GEOTECHNICAL INVESTIGATION

WEST SANTAQUIN CDA PROJECT

Santaquin, Utah

Prepared for:
Santaquin City

February 2015

RB&G
ENGINEERING, INC.

201401-034

RB&G
ENGINEERING, INC.

February 27, 2015

Santaquin City
Attn: Norm Beagley, P.E., City Engineer
275 West Main Street
Santaquin, UT 84655

Re: West Santaquin CDA Project

Dear Mr. Beagley:

A Geotechnical Investigation has been completed for the West Santaquin CDA Project in Santaquin, Utah. The results of this study are summarized in the report transmitted herewith.

We appreciate the opportunity of providing this service for you. If there are any questions relating to the information contained herein, please call.

Sincerely,

RB&G ENGINEERING, INC.

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CDA Project

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RB&G ENGINEERING, INC.

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GEOTECHNICAL STUDY REPORT

WEST SANTAQUIN CDA PROJECT
SANTAQUIN, UTAH

1 INTRODUCTION

This report outlines the results of a geotechnical study performed for the West Santaquin CDA Project located at about 6500 West Highway 6 in Santaquin, Utah. The project area covers approximately 200 acres as shown on the Vicinity Map in Figure 1, with properties owned by either Santaquin City, Summit Creek Irrigation Company, or Cherry Spring Properties, LLC.

1.1 PROJECT PURPOSE AND SCOPE

The purpose of the geotechnical investigation was to determine the characteristics of the subsurface material throughout the site so that the following information could be provided to project designers:

- Design criteria for roads
- Analyses for potential embankments and bridge foundations along a proposed collector road corridor
- Foundation standards for the future business park development
- Soil characteristics for designing future aquifer recharge ponds and facilities
- Analyses and recommendations for a retaining wall and/or slope stabilization along a portion of a proposed collector road
- Other applicable recommendations for development of the project

2 GEOLOGICAL AND EXISTING SITE CONDITIONS

Shown in Figure 3 is a portion of the geologic map prepared by Witkind and others in 1991[1]. The natural surface materials in this general area have been mapped as (1) Qbn - Nearshore deposits of the Bonneville lake cycle (Pleistocene), consisting of light gray to gray, moderately well sorted, even-bedded deposits of cross-bedded silt, sand, gravel and sparse cobbles. Chiefly of deltaic origin. (2) Qbo - Offshore deposits of the Bonneville lake cycle (Pleistocene) consisting of light gray to tan, well-sorted, even-bedded deposits of clay, silt, and some sand. Bedrock in this general area has been mapped as Mgb – Great Blue Limestone (Upper Mississippian) – Light-bluish-gray to bluish-gray limestone and some shale. The limestone is chiefly thick bedded to massive and has been much fractured.[1]

The Nephi Segment of the Wasatch Fault Zone is located approximately 2 ½ to 3 miles east of the site. This is considered an active fault zone capable of generating earthquakes with a magnitude of up to 7.

It will be observed from Figure 1 that the project site includes the Santaquin Sewer Lagoons which are used for Type 1 (treated) water storage. Seepage from the lagoons may influence the depth to groundwater in the drainage basin area west of the lagoons. The proposed future roadway will extend across the drainage northwest of the sewer lagoons and follow along the westerly side of the sewer lagoons, continuing south and tying into Summit Ridge Parkway at the south end of the project. Investigations performed to date include evaluation of embankment settlement and stability, and foundation support for roadway structures crossing the drainage. West of the drainage, the ground surface slopes upward 25 to 30 feet at a rate of about 2 horizontal to 1 vertical (2:1) to open fields presently cropped in alfalfa. The roadway alignment is presently planned to traverse along the easterly edge of the alfalfa fields. The fields slope gently downward in a northerly direction at a rate of about 3%.

The proposed roadway alignment cuts into the hillside southwest of the sewage lagoons, wrapping in a southwesterly direction for about 1400 feet before turning south across relatively flat terrain with drainage ditches and berms. The native vegetative cover generally consists of weeds, grass and sagebrush.

No structures are located in the immediate vicinity of the site from which foundation performance can be inferred.

3 FIELD AND LABORATORY TESTING PROCEDURES

The subsurface investigation for the borings was performed using a CME 55 rotary drill rig with a tri-cone rock bit and NW casing to advance the boring and water as the drilling fluid. During the subsurface investigation, sampling was performed at one- to five-foot intervals throughout the depth investigated. Both disturbed and undisturbed samples were obtained during the field investigations. Disturbed samples were obtained by driving a 2-inch split spoon sampling tube through a distance of 18 inches using a 140-pound weight dropped from a height of 30 inches. The number of blows required to drive the sampling spoon through each 6 inches of penetration is shown on the boring logs. The sum of the last two blow counts, which represents the number of blows to drive the sampling spoon through 12 inches, is defined as the standard penetration value. The standard penetration value, corrected for overburden and hammer energy, provides a good indication of the in-place density of sandy material; however, it only provides an indication of the relative stiffness of the cohesive material, since the penetration resistance of materials of this type is a function of the moisture content. Considerable care must be exercised in interpreting the standard penetration value in gravelly-type soils, particularly where the size of the granular particle exceeds the inside diameter of the sampling spoon. If the spoon can be driven through the full 18 inches with a reasonable core recovery, the standard penetration value provides a good indication of the in-place density of gravelly-type material.

It will be noted that it was not possible to drive the sampling spoon through the full 18 inches at some sampling locations. Where the sampling tube could not be driven through the full 18 inches, the number of blows to drive the spoon through a given depth of penetration is shown on the boring logs.

Undisturbed samples were obtained at select locations by pushing a thin-walled sampling tube into the subsurface material using the hydraulic pressure on the drill rig. The location at which the undisturbed samples were obtained is shown on the boring logs.

Miniature vane shear tests, which provide an indication of the undrained shearing strength of cohesive materials, were performed on samples of the clay soil during the field investigations. The results of these tests are shown on the boring logs as the torvane value in tsf.

Continuous coring was performed in bedrock using an N.Q. sized core barrel with water as the drilling fluid. The core was characterized by determining the percent recovery and the Rock Quality Designation (RQD) for each core interval. Both the percent recovery and the RQD are shown on the boring logs. The RQD is defined as the percent of material within the core interval which has unfractured core lengths greater than 4 inches.

The subsurface investigation for the test pits was performed using a Case 580 backhoe and operator supplied by Santaquin City. The test pits were logged and sampling was performed at about three-foot intervals throughout the depth investigated. Both disturbed and undisturbed samples were obtained during the field investigations. Undisturbed samples were obtained by trimming block samples of the cohesive material encountered in the soil profile.

Each sample obtained in the field was classified in the laboratory according to the Modified Unified Soil Classification System. The symbol designating the soil type according to this system, is presented on the test hole logs. A description of the Modified Unified Soil Classification System is presented in the appendix, and the meaning of the various symbols, shown on the logs, can be obtained from this figure.

Laboratory tests performed during this investigation to define the characteristics of the subsurface material throughout the proposed site included in-place dry unit weight, natural moisture content, Atterberg Limits, mechanical analyses, unconfined compressive strength, consolidation tests, direct shear, soil moisture density (proctor), and California Bearing Ratio (CBR) tests.

Testing was performed following procedures outlined in the American Society for Testing and Materials (ASTM) standards.

4 SUBSURFACE SOIL AND WATER CONDITIONS

The characteristics of the subsurface material were evaluated drilling borings and excavating test pits in areas and to depths shown in the following table. The approximate test hole locations are shown in Figure 2.

The test hole numbers each include the prefix “14” or “15” on the site plan and test hole logs to indicate the year the test hole was completed; however, the prefix will generally be omitted in the discussion below for simplicity.

Test Hole	Location	Depth (ft)
Borings 1 and 2	East and West side of drainage channel for roadway crossing	60
Boring 3	Business Park	50
Boring 4 and 5	Roadway cut section through hillside southwest of sewer lagoons	36
Test Pits 1, 2, 3, & 4	Business Park	12 to 14
Test Pits 5, 6, & 7	Drainage channel	14
Test Pits 7 through 21	Roadway	10 to 14

The logs for the borings are presented in the appendix, and a review of the logs results in the observations outlined below. The latitude, longitude and elevation shown on the logs were obtained using a hand held GPS device. Accuracy of the survey is estimated to be ±20 feet.

4.1 DRAINAGE CHANNEL CROSSING (BORINGS 1 AND 2)

Boring 1 encountered stiff to hard sandy lean clay to 14 feet, followed by very dense gravel with silt and sand from 14 to 33 feet. The gravel was underlain by stiff to hard lean clay from 33 to 45 feet; then vey dense silty gravel with sand to the bottom of the boring at 61 feet.

Boring 2 encountered sandy lean clay and silt to 5.5 feet, followed by very dense gravel with silt and sand from 5.5 to 29.5 feet. The profile below 29.5 feet consisted predominately of firm to soft silt and clay.

Groundwater was measured at a depth of 24 feet in Boring 1 and 45.7 feet in Boring 2 at the time the field investigation was performed (Oct. - Nov. 2014).

4.2 BUSINESS PARK (BORING 3, TEST PITS 1, 2, 3, AND 4)

Boring 3 was drilled near the center of the proposed Business Park to a depth of 51 feet. The soil profile consisted predominately of medium dense to dense silty sand, sandy silt, and firm clay layers. A very dense gravelly layer was encountered between 4 and 8 feet below the surface. Groundwater was not encountered within the 51 foot depth investigated.

Test Pit 1 encountered firm to stiff lean clay to 9 feet followed by dense gravelly soils to the bottom of the test pit at 12 feet. Test Pits 2 and 3 encountered a surface firm lean clay layer extending 2 to 4 feet below the surface followed generally by layers of dense gravel and sand. A lean clay layer was encountered in Test Pit 2 between 5 and 6.5 feet. Test Pit 4 encountered medium dense non-plastic silty sand and sandy silt to 11 feet; then stiff lean clay to the bottom of the test pit at 14 feet. Groundwater was not encountered in any of the test pits.

4.3 ROADWAY CUT (BORINGS 4 AND 5)

Boring 4 encountered 12 feet of overburden consisting predominately of very dense gravel to 6 feet; then dense to hard silt from 6 to 12 feet. The overburden was underlain by fractured limestone interbedded with very highly weathered mudstone/claystone layers from 12 to 37 feet. Percent recovery ranged from 26 to 100, with the RQD varying from 8 to 64%.

Boring 5 encountered clayey overburden in the upper 1 foot followed by highly fractured limestone bedrock with weathered mudstone layers to the bottom of the boring at 36.5 feet. Percent recovery ranged from 14 to 100 with the RQD varying from 0 to 62%.

Groundwater was not encountered in the 37 foot depth investigated.

4.4 DRAINAGE CHANNEL (TEST PITS 5, 6, AND 7)

These test pits were excavated in the drainage channel to evaluate material types and seepage characteristics for construction of detention berms. It will be observed from the test pit logs that the soil profile consists predominately of silty clay with sand and lean clay in the upper12 to 14 feet of the soil profile. Silty gravel w/sand was encountered in Test Pit 6 at about 13.3 feet and silty clayey gravel w/sand was encountered at 12 feet in Test Pit 7. Percolation tests were performed in the silty clay with sand at depths of 6 to 7 feet in Test Pits 5 and 7, and 5 to 6 feet Test Pit 6. The test holes were filled with water and allowed to saturate and swell for 24 hours prior to testing, followed by measurements of water drop at 30 minute intervals. The following rates were recorded.

Test Pit No.	Depth (ft)	Percolation Rate (minutes per inch)	Approx. Infiltration Rate (ft/day)
5	6	44	2.7
6	5	60	2
7	6	20	6

4.5 ROADWAY (TEST PITS 7 THOUGH 21)

The predominant soil type in the upper ~5 feet of the profile along the proposed roadway alignment is shown below.

Test Hole No.	Subgrade Soils
7	**CL – 0-2.5 Lean Clay** CL-ML – 2.5 to 5 Silty Clay
9	**CL – Lean Clay with Silt Layer**
11	**CL – Lean Clay**
13	**CL-ML – 0-2 Silty Clay w/ Sand** ML – 2-5 Silt
15	**GC-GM – Silty Clayey Gravel**
17	**CL – 0-0.6 Sandy Lean Clay** Bedrock
19	**CL – 0-5 Lean Clay w/ Sand**
21	**CL – 0-2.5 Lean Clay** ML – 2.5-5 Silt w/ Sand

Test Hole No.	Subgrade Soils
8	CL-ML – 0-0.5 Silty Sandy Clay **GP-GM – 0.5–2.5 Gravel w/ Silt and Sand** ML – 2.5-4 Silt
10	**GP – Gravel w/ Sand**
12	CL – 0-0.5 Sandy Lean Clay w/ Gravel **GP-GM – 0.5-4 Gravel w/ silt and sand**
14	CL – 0-1 Sandy Lean Clay **GP – 1-5 Gravel w/ Sand**
16	CL – 0-0.8 Lean Clay w/ Sand **GP-GM – 0.8-5 Gravel w/Silt and Sand**
18	**CL – 0-3 Lean Clay** ML - 3-5 Silt
20	**GM, GC-GM – Silty Gravel w/ Sand and Silty Clayey Gravel w/ Sand**

It will be observed from the table that the predominant subgrade soil at 8 of the 15 test pit locations is lean clay or silty clay. The other 7 locations encountered gravelly soils at the expected subgrade level.

4.6 LABORATORY TESTS

The results of classification, density and moisture tests are presented on the boring logs, and the results of all laboratory tests with exception of Direct Shear and Consolidation Tests are summarized in Table 1, Summary of Test Data in the appendix. It will be noted from Table 1 that the cohesive soils have a Liquid Limit ranging from 20 to 48 and a Plasticity Index varying from 4 to 27, with only one sample greater than 15. The gravelly soils had 1 to 28% passing the No. 200 sieve (fines).

The unconfined compressive strength of cohesive samples ranged obtained from the borings ranged from 1200 to 9000 psf. The limestone bedrock had unconfined compressive strengths ranging from 11,380 to 17,230 psi. Unconfined compressive strengths of cohesive samples from the test pits ranged from 1520 to 4000 psf.

Consolidated drained direct shear tests were performed on remolded samples of lean clay from Boring 1 at 10 feet and silt from Boring 4 at 9 feet. Results of the tests are shown in the appendix. The clay sample had a friction angle of 26.5 degrees and 1 psi cohesion. The silt sample showed a friction angle of 30.9 degrees and a cohesion of 1 psi.

The compressibility characteristics of the subsurface material were evaluated by performing consolidation tests on a sample from Boring 1 at 40 feet, Boring 2 at 30, 40, and 55 feet, Boring 3 at 20 feet, Test Pit 1 at 6 feet and Test Pit 3 at 3 feet. The results of these tests are also presented in the appendix. It will be noted that the samples from the borings are over consolidated with relatively low compressibility characteristics.

During the performance of the consolidation tests, each sample was loaded at the natural moisture content until a load intensity of 0.58 tsf had been reached. At this point in the loading cycle, each sample was permitted to absorb water without any increase in the load intensity. Expansive soils always experience an increase in void ratio on absorbing water. Soils having collapsible characteristics always settle without any increase in the load when they become wet or saturated. It will be observed from these tests that no significant increase in the void ratio occurred as the sample absorbed moisture. The samples from the test pits exhibited slight collapse (1.6 and 1.3%) upon wetting.

The results of soil moisture-density tests and CBR tests are shown in the following table:

Test Pit No.	Depth (ft)	Classification	Max. Density (pcf) / Opt. Moist. %	CBR
9	1-2	Lean Clay (CL)	107 / 19.8	4.9
13	1-2	Silty Clay w/ Sand (CL-ML)	113 / 15	5.9
15	1-2	Lean Clay w/ Sand (CL)	105.6 / 19.1	4.7

It is concluded from the consolidation and classification tests that the subsurface materials at this site do not have expansive characteristics. Furthermore, there is no indication that any of the samples tested have collapsible characteristics.

5 DESIGN CONSIDERATIONS AND RECOMMENDATIONS

5.1 EMBANKMENT SETTLEMENT – DRAINAGE CHANNEL CROSSING

We understand that embankments will likely be required to establish the desired roadway grade in the vicinity of the drainage channel crossing. Test holes 14-1, 14-2, 15-7 and 15-10 were completed in this area, and the information obtained from these investigations has been used to calculate consolidation settlements which would be expected to occur under varying embankment loads.

Borings 14-1 and 14-2 encountered alternating layers of cohesive and granular soils. The cohesive soil layers were up to 14 feet thick with a total combined thickness of about 25 feet at each of the boring locations. One-dimensional consolidation tests were performed on three of the cohesive soil samples obtained during these investigations. The consolidation tests indicated the cohesive soils are over-consolidated and have low to moderate compressibility characteristics.

The primary consolidation settlement which is expected to occur beneath embankment loads has been calculated using the computer program Settle 3D. Settlement calculations have been performed for embankment heights ranging from 10 to 30 feet in height. For purposes of these preliminary evaluations, it was assumed the embankments will have top widths of 80 feet, and 2H:1V (Horizontal:Vertical) side slopes. The results of the settlement analyses are graphically illustrated on settlement plots included in the Appendix. It will be noted from this figure than primary consolidation is not expected to be more than about 1 inch beneath embankments up to 15 feet high, and primary consolidation settlement beneath embankments up to 30 feet high is expected to be less than 2 inches. A significant portion of the settlement (est. 30 to 50%) is expected to occur during fill placement.

5.2 EMBANKMENT STABILITY – DRAINAGE CHANNEL CROSSING

The stability of embankments up to 30 feet in height was evaluated using the computer program Slope/W. Spencer’s method, which satisfies force and moment equilibrium was used by the computer program to calculate factors of safety against slope failure. Critical circular failure surfaces were located by the computer program using a grid and radius approach. An optimization routine was then performed in which points along the critical failure surface were iteratively adjusted. This optimization routine generally resulted in a critical failure surface with a factor of safety slightly less than the circular surface. Strength parameters used for the soil materials were estimated based on the results of field and laboratory investigations. Computer program graphics illustrating the results of the stability analyses are included in the Appendix of this report.

The stability of general embankments up to 30 feet in height was evaluated for end of construction and long term conditions. Under both of these conditions, the critical failure surface is contained within the embankment and is relatively shallow. The minimum calculated factor of safety against slope instability is 1.49 for these embankments. This factor of safety is considered adequate, and stabilization of general embankment foundations is not anticipated to be necessary.

We understand that consideration is being given to constructing a bridge structure over the drainage channel located in the northern portion of the proposed project. Preliminary stability evaluations have been performed assuming a bridge structure constructed using vertical Mechanically Stabilized Embankment (MSE) retained abutments 30 feet in height. These preliminary evaluations indicate factors of safety against slope failure are not adequate for the conditions evaluated due to the presence of a surficial clayey zone, which was about 14 feet thick in Boring 14-1. Adequate factors of safety were calculated if the clayey zone is excavated and replaced with granular embankment fill beneath the retaining structures. We recommend that if a bridge structure is selected as the design option, further evaluation of abutment stability be performed once bridge geometry and subsurface conditions are better defined.

5.3 DRAINAGE CHANNEL STRUCTURE

Options to construct the roadway crossing over the drainage channel located in the northern portion of the proposed project include a bridge structure or a box culvert structure. Preliminary considerations for each of these options are discussed in the following sections of this report.

5.3.1 Box Culvert Foundation Considerations

If a box culvert is selected to provide the roadway crossing over the drainage channel, the bearing capacity for the structure will likely be controlled by the shallow clayey soils encountered in Borings 14-1 and 14-2. Based upon the results of the field and laboratory investigations, the shallow clayey soils have a factored bearing capacity of about 3,000 psf. This value assumes the box culvert would be about 15 feet wide.

The settlement of a box culvert structure will be a critical factor in design. Settlement of a box culvert is likely to be caused by embankment fill placed on either side of the structure. For preliminary purposes, we recommend the settlement analysis discussed in Section 5.1 of this report be used as a general guideline for box culvert design. It should be noted the estimated settlement could be decreased by excavating and replacing the upper portion of the clayey soils encountered in the test holes. If five feet of the shallow clayey soils is replaced with compacted granular fill, the estimated settlement beneath a 30 foot embankment is reduced to 1.2 inches. The estimated settlement is reduced to 1 inch if the upper 8 feet of the clayey soil is replaced with granular fill. Excavation and replacement of the upper clayey soils would also increase the allowable bearing capacity for a box culvert structure.

5.3.2 BRIDGE STRUCTURE FOUNDATION CONSIDERATIONS

If a bridge structure is selected to provide the drainage channel crossing, we recommend consideration be given to supporting the structure using drilled shaft foundations. The dense gravelly soils located within 15 feet of the ground surface in the vicinity of the contemplated structure will provide relatively high resistance values for foundation elements which extend to depths sufficient to provide scour protection. We have calculated preliminary capacities for drilled shafts with diameters between 3 and 6 feet which can be used for conceptual design. We have assumed that the drilled shafts would extend to elevation 4817 feet, which is about 19 feet below the existing ground surface. The calculated drilled shaft geotechnical axial capacity values are summarized in the following table:

Drilled Shaft Diameter (ft)	Nominal Compressive Resistance (kips)	Strength I Compressive Resistance (kips)	Nominal Uplift Capacity (kips)	Strength I Uplift Capacity (kips)
3	424	212	250	107
4	754	377	333	143
5	1178	589	417	178
6	1696	848	500	214

5.4 DRAINAGE CHANNEL DETENTION BASINS

The silty clay and lean clay encountered in Test Pits 5, 6, and 7 can be used to construct Detention Basin berms in the drainage channel. It is recommended that the berms be keyed into the stripped foundation with a 2 foot deep trench extending along centerline. The berms should have embankment slopes no steeper than 3 Horizontal to 1 Vertical. Fill should be moisture conditioned to within 2% of optimum, placed in lifts not exceeded 6 inches after compaction, and compacted to at least 95% of the maximum density as determined by ASTM D 698. We recommend that at least 8 inches of roadbase be used for slope protection. Where velocities are expected to exceed 6 fps, we recommend using riprap with an average rock size of 6 inches.

The clay soils have very low infiltration rates and will retain storm water for a substantial period of time. Granular soils were encountered at 12 to 14 feet in two of the test pits. It may be feasible to construct drainage sumps or wells extending into deep granular layers at select locations. If this option is to be considered, we recommend drilling borings to about 30 feet and performing field permeability tests at about 5 foot intervals.

5.5 FOUNDATION TYPES & BEARING CAPACITIES – BUSINESS PARK AREA

Boring 3 and Test Pits 1, 2, 3, and 4, located in the proposed Business Park area, were used to evaluate preliminary foundation types and bearing capacities. It is anticipated that buildings will be masonry or tilt-up type structures supported using continuous and spot footings. The magnitude of the structural loads are not known as of the preparation of this report; however, it has been assumed that the column loads will not likely exceed 500 kips and that wall loads will not likely exceed 12 klf.

We recommend that all exterior foundations be located at a depth below finished grade sufficient to provide frost protection, which is about 2.5 feet in this area, and that interior footings be located at least 1 foot below floor level. If this action is taken, it is apparent from the test hole logs that foundations will be located in soils varying from firm lean clay, medium dense sandy silt and silty sand, and very dense gravel. Since the cohesive soils (lean clay and silty clay) have a slight collapse potential when wetted, it is recommended that no footings be placed directly on this material. For preliminary design, we recommend that foundation areas encountering cohesive soils be over excavated to a depth of at least 2 feet below footing subgrade. The width of the excavation should extend 0.5 times the fill thickness plus 6 inches beyond the footing perimeter. For example, for 2 feet of fill the width should be 1.5 feet beyond the footing perimeter.

If the above action is taken, we recommend using an allowable bearing capacity for preliminary design of 3200 psf for 3 to 6 foot wide square footings and 2500 psf for 7 to 12 foot wide square footings. For continuous footings, we recommend preliminary design use an allowable bearing capacity of 2500 psf for 2 to 5 foot wide footings and 2000 psf for 6 to 12 foot wide footings. A significant increase in allowable bearing capacity can be obtained by increasing the thickness of structural fill beneath footings. It is recommended that the fill depth and footing size be optimized during final design, once loads are known and site specific investigations have been completed for each structure.

We recommend that the structural fill be relatively well-graded sandy gravel with a maximum size of 3 inches and with less than 15% passing a No. 200 sieve. Material passing the No. 40 seive should have a plasticity index less than 6. The fill should be compacted to an in-place density equal to at least 95% of the maximum density as determined by ASTM D 1557.

To ensure that compaction requirements are met, each lift should be tested, with testing performed at 50 foot intervals along continuous footing lines and at each spot footing. Testing should be performed in accordance with ASTM D 6938 (nuclear method), or ASTM D 1556 (sand cone method).

