A
22	86.0	37	SM	Silty Sand	MC	No	3.0	2.500	None	35	120	120	57.6	1.5	1.15	1.00	1.00	0.77	49.0	10320.0	5702.4	0.61	29.8	5.5	35.3
23	90.5	100	SM	Silty Sand	SPT	No	2.0	1.375	None	35	120	120	57.6	1.5	1.15	1.00	1.00	1.00	172.5	10860.0	5961.6	0.60	102.8	5.5	108.3
24	96.0	92	SM	Silty Sand	SPT	No	2.0	1.375	None	35	120	120	57.6	1.5	1.15	1.00	1.00	1.00	158.7	11520.0	6278.4	0.58	92.1	5.5	97.6
25	101.0	16	CL	Lean Clay	SPT	No	2.0	1.375	Clay		115	115	52.6	1.5	1.15	1.00	1.00	1.00	27.6	11615.0	6061.4	0.59	16.3	N/A	N/A

Liquefaction Analysis

Sample Number	Depth to Middle of Sample (ft)	$(N_1)_{60-cs}$	r_d	MSF for sand	K_σ for sand	CSR (M=7.5 & σ'vc=1 ATM)	CRR (M=7.5 & σ'vc=1 ATM)	FS	Volumetric Strain, εv (%)	Layer Thickness (ft)	Liquefaction Settlement, s_{liq} (in)
1	1.0	N/A	1.00	1.31	1.10	0.21	2.00	2.00	N/A	1.0	N/A
2	3.5	N/A	0.99	1.31	1.10	0.20	2.00	2.00	N/A	2.5	N/A
3	6.0	86.5	0.98	1.31	1.10	0.20	2.00	2.00	N/A	2.5	N/A
4	8.5	94.3	0.97	1.31	1.10	0.20	2.00	2.00	N/A	2.5	N/A
5	11.0	28.4	0.96	1.31	1.09	0.20	0.40	2.00	N/A	2.5	N/A
6	13.5	25.4	0.95	1.31	1.05	0.22	0.30	1.39	N/A	2.5	N/A
7	16.0	20.4	0.93	1.31	1.03	0.24	0.21	0.90	1.0	2.5	0.21
8	18.5	22.5	0.92	1.31	1.02	0.25	0.24	0.97	0.5	2.5	0.10
9	21.0	36.5	0.90	1.31	1.01	0.26	1.56	2.00	N/A	2.5	N/A
10	26.0	54.2	0.87	1.31	0.97	0.28	2.00	2.00	N/A	5.0	N/A
11	31.0	N/A	0.84	1.31	0.97	0.30	2.00	2.00	N/A	5.0	N/A
12	36.0	N/A	0.81	1.31	0.93	0.31	2.00	2.00	N/A	5.0	N/A
13	41.0	N/A	0.77	1.31	0.91	0.31	2.00	2.00	N/A	5.0	N/A
14	46.0	88.9	0.74	1.31	0.84	0.32	2.00	2.00	N/A	5.0	N/A
15	51.0	56.9	0.71	1.31	0.82	0.32	2.00	2.00	N/A	5.0	N/A
16	56.0	N/A	0.68	1.31	0.84	0.32	2.00	2.00	N/A	5.0	N/A
17	61.0	N/A	0.65	1.31	0.82	0.32	2.00	2.00	N/A	5.0	N/A
18	66.0	N/A	0.63	1.31	0.80	0.32	2.00	2.00	N/A	5.0	N/A
19	70.5	N/A	0.60	1.31	0.78	0.32	2.00	2.00	N/A	4.5	N/A
20	76.0	N/A	0.58	1.31	0.75	0.32	2.00	2.00	N/A	5.5	N/A
21	81.0	N/A	0.56	1.31	0.73	0.31	2.00	2.00	N/A	5.0	N/A
22	86.0	35.3	0.54	1.31	0.74	0.30	1.19	2.00	N/A	5.0	N/A
23	90.5	108.3	0.53	1.31	0.69	0.31	2.00	2.00	N/A	4.5	N/A
24	96.0	97.6	0.52	1.31	0.68	0.32	2.00	2.00	N/A	5.5	N/A
25	101.0	N/A	0.51	1.31	0.69	0.32	2.00	2.00	N/A	5.0	N/A
											0.31