If foundations for the proposed facilities are designed in accordance with the recommendations outlined above, the maximum settlement of any footing should not exceed one inch and differential settlement throughout the structures should not exceed 0.5 inch. It is generally recognized that the tolerable differential settlement for steel and concrete structures is about 0.002 times the column spacing. This criterion is tantamount to a differential settlement of about 0.5 inch for column spacings of 20 feet and 0.7 inch for column spacings of 30 feet. Since it is not anticipated that the column spacing for this structure will be less than 20 feet, a differential settlement of 0.5 inch should be satisfactory for the proposed facilities.

5.6 SEISMIC CONSIDERATIONS

The site is classified as Site Class D, as per Section 1613 of the 2009 and 2012 International Building Code and Chapter 20 of ASCE 7-10. The site is located at latitude 39.9786° North and longitude 111.8135° West. The Site Class D risk-targeted spectral acceleration values for use with these publications are tabulated below:

Design and MCE$_R$ ground motion values in g.

Period	Design	MCE$_R$
PGA (0 sec)	n/a	0.607
0.2 sec SA	0.903	1.354
1.0 sec SA	0.478	0.716

The allowable soil bearing pressure indicated above may be increased by one-third where seismic forces are involved in the structural loads. If the frictional resistance of the footings and floor slabs are used to resist seismic forces, we recommend a coefficient of friction of 0.40 be used to calculate these forces. See Section 5.3 below for recommendations related to resistance provided by passive earth pressures.

Since the static groundwater level is below 25 feet and the soils consist of lean clay and medium dense to very dense silty sand and gravel, problems associated with liquefaction during a seismic event are unlikely at this site, and no special mitigation of the foundation soils is required.

5.7 LATERAL EARTH PRESSURES

It is not anticipated that earth-retaining structures will be required for the proposed facilities. If earth-retaining structures are required, however, and if backfilling is performed using granular material, and if the backfill behind the wall is horizontal, we recommend that the earth pressures be calculated using the following equation, along with the earth pressure coefficient outlined below:

$$P = \tfrac{1}{2}\,\gamma\,K\,H^2$$

Where P = total lateral force on wall, plf
K = earth pressure coefficient
γ = unit weight of soil (125 pcf)
H = height of retained soil against wall

The earth pressure coefficient used in designing the walls will depend upon whether the wall is free to move during backfilling operations, or whether the wall is restrained during backfilling. If the wall is free to move during backfilling operations and the backfill material is granular soil, we recommend an active earth pressure coefficient of 0.30 be used in the above equation to calculate the lateral earth pressures. If the walls are restrained from any movement during backfilling and the backfill material is granular soil, we recommend an at-rest earth pressure coefficient of 0.45 be used to calculate the lateral earth pressure. We recommend a passive earth pressure coefficient of 3.0 be used where the granular soil is used to restrain lateral movement.

The additional active earth pressure due to ground acceleration equal to two thirds of the MCE may be estimated using a coefficient of 0.24. The seismic ground motion will reduce the available passive resistance. This reduction may be accounted for as an earth pressure acting in the direction opposite the passive resistance, and computed using a coefficient of 0.64. The pressure diagrams for these forces may be roughly approximated as inverted triangles, such that the resultant forces of the seismic components act at heights of approximately 2H/3 above the base of the wall.

It should be recognized that the pressures calculated by the above equation are earth pressures only and do not include hydrostatic pressures. Where hydrostatic pressures may exist behind a retaining structure, we recommend either the wall be designed to resist hydrostatic pressure, or that a drainage system be placed behind the wall to prevent the development of hydrostatic pressures.

5.8 FLOOR SLABS

We recommend that preliminary design consider using one foot of imported granular fill beneath all floor slabs. The upper 4 inches should consist of a free-draining granular layer and should have a maximum size less than 1 inch and not more than 5% passing a 200 sieve. The free-draining material should be densified using at least 4 passes of a smooth drum 5-ton vibratory roller or equivalent. If the above specifications are followed, the granular layer will prevent the accumulation of moisture beneath the floor slab and will also serve adequately as a base beneath the floor slabs. Where moisture sensitive flooring is planned, such as tile flooring systems, it is recommended that a vapor retarder/barrier be placed directly beneath the concrete floor, in lieu of the free-draining granular layer. It is recommended that the vapor barrier conform to ASTM E 1745 Class A requirements. A subgrade modulus of 100 pci can be used for design.

6 SITE PREPARATION AND COMPACTED FILL REQUIREMENTS

As indicated above, the vegetative cover throughout the site consists of sparse weeds and grass, with alfalfa in the cultivated fields. We recommend that the upper 6 inches be stripped from the weed and grass areas and 8 inches from cultivated areas to remove the excess organic matter in the upper portion of the soil profile. We recommend that imported fill used to establish final grade throughout the site consist of granular soil having a maximum size of 6 inches with less than 30% passing a No. 200 sieve. We recommend that the material passing a No. 40 sieve have a plasticity index less than 6. The fill should be compacted to an in-place density equal to at least 92% of the maximum density as determined by ASTM D 1557. Structural fill beneath foundations should meet requirements outlined in Section 5.1.

Roadway embankments can be constructed using overburden soils from required excavations within the project boundaries or imported fill. Roadway embankments constructed throughout the site should have side slopes of 2 Horizontal to 1 Vertical or flatter. Cohesive fill should be moisture conditioned to within 2% of optimum, placed in lifts not exceeding 8 inches in thickness, and compacted to at least 92% of the maximum laboratory density as determined by ASTM D 1557.

Excavated slopes should follow OSHA guidelines for Type B soils in overburden. Cut slopes in bedrock should be 1 Horizontal to 1 Vertical or flatter. The limestone bedrock is fractured and can likely be ripped and excavated; however, localized blasting may be required for deeper excavations.

Grading around structures should be performed in such a manner that all surface water will flow freely from the area and that no ponding will occur adjacent to the structure which will permit deep percolation into the foundation area. Roof drains should extend well beyond the building lines to prevent seepage into the foundation soils. Sprinkler heads located adjacent to the building should be directed away from the structure to prevent the percolation of water into the foundation zone. Backfilling around foundation walls should be performed using granular material densified to an in-place unit weight equal to at least 90% of the maximum laboratory density indicated above.

7 FLEXIBLE PAVEMENT DESIGN

It is recommended that a CBR value of 4.5 be used for pavement design. We also recommend that the pavement section consist of non-frost susceptible soils to a depth of 21 inches below the pavement surface. To be non-frost susceptible, the fill should have less than 8% non-plastic fines.

7.1 PAVEMENT DESIGN METHODOLOGY

The pavement design has been prepared for the subject project in accordance with the current UDOT Pavement Management and Pavement Design Manual, and the AASHTO 1993 Guide for the Design of Pavement Structures. The pavement design was calculated using AASHTOWare DARWin 3.1 Pavement Design software.

7.2 DESIGN TRAFFIC

We have assumed an AADT of 3500. Procedures in the *UDOT Pavement Management and Pavement Design Guide* were used to determine the design ESAL's for the roadway. Function Class 16 (Urban Minor Arterial Systems) was assumed with an annual growth rate of 7%. Based on these assumptions, the 20 year design life ESALs were calculated to be about 1.35 million. A copy of the ESAL spreadsheet is included in the appendix.

In providing recommendations for flexible pavement design for driveways and parking areas, an equivalent single axle load (ESAL) of 20,500 has been used. This value is comparable to 600 passenger cars and light trucks per day and 2 heavy trucks per day over a design life of 20 years.

If traffic loading is significantly different than what has been assumed, it is requested that we be notified so that appropriate modifications can be made in pavement design.

7.3 SUMMARY OF DESIGN ASSUMPTIONS

A summary of all pavement design input assumptions used to develop recommended structural pavement sections are shown below.

• Design Life	20 years (flexible)
• Roadbed (Subgrade) Modulus	CBR value of 4.5. This correlates to a design roadbed modulus of 6,750 psi. (assumed Mr (psi) = CBR x 1500)
• Granular Borrow Modulus	15,000 psi per UDOT Pavement Design Manual
• Untreated Base Course Modulus	27,000 psi per UDOT Pavement Design Manual
• Serviceability	Initial Serviceability – 4.2 Terminal Serviceability – 2.25
• Reliability	90%
• Structural Layer Coefficients	Asphalt Concrete (HMA) – 0.44 Untreated Base Course (UTBC) – 0.14
• Drainage Coefficient	1.0 for all layers
• Standard Deviation	0.45 (flexible)
• Frost Protection	For this project's location, it is recommended that a minimum of 21 inches below the pavement surface consist of non-frost susceptible material (AASHTO A-1-a, non-plastic, 3 inch max. size) or better.

7.4 PAVEMENT DESIGN RECOMMENDATIONS

The proposed pavement sections for the project are conventional HMA, Untreated Base Course, and Granular Borrow. These designs are based on AASHTOWare DarWin 3.1.011 output and engineering judgment. The pavement design calculations are included in the appendix of this report.

The proposed pavement section for the minor arterial roadway is:

Course Type	Thickness
Hot Mix Asphalt	5”
Untreated Base	6”
Granular Borrow	10”

The required structural pavement thickness is 18.6 inches. The recommended section provides a Structural Number (SN) of 4.00 which exceeds the required SN of 3.69 for 1.35 million ESALs. We also note that this design meets the recommended 21-inch frost protection depth. As requested, we have considered options of reducing the HMA thickness and increasing the underlying base and/or subbase to allow evaluation of cost efficiency. Using an AADT value of 3500 over a design life of 20 years, results in a calculated ESAL of 1.35 million. For this magnitude of loading, we show a minimum HMA thickness of 4.5 inches to prevent rutting. Options to the section shown in the above table include sections consisting of 4.5” HMA / 6” UTB / 12” GB or 4.5” HMA / 8” UTB / 8”GB. Another alternate that could be considered is to reduce the ESAL’s to assume a 5 year design life, reducing the ESAL’s to 675,000. This allows an HMA thickness of 4 inches with a future overlay. If the roadway will experience significantly greater truck traffic related to construction development in the early years, this may not be the best option.

The results of the analysis for driveways and parking areas indicates that a flexible pavement consisting of 3 inches of an asphalt surface course plus 6 inches of untreated granular base will be adequate to support the contemplated traffic. The fine grained native soils are susceptible to frost heave if they become wet during freezing conditions. Since the groundwater level is at a substantial depth below the surface, saturation of the near surface native soils would be from surface water. Providing good drainage and sealing surface cracks in the pavement as they develop will reduce the risk of frost heave. If it is desired to minimize the risk, we recommend placing an additional 12 inches of non-frost susceptible granular soil (minus 3 inch sandy gravel with less than 8% non-plastic fines) beneath the pavement section.

The flexible pavement design indicated above is adequate to support the traffic distribution as indicated. It should be recognized, however, that if construction is performed during periods when the subsurface material throughout the site is in a wet condition, the subsurface material will not be capable of supporting the wheel loads associated with construction equipment. As a consequence of this condition, the pavement cannot be constructed as designed. It is recommended, therefore, that the pavement for the development be constructed during the summer months when the surface moisture content is at a minimum. If the pavement must be constructed during periods when the surface moisture is high, it may be necessary to stabilize the subgrade prior to construction of the pavement section. Stabilization techniques are dependent upon the conditions encountered and construction methods. An additional 1-foot of granular subbase plus a geotextile fabric may be required at select locations if wet conditions exist at the subgrade level such that compaction of the subgrade is not feasible.

All base material should be densified to an in-place unit weight equal to 95% of the maximum laboratory density indicated above and all untreated granular base should conform to Utah Department of Transportation Specifications. Mineral aggregates used in the asphalt surface course should conform to Section 02741 of the standard specifications of the Utah State Department of Transportation. Mixing, placing, and densification of all asphalt materials should also conform to UDOT standards.

8 LIMITATIONS

The conclusions and recommendations presented in this report are based upon the results of the field and laboratory tests performed throughout the site. It should be recognized that soil materials are inherently heterogeneous and that conditions may exist throughout this site which could not be defined during this investigation. With respect to structures, this report should be considered preliminary in nature, requiring site specific investigations once the building sites and structure type have been defined.

If, during construction, conditions are encountered which appear to be different than those presented in this report, it is requested that we be advised in order that appropriate action may be taken.

The information contained in this report is provided for the specific location and purpose of the client named herein and is not intended or suitable for reuse by any other person or entity whether for the specified use, or for any other use. Any such unauthorized reuse, by any other party is at that party's sole risk and RB&G Engineering, Inc. does not accept any liability or responsibility for its use.

9 REFERENCES

1. Geologic Map of the Nephi 30’ x 60’ Quadrangle, Carbon, Emery, Juab, Sanpete, Utah, and Wasatch Counties, Utah, Department of the Interior, U.S. Geological Survey, *Irving J. Witkind and Malcolm P. Weiss, 1991*.

FIGURES

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Figure 1 VICINITY MAP

Santaquin (West) CDA Project

Santaquin, Utah County, Utah

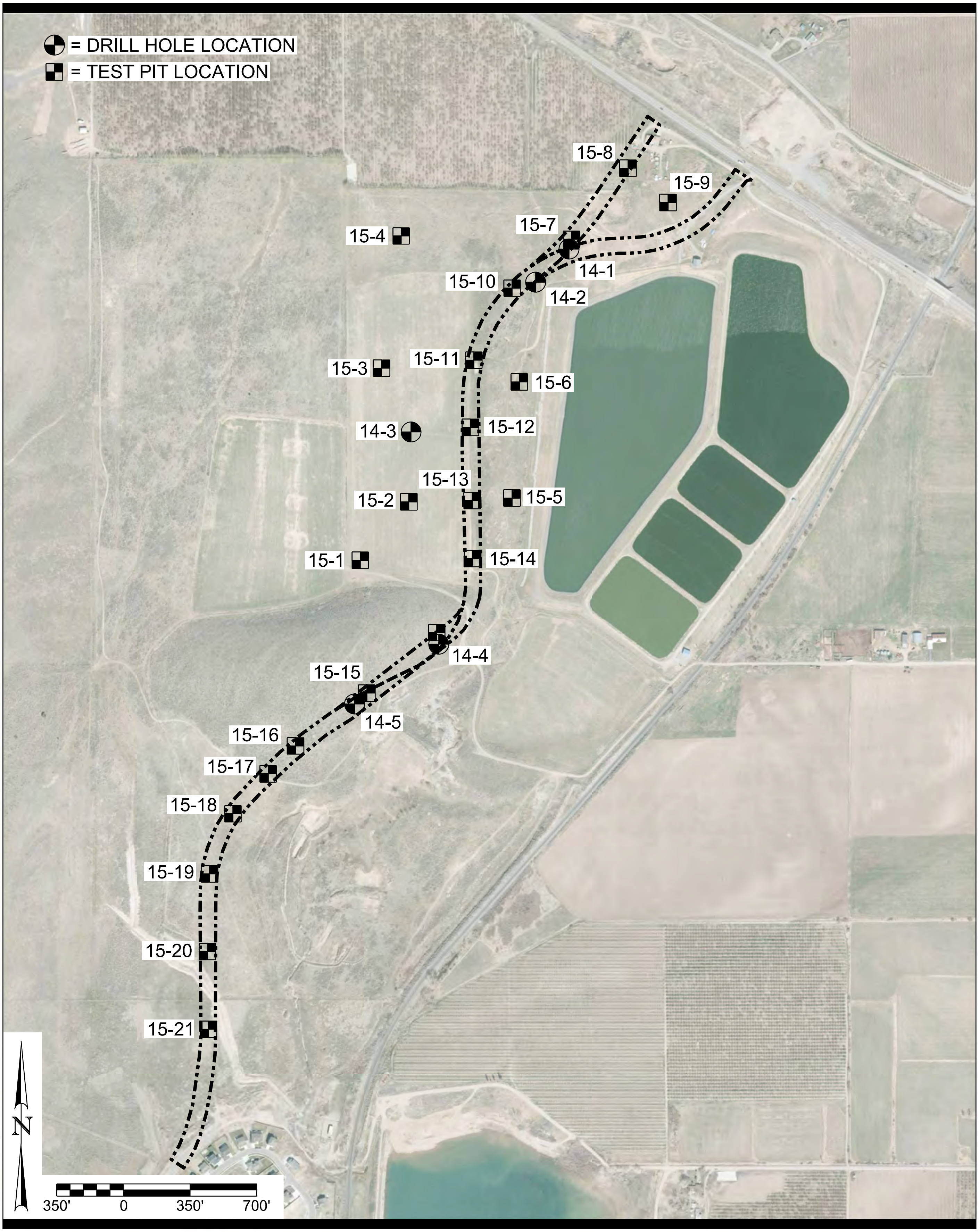

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Figure 2 SITE PLAN & TEST HOLE LOCATIONS

Santaquin (West) CDA Project

Santaquin, Utah County, Utah

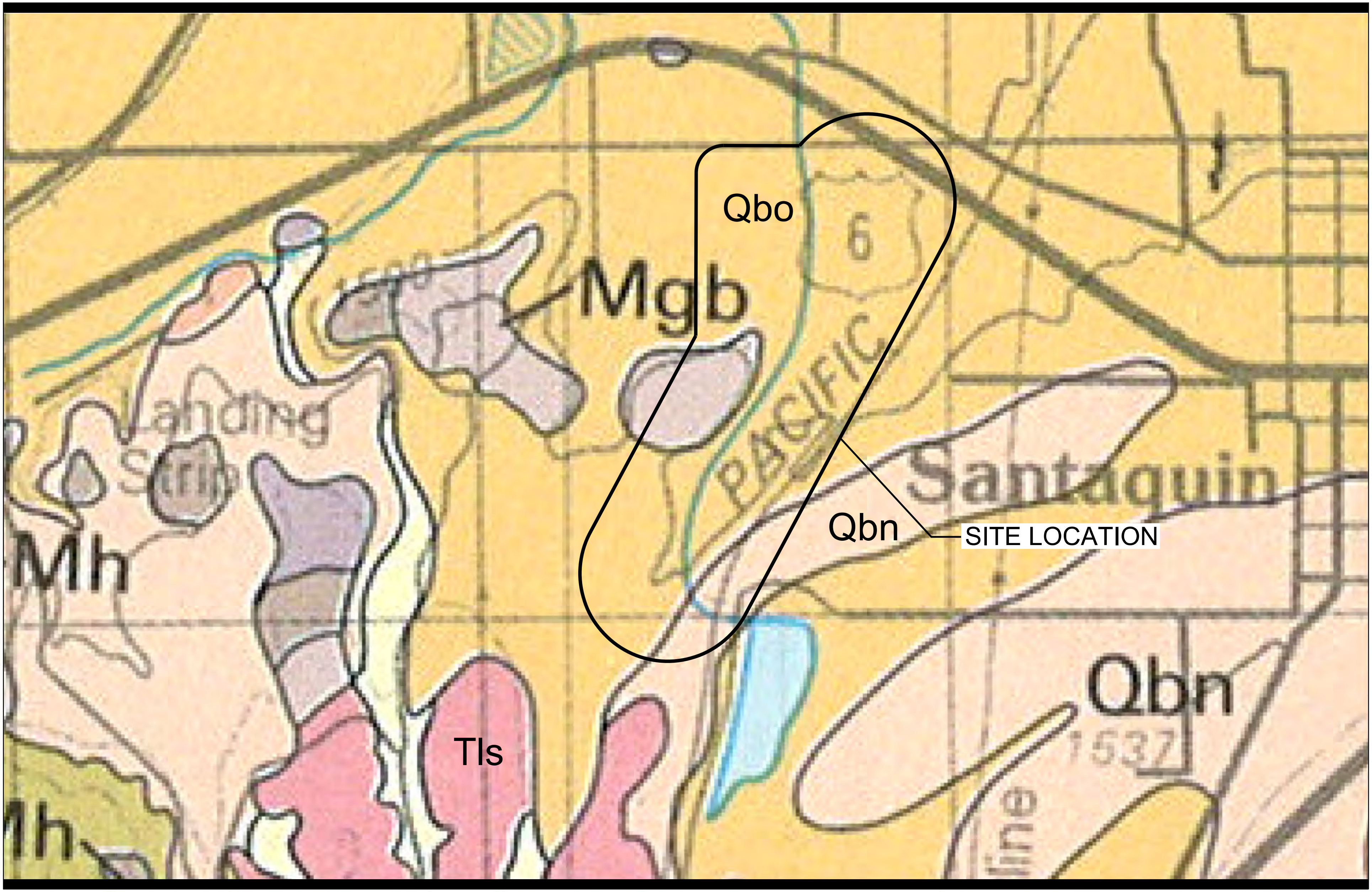

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Figure 3 GEOLOGIC MAP

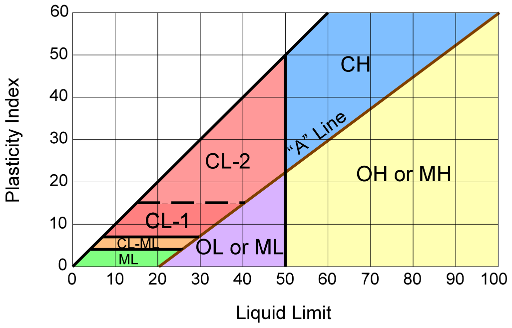
Santaquin (West) CDA Project

Santaquin, UJtah County, Utah

APPENDIX

Unified Soil Classification System

Major Divisions			Group Symbols		Typical Names	Laboratory Classification Criteria		
COARSE-GRAINED SOILS *more than half of material is larger than No. 200 sieve*	**Gravels** *more than half of coarse fraction is larger than No. 4 sieve size*	**Clean Gravels** *little or no fines*	**GW**		Well graded gravels, gravel-sand mixtures, little or no fines	*For laboratory classification of coarse-grained soils* Determine percentage of gravel and sand from grain-size curve. Depending on percentage of fines (*fraction smaller than No. 200 sieve size*), coarse-grained soils are classified as follows: **Less than 5%** GW, GP, SW, SP **More than 12%** GM, GC, SM, SC **5% to 12%** Borderline cases requiring use of dual symbols**	$C_u = \frac{D_{60}}{D_{10}}$ $C_c = \frac{(D_{30})^2}{D_{10}\ x\ D_{60}}$	Greater than 4 Between 1 and 3
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels With Fines *appreciable amount of fines*	**GM***	**d**	Silty gravels, poorly graded gravel-sand-silt mixtures		Atterberg limits below "A" line, or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring uses of dual symbols
				u				
			GC		Clayey gravels, poorly graded gravel-sand-clay mixtures		Atterberg limits above "A" line, or PI greater	
	Sands *more than half of coarse fraction is smaller than No. 4 sieve size*	**Clean Sands** *little or no fines*	**SW**		Well graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ $C_c = \frac{(D_{30})^2}{D_{10}\ x\ D_{60}}$	Greater than 6 Between 1 and 3
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with Fines *appreciable amount of fines*	**SM***	**d**	Silty sands, poorly graded sand-silt mixtures		Atterberg limits below "A" line, or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring uses of dual symbols
				u				
			SC		Clayey sands, poorly graded sand-clay mixtures		Atterberg limits above "A" line, or PI greater	
FINE-GRAINED SOILS *more than half of material is smaller than No. 200 sieve*	**Silts and Clays** *liquid limit is less than 50*		**ML**		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	*For laboratory classification of fine-grained soils*		
			CL	**1**	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
				2				
			OL		Organic silts and organic silt-clays of low plasticity			
	Silts and Clays *liquid limit is greater than 50*		**MH**		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH		Inorganic clays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
HIGHLY ORGANIC SOILS			**Pt**		Peat and other highly organic soils			



Plasticity Chart

NOTE: USCS Modified to include CL-type subcategories

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*Division of GM and SM groups into subdivisions of d and u for roads and airfields only. Subdivision is based on Atterberg limits; suffix d used when liquid limit is 28 or less and the PI is 6 or less, the suffix u used when liquid limit is greater than 28.

***Borderline classification*: Soils possessing characteristics of two groups are designated by combinations of group symbols. (For example GW-GC, well graded gravel-sand mixture with clay biner.)