Notes:

1) Factor of Safety against liquefaction limited to 2.0

EB-3

Job No.	144993

HDR

Project	Sonoma WWTP - Tertiary Pond	Computed	KIB	Date	#########
Task		Checked	TAQ	Date	#########

General Parameters		
Return Period	475	yrs
PGA	0.4553	g
M	6.48	
$d_{water\ table}$	12	ft
γ_w	62.4	pcf
$\phi_{borehole}$	6	in
Rod Extension	3	ft
Hammer Type	Automatic Triphammer	
Energy Ratio (ER)	90	%
Use C_S	No	
Weight of Hammer	140	lbs
Height of Drop	30	in

http://eqint.cr.usgs.gov/deaggint/2002/

Blow Count Correction

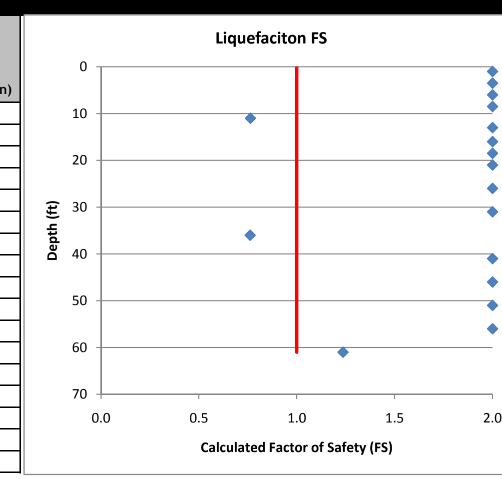
Sample Number	Depth to Middle of Sample (ft)	N	Soil Type from Boring Log (USCS)		Sampler Type	Sampler Lined?	Outside Diameter (in)	Inside Diameter (in)	Flag "Clay" "Unsaturated" "Unreliable"	FC (%)	γ_t (pcf)	γ_{sat} (pcf)	γ_b (pcf)	C_E	C_B	C_R	C_S	C_D	N_{60}	σ_{vc} (psf)	σ'_{vc} (psf)	C_N	$(N_1)_{60}$	$(\Delta N_1)_{60}$ (fines)	$(N_1)_{60-cs}$
1	1.0	30	SM	Silty Sand	MC	No	3.0	2.500	None	27	105	105	42.6	1.5	1.15	0.75	1.00	0.77	29.8	105.0	105.0	1.70	50.6	5.2	55.8
2	3.5	31	SM	Silty Sand	MC	No	3.0	2.500	None	27	105	105	42.6	1.5	1.15	0.75	1.00	0.77	30.8	367.5	367.5	1.70	52.3	5.2	57.5
3	6.0	25	ML	Silt	MC	No	3.0	2.500	None		115	115	52.6	1.5	1.15	0.75	1.00	0.77	24.8	690.0	690.0	1.70	42.2	0.0	42.2
4	8.5	16	SM	Silty Sand	MC	No	3.0	2.500	None	27	120	120	57.6	1.5	1.15	0.80	1.00	0.77	16.9	1020.0	1020.0	1.44	24.4	5.2	29.6
5	11.0	7	SM	Silty Sand	MC	No	3.0	2.500	None	27	120	120	57.6	1.5	1.15	0.85	1.00	0.77	7.9	1320.0	1320.0	1.27	10.0	5.2	15.2
6	13.0	100	SP-SM	Poorly Graded Sand with Silt	MC	No	3.0	2.500	None	5	125	125	62.6	1.5	1.15	0.85	1.00	0.77	112.5	1625.0	1562.6	1.16	130.9	0.0	130.9
7	16.0	42	GW	Well Graded Gravel	SPT	No	2.0	1.375	None	3	125	125	62.6	1.5	1.15	0.85	1.00	1.00	61.6	2000.0	1750.4	1.10	67.7	0.0	67.7
8	18.5	30	CL	Lean Clay	SPT	No	2.0	1.375	Clay		115	115	52.6	1.5	1.15	0.95	1.00	1.00	49.2	2127.5	1721.9	1.11	54.5	N/A	N/A
9	21.0	16	CL	Lean Clay	SPT	No	2.0	1.375	Clay		115	115	52.6	1.5	1.15	0.95	1.00	1.00	26.2	2415.0	1853.4	1.07	28.0	N/A	N/A
10	26.0	22	SM	Silty Sand	MC	No	3.0	2.500	None	27	120	120	57.6	1.5	1.15	0.95	1.00	0.77	27.7	3120.0	2246.4	0.97	26.8	5.2	32.1
11	31.0	16	CL	Lean Clay	MC	No	3.0	2.500	Clay		115	115	52.6	1.5	1.15	1.00	1.00	0.77	21.2	3565.0	2379.4	0.94	20.0	N/A	N/A
12	36.0	14	SM	Silty Sand	MC	No	3.0	2.500	None	27	120	120	57.6	1.5	1.15	1.00	1.00	0.77	18.5	4320.0	2822.4	0.87	16.0	5.2	21.3
13	41.0	22	CL	Lean Clay	MC	No	3.0	2.500	Clay		122	122	59.6	1.5	1.15	1.00	1.00	0.77	29.1	5002.0	3192.4	0.81	23.7	N/A	N/A
14	46.0	5	CL	Lean Clay	MC	No	3.0	2.500	Clay		122	122	59.6	1.5	1.15	1.00	1.00	0.77	6.6	5612.0	3490.4	0.78	5.2	N/A	N/A
15	51.0	46	CL	Lean Clay	MC	No	3.0	2.500	Clay		122	122	59.6	1.5	1.15	1.00	1.00	0.77	60.9	6222.0	3788.4	0.75	45.5	N/A	N/A
16	56.0	14	CL	Lean Clay	MC	No	3.0	2.500	Clay		122	122	59.6	1.5	1.15	1.00	1.00	0.77	18.5	6832.0	4086.4	0.72	13.3	N/A	N/A
17	61.0	24	SM	Silty Sand	MC	No	3.0	2.500	None	27	122	122	59.6	1.5	1.15	1.00	1.00	0.77	31.8	7442.0	4384.4	0.69	22.1	5.2	27.3