Boring Logs

DRILL HOLE LOG

BORING NO. 14-1

SHEET 1 OF 2

PROJECT: SANTAQUIN (WEST) CDA PROJECT

CLIENT: SANTAQUIN CITY

LOCATION: LAT: N 39.981146, LON: W -111.810593 (SEE SITE PLAN)

DRILLING METHOD: 96-CME-55 / N.W. CASING TO 43.5'

DRILLER: T. KERN, S. CHAFFIN

DEPTH TO WATER - INITIAL: ▽ 27.0' **AFTER 24 HOURS:** ▼ 24.0'

PROJECT NUMBER: 201401.034

DATE STARTED: 10/16/14

DATE COMPLETED: 10/16/14

GROUND ELEVATION: ~4836.0'

LOGGED BY: M. HANSEN, J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample				Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.		Gradation			Other Tests
			Type	Rec. (in)	See Legend	USCS (AASHTO)					Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	
4835			⧗	14	16,22,11,(70)	CL	brown, moist to dry, very stiff									
4830	5		⧗	8	8,7,4,(23) *PP 2.5*	CL	brown, slightly moist, stiff	SANDY LEAN CLAY								
4825	10		⧗	12	16,20,15,(56) *PP 4.5*	CL	brown, slightly moist, hard			11.0	25	8				DS
4820	15		⧗	10	20,50,50,(99+)	GP-GM	brown, slightly moist, very dense									
4815	20		⧗	10	30,65,75,(99+)	GP-GM	brown, moist, very dense			8.3		NP	58	35	7	
	▼							GRAVEL W/SILT & SAND possible cobbles								
4810	25		⧗	0	80/5"	-	no recovery									
	▽															
4805	30		⧗	12	44,40,40,(82)	GP-GM	red-brown, moist, very dense									
4800	35		⧗	16	20,21,24,(44)	CL-ML	red, slightly moist, hard	SILTY CLAY								
								LEAN CLAY								

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LEGEND:

- ■ 2" OD Split Spoon (SPT)
- ⧗ 2.5" OD Split Spoon
- ▚ 3" OD Split Spoon

Split Spoon Sample:
2,3,2,(6) ← Blow Count per 6" ← $(N_1)_{60}$ Value
T 0.45 ← Torvane (tsf)
PP 2.0 ← Pocket Penetrometer (tsf)
With Liners

Thin-Walled Tube Sample ☒:
Pushed
T 0.45 ← Torvane (tsf)
PP 2.0 ← Pocket Penetrometer (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
Chem. = pH, Resistivity, Sulfate, Chloride
Hyd. = Hydrometer

DRILL HOLE LOG

BORING NO. 14-1

SHEET 2 OF 2

PROJECT: SANTAQUIN (WEST) CDA PROJECT

CLIENT: SANTAQUIN CITY

LOCATION: LAT: N 39.981146, LON: W -111.810593 (SEE SITE PLAN)

DRILLING METHOD: 96-CME-55 / N.W. CASING TO 43.5'

DRILLER: T. KERN, S. CHAFFIN

DEPTH TO WATER - INITIAL: ▽ 27.0' **AFTER 24 HOURS:** ▼ 24.0'

PROJECT NUMBER: 201401.034

DATE STARTED: 10/16/14

DATE COMPLETED: 10/16/14

GROUND ELEVATION: ~4836.0'

LOGGED BY: M. HANSEN, J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample				Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.		Gradation			Other Tests
			Type	Rec. (in)	See Legend	USCS (AASHTO)				Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	
4795		▨	☒	18	Pushed *T 0.73*	CL	brown, moist, stiff	91.4	25.2	48	27				CT
							LEAN CLAY								
	45														
4790															
	50														
4785			⧗	16	18,41,90,(99+)	GM	brown, very moist, very dense		6.5		NP	54	29	17	
							SILTY GRAVEL W/SAND clay seams								
	55														
4780															
	60														
4775			⧗	15	35,55,55,(91)	GM	red-brown, very moist, very dense								
							BOH								
	65														
4770															
	70														
4765															
	75														
4760															

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LEGEND:

- ▮ 2" OD Split Spoon (SPT)
- ⧗ 2.5" OD Split Spoon
- ▚ 3" OD Split Spoon

Split Spoon Sample
2,3,2,(6) ← Blow Count per 6"
← $(N_1)_{60}$ Value
T 0.45 ← Torvane (tsf)
PP 2.0 ← Pocket Penetrometer (tsf)
← With Liners

Thin-Walled Tube Sample ☒
Pushed
T 0.45 ← Torvane (tsf)
PP 2.0 ← Pocket Penetrometer (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
Chem. = pH, Resistivity, Sulfate, Chloride
Hyd. = Hydrometer

DRILL HOLE LOG

BORING NO. 14-2

SHEET 1 OF 2

PROJECT: SANTAQUIN (WEST) CDA PROJECT

CLIENT: SANTAQUIN CITY

LOCATION: LAT: N 39.980669, LON: W -111.811226 (SEE SITE PLAN)

DRILLING METHOD: 96-CME-55 / N.W. CASING TO 40'

DRILLER: T. KERN

DEPTH TO WATER - INITIAL: ▽ N.M. **AFTER 24 HOURS:** ▼ 45.7'

PROJECT NUMBER: 201401.034

DATE STARTED: 11/10/14

DATE COMPLETED: 11/11/14

GROUND ELEVATION: ~4836.0'

LOGGED BY: M. HANSEN, J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	Sample USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
4835			⧗	17	8,16,25,(87)	CL	lt. brown, moist to slightly moist SANDY LEAN CLAY W/GRAVEL								
							SILT W/SAND slight pinhole structure								
	5					ML	brown, moist		20.4		NP	1	24	75	
4830			⧗	17	22,37,41,(99+)	GP-GM	brown, slightly moist, very dense								
	10														
4825			⧗	14	43,50,55,(99+)	GP-GM	brown, moist, very dense								
	15														
4820			⧗	13	23,28,30,(80)	GP-GM	brown, moist, very dense		6.6		NP	51	41	8	
							GRAVEL W/SILT & SAND possible cobbles								
	20														
4815			⧗	12	25,27,35,(72)	GP-GM	brown, moist, dense								
	25														
4810			⧗	13	25,25,31,(59)	GP-GM	brown, moist, dense								
	30														
4805			☒	18	Pushed T 0.44	CL-ML	lt. brown, moist	100.2	21.9	26	7				CT
							SANDY SILTY CLAY								
	35														
4800			⧗	14	T 0.29 3,8,22,(27)	CL-ML GP-GM	lt. brown, very moist, firm lt. brown, very moist, med. dense								
							GRAVEL W/SILT & SAND								
							SANDY SILT								

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LEGEND:

- ■ 2" OD Split Spoon (SPT)
- ⧗ 2.5" OD Split Spoon
- ▚ 3" OD Split Spoon

Split Spoon Sample
2,3,2,(6) ← Blow Count per 6" ← $(N_1)_{60}$ Value
T 0.45 ← Torvane (tsf)
PP 2.0 ← Pocket Penetrometer (tsf)
With Liners

Thin-Walled Tube Sample ☒
Pushed
T 0.45 ← Torvane (tsf)
PP 2.0 ← Pocket Penetrometer (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
Chem. = pH, Resistivity, Sulfate, Chloride
Hyd. = Hydrometer

DRILL HOLE LOG

BORING NO. 14-2

SHEET 2 OF 2

PROJECT: SANTAQUIN (WEST) CDA PROJECT

CLIENT: SANTAQUIN CITY

LOCATION: LAT: N 39.980669, LON: W -111.811226 (SEE SITE PLAN)

DRILLING METHOD: 96-CME-55 / N.W. CASING TO 40'

DRILLER: T. KERN

DEPTH TO WATER - INITIAL: ▽ N.M. **AFTER 24 HOURS:** ▼ 45.7'

PROJECT NUMBER: 201401.034

DATE STARTED: 11/10/14

DATE COMPLETED: 11/11/14

GROUND ELEVATION: ~4836.0'

LOGGED BY: M. HANSEN, J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
4795			☒	11	Pushed *T 0.30*	ML	brown, very moist	99.6	22.9		NP	0	38	62	CT
							SANDY SILT								
4790	45 ▼		■	18	1,2,3,(4) *T 0.34*	ML	brown, wet, loose								
4785	50		■	18	1,3,3,(5) *T 0.20*	CL-ML	pink-brown, wet, soft SILTY CLAY								
4780	55		☒	18	Pushed *T 0.45*	CL	lt. brown, moist, firm	90.4	32.4	35	13				CT
							LEAN CLAY								
4775	60		■	18	*T 0.20* 1,3,9,(9)	CL SM	lt. brown, moist, soft brown, wet, loose SILTY SAND BOH								
4770	65														
4765	70														
4760	75														

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LEGEND:

- ■ 2" OD Split Spoon (SPT)
- ☒ 2.5" OD Split Spoon
- ▚ 3" OD Split Spoon

Split Spoon Sample:
2,3,2,(6) ← Blow Count per 6"
(6) ← $(N_1)_{60}$ Value
T 0.45 ← Torvane (tsf)
PP 2.0 ← Pocket Penetrometer (tsf)
With Liners

Thin-Walled Tube Sample ☒:
Pushed
T 0.45 ← Torvane (tsf)
PP 2.0 ← Pocket Penetrometer (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
Chem = pH, Resistivity, Sulfate, Chloride
Hyd. = Hydrometer

DRILL HOLE LOG

BORING NO. 14-3

SHEET 1 OF 2

PROJECT: SANTAQUIN (WEST) CDA PROJECT
CLIENT: SANTAQUIN CITY
LOCATION: LAT: N 39.978462, LON: W -111.813588 (SEE SITE PLAN)
DRILLING METHOD: 96-CME-55 / N.W. CASING TO 13.5'
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201401.034
DATE STARTED: 11/11/14
DATE COMPLETED: 11/11/14
GROUND ELEVATION: ~4874.0'
LOGGED BY: M. HANSEN, J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	Sample USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
			⧗	17	8,8,7,(32)	CL-ML	brown, moist to dry SANDY SILTY CLAY								
			☒	7	Pushed *PP>4.5*	CL-ML	brown, dry, hard		1.6	26	6				
4870	5						GRAVEL W/SILT & SAND								
			⧗	12	10,19,40,(99+)	GP-GM	brown, moist, very dense								
4865	10		■	11	10,12,10,(40)	SM	brown, moist, dense SILTY SAND		21.3		NP	0	60	40	
			■	10	7,7,7,(22)	SM	brown, moist, med. dense								
4860	15					SM	brown, moist								
			■	15	6,4,4,(11) *T 0.25*	CL	brown & red-brown, moist, firm LEAN CLAY								
4855	20		☒	16	Pushed *T 0.50* *T 0.89*	CL-ML	red-brown, very moist, stiff SILTY CLAY	100.4	25.6	25	5				CT UU 5587 psf
4850	25		■	17	*T 0.46* 4,8,14,(25)	CL-ML SM	red-brown, moist, firm brown, moist, med. dense SILTY SAND clay lenses & layers								
4845	30		☒	9	Pushed	SM ML	brown, moist brown, moist								
			■	13	3,12,19,(26)	ML	brown, moist, med. dense SILT W/SAND								
4840	35		■	12	6,14,15,(27)	ML SM	brown, very moist brown, very moist, med. dense SILTY SAND		24.4		NP	0	21	79	
4835															

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LEGEND:

■ 2" OD Split Spoon (SPT)
⧗ 2.5" OD Split Spoon
▣ 3" OD Split Spoon

Split Spoon Sample: 2,3,2,(6) — Blow Count per 6", $(N_1)_{60}$ Value; *T 0.45* — Torvane (tsf); *PP 2.0* — Pocket Penetrometer (tsf); With Liners

Thin-Walled Tube Sample ☒: Pushed; *T 0.45* — Torvane (tsf); *PP 2.0* — Pocket Penetrometer (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
Chem. = pH, Resistivity, Sulfate, Chloride
Hyd = Hydrometer

DRILL HOLE LOG

BORING NO. 14-3

SHEET 2 OF 2

PROJECT: SANTAQUIN (WEST) CDA PROJECT
CLIENT: SANTAQUIN CITY
LOCATION: LAT: N 39.978462, LON: W -111.813588 (SEE SITE PLAN)
DRILLING METHOD: 96-CME-55 / N.W. CASING TO 13.5'
DRILLER: T. KERN
DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.
PROJECT NUMBER: 201401.034
DATE STARTED: 11/11/14
DATE COMPLETED: 11/11/14
GROUND ELEVATION: ~4874.0'
LOGGED BY: M. HANSEN, J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	Sample USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
			■	12	17,19,18,(33)	SM	brown, moist, dense SILTY SAND								
4830															
	45		■	4	9,8,7,(13)	ML	SILT W/SAND brown, moist, med. dense very slightly plastic								
4825															
	50						SANDY LEAN CLAY gravels in bottom of sample								
			■	16	5,8,26,(25)	CL	brown, moist								
							BOH								
4820															
	55														
4815															
	60														
4810															
	65														
4805															
	70														
4800															
	75														
4795															

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LEGEND:

■ 2" OD Split Spoon (SPT)
2.5" OD Split Spoon
3" OD Split Spoon

Split Spoon Sample
2,3,2,(6) ← Blow Count per 6"
← $(N_1)_{60}$ Value
T 0.45 ← Torvane (tsf)
PP 2.0 ← Pocket Penetrometer (tsf)
With Liners

Thin-Walled Tube Sample
Pushed
T 0.45 ← Torvane (tsf)
PP 2.0 ← Pocket Penetrometer (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
Chem. = pH, Resistivity, Sulfate, Chloride
Hyd. = Hydrometer

DRILL HOLE LOG

BORING NO. 14-4

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT
CLIENT: SANTAQUIN CITY
LOCATION: LAT: N 39.975393, LON: W -111.813046 (SEE SITE PLAN)
DRILLING METHOD: 96-CME-55 / N.W. CASING TO 11', N.Q. CORE
DRILLER: T. KERN, S. CHAFFIN
DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201401.034
DATE STARTED: 11/12/14
DATE COMPLETED: 11/13/14
GROUND ELEVATION: ~4919.0'
LOGGED BY: M. HANSEN, J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
						CL	brown, moist	SANDY LEAN CLAY								
			⧗	16	7,30,23,(99+)	GM	gray, slightly moist									
			⧗	15	49,60/6"	GM	gray, slightly moist, very dense	SILTY GRAVEL W/SAND clay layers, possible cobbles		4.2		NP	49	30	21	
4915																
	5															
						GM	black-gray, slightly moist									
			⧗	15	30,40,40,(99+)	ML	lt. gray, slightly moist, very dense	SILT								
4910																
	10		⧗	16	12,28,20,(81)	ML	yellow-brown, moist, hard	SILT W/SAND		14.2	21	2				DS
				0	30/0.25"	-	no recovery									
4905																
	15		■	26	Core *88,48*	-	gray, dry, hard rock		156.9	0.1						UC 12,570 psi
4900																
	20		■	16	Core *26,12*	-	gray, dry, hard rock	LIMESTONE interbedded w/very highly weathered mudstone/claystone layers								
4895																
	25		■	16	Core *26,8*	-	gray, dry, hard rock		162.1	0.1						UC 14,550 psi
4890																
	30		■	64	Core *106,64*	-	gray, dry, hard rock									
4885																
	35		■	37	Core *69,27*	-	gray, dry	MUDSTONE/CLAYSTONE very highly weathered								
								BOH								
4880																

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LEGEND:

■ 2" OD Split Spoon (SPT)
⧗ 2.5" OD Split Spoon
▚ 3" OD Split Spoon

Split Spoon Sample
2,3,2,(6) ← Blow Count per 6"; (N₁)₆₀ Value
T 0.45 ← Torvane (tsf)
PP 2.0 ← Pocket Penetrometer (tsf)
With Liners

Thin-Walled Tube Sample
Pushed
T 0.45 ← Torvane (tsf)
PP 2.0 ← Pocket Penetrometer (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
Chem. = pH, Resistivity, Sulfate, Chloride
Hyd. = Hydrometer

DRILL HOLE LOG

BORING NO. 14-5

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT
CLIENT: SANTAQUIN CITY
LOCATION: LAT: N 39.974557, LON: W -111.814608 (SEE SITE PLAN)
DRILLING METHOD: 96-CME-55 / N.W. CASING, N.Q. CORE
DRILLER: T. KERN, S. CHAFFIN
DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201401.034
DATE STARTED: 11/13/14
DATE COMPLETED: 11/13/14
GROUND ELEVATION: ~4954.0'
LOGGED BY: M. HANSEN, J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
		▨	⧗	4	6,8,50/1" *T 0.33*	CL	brown, dry SANDY LEAN CLAY W/GRAVEL								
			■	18	Core *79,24*	-	gray, dry, hard rock								
4950	5		■	54	Core *100,0*	-	gray, dry, hard rock								
								168.3	0.1						UC 11,380 psi
4945	10		■	41	Core *68,38*	-	gray, dry, hard rock								
4940	15		■	8	Core *14,11*	-	gray, dry, hard rock LIMESTONE very highly fractured, some chert nodules, many soft layers w/no recovery, likely very highly weathered mudstone washing away, many fractures w/white-yellow calcareous carbonate coating								
4935	20		■	48	Core *80,54*	-	gray, dry, hard rock	163.8	0.2						UC 17,230 psi
4930	25		■	47	Core *78,62*	-	gray, dry, hard rock								
4925	30		■	12	Core *20,0*	-	gray, dry, hard rock								
4920	35		■	40	Core *94,40*	-	gray, dry, hard rock	163.2	0.1						UC 12,270 psi
							BOH								
4915															

DH_LOG_V8-2014-1 SANTAQUIN_WEST_CDA.GPJ US EVAL.GDT 2/5/15

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LEGEND:

■	2" OD Split Spoon (SPT)
⧗	2.5" OD Split Spoon
▚	3" OD Split Spoon

Split Spoon Sample: 2,3,2,(6) ← Blow Count per 6" ← $(N_1)_{60}$ Value; *T 0.45* ← Torvane (tsf); *PP 2.0* ← Pocket Penetrometer (tsf); With Liners

Thin-Walled Tube Sample ☒: Pushed; *T 0.45* ← Torvane (tsf); *PP 2.0* ← Pocket Penetrometer (tsf)

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
Chem. = pH, Resistivity, Sulfate, Chloride
Hyd. = Hydrometer

Test Pit Logs

TEST PIT LOG

TEST PIT NO. 15-01

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT
CLIENT: SANTAQUIN CITY
LOCATION: LAT: N 39.97683, LON: W -111.81422 (SEE SITE PLAN)
EXCAVATION METHOD: CASE 580 BACKHOE
OPERATOR: NA
DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201401.034
DATE STARTED: 1/15/15
DATE COMPLETED: 1/15/15
GROUND ELEVATION: ~4900.0
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
	0–1	▨						Organics in top 8"								
	3–4	▨	☒		Bulk *T 0.45*	CL	gray-brown, moist, firm		86.2	23.5	33	11				
4895	4–5	▨						LEAN CLAY sand lenses, very slight pinhole structure								
	6–7	▨	☒		Bulk *T 0.72*	CL	lt. red-brown, moist stiff		90.3	26.4	30	9				CT
4890	9–11	▨	■		Bulk	GC-GM	brown, slightly moist, dense	SILTY CLAYEY GRAVEL W/SAND few cobbles								
	11–12	▨				GM	brown, slightly moist, very dense	SILTY GRAVEL W/SAND slightly cemented, few cobbles								
	12							BOH								

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LEGEND:

DISTURBED SAMPLE ■ Bucket ← Sample Type
0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE ☒

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 15-02

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT
CLIENT: SANTAQUIN CITY
LOCATION: LAT: N 39.97799, LON: W -111.81354 (SEE SITE PLAN)
EXCAVATION METHOD: CASE 580 BACKHOE
OPERATOR: NA
DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201401.034
DATE STARTED: 1/15/15
DATE COMPLETED: 1/15/15
GROUND ELEVATION: ~4878.0
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
	0		☒		Bulk *T 0.40*	CL	dk. brown to brown, very moist, firm	Organics in top 8" LEAN CLAY	98.7	19.8						
	1															
	2															
4875	3		▮		Bulk	GM	brown, slightly moist, very dense	SILTY GRAVEL W/SAND few cobbles, very slightly plastic	120.0	2.7			59	25	16	
	4															
	5		☒		Bulk *T 0.99+*	CL	brown, slightly moist, very stiff	LEAN CLAY sand lenses, blocky	103.7	17.1	31	9				
	6															
	7															
4870	8															
	9		▮		Bulk	GP-GM	brown, slightly moist, dense	GRAVEL W/SILT & SAND cobbles, sand layers								
	10															
	11															
	12		▮		Bulk	GP-GM	brown, slightly moist, dense									
4865	13							BOH								

TP UDOT LOGV1 SANTAQUIN WEST CDA TP.GPJ US EVAL.GDT 2/6/15

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LEGEND:

DISTURBED SAMPLE ▮ Bucket ← Sample Type
0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE ☒

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 15-03

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT
CLIENT: SANTAQUIN CITY
LOCATION: LAT: N 39.97944, LON: W -111.81416 (SEE SITE PLAN)
EXCAVATION METHOD: CASE 580 BACKHOE
OPERATOR: NA
DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201401.034
DATE STARTED: 1/15/15
DATE COMPLETED: 1/15/15
GROUND ELEVATION: ~4867.0
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample					Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.		Gradation			Other Tests
			Type	Rec. (in)	See Legend	USCS (AASHTO)					Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	
								Organics in top 8"								
	1															
			☒		Bulk T 0.31	CL	dk. brown, moist, firm	LEAN CLAY pinhole structure, blocky	89.6	24.9						
4865	2															
	3															
			☒		Bulk T 0.80	CL	gray-brown, moist, stiff		89.4	13.1	28	9				CT
	4															
						GP-GM	brown, slightly moist	GRAVEL W/SILT & SAND								
	5															
					T 0.92	CL	brown, moist, stiff	LEAN CLAY no pinhole structure								
						SM	red-brown, moist	SILTY SAND								
	6															
			■		Bulk	SP	brown, moist, dense	SAND W/GRAVEL small size gravel layers	115.7	5.3		NP	27	69	4	
4860	7															
	8															
	9															
			■		Bulk	GP-GM	brown, moist, dense	GRAVEL W/SILT & SAND no cobbles								
	10															
	11															
								SILTY SAND W/GRAVEL clay layers to 3" thick								
4855	12															
			■		Bulk	SM	brown, moist									
	13							BOH								

TP_UDOT_LOGV1 SANTAQUIN_WEST_CDA_TP.GPJ US EVAL.GDT 2/6/15

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LEGEND:

DISTURBED SAMPLE ■ Bucket ← Sample Type
0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE ☒

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 15-04

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT
CLIENT: SANTAQUIN CITY
LOCATION: LAT: N 39.98101, LON: W -111.81406 (SEE SITE PLAN)
EXCAVATION METHOD: CASE 580 BACKHOE
OPERATOR: NA
DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201401.034
DATE STARTED: 1/15/15
DATE COMPLETED: 1/15/15
GROUND ELEVATION: ~4858.0
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample				Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.		Gradation			Other Tests
			Type	Rec. (in)	See Legend	USCS (AASHTO)				Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	
	1		☒		Bulk *T 0.45*	SM	brown, moist SILTY SAND	105.8	14.3		NP	0	59	41	
	2														
4855	3		■		Bulk	ML	brown, slightly moist, med. dense	93.9	5.9		NP	0	37	63	
	4						SANDY SILT								
	5														
	6		■		Bulk	ML	brown, slightly moist, med. dense	94.9	17.8						
	7														
4850	8						SANDY SILT clay layers, increasing w/depth								
	9		■		Bulk	ML	brown, slightly moist, med. dense								
	10														
	11														
	12		■		Bulk	CL	brown, moist, stiff LEAN CLAY interbedded w/silty sand layers								
4845	13														
	14						BOH								

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LEGEND:

DISTURBED SAMPLE ■ Bucket ← Sample Type
0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE ☒

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 15-05

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT
CLIENT: SANTAQUIN CITY
LOCATION: LAT: N 39.97750, LON: W -111.81158 (SEE SITE PLAN)
EXCAVATION METHOD: CASE 580 BACKHOE
OPERATOR: NA
DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201401.034
DATE STARTED: 1/15/15
DATE COMPLETED: 1/15/15
GROUND ELEVATION: ~4858.0
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample				Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.		Gradation			Other Tests
			Type	Rec. (in)	See Legend	USCS (AASHTO)					Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	
	0							Organics in top 6"								
	1		☒		Bulk *T 0.53*	CL	brown, moist, stiff	LEAN CLAY								
	2															
4855	3		☒		Bulk *T 0.67*	CL-ML	lt. brown, slightly moist to moist, stiff		89.9	6.6						
	4															
	5															
	6		☒		Bulk *T 0.75*	CL-ML	lt. brown, slightly moist to moist, stiff		93.1	9.7	20	4				Perc. Test
	7															
4850	8							SILTY CLAY W/SAND pinhole structure, decreasing w/depth								
	9		☒		Bulk *T 0.60*	CL-ML	lt. brown, moist, stiff			9.7	26	6				
	10															
	11															
	12		☒		Bulk *T 0.81*	CL-ML	lt. brown, moist, stiff									
4845	13															
	14							BOH								

TP UDOT LOGV1 SANTAQUIN WEST CDA TP.GPJ US EVAL.GDT 2/6/15

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LEGEND:

DISTURBED SAMPLE ■ Bucket ◄—— Sample Type
0.45 ◄—— Torvane (tsf)