Liquefaction Analysis

Sample Number	Depth to Middle of Sample (ft)	$(N_1)_{60-cs}$	r_d	MSF for sand	K_σ for sand	CSR (M=7.5 & σ'vc=1 ATM)	CRR (M=7.5 & σ'vc=1 ATM)	FS	Volumetric Strain, εv (%)	Layer Thickness (ft)	Liquefaction Settlement, s_{liq} (in)
1	1.0	55.8	1.00	1.31	1.10	0.21	2.00	2.00	N/A	1.0	N/A
2	3.5	57.5	0.99	1.31	1.10	0.20	2.00	2.00	N/A	2.5	N/A
3	6.0	42.2	0.98	1.31	1.10	0.20	2.00	2.00	N/A	2.5	N/A
4	8.5	29.6	0.97	1.31	1.10	0.20	0.46	2.00	N/A	2.5	N/A
5	11.0	15.2	0.96	1.31	1.05	0.21	0.16	0.76	1.8	2.5	0.38
6	13.0	130.9	0.95	1.31	1.09	0.21	2.00	2.00	N/A	2.0	N/A
7	16.0	67.7	0.93	1.31	1.06	0.23	2.00	2.00	N/A	3.0	N/A
8	18.5	N/A	0.92	1.31	1.06	0.24	2.00	2.00	N/A	2.5	N/A
9	21.0	N/A	0.90	1.31	1.04	0.26	2.00	2.00	N/A	2.5	N/A
10	26.0	32.1	0.87	1.31	0.99	0.28	0.65	2.00	N/A	5.0	N/A
11	31.0	N/A	0.84	1.31	0.97	0.30	2.00	2.00	N/A	5.0	N/A
12	36.0	21.3	0.81	1.31	0.96	0.29	0.22	0.76	1.3	5.0	0.54
13	41.0	N/A	0.77	1.31	0.88	0.31	2.00	2.00	N/A	5.0	N/A
14	46.0	N/A	0.74	1.31	0.85	0.32	2.00	2.00	N/A	5.0	N/A
15	51.0	N/A	0.71	1.31	0.83	0.32	2.00	2.00	N/A	5.0	N/A
16	56.0	N/A	0.68	1.31	0.81	0.32	2.00	2.00	N/A	5.0	N/A
17	61.0	27.3	0.65	1.31	0.87	0.29	0.36	1.24	N/A	5.0	N/A
											0.92

Notes:

1) Factor of Safety against liquefaction limited to 2.0



EB-4

Job No.	144993

Project	Sonoma WWTP - Tertiary Pond	Computed	KIB	Date	#########
Task		Checked		Date	

General Parameters		
Return Period	475	yrs
PGA	0.4553	g
M	6.48	
$d_{water\ table}$	12	ft
γ_w	62.4	pcf
$\phi_{borehole}$	6	in
Rod Extension	3	ft
Hammer Type	Automatic Triphammer	
Energy Ratio (ER)	90	%
Use C_S	No	
Weight of Hammer	140	lbs
Height of Drop	30	in

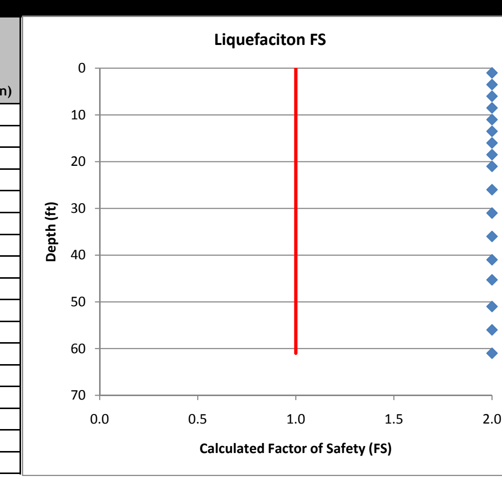
http://eqint.cr.usgs.gov/deaggint/2002/

Blow Count Correction

Sample Number	Depth to Middle of Sample (ft)	N	Soil Type from Boring Log (USCS)		Sampler Type	Sampler Lined?	Outside Diameter (in)	Inside Diameter (in)	Flag "Clay" "Unsaturated" "Unreliable"	FC (%)	γ_t (pcf)	γ_{sat} (pcf)	γ_b (pcf)	C_E	C_B	C_R	C_S	C_D	N_{60}	σ_{vc} (psf)	σ'_{vc} (psf)	C_N	$(N_1)_{60}$	$(\Delta N_1)_{60}$ (fines)	$(N_1)_{60\text{-}cs}$
1	1.0	8	CL	Lean Clay	MC	No	3.0	2.500	Clay		105	105	42.6	1.5	1.15	0.75	1.00	0.77	7.9	105.0	105.0	1.70	13.5	N/A	N/A
2	3.5	47	SW-SM	Well Graded Sand with Silt	MC	No	3.0	2.500	None	47	115	115	52.6	1.5	1.15	0.75	1.00	0.77	46.6	402.5	402.5	1.70	79.3	5.6	84.9
3	6.0	84	SW-SM	Well Graded Sand with Silt	MC	No	3.0	2.500	None	47	115	115	52.6	1.5	1.15	0.75	1.00	0.77	83.4	690.0	690.0	1.70	141.7	5.6	147.3
4	8.5	17	CL	Lean Clay	MC	No	3.0	2.500	Clay		118	118	55.6	1.5	1.15	0.80	1.00	0.77	18.0	1003.0	1003.0	1.45	26.1	N/A	N/A
5	11.0	25	CL	Lean Clay	MC	No	3.0	2.500	Clay		118	118	55.6	1.5	1.15	0.85	1.00	0.77	28.1	1298.0	1298.0	1.28	35.9	N/A	N/A
6	13.5	35	CL	Lean Clay	MC	No	3.0	2.500	Clay		118	118	55.6	1.5	1.15	0.85	1.00	0.77	39.4	1593.0	1499.4	1.19	46.8	N/A	N/A
7	16.0	19	CL	Lean Clay	MC	No	3.0	2.500	Clay		118	118	55.6	1.5	1.15	0.85	1.00	0.77	21.4	1888.0	1638.4	1.14	24.3	N/A	N/A
8	18.5	23	CL	Lean Clay	MC	No	3.0	2.500	Clay		120	120	57.6	1.5	1.15	0.95	1.00	0.77	28.9	2220.0	1814.4	1.08	31.2	N/A	N/A
9	21.0	23	CL	Lean Clay	MC	No	3.0	2.500	Clay		120	120	57.6	1.5	1.15	0.95	1.00	0.77	28.9	2520.0	1958.4	1.04	30.1	N/A	N/A
10	26.0	9	CL	Lean Clay	MC	No	3.0	2.500	Clay		122	122	59.6	1.5	1.15	0.95	1.00	0.77	11.3	3172.0	2298.4	0.96	10.9	N/A	N/A