UNDISTURBED SAMPLE ☒

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 15-06

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT
CLIENT: SANTAQUIN CITY
LOCATION: LAT: N 39.97920, LON: W -111.81143 (SEE SITE PLAN)
EXCAVATION METHOD: CASE 580 BACKHOE
OPERATOR: NA
DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201401.034
DATE STARTED: 1/15/15
DATE COMPLETED: 1/15/15
GROUND ELEVATION: ~4842.0
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
								Organics in top 6"								
	1					GM	brown, very moist, loose	SILTY GRAVEL W/SAND								
4840	2				T 0.39	CL	brown, slightly moist, firm	LEAN CLAY								
	3		☒		Bulk T 0.57	CL-ML	lt. brown, slightly, moist to moist, stiff		90.2	10.3						
	4															
	5		☒		Bulk T 0.65	CL-ML	lt. brown, moist, stiff	SILTY CLAY W/SAND very slight pinhole structure	88.3	12.5	24	6				Perc. Test
	6															
4835	7															
	8															
	9		☒		Bulk T 0.80	CL	brown, slightly moist, stiff			14.7	30	10				
	10							LEAN CLAY								
	11															
4830	12		☒		Bulk T 0.83	CL	brown, slightly moist, stiff									
	13					GM	brown, moist	SILTY GRAVEL W/SAND very slightly plastic								
	14							BOH								

TP UDOT LOGV1 SANTAQUIN WEST CDA TP.GPJ US EVAL GDT 2/6/15

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LEGEND:

DISTURBED SAMPLE ■ Bucket ← Sample Type
0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE ☒

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 15-07

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT

CLIENT: SANTAQUIN CITY

LOCATION: LAT: N 39.98147, LON: W -111.81089 (SEE SITE PLAN)

EXCAVATION METHOD: CASE 580 BACKHOE

OPERATOR: NA

DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201401.034

DATE STARTED: 1/15/15

DATE COMPLETED: 1/15/15

GROUND ELEVATION: ~4831.0

LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
		▨						Organics in top 6"								
4830	1	▨			T 0.40	CL	brown, very moist, firm	LEAN CLAY								
	2	▨														
	3	▨	☒		Bulk T 0.55	CL-ML	lt. brown, slightly moist, stiff		92.6	6.1						
	4	▨														
	5	▨														
4825	6	▨	☒		Bulk T 0.57	CL-ML	lt. brown, slightly moist, stiff		91.6	15.5	27	7				Perc. Test
	7	▨						SILTY CLAY W/SAND slight pinhole structure								
	8	▨														
	9	▨	☒		Bulk T 0.79	CL-ML	lt. brown, moist, stiff									
	10	▨														
4820	11	▨														
	12	▩	■		Bulk	GC-GM	brown, slightly moist, very dense			6.5	23	6	56	17	27	
	13	▩						SILTY CLAYEY GRAVEL W/SAND								
	14							BOH								

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LEGEND:

DISTURBED SAMPLE ■ Bucket ← Sample Type
0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE ☒

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay

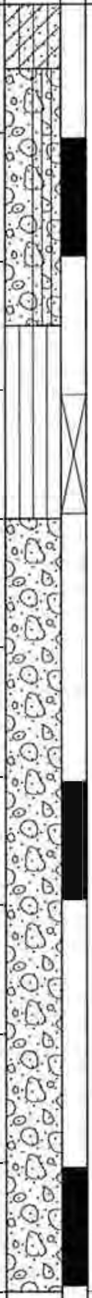
TEST PIT LOG

TEST PIT NO. 15-08

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT
CLIENT: SANTAQUIN CITY
LOCATION: LAT: N 39.98200, LON: W -111.80930 (SEE SITE PLAN)
EXCAVATION METHOD: CASE 580 BACKHOE
OPERATOR: NA
DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201401.034
DATE STARTED: 1/15/15
DATE COMPLETED: 1/15/15
GROUND ELEVATION: ~4867.0
LOGGED BY: J. BOONE



Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
						CL-ML	dk. brown, very moist	SILTY SAND CLAY organics								
	1															
			■		Bulk	GP-GM	brown, moist, dense	GRAVEL W/SILT & SAND	121.5	7.0		NP	65	29	6	
4865	2															
	3							SILT plastic, pinhole structure								
			⊠		Bulk *T 0.66*	ML	brown, slightly moist, stiff		91.2	15.2	35	9				
	4															
	5															
	6															
			■		Bulk	GP	gray-brown, moist, loose		113.1	5.0						
4860	7							GRAVEL W/SAND								
	8															
	9															
			■		Bulk	GP	gray-brown, moist, loose									
	10							BOH								

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LEGEND:

DISTURBED SAMPLE	■	Bucket ◄—— *0.45* ◄——	Sample Type Torvane (tsf)
UNDISTURBED SAMPLE	⊠		

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 15-09

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT
CLIENT: SANTAQUIN CITY
LOCATION: LAT: N 39.98130, LON: W -111.80850 (SEE SITE PLAN)
EXCAVATION METHOD: CASE 580 BACKHOE
OPERATOR: NA
DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201401.034
DATE STARTED: 1/15/15
DATE COMPLETED: 1/15/15
GROUND ELEVATION: ~4874.0
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
	1 2	▨	■		Bulk *T 0.79*	CL	Organics in top 4" lt. red-brown, moist, stiff LEAN CLAY	94.2	19.6	27	8				Proct. CBR
4870	3 4	▥	☒		Bulk *T 0.38*	ML	gray-brown, slightly moist, firm SILT very slight pinhole structure		19.6		NP	0	1	99	
	5	▨			*T 0.63*	CL	brown, moist, stiff LEAN CLAY								
	6 7 8	▥	■		Bulk	ML	gray-brown, slightly moist SILT W/SAND	104.4	17.7						
4865	9 10	▨	☒		Bulk *T 0.90*	CL	LEAN CLAY blocky red-brown, moist, stiff								
	11	⁘				SM	brown, moist SILTY SAND								
							BOH								

TP UDOT LOGV1 SANTAQUIN WEST CDA TP.GPJ US EVAL.GDT 2/6/15

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LEGEND:

DISTURBED SAMPLE ■ Bucket ← Sample Type
0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE ☒

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 15-10

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT

CLIENT: SANTAQUIN CITY

LOCATION: LAT: N 39.98056, LON: W -111.81220 (SEE SITE PLAN)

EXCAVATION METHOD: CASE 580 BACKHOE

OPERATOR: NA

DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201401.034

DATE STARTED: 1/15/15

DATE COMPLETED: 1/15/15

GROUND ELEVATION: ~4863.0

LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample					Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.		Gradation			Other Tests
			Type	Rec. (in)	See Legend	USCS (AASHTO)					Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	
								Organics in top 6"								
	1															
	2							GRAVEL W/SAND								
4860	3															
			■		Bulk	GP	brown, moist, med. dense		106.7	4.5		NP	62	34	4	
	4															
			☒		Bulk *T 0.99+*	CL	brown, slightly moist, very stiff	LEAN CLAY	97.6	8.0	30	9				
	5															
	6															
			■		Bulk	SP-SM	gray-brown, slightly moist, med. dense	SAND W/SILT	95.9	4.5						
	7															
4855	8															
	9															
			■		Bulk	SM	gray-brown, moist	SILTY SAND clay layers to 4" thick								
	10															
	11															
	12								BOH							

TP_UDOT_LOGV1 SANTAQUIN_WEST_CDA_TP.GPJ US_EVAL.GDT 2/6/15

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LEGEND:

DISTURBED SAMPLE ■ Bucket ← Sample Type
0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE ☒

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 15-11

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT
CLIENT: SANTAQUIN CITY
LOCATION: LAT: N 39.97946, LON: W -111.81230 (SEE SITE PLAN)
EXCAVATION METHOD: CASE 580 BACKHOE
OPERATOR: NA
DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201401.034
DATE STARTED: 1/15/15
DATE COMPLETED: 1/15/15
GROUND ELEVATION: ~4862.0
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	Sample USCS (AASHTO)		Material Description	Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
						CL-ML	dk. brown, moist	Organics in top 6" SANDY SILTY CLAY								
	1															
						CL	brown, moist, stiff									
4860	2															
	3															
			☒		Bulk *T 0.73*	CL	brown, moist, stiff		95.4	24.9	32	9				
	4															
	5															
								LEAN CLAY sand lenses & layers, increasing w/depth								
	6															
			☒		Bulk *T 0.70*	CL	brown, moist, stiff		97.8	23.8						
4855	7															
	8															
	9															
			☒		Bulk *T 0.81*	CL	brown, moist, stiff									
	10							BOH								

TP UDOT_LOGV1 SANTAQUIN_WEST_CDA_TP.GPJ US EVAL.GDT 2/6/15

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LEGEND:

DISTURBED SAMPLE ■ Bucket ← Sample Type
0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE ☒

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 15-12

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT
CLIENT: SANTAQUIN CITY
LOCATION: LAT: N 39.97853, LON: W -111.81223 (SEE SITE PLAN)
EXCAVATION METHOD: CASE 580 BACKHOE
OPERATOR: NA
DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201401.034
DATE STARTED: 1/15/15
DATE COMPLETED: 1/15/15
GROUND ELEVATION: ~4874.0
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample				Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.		Gradation			Other Tests
			Type	Rec. (in)	See Legend	USCS (AASHTO)					Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	
	0					CL	dk. brown, very moist	SANDY LEAN CLAY W/GRAVEL organics								
	1															
	2							GRAVEL W/SILT & SAND scattered cobbles								
	3		■		Bulk	GP-GM	brown, moist, very dense		123.1	3.1		NP	74	16	10	
4870	4															
	5		☒		Bulk *T 0.90*	CL	brown, moist, stiff	LEAN CLAY	100.7	19.4						
	6		■		Bulk	GP-GM/GP	brown, slightly moist, loose		111.2	4.1						
	7															
	8							GRAVEL W/SILT & SAND TO GRAVEL W/SAND								
4865	9		■		Bulk	GP-GM/GP	brown, slightly moist, loose									
	10															
	11							BOH								

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LEGEND:

DISTURBED SAMPLE ■ Bucket ← Sample Type
0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE ☒

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 15-13

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT

CLIENT: SANTAQUIN CITY

LOCATION: LAT: N 39.97743, LON: W -111.81219 (SEE SITE PLAN)

EXCAVATION METHOD: CASE 580 BACKHOE

OPERATOR: NA

DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201401.034

DATE STARTED: 1/15/15

DATE COMPLETED: 1/15/15

GROUND ELEVATION: ~4866.0

LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
4865	1	▨	■		Bulk *T 0.35*	CL-ML	SILTY CLAY W/SAND brown, moist, firm		18.8	23	6				Proct. CBR
	2														
	3		☒		Bulk *T 0.47*	ML	SILT W/SAND plastic brown, moist, firm	97.6	25.1	26	4				
	4														
	5						GRAVEL W/SAND cobbles, very slightly cemented								
4860	6		■		Bulk	GP	gray w/rust, slightly moist, very dense	123.9	4.1		NP	71	25	4	
	7														
	8														
	9		■		Bulk	GP	gray w/rust, slightly moist, very dense								
	10						BOH								

TP_UDOT_LOGV1 SANTAQUIN_WEST_CDA_TP.GPJ US EVAL.GDT 2/6/15

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LEGEND:

DISTURBED SAMPLE ■ Bucket ← Sample Type
0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE ☒

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 15-14

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT
CLIENT: SANTAQUIN CITY
LOCATION: LAT: N 39.97670, LON: W -111.81223 (SEE SITE PLAN)
EXCAVATION METHOD: CASE 580 BACKHOE
OPERATOR: NA
DEPTH TO WATER - INITIAL: ▽ DRY'
AFTER 24 HOURS: ▼ N.M.

PROJECT NUMBER: 201401.034
DATE STARTED: 1/15/15
DATE COMPLETED: 1/15/15
GROUND ELEVATION: ~4887.0
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample				Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.		Gradation			Other Tests
			Type	Rec. (in)	See Legend	USCS (AASHTO)					Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	
						CL	dk. brown, very moist	SANDY LEAN CLAY organics								
	1															
			■		Bulk	GP	brown, moist, very dense		124.0	4.5						
4885	2															
	3							GRAVEL W/SAND cobbles, very slightly cemented								
			■		Bulk	GP	brown, slightly moist, very dense		122.1	2.2		NP	76	23	1	
	4															
	5															
	6															
			■		Bulk	SP	brown, moist, dense	SAND W/GRAVEL very slightly cemented		5.8		NP	21	78	1	
4880	7															
	8															
	9							SILTY SAND								
			■		Bulk	SM	brown, moist, med. dense									
	10							BOH								

TP_UDOT_LOGV1 SANTAQUIN_WEST_CDA_TP.GPJ US EVAL.GDT 2/6/15

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LEGEND:

DISTURBED SAMPLE ■ Bucket ◄— Sample Type
0.45 ◄— Torvane (tsf)

UNDISTURBED SAMPLE ☒

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 15-15

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT
CLIENT: SANTAQUIN CITY
LOCATION: LAT: N 39.97467, LON: W -111.81416 (SEE SITE PLAN)
EXCAVATION METHOD: CASE 580 BACKHOE
OPERATOR: NA
DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201401.034
DATE STARTED: 1/15/15
DATE COMPLETED: 1/15/15
GROUND ELEVATION: ~4950.0
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample Type	Sample Rec. (in)	Sample See Legend	Sample USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter. Liquid Limit	Atter. Plast. Index	Gradation Gravel (%)	Gradation Sand (%)	Gradation Silt/Clay (%)	Other Tests
	0–1.25					GC-GM	brown, moist	SILTY CLAYEY GRAVEL W/SAND many cobbles								
	1.25–3		■		Bulk	GP-GM	gray-brown, slightly moist	GRAVEL W/SILT & SAND many cobbles, slightly cemented								
	3							BOH Backhoe refusal at 3'								
4945	5															

LEGEND:
DISTURBED SAMPLE ■ Bucket ◄—— Sample Type
0.45 ◄—— Torvane (tsf)
UNDISTURBED SAMPLE ☒

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay

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TEST PIT LOG

TEST PIT NO. 15-16

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT

CLIENT: SANTAQUIN CITY

LOCATION: LAT: N 39.97395, LON: W -111.81546 (SEE SITE PLAN)

EXCAVATION METHOD: CASE 580 BACKHOE

OPERATOR: NA

DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201401.034

DATE STARTED: 1/15/15

DATE COMPLETED: 1/15/15

GROUND ELEVATION: ~4964.0

LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample				Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.		Gradation			Other Tests
			Type	Rec. (in)	See Legend	USCS (AASHTO)					Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	
		▨				CL	brown, very moist	LEAN CLAY W/SAND organics								
	1		■		Bulk	GP-GM	lt. brown, slightly moist, very dense									
	2															
	3							GRAVEL W/SILT & SAND cobbles & boulders to 3'+ in diameter, slightly cemented								
4960	4		■		Bulk	GP-GM	lt. brown, slightly moist, very dense									
	5															
								BOH Backhoe refusal at 5.5'								
	6															
	7															
	8															
4955	9															

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LEGEND:

DISTURBED SAMPLE ■ Bucket ← Sample Type
0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE ☒

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 15-17

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT

CLIENT: SANTAQUIN CITY

LOCATION: LAT: N 39.97356, LON: W -111.81589 (SEE SITE PLAN)

EXCAVATION METHOD: CASE 580 BACKHOE

OPERATOR: NA

DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201401.034

DATE STARTED: 1/15/15

DATE COMPLETED: 1/15/15

GROUND ELEVATION: ~4953.0

LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample				Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.		Gradation			Other Tests
			Type	Rec. (in)	See Legend	USCS (AASHTO)				Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	
		▨				CL	brown, wet SANDY LEAN CLAY organics								
							BEDROCK BOH Backhoe refusal at 8"								
	1														
	2														
4950	3														
	4														
	5														
	6														
	7														
4945	8														
	9														

TP_UDOT_LOGV1 SANTAQUIN_WEST_CDA_TP.GPJ US EVAL.GDT 2/6/15

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LEGEND:

DISTURBED SAMPLE ■ Bucket ← Sample Type
0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE ☒

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 15-18

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT
CLIENT: SANTAQUIN CITY
LOCATION: LAT: N 39.97295, LON: W -111.81653 (SEE SITE PLAN)
EXCAVATION METHOD: CASE 580 BACKHOE
OPERATOR: NA
DEPTH TO WATER - INITIAL: ▽ DRY'
AFTER 24 HOURS: ▼ N.M.
PROJECT NUMBER: 201401.034
DATE STARTED: 1/16/15
DATE COMPLETED: 1/16/15
GROUND ELEVATION: ~4937.0
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample				Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.		Gradation			Other Tests
			Type	Rec. (in)	See Legend	USCS (AASHTO)				Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	
		▨					Organics in top 6"								
	1	▨	■		Bulk *T 0.47*	CL	brown, moist to slightly moist, firm LEAN CLAY pinhole structure		18.2	31	11				
4935	2	▨													
	3	░	☒		Bulk	ML	lt. red-brown, slightly moist, med. dense	86.8	3.3		NP	0	17	83	
	4	░					SANDY SILT non-plastic, pinhole structure								
	5	░													
	6	▨	☒		Bulk *T 0.99+*	CL	red-brown, slightly moist, very stiff								
4930	7	▨													
	8	▨					LEAN CLAY sand lenses, blacky								
	9	▨	☒		Bulk *T 0.99+*	CL	red-brown, slightly moist, very stiff								
	10						BOH								

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LEGEND:

DISTURBED SAMPLE ■ Bucket ← Sample Type
0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE ☒

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 15-19

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT
CLIENT: SANTAQUIN CITY
LOCATION: LAT: N 39.97206, LON: W -111.81703 (SEE SITE PLAN)
EXCAVATION METHOD: CASE 580 BACKHOE
OPERATOR: NA
DEPTH TO WATER - INITIAL: ▽ DRY'
AFTER 24 HOURS: ▼ N.M.

PROJECT NUMBER: 201401.034
DATE STARTED: 1/16/15
DATE COMPLETED: 1/16/15
GROUND ELEVATION: ~4933.0
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample				Material Description	Dry Density (pcf)	Moisture Content (%)	Atter.		Gradation			Other Tests
			Type	Rec. (in)	See Legend	USCS (AASHTO)				Liquid Limit	Plast. Index	Gravel (%)	Sand (%)	Silt/Clay (%)	
	0–9	▨					LEAN CLAY W/SAND pinhole structure								
	1–2		■		Bulk *T 0.40*	CL	brown, moist, firm		15.6	32	12				Proct. CBR
4930	3–4		☒		Bulk *T 0.85*	CL	brown, slightly moist, stiff	96.4	11.9	33	13				
	6–7		☒		Bulk *T 0.99+*	CL	brown, slightly moist, very stiff	92.1	9.0						
4925	8														
	9–10.5	▦	■		Bulk	ML	SANDY SILT red-brown, slightly moist								
							BOH								

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LEGEND:

DISTURBED SAMPLE ■ Bucket ← Sample Type
0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE ☒

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 15-20

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT

CLIENT: SANTAQUIN CITY

LOCATION: LAT: N 39.97095, LON: W -111.81707 (SEE SITE PLAN)

EXCAVATION METHOD: CASE 580 BACKHOE

OPERATOR: NA

DEPTH TO WATER - INITIAL: ▽ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201401.034

DATE STARTED: 1/16/15

DATE COMPLETED: 1/16/15

GROUND ELEVATION: ~4937.0

LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
						GM	dk. brown, very moist	SILTY GRAVEL W/SAND								
	1															
			■		Bulk	GC-GM	lt. brown, moist, very dense	SILTY CLAYEY GRAVEL W/SAND		15.2			47	25	28	
4935	2															
	3															
			■		Bulk	GP-GM	brown, slightly moist, very dense		124.0	4.2						
	4															
	5															
	6															
			■		Bulk	GP-GM	brown, slightly moist, very dense	GRAVEL W/SILT & SAND many cobbles								
4930	7															
	8															
	9															
	10							BOH								

TP UDOT LOGV1 SANTAQUIN WEST CDA TP.GPJ US EVAL.GDT 2/6/15

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LEGEND:

DISTURBED SAMPLE ■ Bucket ← Sample Type

0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE ☒

OTHER TESTS

UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay

TEST PIT LOG

TEST PIT NO. 15-21

SHEET 1 OF 1

PROJECT: SANTAQUIN (WEST) CDA PROJECT
CLIENT: SANTAQUIN CITY
LOCATION: LAT: N 39.96961, LON: W -111.81692 (SEE SITE PLAN)
EXCAVATION METHOD: CASE 580 BACKHOE
OPERATOR: NA
DEPTH TO WATER - INITIAL: ∇ DRY' **AFTER 24 HOURS:** ▼ N.M.

PROJECT NUMBER: 201401.034
DATE STARTED: 1/16/15
DATE COMPLETED: 1/16/15
GROUND ELEVATION: ~4934.0
LOGGED BY: J. BOONE

Elev. (ft)	Depth (ft)	Lithology	Sample: Type	Sample: Rec. (in)	Sample: See Legend	Sample: USCS (AASHTO)	Material Description		Dry Density (pcf)	Moisture Content (%)	Atter.: Liquid Limit	Atter.: Plast. Index	Gradation: Gravel (%)	Gradation: Sand (%)	Gradation: Silt/Clay (%)	Other Tests
	1 2	▨	■		Bulk *T 0.81*	CL	brown, moist, stiff	LEAN CLAY		21.6	32	13				
4930	3 4 5	░	☒		Bulk	ML	lt. gray, slightly moist, med. dense	SILT W/SAND plastic, pinhole structure		12.7	34	10				
	6 7 8	░	☒		Bulk	ML	brown, slightly moist, med. dense	SANDY SILT pinhole structure, clay lenses & layers to 3" thick	87.7	14.2						
4925	9 10	▨	☒		Bulk *T 0.99+*	CL	gray-brown, slightly moist, very stiff	LEAN CLAY								
								BOH								

TP_UDOT_LOGV1 SANTAQUIN_WEST_CDA_TP.GPJ US EVAL.GDT 2/6/15

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LEGEND:

DISTURBED SAMPLE ■ Bucket ← Sample Type
0.45 ← Torvane (tsf)

UNDISTURBED SAMPLE ☒

OTHER TESTS
UC = Unconfined Compression
CT = Consolidation
DS = Direct Shear
UU = Unconsolidated, Undrained
CU = Consolidated, Undrained
HYD = Hydrometer
SS = Soluble Salt
DC = Dispersive Clay

Laboratory Testing

RB&G
ENGINEERING, INC

Table 1

SUMMARY OF TEST DATA

PROJECT	Santaquin (West) CDA Project	PROJECT NO.	201401-034
LOCATION	see site plan	FEATURE	Foundations

HOLE NO.	DEPTH BELOW GROUND SURFACE (ft)	IN-PLACE		UNCONFINED OR UU TRIAXIAL COMPRESSIVE STRENGTH (psf)	ATTERBERG LIMITS			MECHANICAL ANALYSIS			PERCENT FINER THAN 0.005 mm	UNIFIED SOIL CLASSIFICATION SYSTEM / (AASHTO CLASSIFICATION)
		DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY		
14-01	10-11.5		11.0	9000**	25	17	8					CL-1
	20-21.5		8.3				NP	58	35	7		GP-GM
	40-41.5	91.4	25.2	2920*	48	21	27					CL-2
	50-51.5		6.5				NP	54	29	17		GM
14-02	5-6.5		20.4				NP	1	24	75		ML
	15-16.5		6.6				NP	51	41	8		GP-GM
	30-31.5	100.2	21.9	1760*	26	19	7					CL-ML
	40-41.5	99.6	22.9	1200*			NP	0	38	62		ML
	55-56.5	90.4	32.4	1800*	35	22	13					CL-1
14-03	3-3.3		1.6	9000**	26	20	6					CL-ML
	9-10.5		21.3				NP	0	60	40		SM
	20-21.5	100.4	25.6	uu 5587	25	20	5					CL-ML
	35-36.5		24.4				NP	0	21	79		ML
14-04	3-4		4.2				NP	49	30	21		GM
	9-10.5		14.2		21	19	2					ML
	15-16	156.9	0.1	uc 12,570 psi								
	25-26	162.1	0.1	uc14,550 psi								
14-05	8-8.5	168.3	0.1	uc 11,380 psi								
	20-20.5	163.8	0.2	uc 17,230 psi								
	36-36.5	163.2	0.1	uc 12,270 psi								

*Torvane value used to estimate unconfined compressive strength.
**Pocket Penetrometer
NP=Non-Plastic

H:\2014\034_Santaquin(West)CDA_Project\Lab Testing\Testing Summary

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Table 1

SUMMARY OF TEST DATA

PROJECT Santaquin (West) CDA Project PROJECT NO. 201401-034
LOCATION see site plan FEATURE Foundations