11	31.0	17	CL	Lean Clay	MC	No	3.0	2.500	Clay		122	122	59.6	1.5	1.15	1.00	1.00	0.77	22.5	3782.0	2596.4	0.90	20.3	N/A	N/A
12	36.0	27	CL	Lean Clay	MC	No	3.0	2.500	Clay		122	122	59.6	1.5	1.15	1.00	1.00	0.77	35.7	4392.0	2894.4	0.86	30.5	N/A	N/A
13	41.0	21	CL	Lean Clay	MC	No	3.0	2.500	Clay		122	122	59.6	1.5	1.15	1.00	1.00	0.77	27.8	5002.0	3192.4	0.81	22.6	N/A	N/A
14	45.3	100	SW-SM	Well Graded Sand with Silt	MC	No	3.0	2.500	None	10	125	125	62.6	1.5	1.15	1.00	1.00	0.77	####	5662.5	3584.6	0.77	101.7	1.1	102.8
15	51.0	57	SW-SM	Well Graded Sand with Silt	SPT	No	2.0	1.375	None	10	125	125	62.6	1.5	1.15	1.00	1.00	1.00	98.3	6375.0	3941.4	0.73	72.0	1.1	73.2
16	56.0	59	SW-SM	Well Graded Sand with Silt	SPT	No	2.0	1.375	None	10	125	125	62.6	1.5	1.15	1.00	1.00	1.00	####	7000.0	4254.4	0.71	71.8	1.1	72.9
17	61.0	48	SW-SM	Well Graded Sand with Silt	SPT	No	2.0	1.375	None	10	125	125	62.6	1.5	1.15	1.00	1.00	1.00	82.8	7625.0	4567.4	0.68	56.4	1.1	57.5

Liquefaction Analysis

Sample Number	Depth to Middle of Sample (ft)	$(N_1)_{60\text{-}cs}$	r_d	MSF for sand	K_σ for sand	CSR (M=7.5 & σ'vc=1 ATM)	CRR (M=7.5 & σ'vc=1 ATM)	FS	Volumetric Strain, ε_v (%)	Layer Thickness (ft)	Liquefaction Settlement, s_{liq} (in)
1	1.0	N/A	1.00	1.31	1.10	0.21	2.00	2.00	N/A	1.0	N/A
2	3.5	84.9	0.99	1.31	1.10	0.20	2.00	2.00	N/A	2.5	N/A
3	6.0	147.3	0.98	1.31	1.10	0.20	2.00	2.00	N/A	2.5	N/A
4	8.5	N/A	0.97	1.31	1.10	0.20	2.00	2.00	N/A	2.5	N/A
5	11.0	N/A	0.96	1.31	1.10	0.20	2.00	2.00	N/A	2.5	N/A
6	13.5	N/A	0.95	1.31	1.10	0.21	2.00	2.00	N/A	2.5	N/A
7	16.0	N/A	0.93	1.31	1.08	0.23	2.00	2.00	N/A	2.5	N/A
8	18.5	N/A	0.92	1.31	1.05	0.24	2.00	2.00	N/A	2.5	N/A
9	21.0	N/A	0.90	1.31	1.02	0.26	2.00	2.00	N/A	2.5	N/A
10	26.0	N/A	0.87	1.31	0.98	0.28	2.00	2.00	N/A	5.0	N/A
11	31.0	N/A	0.84	1.31	0.94	0.30	2.00	2.00	N/A	5.0	N/A
12	36.0	N/A	0.81	1.31	0.91	0.31	2.00	2.00	N/A	5.0	N/A
13	41.0	N/A	0.77	1.31	0.88	0.31	2.00	2.00	N/A	5.0	N/A
14	45.3	102.8	0.75	1.31	0.84	0.32	2.00	2.00	N/A	4.3	N/A
15	51.0	73.2	0.71	1.31	0.82	0.32	2.00	2.00	N/A	5.7	N/A
16	56.0	72.9	0.68	1.31	0.79	0.32	2.00	2.00	N/A	5.0	N/A
17	61.0	57.5	0.65	1.31	0.77	0.32	2.00	2.00	N/A	5.0	N/A
											0.00