HOLE NO	DEPTH BELOW GROUND SURFACE (ft)	IN-PLACE		UNCONFINED OR UU TRIAXIAL COMPRESSIVE STRENGTH (psf)	ATTERBERG LIMITS			MECHANICAL ANALYSIS			PERCENT FINER THAN 0.005 mm	UNIFIED SOIL CLASSIFICATION SYSTEM / (AASHTO CLASSIFICATION)
		DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY		
			Test Pits									
15-01	3-4	86.2	23.5	1800*	33	22	11					CL-1
	6-7	90.3	26.4	2880*	30	21	9					CL-1
15-02	3-4		2.7				2	59	25	16		GM
	5-6	103.7	17.1	4000**	31	22	9					CL-1
15-03	3-3.5	89.4	13.1	3200*	28	19	9					CL-1
	6-7		2.7				NP	27	69	4		SP
15-04	1-2	105.8	14.3				NP	0	59	41		SM
	3-4		5.9				NP	0	37	63		ML
15-05	6-7	93.1	9.7	3000*	20	16	4					CL-ML
	9-10		9.7	2400*	26	20	6					CL-ML
15-06	6-7	88.3	12.5	2600*	24	18	6					CL-ML
	9-10		14.7	3200*	30	20	10					CL-1
15-07	6-7	91.6	15.5	2280*	27	20	7					CL-ML
	12-13		6.5		23	17	6	56	17	27		GC-GM
15-08	1-2		7.0				NP	65	29	6		GP-GM
	3-4	91.2	15.2	2640*	35	26	9					ML
15-09	1-2	94.2	19.6	3160*	27	19	8					CL-1
	3-4		19.6	1520*			NP	0	1	99		ML

*Torvane value used to estimate unconfined compressive strength.
**Pocket Penetrometer
NP=Non-Plastic

H:\2014\034_Santaquin(West)CDA_Project\Lab Testing\Testing Summary

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Table 1

SUMMARY OF TEST DATA

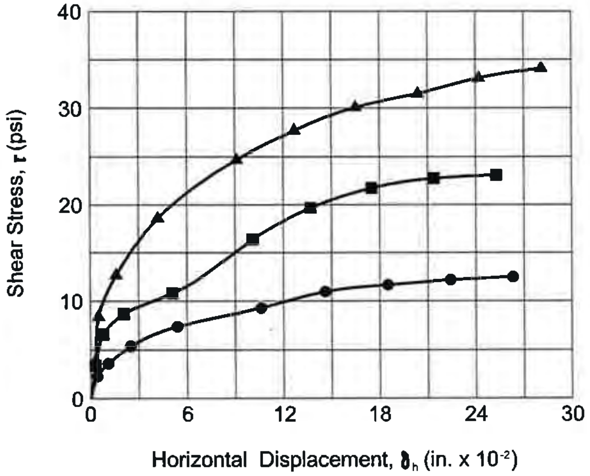
PROJECT Santaquin (West) CDA Project
LOCATION see site plan

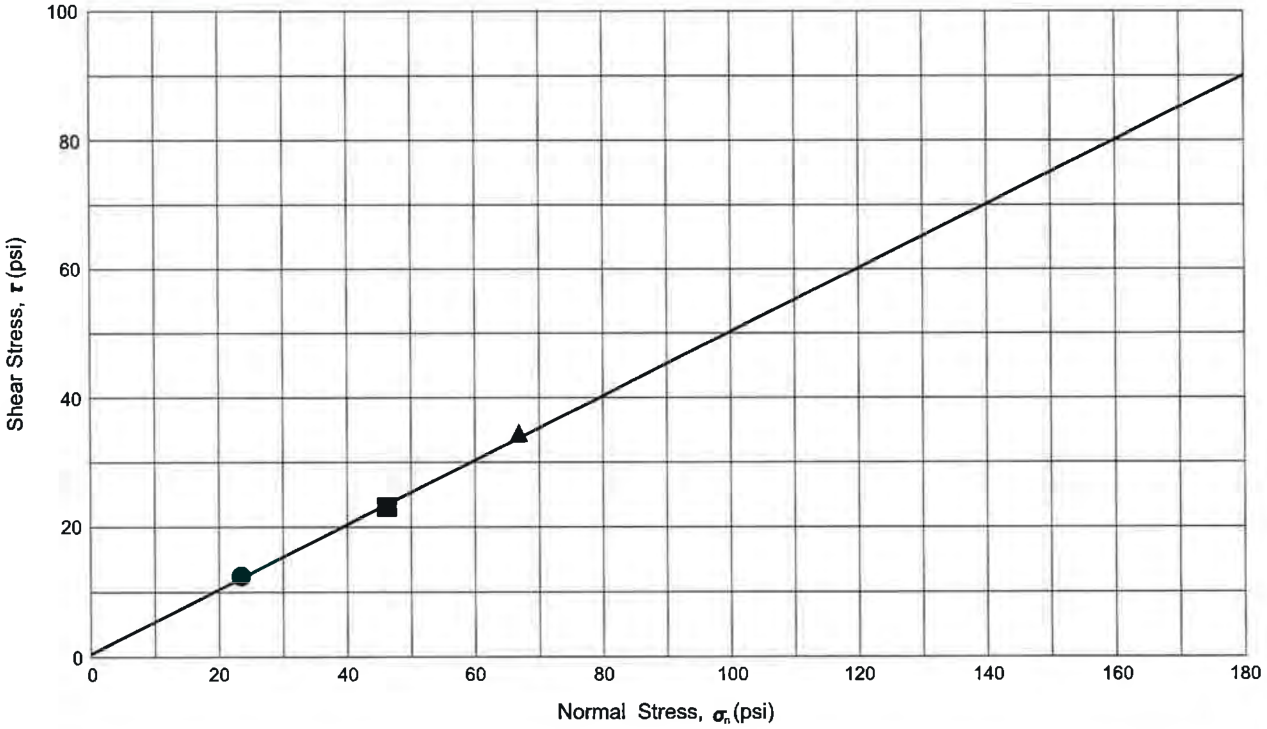
PROJECT NO. 201401-034
FEATURE Foundations

HOLE NO.	DEPTH BELOW GROUND SURFACE (ft)	IN-PLACE		UNCONFINED OR UU TRIAXIAL COMPRESSIVE STRENGTH (psf)	ATTERBERG LIMITS			MECHANICAL ANALYSIS			PERCENT FINER THAN 0.005 mm	UNIFIED SOIL CLASSIFICATION SYSTEM / (AASHTO CLASSIFICATION)
		DRY UNIT WEIGHT (pcf)	MOISTURE (%)		LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	PERCENT GRAVEL	PERCENT SAND	PERCENT SILT & CLAY		
			Test Pits									
15-10	3-4		4.5				NP	62	34	4		GP
	4.5-5	97.6	8.0	4000**	30	21	9					CL-1
15-11	3-4	95.4	24.9	2920*	32	23	9					CL-1
15-12	3-4		3.1				NP	74	16	10		GP-GM
15-13	1-2		18.8	1400**	23	17	6					CL-ML
	3-4	97.6	25.1	1880*	26	22	4					ML
	6-7		4.1				NP	71	25	4		GP
15-14	3-4		2.2				NP	76	23	1		GP
	6-7		5.8				NP	21	78	1		SP
15-18	1-2		18.2	1880*	31	20	11					CL-1
	3-4	86.8	3.3				NP	0	17	83		ML
15-19	1-2		15.6	1600*	32	20	12					CL-1
	3-4	96.4	11.9	3400*	33	20	13					CL-1
15-20	1-2		15.2				4	47	25	28		GC-GM
15-21	1-2		21.6	3240*	32	19	13					CL-1
	3-4		12.7		34	24	10					ML

*Torvane value used to estimate unconfined compressive strength.
**Pocket Penetrometer
NP=Non-Plastic

H:\2014\034_Santaquin(West)CDA_Project\Lab Testing\Testing Summary





Test No. or Symbol	Sample Size (inches)	Sample Data		Degree of Saturation (%)	Normal Stress σₙ (psi)	Maximum Shear Stress τ (psi)	Strain Rate (inches/ minute)	Shear Strength Parameters	
		Dry Density (pcf)	Moisture Content (%)					Friction Angle (degrees)	Cohesion (psi)
●	2.36	102.4	11.9	~100	23.4	12.5	0.0006	26.5	1
■	2.37	102.1	11.8	~100	46.2	23.1	0.0006		
▲	2.43	102.8	11.9	~100	66.8	34.1	0.0006		

MATERIAL: SANDY LEAN CLAY, CL (REMOLDED)

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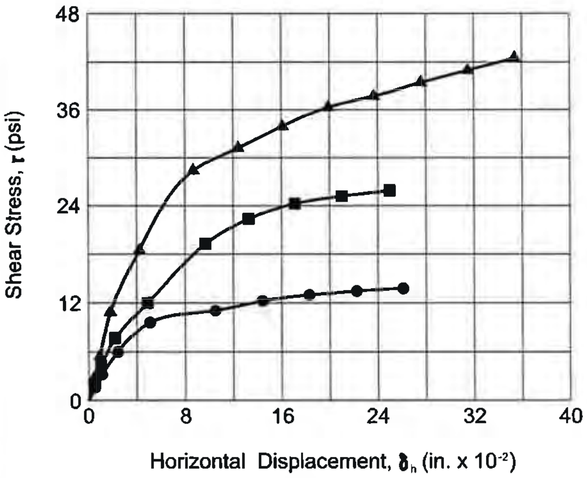
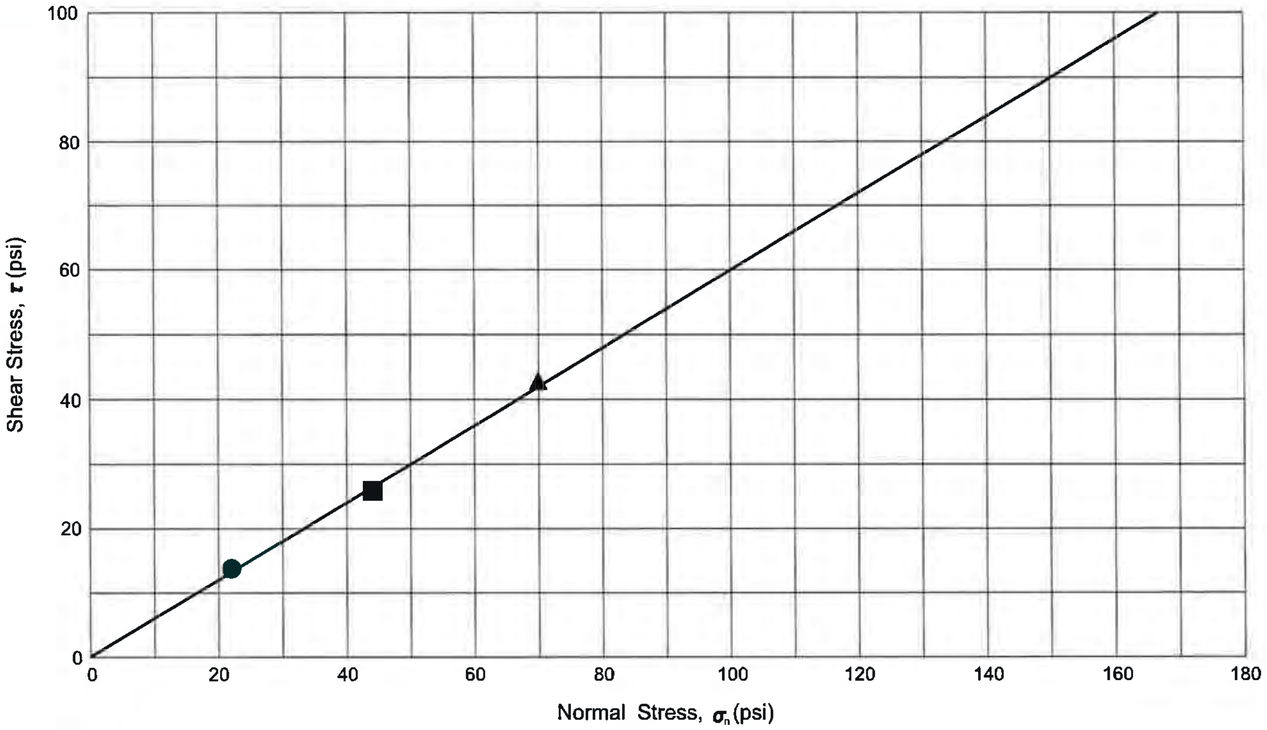
DIRECT SHEAR TEST

Project: *Santaquin (West) CDA Project*
Santaquin, Utah County, Utah

HOLE NO.: 14-1

DEPTH: 10'-11.5'





Test No. or Symbol	Sample Size (inches)	Sample Data		Degree of Saturation (%)	Normal Stress σ_n (psi)	Maximum Shear Stress τ (psi)	Strain Rate (inches/ minute)	Shear Strength Parameters	
		Dry Density (pcf)	Moisture Content (%)					Friction Angle (degrees)	Cohesion (psi)
●	2.43	110.9	14.1	~100	22.0	13.8	0.0006	30.9	1
■	2.42	110.4	14.1	~100	44.0	25.9	0.0006		
▲	2.43	111.0	14.0	~100	69.9	42.5	0.0006		

SILT W/SAND (PLASTIC), ML (REMOLDED)

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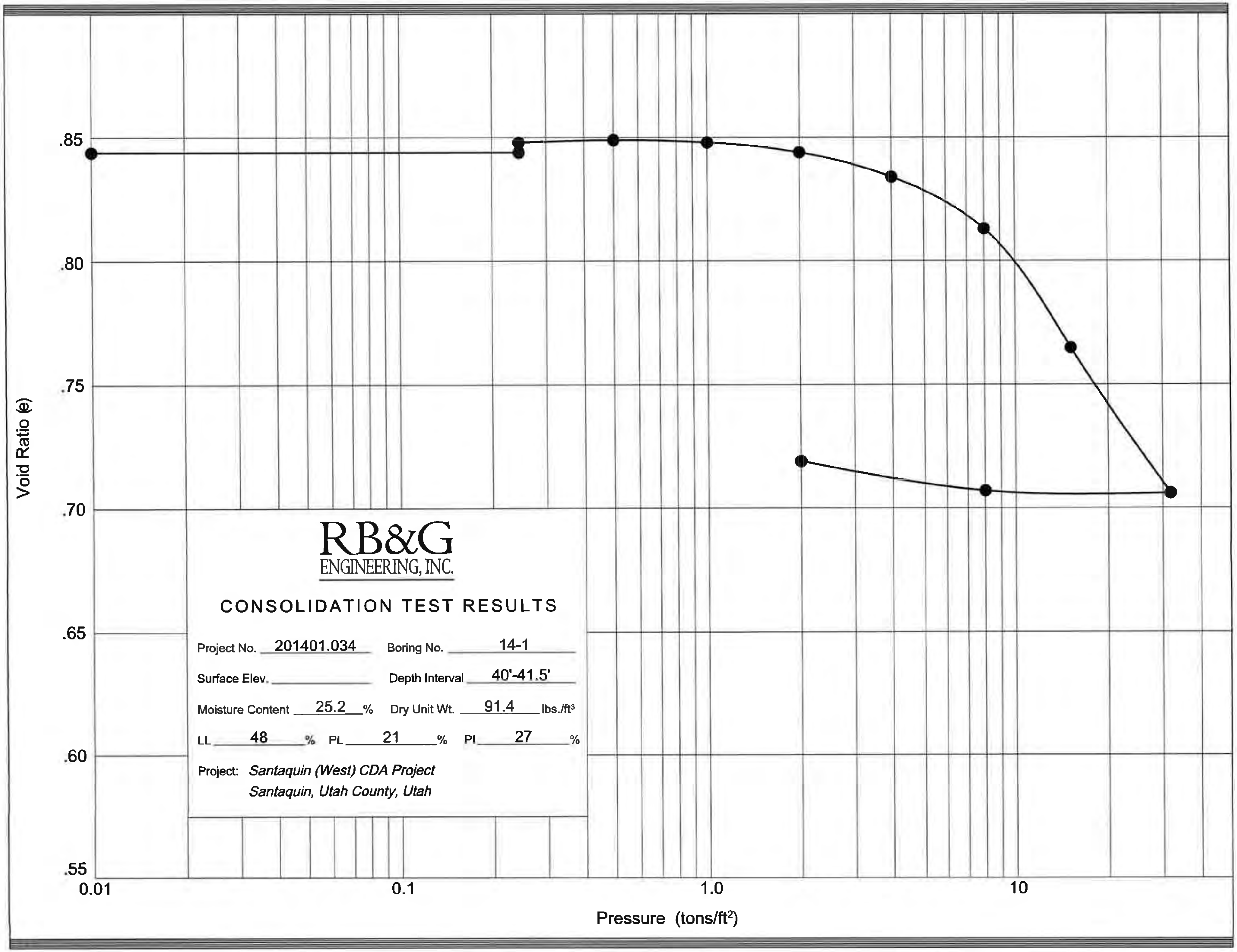
DIRECT SHEAR TEST

Project: *Santaquin (West) CDA Project*
Santaquin, Utah County, Utah

HOLE NO.: 14-4

DEPTH: 9'-10.5'



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CONSOLIDATION TEST RESULTS

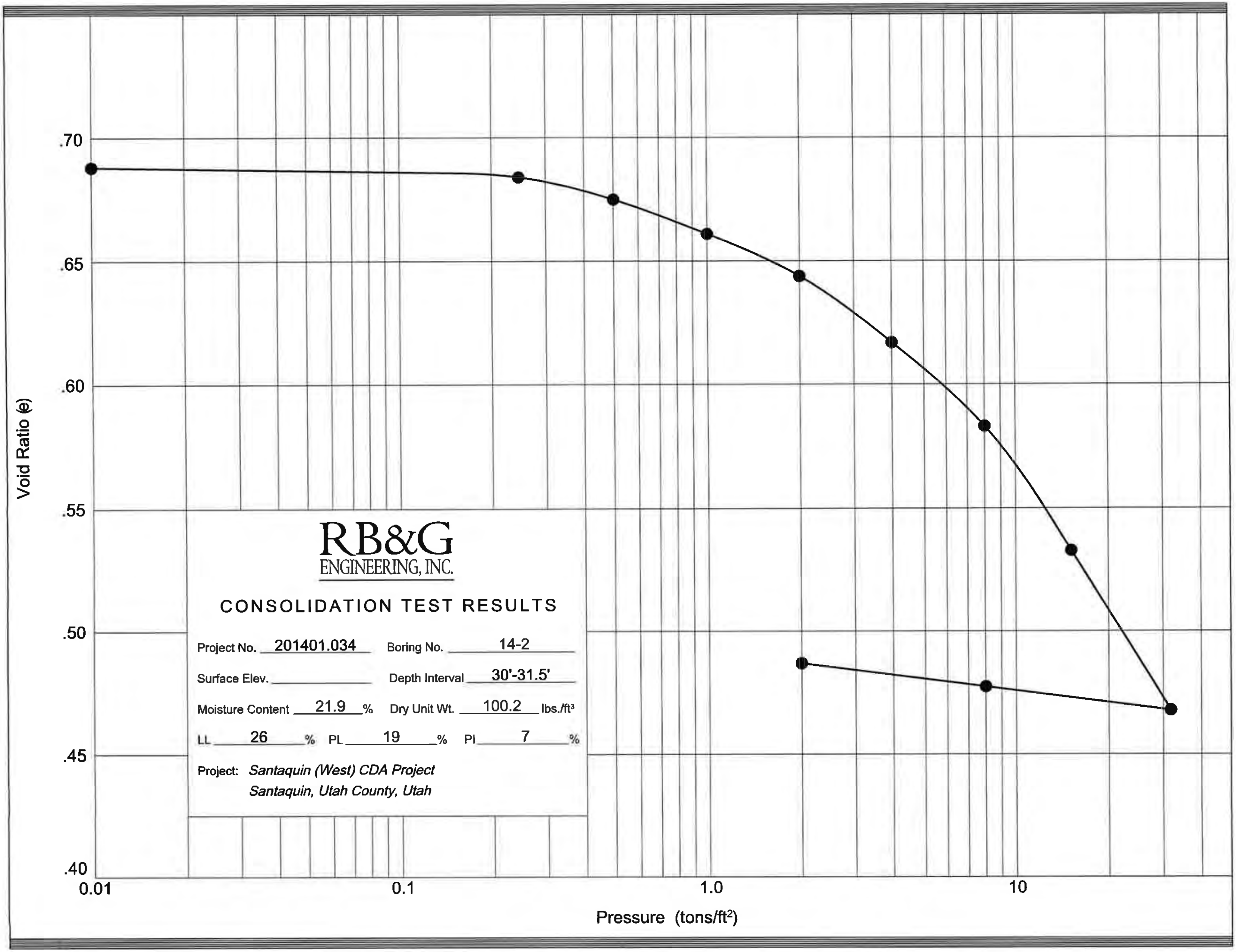
Project No. 201401.034 Boring No. 14-1

Surface Elev. ______ Depth Interval 40'-41.5'

Moisture Content 25.2 % Dry Unit Wt. 91.4 lbs./ft³

LL 48 % PL 21 % PI 27 %

Project: *Santaquin (West) CDA Project*
Santaquin, Utah County, Utah



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CONSOLIDATION TEST RESULTS

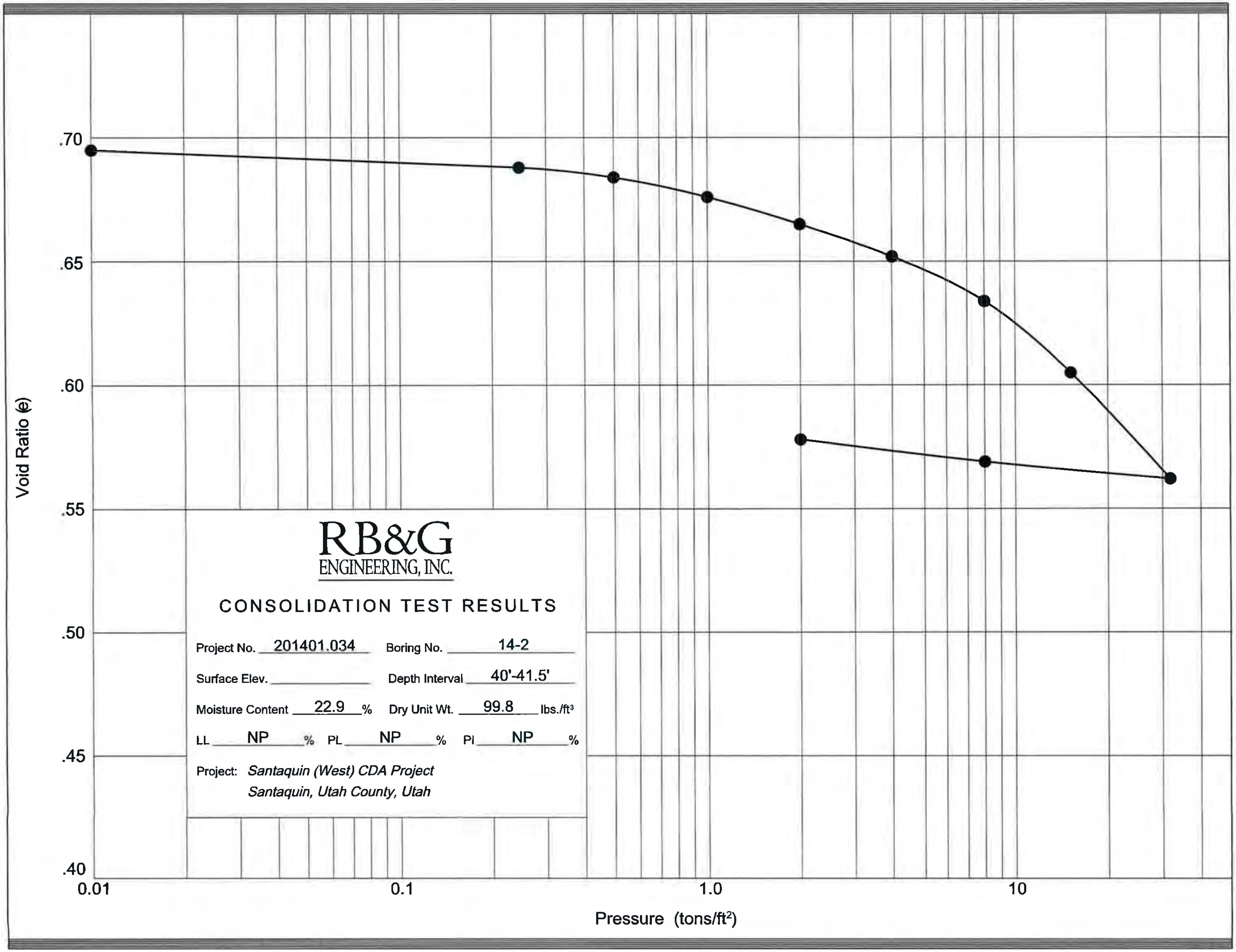
Project No. 201401.034 Boring No. 14-2

Surface Elev. Depth Interval 30'-31.5'