Notes:

1) Factor of Safety against liquefaction limited to 2.0

EB-5

Job No.	144993

Project	Sonoma WWTP - Tertiary Pond	Computed	KIB	Date	#########
Task		Checked		Date	

General Parameters		
Return Period	475	yrs
PGA	0.4553	g
M	6.48	
$d_{water\ table}$	12	ft
γ_w	62.4	pcf
$\phi_{borehole}$	6	in
Rod Extension	3	ft
Hammer Type	Automatic Triphammer	
Energy Ratio (ER)	90	%
Use C_S	No	
Weight of Hammer	140	lbs
Height of Drop	30	in

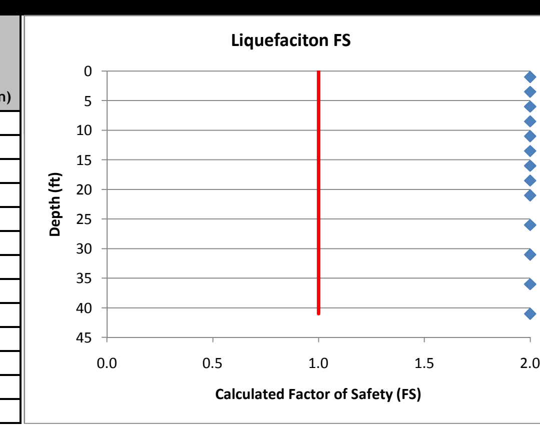
http://eqint.cr.usgs.gov/deaggint/2002/

Blow Count Correction

Sample Number	Depth to Middle of Sample (ft)	N	Soil Type from Boring Log (USCS)		Sampler Type	Sampler Lined?	Outside Diameter (in)	Inside Diameter (in)	Flag "Clay" "Unsaturated" "Unreliable"	FC (%)	γ_t (pcf)	γ_{sat} (pcf)	γ_b (pcf)	C_E	C_B	C_R	C_S	C_D	N_{60}	σ_{vc} (psf)	σ'_{vc} (psf)	C_N	$(N_1)_{60}$	$(\Delta N_1)_{60}$ (fines)	$(N_1)_{60-cs}$
1	1.0	16	CH	Fat Clay	MC	No	3.0	2.500	Clay		117	117	54.6	1.5	1.15	0.75	1.00	0.77	15.9	117.0	117.0	1.70	27.0	N/A	N/A
2	3.5	28	CH	Fat Clay	MC	No	3.0	2.500	Clay		117	117	54.6	1.5	1.15	0.75	1.00	0.77	27.8	409.5	409.5	1.70	47.2	N/A	N/A
3	6.0	40	CH	Fat Clay	MC	No	3.0	2.500	Clay		117	117	54.6	1.5	1.15	0.75	1.00	0.77	39.7	702.0	702.0	1.70	67.5	N/A	N/A
4	8.5	38	CH	Fat Clay	MC	No	3.0	2.500	Clay		117	117	54.6	1.5	1.15	0.80	1.00	0.77	40.2	994.5	994.5	1.46	58.7	N/A	N/A
5	11.0	22	CH	Fat Clay	MC	No	3.0	2.500	Clay		117	117	54.6	1.5	1.15	0.85	1.00	0.77	24.7	1287.0	1287.0	1.28	31.7	N/A	N/A
6	13.5	19	CH	Fat Clay	MC	No	3.0	2.500	Clay		117	117	54.6	1.5	1.15	0.85	1.00	0.77	21.4	1579.5	1485.9	1.19	25.5	N/A	N/A
7	16.0	16	CL	Lean Clay	MC	No	3.0	2.500	Clay		112	112	49.6	1.5	1.15	0.85	1.00	0.77	18.0	1792.0	1542.4	1.17	21.1	N/A	N/A