Moisture Content 21.9 % Dry Unit Wt. 100.2 lbs./ft³

LL 26 % PL 19 % PI 7 %

Project: *Santaquin (West) CDA Project*
Santaquin, Utah County, Utah



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CONSOLIDATION TEST RESULTS

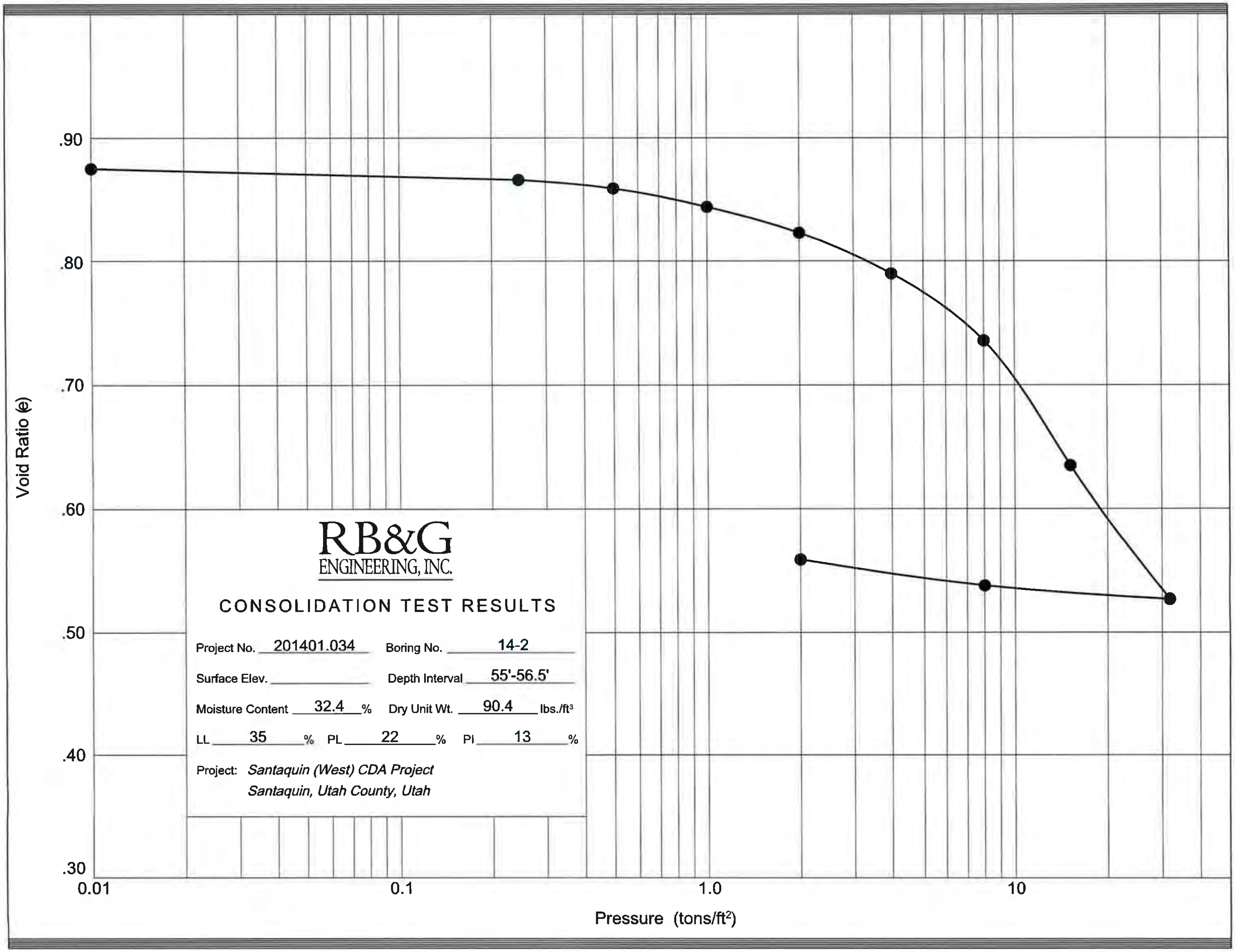
Project No. 201401.034 Boring No. 14-2

Surface Elev. ______ Depth Interval 40'-41.5'

Moisture Content 22.9 % Dry Unit Wt. 99.8 lbs./ft³

LL NP % PL NP % PI NP %

Project: *Santaquin (West) CDA Project*
Santaquin, Utah County, Utah



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CONSOLIDATION TEST RESULTS

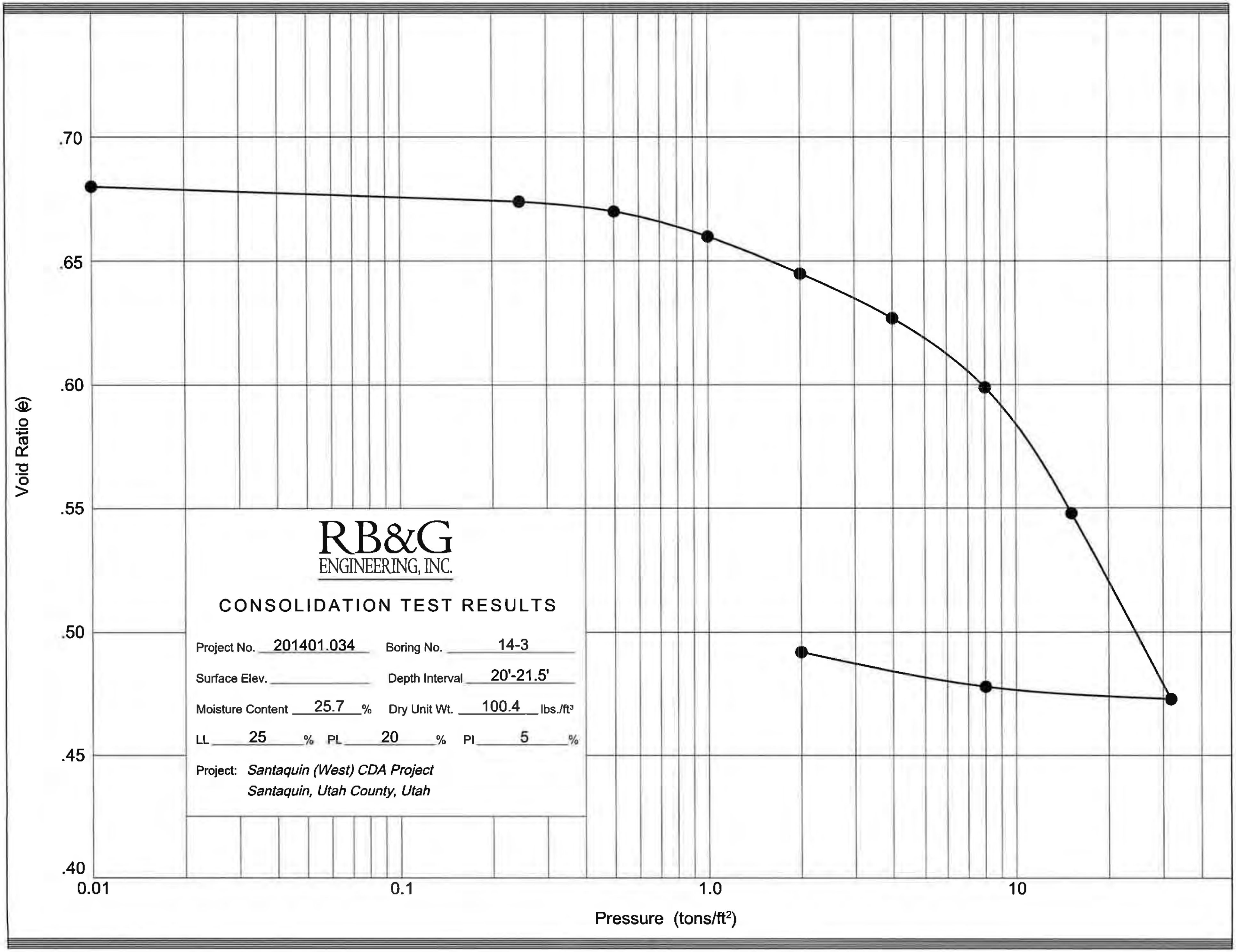
Project No. 201401.034 Boring No. 14-2

Surface Elev. ______ Depth Interval 55'-56.5'

Moisture Content 32.4 % Dry Unit Wt. 90.4 lbs./ft³

LL 35 % PL 22 % PI 13 %

Project: *Santaquin (West) CDA Project*
Santaquin, Utah County, Utah



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CONSOLIDATION TEST RESULTS

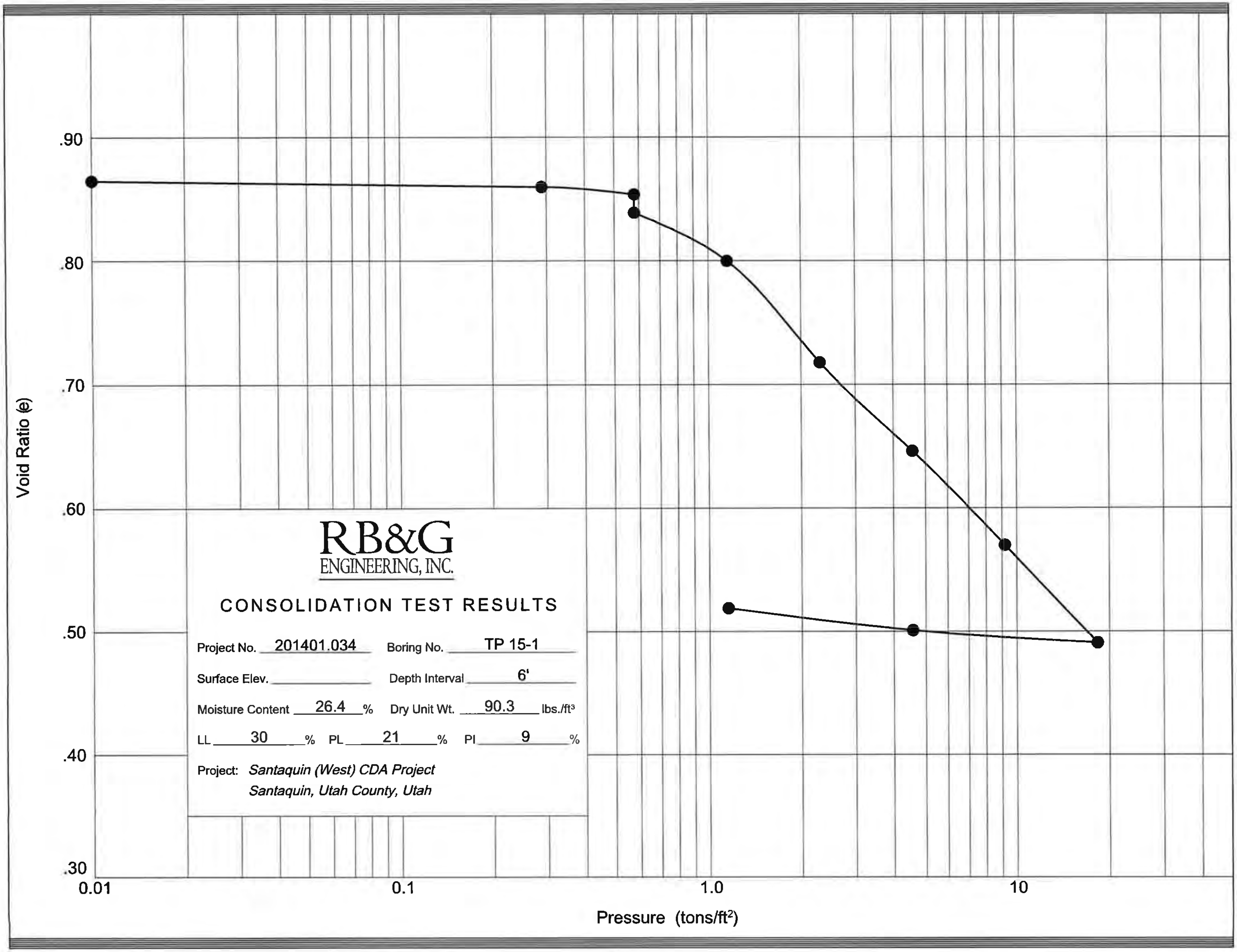
Project No. 201401.034 Boring No. 14-3

Surface Elev. ______ Depth Interval 20'-21.5'

Moisture Content 25.7 % Dry Unit Wt. 100.4 lbs./ft³

LL 25 % PL 20 % PI 5 %

Project: *Santaquin (West) CDA Project*
Santaquin, Utah County, Utah



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CONSOLIDATION TEST RESULTS

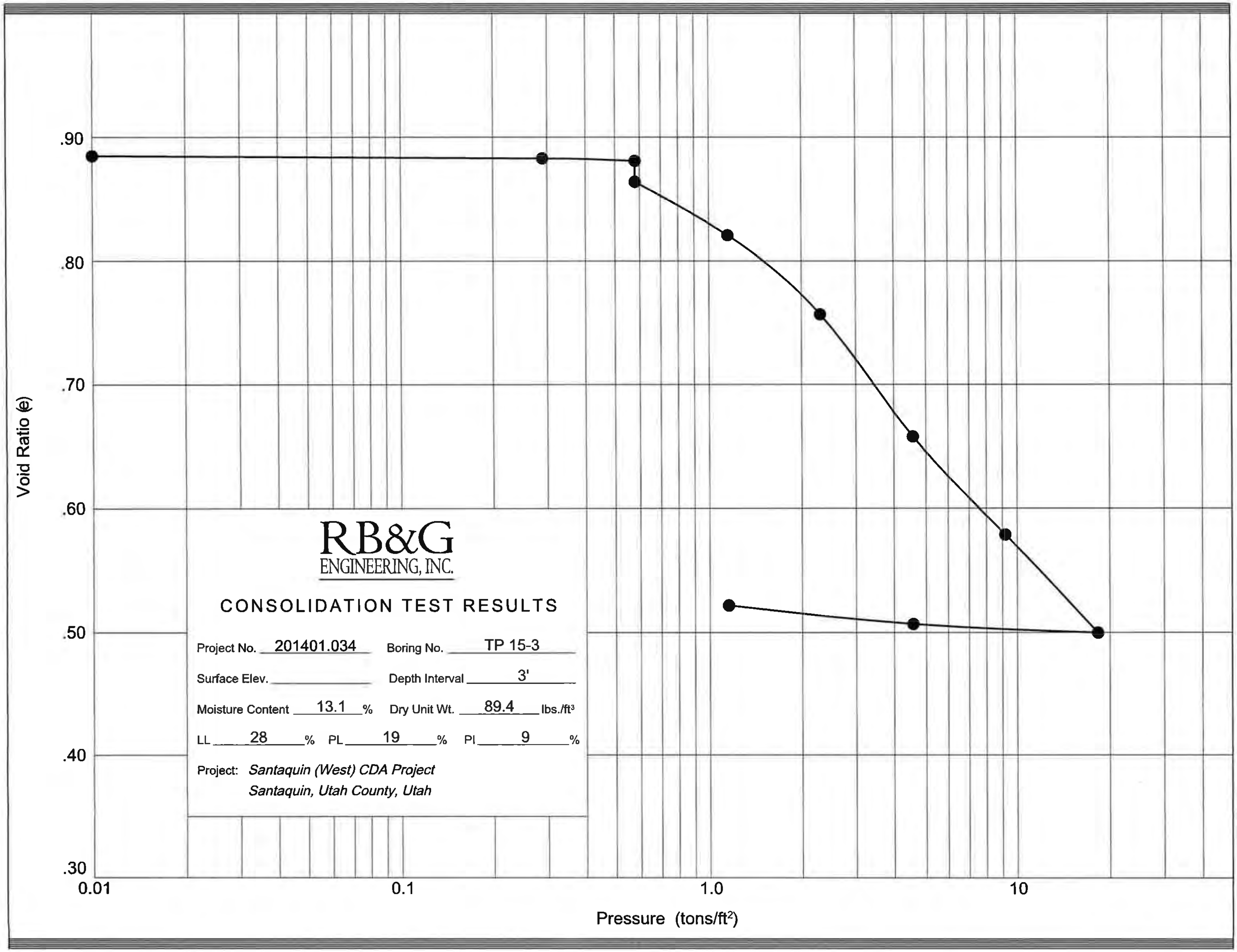
Project No. 201401.034 Boring No. TP 15-1

Surface Elev. ________ Depth Interval 6'

Moisture Content 26.4 % Dry Unit Wt. 90.3 lbs./ft³

LL 30 % PL 21 % PI 9 %

Project: *Santaquin (West) CDA Project*
Santaquin, Utah County, Utah



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CONSOLIDATION TEST RESULTS

Project No. 201401.034 Boring No. TP 15-3

Surface Elev. Depth Interval 3'

Moisture Content 13.1 % Dry Unit Wt. 89.4 lbs./ft³

LL 28 % PL 19 % PI 9 %

Project: *Santaquin (West) CDA Project*
Santaquin, Utah County, Utah

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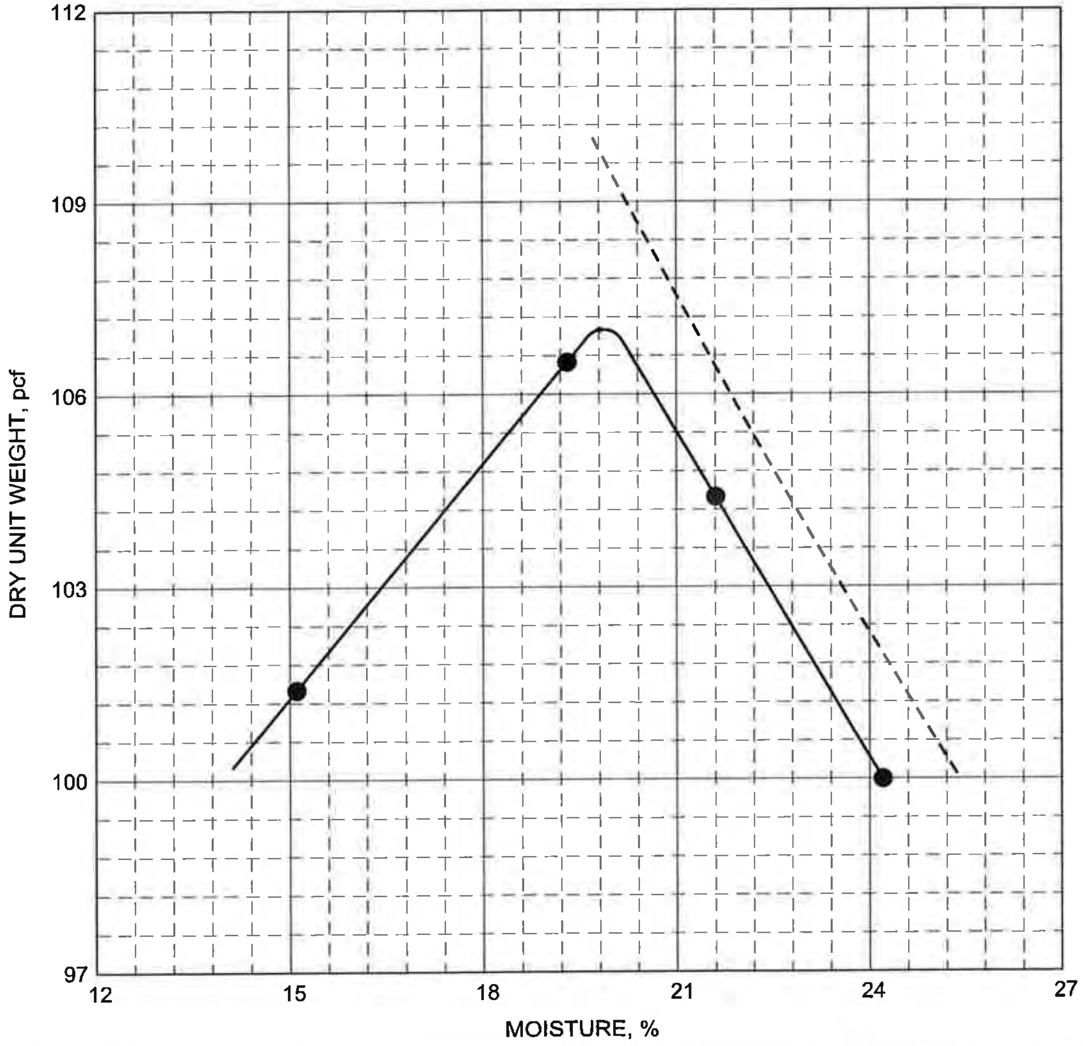
RBG No. 201401.034
Report No. NA
Sheet 1 of 1

SANTAQUIN (WEST) CDA PROJECT

Santaquin, Utah County, Utah

MOISTURE-DENSITY RELATION (PROCTOR) ASTM D698

Location	TEST PIT 15-9 AT 1'-2'	Test Date	01/19/2015
Sample ID	NA	Technician	D. MALEN, J. BOONE
Material	LEAN CLAY	Classification	CL (Test)



-- 100% Saturation Curve NA Not applicable / available	*UNCORRECTED RESULTS*		*OVERSIZE CORRECTION*	
Specific gravity type is bulk unless otherwise indicated. Results are as per the test method listed above and relate only to the items tested. Rock correction for >3/4-inch material is per ASTM D4718 or AASHTO T224.	Max. Dry Density (pcf)	107.0	Max. Dry Density (pcf)	NA
	Optimum Moisture (%)	19.8	Optimum Moisture (%)	NA
	Specific Gravity	2.70	Specific Gravity	NA
	Moisture, As-Received (%)	19	Percent Oversize (%)	0

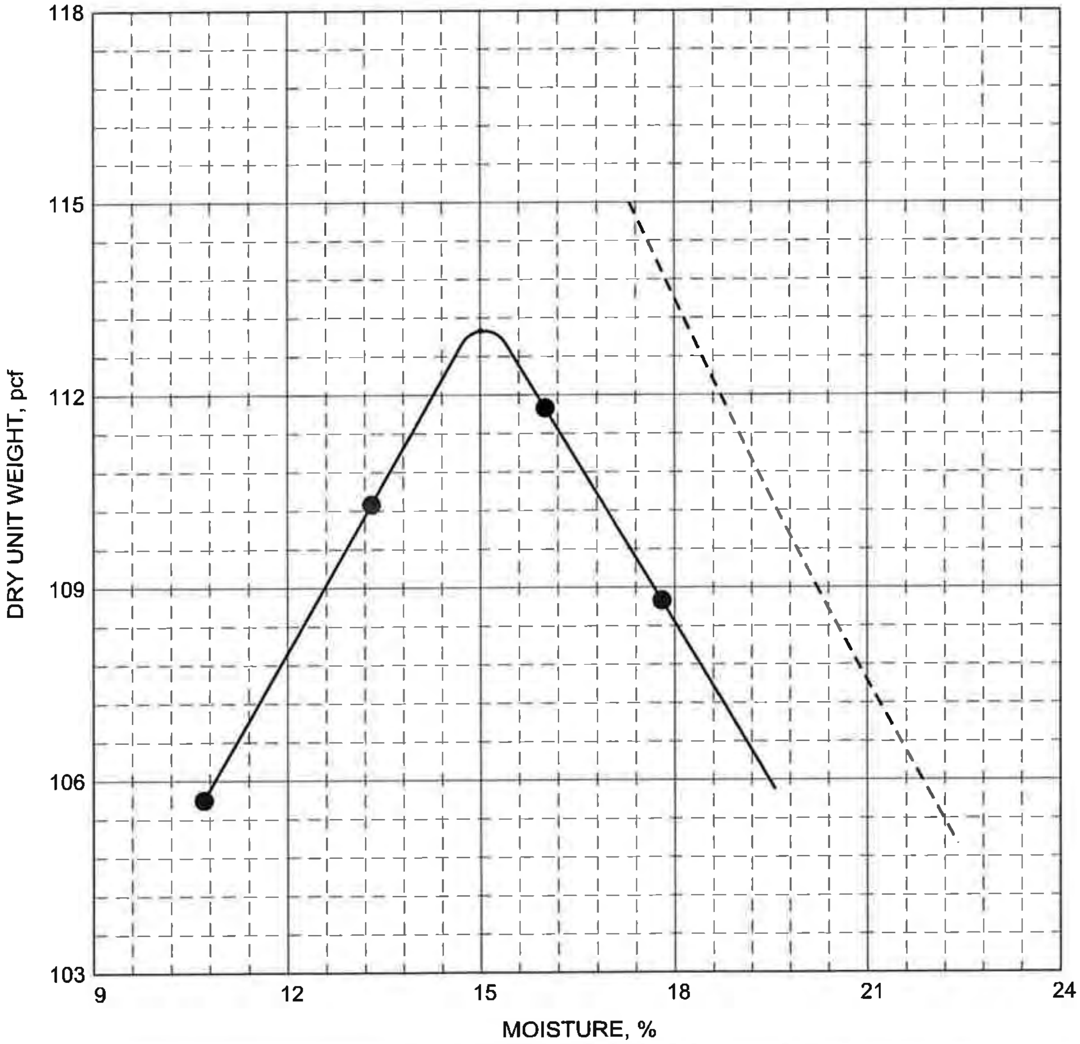
RBG No.	201401.034
Report No.	NA
Sheet	1 of 1

SANTAQUIN (WEST) CDA PROJECT

Santaquin, Utah County, Utah

MOISTURE-DENSITY RELATION (PROCTOR) ASTM D698

Location	TEST PIT 15-13 AT 1'-2'	Test Date	01/19/2015
Sample ID	NA	Technician	J. NEIL
Material	SILTY CLAY W/SAND	Classification	CL-ML (Test)



	UNCORRECTED RESULTS		OVERSIZE CORRECTION	
-- 100% Saturation Curve NA Not applicable / available	Max. Dry Density (pcf)	113.0	Max. Dry Density (pcf)	NA
Specific gravity type is bulk unless otherwise indicated. Results are as per the test method listed above and relate only to the items tested. Rock correction for >3/4-inch material is per ASTM D4718 or AASHTO T224.	Optimum Moisture (%)	15.0	Optimum Moisture (%)	NA
	Specific Gravity	2.70	Specific Gravity	NA
	Moisture, As-Received (%)	18	Percent Oversize (%)	0

RBG No.	201401.034
Report No.	NA
Sheet	1 of 1

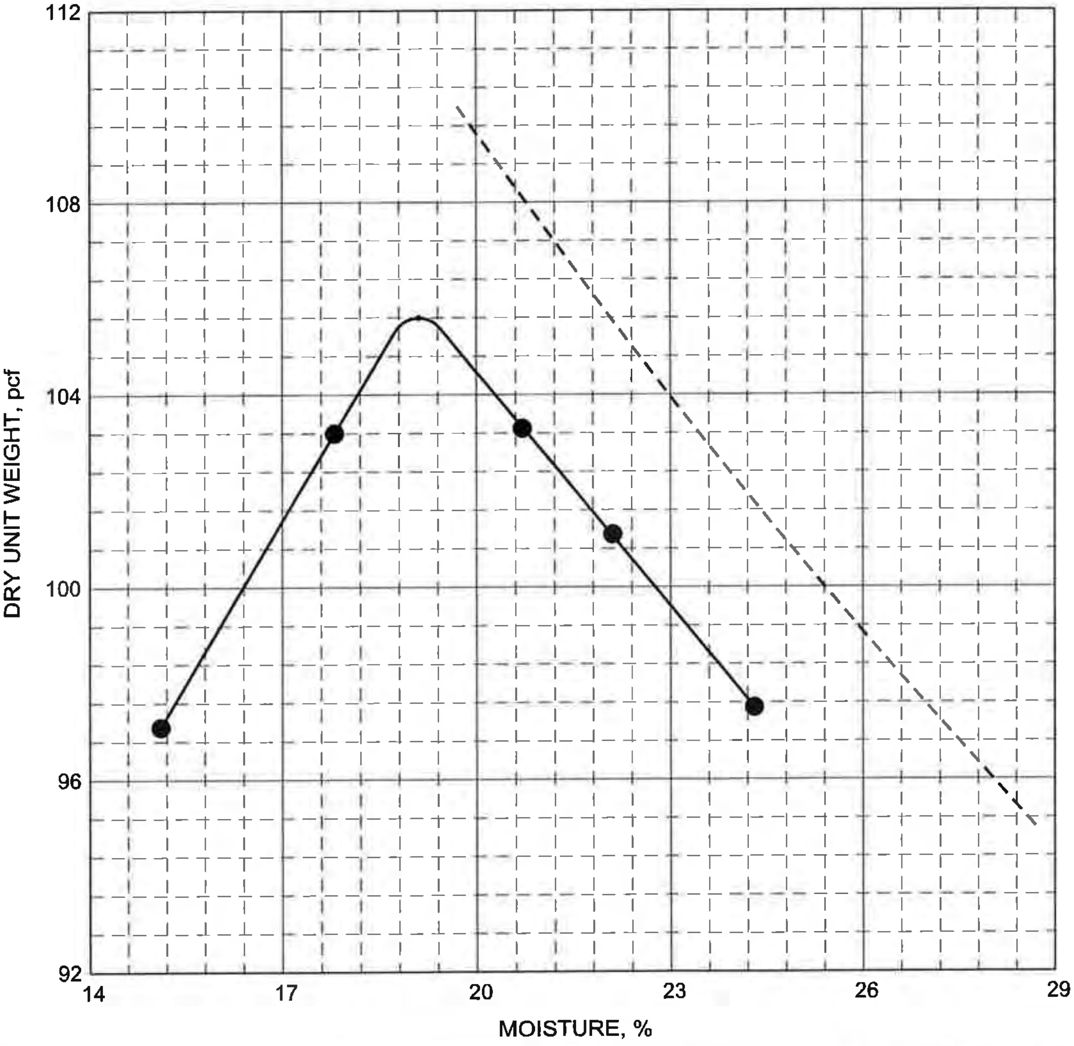
SANTAQUIN (WEST) CDA PROJECT

Santaquin, Utah County, Utah

MOISTURE-DENSITY RELATION (PROCTOR)

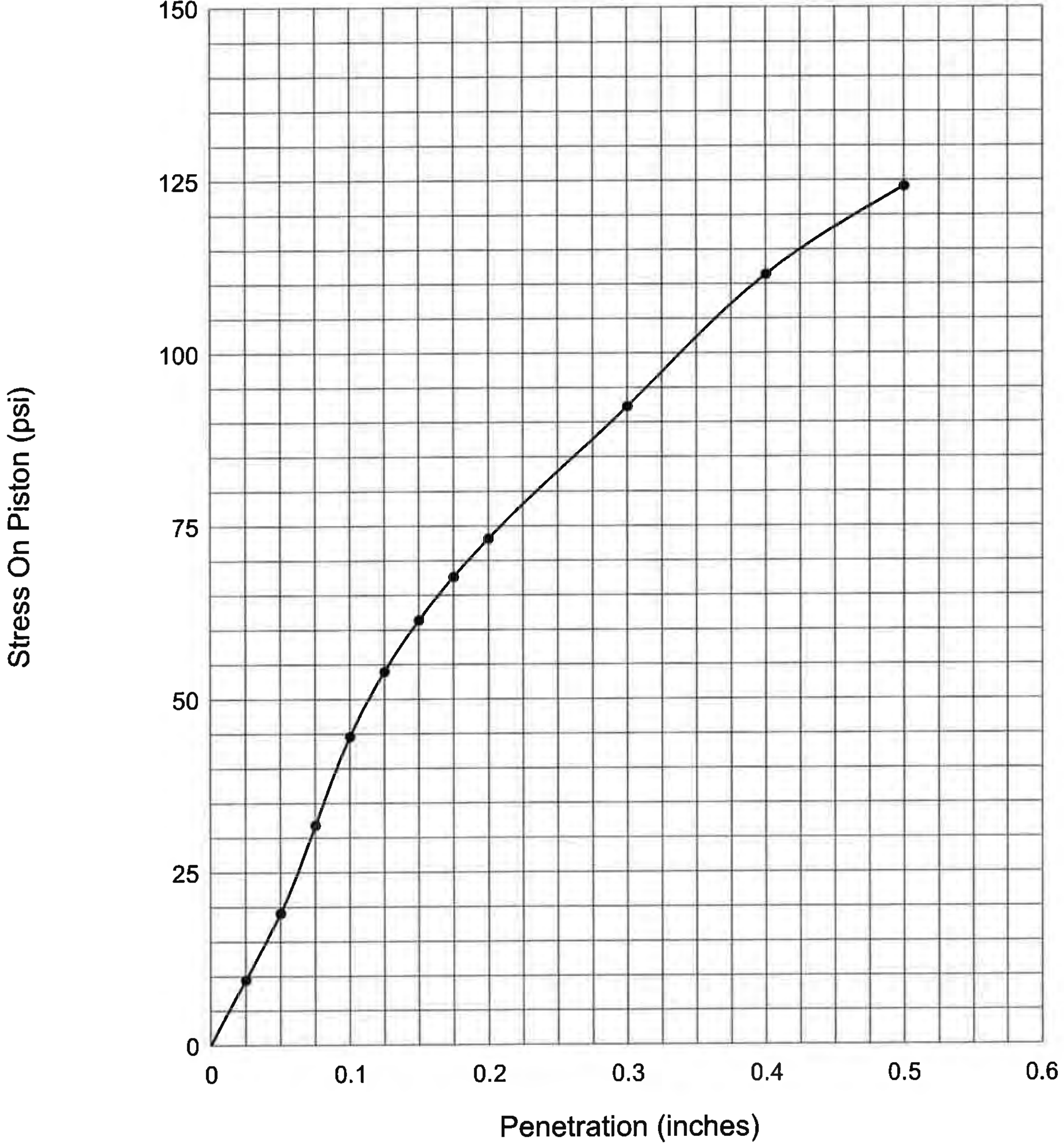
ASTM D698

Location	TEST PIT 15-19 AT 1'-2'	Test Date	01/19/2015
Sample ID	NA	Technician	D. MALEN, J. NEIL, J. BOONE
Material	LEAN CLAY W/SAND	Classification	CL (Test)



-- 100% Saturation Curve NA Not applicable / available	*UNCORRECTED RESULTS*		*OVERSIZE CORRECTION*	
	Max. Dry Density (pcf)	105.6	Max. Dry Density (pcf)	NA
Specific gravity type is bulk unless otherwise indicated. Results are as per the test method listed above and relate only to the items tested. Rock correction for >3/4-inch material is per ASTM D4718 or AASHTO T224.	Optimum Moisture (%)	19.1	Optimum Moisture (%)	NA
	Specific Gravity	2.70	Specific Gravity	NA
	Moisture, As-Received (%)	15	Percent Oversize (%)	0

Project No.: 201401.034



Location TEST PIT 15-9 AT 1'-2'

Material LEAN CLAY, CL

Dry unit weight before soak 107.5 pcf

Moisture content of top 1" after soak 21.4 %

Test method: ASTM ☒ D698 ☐ D1557

Maximum density 107.0 pcf

Condition ☐ unsoaked ☒ soaked

Surcharge amount 10 lbs

Swell 0.3 %

Bearing ratio at 0.1 4.5 %

Bearing ratio at 0.2 4.9 %

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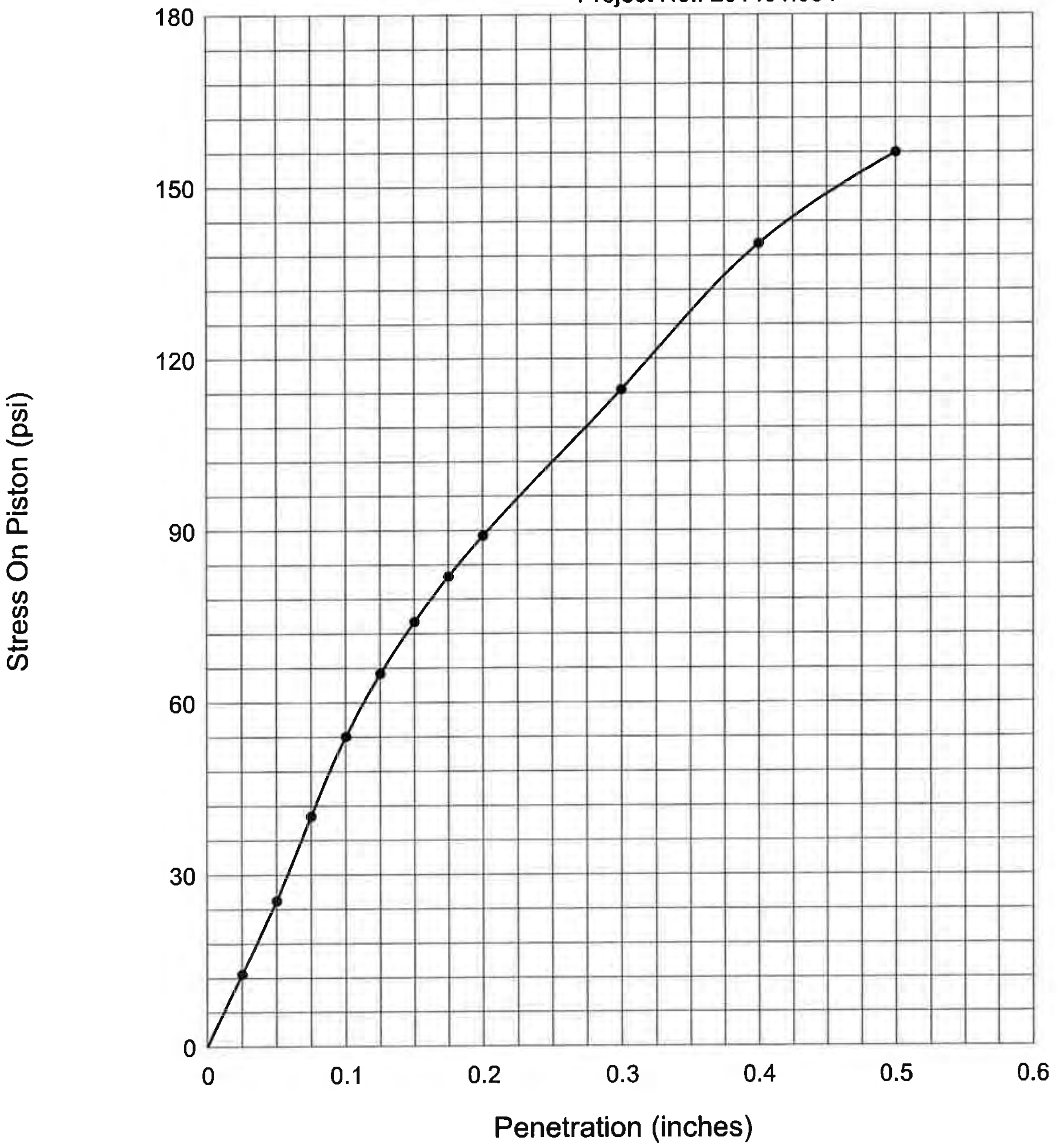
Figure CALIFORNIA BEARING RATIO TEST RESULTS

Santaquin (West) CDA Project
Santaquin, Utah County, Utah

Project No.: 201401.034



Location TEST PIT 15-13 AT 1'-2'
Material SILTY CLAY W/SAND, CL-ML

Dry unit weight before soak 113.7 pcf
Moisture content of top 1" after soak 17.0 %

Test method: ASTM ☒ D698 ☐ D1557
Maximum density 113.0 pcf

Condition ☐ unsoaked ☒ soaked
Surcharge amount 10 lbs
Swell 0.1 %
Bearing ratio at 0.1 5.4 %
Bearing ratio at 0.2 5.9 %

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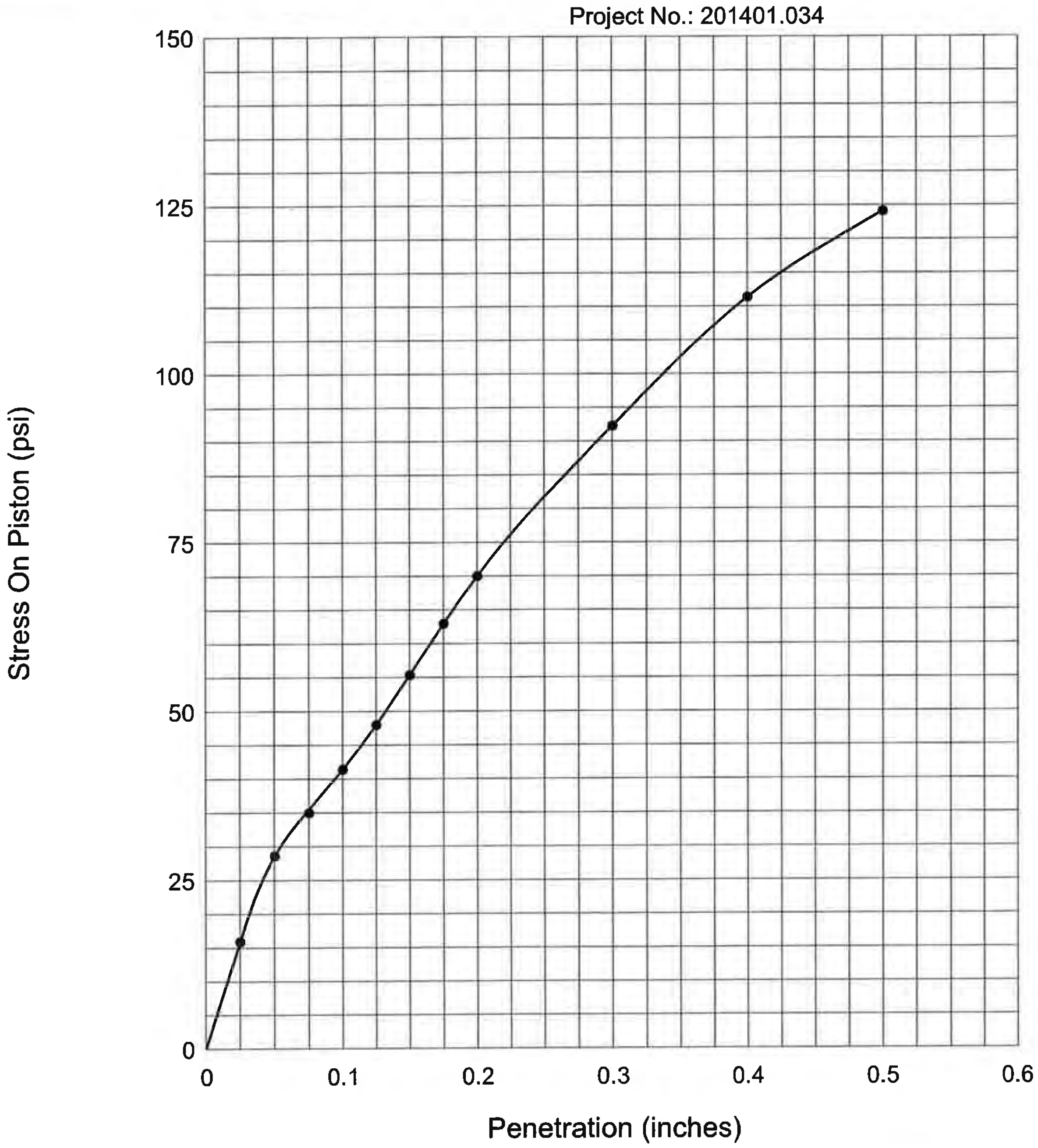
Figure CALIFORNIA BEARING RATIO TEST RESULTS

Santaquin (West) CDA Project
Santaquin, Utah County, Utah



Location TEST PIT 15-19 AT 1'-2'

Material LEAN CLAY W/SAND, CL

Dry unit weight before soak 106.2 pcf

Moisture content of top 1" after soak 20.8 %

Test method: ASTM ☒ D698 ☐ D1557

Maximum density 105.6 pcf

Condition ☐ unsoaked ☒ soaked

Surcharge amount 10 lbs

Swell 0.3 %

Bearing ratio at 0.1 4.1 %

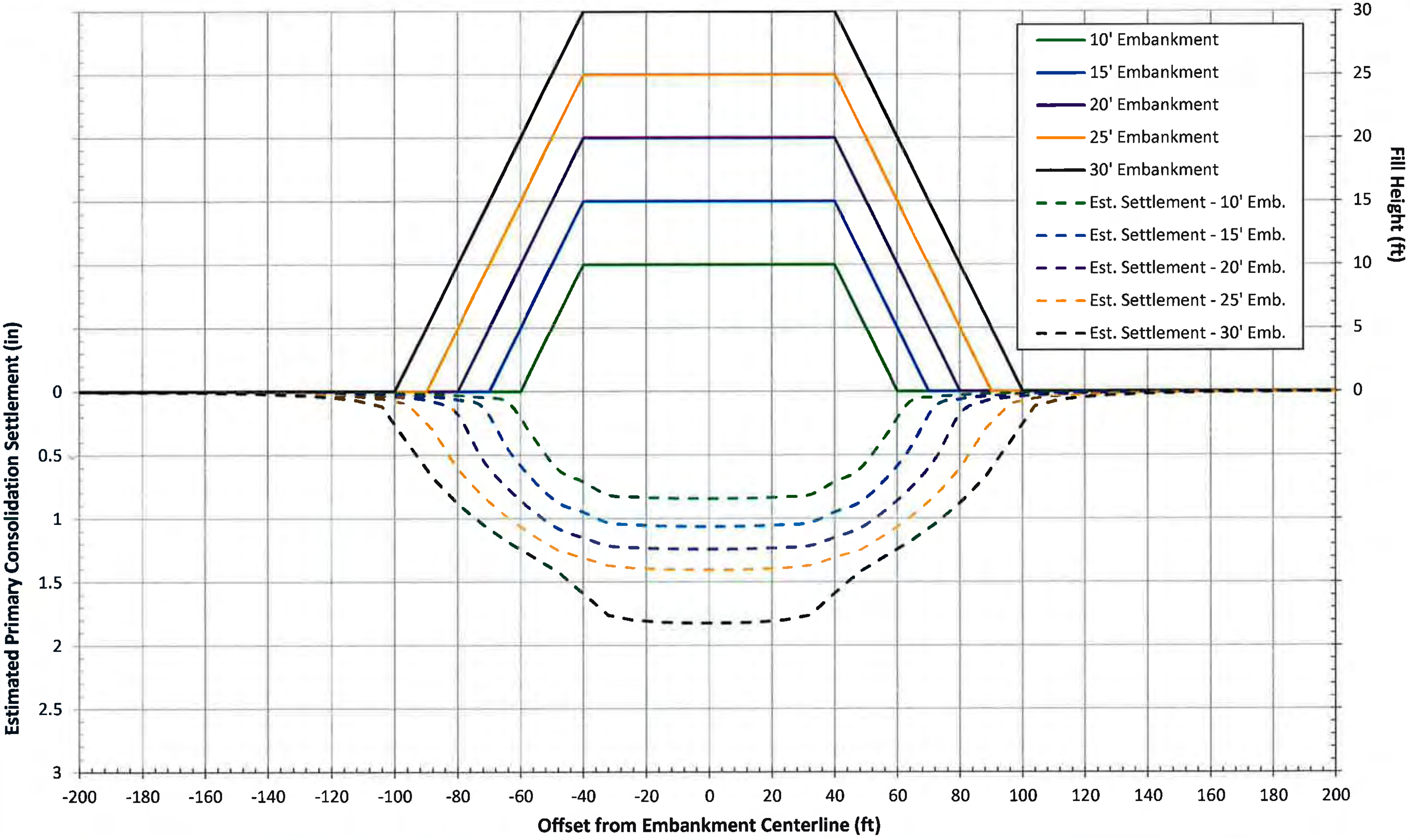
Bearing ratio at 0.2 4.7 %

RB&G ENGINEERING, INC.

Figure CALIFORNIA BEARING RATIO TEST RESULTS

Santaquin (West) CDA Project
Santaquin, Utah County, Utah

Settlement Analyses

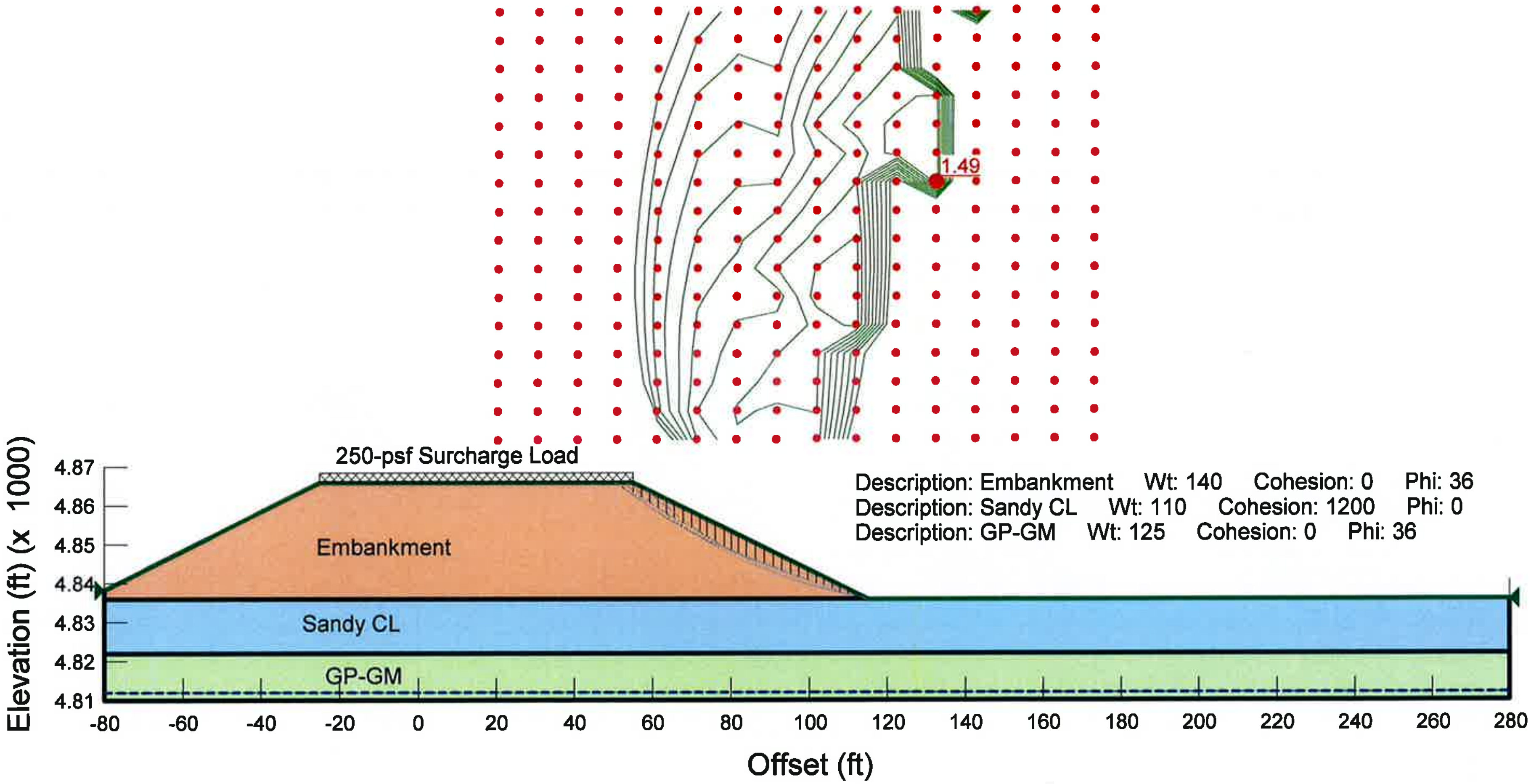


RB&G
ENGINEERING, INC.