8	18.5	8	CL	Lean Clay	MC	No	3.0	2.500	Clay		112	112	49.6	1.5	1.15	0.95	1.00	0.77	10.1	2072.0	1666.4	1.13	11.3	N/A	N/A
9	21.0	18	ML-CL	Silty Clay	MC	No	3.0	2.500	Clay		112	112	49.6	1.5	1.15	0.95	1.00	0.77	22.6	2352.0	1790.4	1.09	24.6	N/A	N/A
10	26.0	14	ML-CL	Silty Clay	MC	No	3.0	2.500	Clay		108	108	45.6	1.5	1.15	0.95	1.00	0.77	17.6	2808.0	1934.4	1.05	18.4	N/A	N/A
11	31.0	14	CH	Fat Clay	MC	No	3.0	2.500	Clay		108	108	45.6	1.5	1.15	1.00	1.00	0.77	18.5	3348.0	2162.4	0.99	18.3	N/A	N/A
12	36.0	7	CH	Fat Clay	MC	No	3.0	2.500	Clay		108	108	45.6	1.5	1.15	1.00	1.00	0.77	9.3	3888.0	2390.4	0.94	8.7	N/A	N/A
13	41.0	9	CH	Fat Clay	MC	No	3.0	2.500	Clay		108	108	45.6	1.5	1.15	1.00	1.00	0.77	11.9	4428.0	2618.4	0.90	10.7	N/A	N/A

Liquefaction Analysis

Sample Number	Depth to Middle of Sample (ft)	$(N_1)_{60-cs}$	r_d	MSF for sand	K_σ for sand	CSR (M=7.5 & σ'vc=1 ATM)	CRR (M=7.5 & σ'vc=1 ATM)	FS	Volumetric Strain, εv (%)	Layer Thickness (ft)	Liquefaction Settlement, s_{liq} (in)
1	1.0	N/A	1.00	1.31	1.10	0.21	2.00	2.00	N/A	1.0	N/A
2	3.5	N/A	0.99	1.31	1.10	0.20	2.00	2.00	N/A	2.5	N/A
3	6.0	N/A	0.98	1.31	1.10	0.20	2.00	2.00	N/A	2.5	N/A
4	8.5	N/A	0.97	1.31	1.10	0.20	2.00	2.00	N/A	2.5	N/A
5	11.0	N/A	0.96	1.31	1.10	0.20	2.00	2.00	N/A	2.5	N/A
6	13.5	N/A	0.95	1.31	1.10	0.21	2.00	2.00	N/A	2.5	N/A
7	16.0	N/A	0.93	1.31	1.09	0.22	2.00	2.00	N/A	2.5	N/A
8	18.5	N/A	0.92	1.31	1.07	0.24	2.00	2.00	N/A	2.5	N/A
9	21.0	N/A	0.90	1.31	1.05	0.26	2.00	2.00	N/A	2.5	N/A
10	26.0	N/A	0.87	1.31	1.03	0.28	2.00	2.00	N/A	5.0	N/A
11	31.0	N/A	0.84	1.31	0.99	0.30	2.00	2.00	N/A	5.0	N/A
12	36.0	N/A	0.81	1.31	0.96	0.31	2.00	2.00	N/A	5.0	N/A
13	41.0	N/A	0.77	1.31	0.94	0.32	2.00	2.00	N/A	5.0	N/A
											0.00



Notes:

1) Factor of Safety against liquefaction limited to 2.0