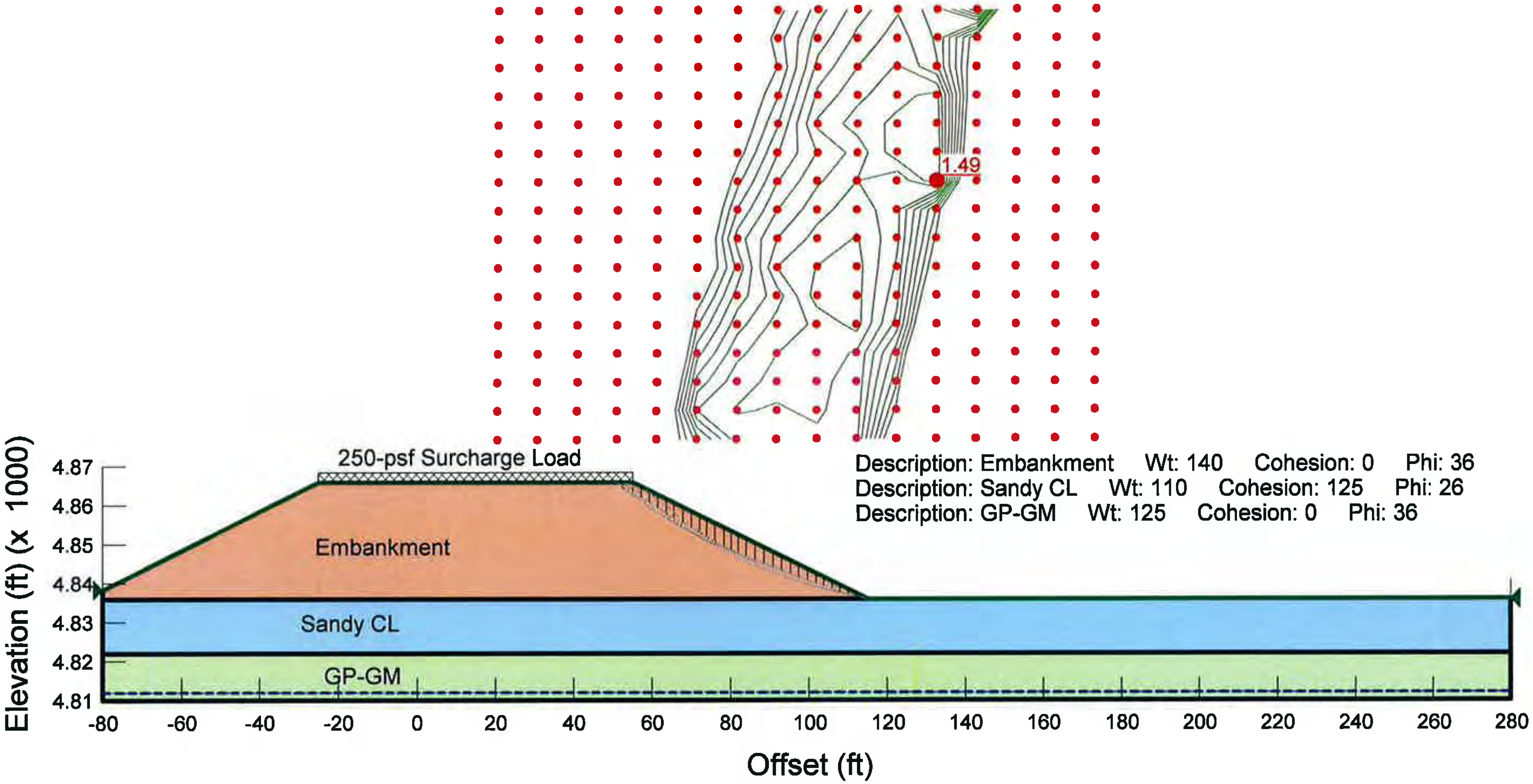
Santaquin (West) CDA Project
Estimated Primary Consolidation Settlement Profile Beneath Roadway Embankment

Stability Analyses

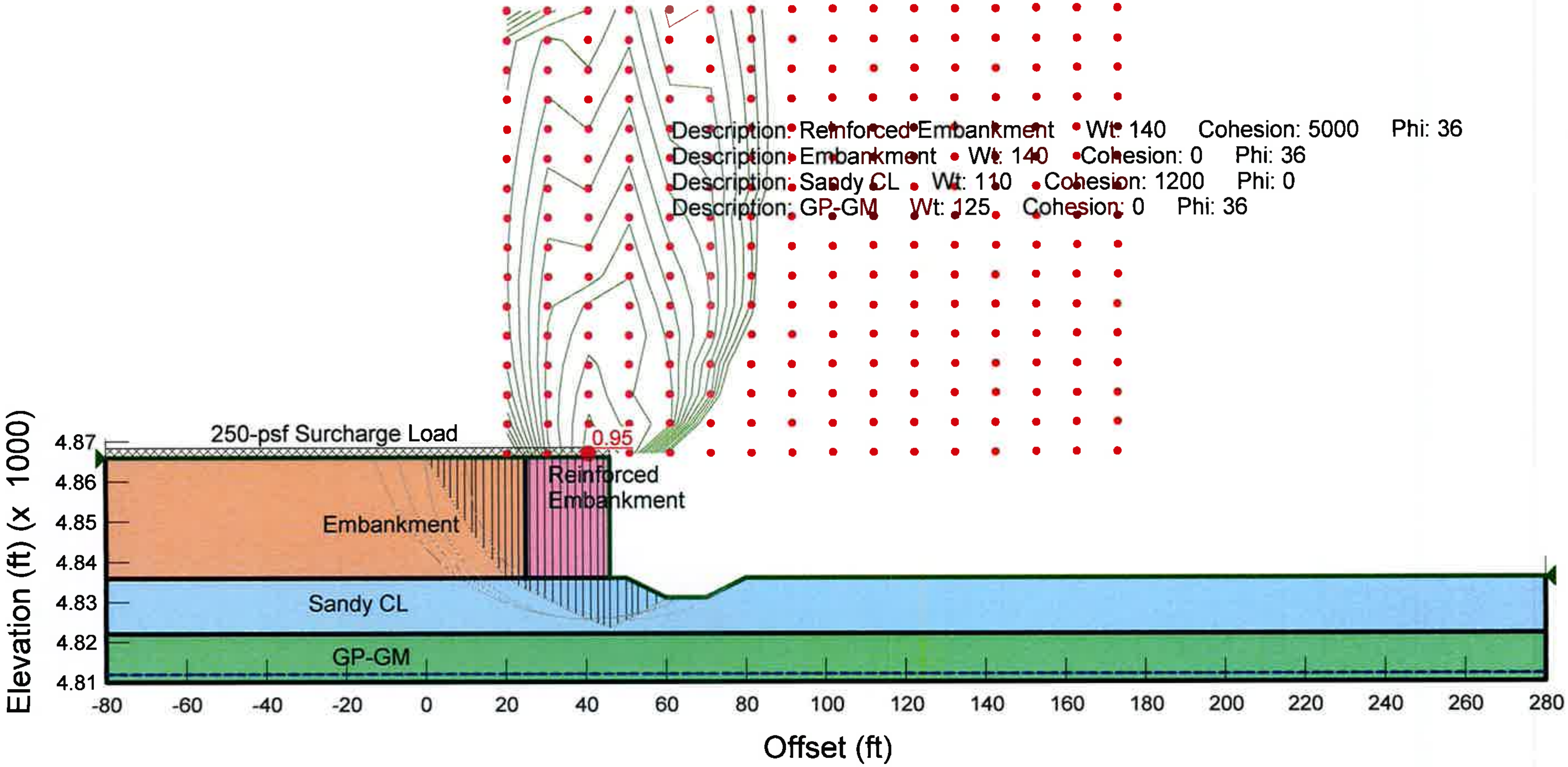
Santaquin (West) CDA Project
30-ft Embankment Stability
Static -End of Construction Condition



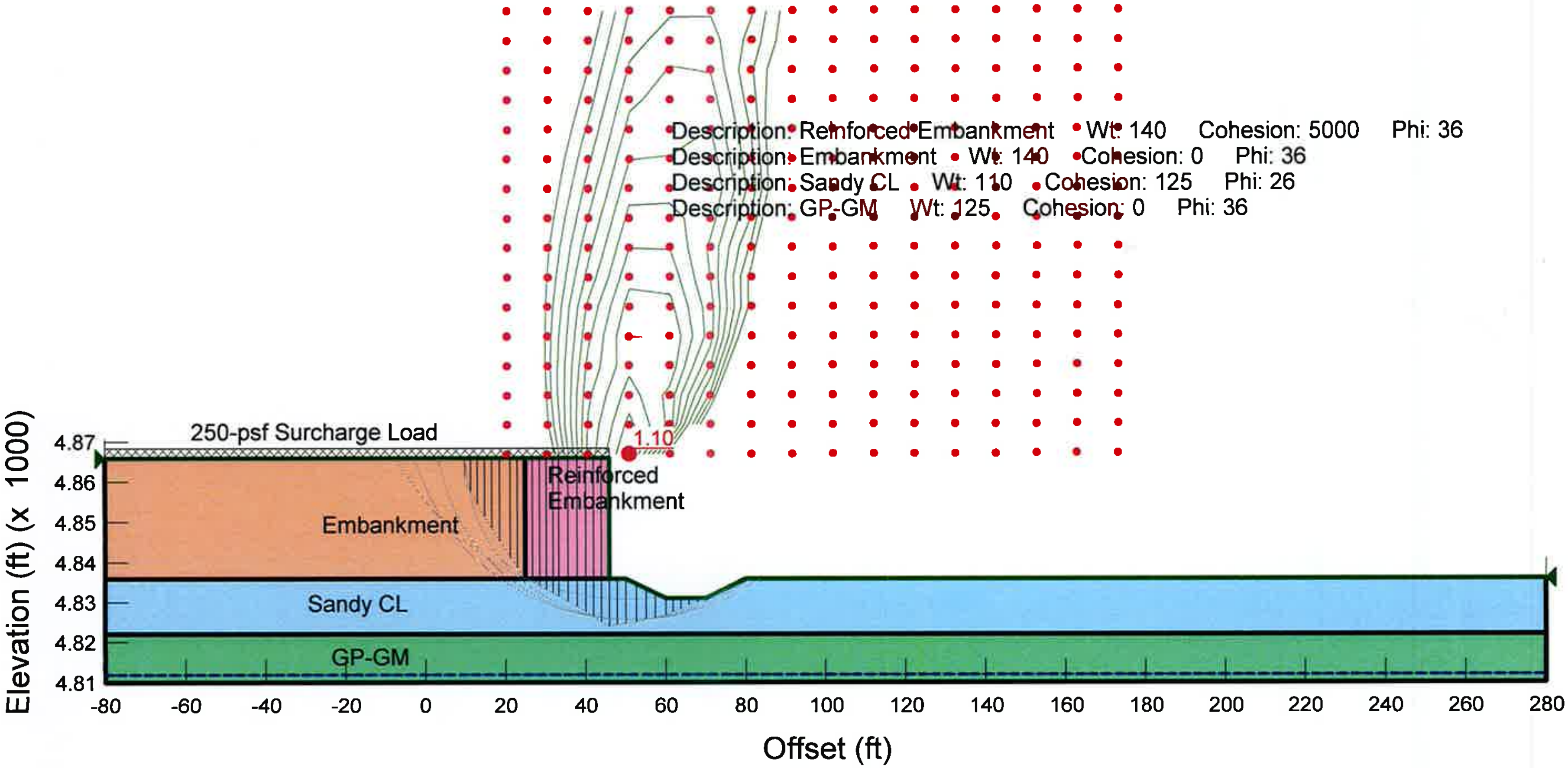
Santaquin (West) CDA Project
30-ft Embankment Stability
Static - Long Term Condition



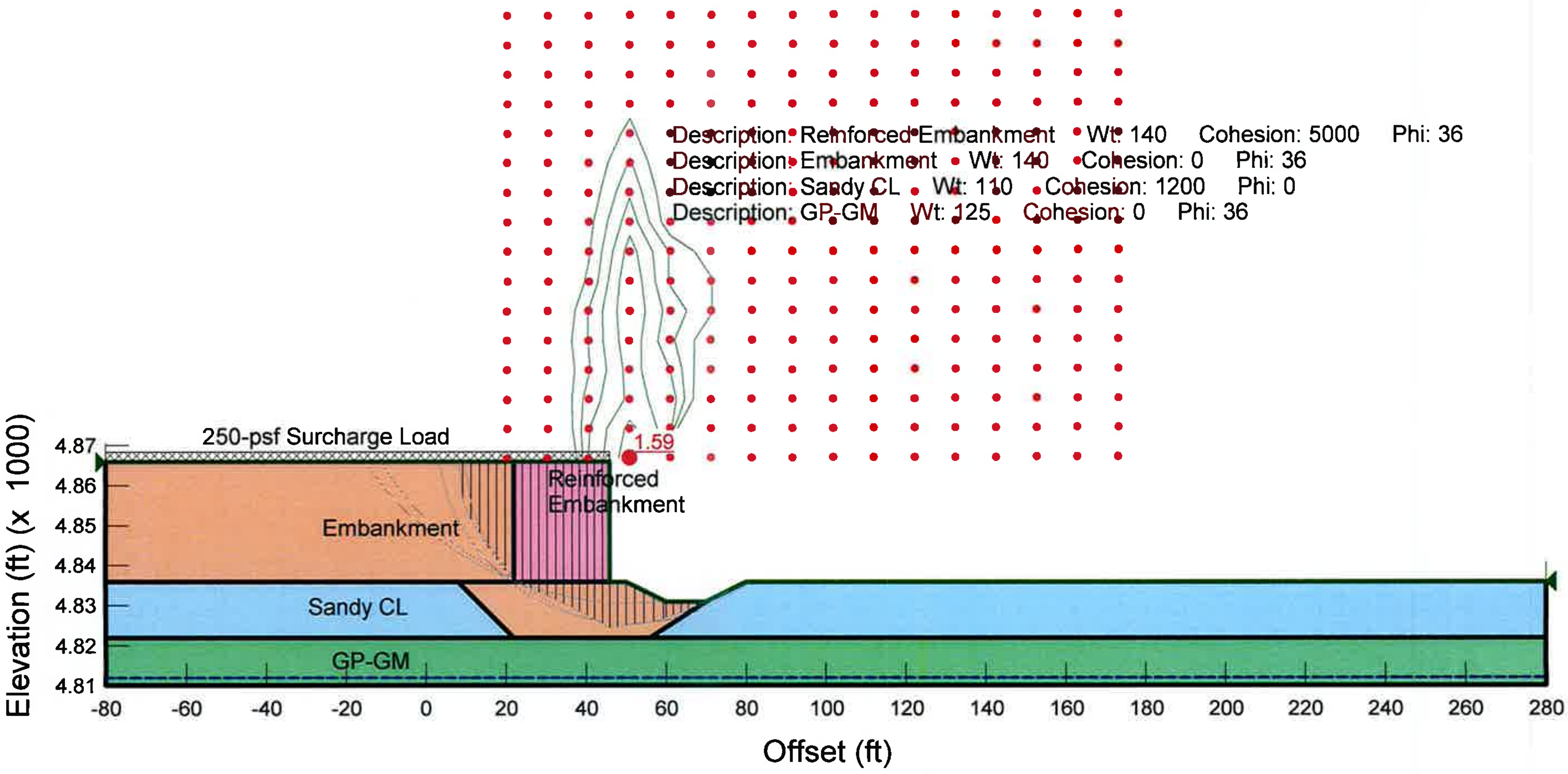
Santaquin (West) CDA Project
30-ft Abutment Stability
21-ft Reinforced Zone Length
Static -End of Construction Condition



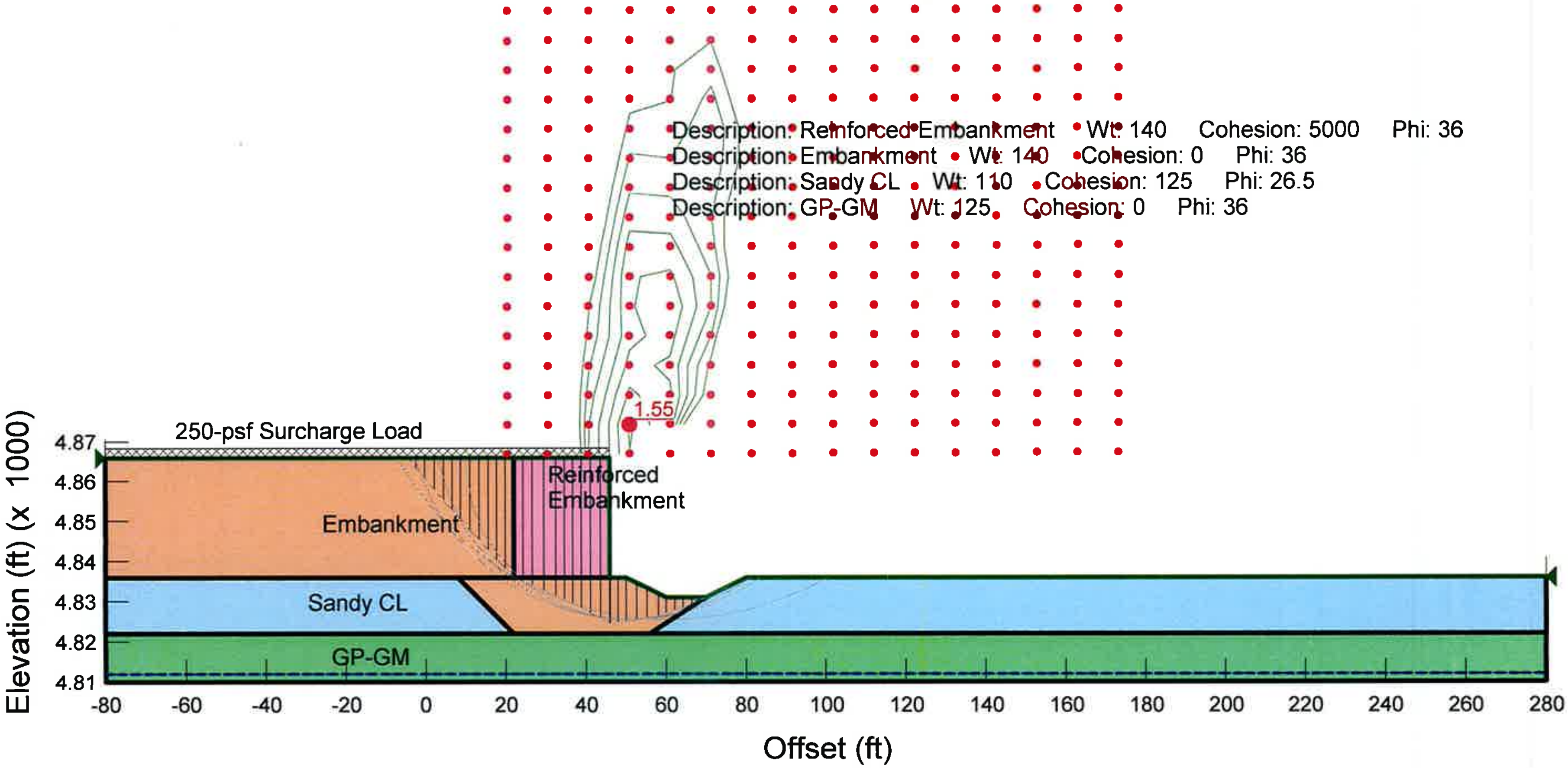
Santaquin (West) CDA Project
30-ft Abutment Stability
21-ft Reinforced Zone Length
Static - Long Term Condition



Santaquin (West) CDA Project
30-ft Abutment Stability
24-ft Reinforced Zone Length
Clayey Soils Removed and Replaced
Beneath Reinforced Zone
End of Construction Condition



Santaquin (West) CDA Project
30-ft Abutment Stability
24-ft Reinforced Zone Length
Clayey Soils Removed and Replaced
Beneath Reinforced Zone



Pavement Calculations

BY: JSP

2/17/2015

ESAL Calculations

West Santaquin CDA Project
Santaquin, Utah

	Assumed	3,500
Vehicle Type (Axle Class)	**% of Traffic**	**2015 AADT By Class**
1-2	47	1645
3	47.5	1663
4	1	35
5-7	4	140
8-10	0.25	9
11-13	0.25	9
total	*100*	

Assumed

Distribution assumed by RB&G Engineering

State Route	Santaquin CDA		
Beg. M.P.		**End M.P.**	
Project Scope	West Santaquin CDA Project	**Region**	3
Pavement Type	Flexible		
Construction	2015	**Functional Class**	16
Design Period (years)	20	**Growth Rate (%)**	7.00

Vehicle Type (Axle Class)	**2015 AADT**	**Growth Factors**	**Design Traffic**	**ESAL Factor**	**MidPoint Adjust Factor**	**MidPoint Truck Factor**	**Directional Factor**	**Lane Factor**	**Design ESALs**
	(A)	**(B)**	**(C)**	**(D)**		**(D')**			**(E)**
1-2	1,645	41.00	24,614,718	0.0002	0	0.0002	0.5	1.0	2,461.5
3	1,663	41.00	24,884,059	0.03	0	0.03	0.5	1.0	373,260.9
4	35	41.00	523,717	0.88	0	0.88	0.5	1.0	230,435.7
5-7	140	41.00	2,094,870	0.1912	0.1	0.2912	0.5	1.0	305,013.0
8-10	9	41.00	134,670	2.6028	0.3	2.9028	0.5	1.0	195,460.3
11-13	9	41.00	134,670	3.3584	0.3	3.6584	0.5	1.0	246,338.7
									1,352,970

Patterned after Table 3B-2 UDOT Pavement Design Manual

1993 AASHTO Pavement Design

DARWin Pavement Design and Analysis System

A Proprietary AASHTOWare
Computer Software Product

Engineer

Flexible Structural Design Module

West Santaquin CDA Project
Subgrade CBR 4.5, ESALS

Flexible Structural Design

18-kip ESALs Over Initial Performance Period	1,350,000
Initial Serviceability	4.2
Terminal Serviceability	2.25
Reliability Level	90 %
Overall Standard Deviation	0.45
Roadbed Soil Resilient Modulus	6,750 psi
Stage Construction	1
Calculated Design Structural Number	3.69 in

Specified Layer Design

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Thickness (Di)(in)	Width (ft)	Calculated SN (in)
1	HMA	0.44	1	5	-	2.20
2	UTBC	0.14	1	6	-	0.84
3	GB	0.12	0.8	10	-	0.96
Total	-	-	-	21.00	-	4.00

Layered Thickness Design

Thickness precision	Actual

Layer	Material Description	Struct Coef. (Ai)	Drain Coef. (Mi)	Spec Thickness (Di)(in)	Min Thickness (Di)(in)	Elastic Modulus (psi)	Width (ft)	Calculated Thickness (in)	Calculated SN (in)
1	HMA	0.44	1	-	1	365,000	12	5.03	2.21
2	UTBC	0.14	1	-	-	27,000	12	3.89	0.54
3	GB	0.12	0.8	-	-	15,000	12	9.72	0.93
Total	-	-	-	-	-	-	-	18.64	3.69