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Geotechnical Investigation
Proposed Residential Subdivision
200 East 1250 North
Nephi, Utah
IGES Project No. 03992-002

June 24, 2022

Prepared for
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APPENDICES

1.0 EXECUTIVE SUMMARY

This report presents the results of a geotechnical investigation conducted for the Proposed Residential Subdivision located in Nephi, Utah at 200 East 1250 North. Based on the subsurface conditions encountered there is a high potential for collapse in the native soils encountered. The subject site is considered suitable for the proposed construction, but we recommend mitigation measures be used to reduce the potential for adverse settlement due to the collapsible soils. Recommendations for mitigation along with other design and construction recommendations are provided in this report. A brief summary of the critical recommendations and findings are included below:

- Based on our observations the site is overlain with 6 to 18 inches of topsoil comprised of SILT (ML) and Silty CLAY (CL-ML). The underlying fine-grained native soils classifies as SILT (ML) and Silty CLAY (CL-ML) with varying amounts of sand and gravel. Native granular soils at the site include Silty GRAVEL (GM) and Clayey GRAVEL (GC). Various soil types were observed in the exploratory test pits, for more details on the site stratigraphy see the test pit logs in Appendix A.
- Collapse test results show a 7.6% to 15.2% collapse potential of the native soil with pinholes being observed to 10 feet below existing grade in most test pits. The extent of the collapse was not able to be explored with test pits alone; therefore, we recommend borings to 30 feet or deeper be considered to establish a minimum depth for deep foundations.
- The client should closely follow the moisture protection and surface drainage recommendations contained in Section 6.9 of this report to minimize the potential for water to infiltrate underlying soils, due to the presence of soils having a very high potential for collapse. We also recommend that IGES be on site at key points during construction to see that the recommendations in this report are implemented.
- No groundwater was encountered during our investigation.
- Shallow spread or continuous wall footings may be constructed on granular soils (GC and GM soils) having a minimum thickness of 4 feet and may be proportioned utilizing a maximum net allowable bearing pressure of **2,000 psf** for dead load plus live load conditions. However, due to the presence of highly collapsible soils over a large portion of the site, we recommend deep foundations such as helical piers, push piers or micro piles be used to carry foundation loads to suitable granular soils at depth if a minimum of 4 feet cannot be observed in the home excavation. We anticipate this will impact close to half of the lots in the subdivision (southwest portion).
- Concrete slabs-on-grade should be constructed over a minimum of 4 inches of compacted gravel over a zone of structural fill having a minimum thickness of 24 inches that is comprised of reworked native subgrade soils (Section 6.2.5). The slab may be designed with a Modulus of Subgrade Reaction of **175 psi/inch**.

- Flexible pavement section of 3.5/8 (inches of asphalt/road base) is recommended over a zone of structural fill having a minimum thickness of 24 inches that is comprised of reworked native subgrade soils.

NOTICE: The executive summary is not intended to replace the information presented in the report, of which the executive summary is an essential part. The executive summary should not be used separately from the report and is only provided as an overview, to summarize the primary conclusions and recommendations. The executive summary may omit a number of details, any one of which could be crucial to the proper interpretation and application of the report and implementation of the recommendations.

2.0 INTRODUCTION

2.1 PURPOSE AND SCOPE OF WORK

This report presents the results of a geotechnical investigation completed for the Proposed Residential Development located in Nephi, Utah at 200 East 1250 North. The purposes of this investigation were to assess the nature and engineering properties of the subsurface soils, provide recommendations for design and construction of foundations, pavement, and slabs-on-grade, as well as assess settlement, lateral earth pressures and identify any geotechnical issues such as fill, collapsible soils and groundwater.

The scope of work completed for this study included a site reconnaissance, subsurface exploration, soil sampling, laboratory testing, engineering analyses, and preparation of this report. Our services were performed in accordance with our proposal and signed authorization.

The recommendations presented in this report are subject to the limitations presented in the **Limitations** section of this report (Section 7.1).

2.2 PROJECT DESCRIPTION

The subject property is located at 200 East 1250 North in Nephi, Utah (see Figure A-1, *Site Vicinity Map*). Our understanding of the project is based on information provided by the client. The property has a total area of approximately 15.5 acres. The proposed project area is planned to be divided into 42 Lots. Additionally, approximately 1,500 feet of road is planned to be constructed. A detention basin was not marked on the plans provided to us at the time of this report, but IGES understands that stormwater will be infiltrated near the northwest corner of the subject property. The proposed structures are anticipated to be 1- to 2-story single-family homes that will be wood-framed constructed with a basement. IGES understands that the homes will be relatively lightly loaded and that cut fill sections will be limited to 3 feet or less.

3.0 METHODS OF STUDY

3.1 FIELD INVESTIGATION

As a part of this investigation, subsurface soil conditions were explored by completing seven exploratory test pits to a depth of approximately 10 feet below the existing site grade using a client-provided excavator. The approximate locations of the explorations are shown on Figure A-2 (*Geotechnical Map*) in Appendix A. Exploration points were placed to provide representative coverage of the site. Photos of some of the test pits and site conditions are presented in Figure A-3 (*Site Photos*). Logs of the subsurface conditions as encountered in the explorations were recorded at the time of excavation by a member of our technical staff and are presented as Figures A-4 through A-10 in Appendix A. A *Key to Soil Symbols and Terminology* used on the test pit logs is included as Figure A-11.

The test pits were completed using a Case CX75 CSR mini-excavator. Soil sampling was completed to collect representative samples of the various layers observed at the site. Disturbed samples were placed in plastic bags. Relatively undisturbed soil samples were collected with the use of a 6-inch-long brass tube attached to a hand sampler driven with a 2-lb sledgehammer. All samples were transported to our laboratory to evaluate the engineering properties of the various earth materials observed. The soils were classified in accordance with the *Unified Soil Classification System* (USCS) by our field personnel. Classifications for the individual soil units are shown on the attached test pit logs (Figures A-4 through A-10).

3.2 LABORATORY INVESTIGATION

Geotechnical laboratory tests were conducted on selected relatively undisturbed and bulk soil samples obtained during our field investigation. The laboratory testing program was designed to evaluate the engineering characteristics of onsite earth materials. Laboratory tests conducted during this investigation include:

- Water Content and Dry Density (ASTM D7263)
- Atterberg Limits (ASTM D4318)
- Particle-Size Distribution (ASTM D6913)
- Percent Fines (ASTM D1140)
- Standard Proctor (ASTM D698)
- California Bearing Ratio (ASTM D1883)
- Collapse/Swell Potential (ASTM D4546)
- Soluble Sulfates (ASTM C1580), Soluble Chloride (ASTM D4237), pH (ASHTO T288), Minimum Resistivity (ASHTO T289)

The results of the laboratory tests are presented on the test pit logs in Appendix A (Figures A-4 through A-10) and the laboratory test results presented in Appendix B.

3.3 ENGINEERING ANALYSIS

Engineering analyses were performed using soil data obtained from the laboratory test results and empirical correlations from material density, depositional characteristics and classifications. Analyses were performed using formulas, calculations and software that represent methods currently accepted by the geotechnical industry. These methods include settlement, bearing capacity, pavement design, lateral earth pressures, and trench stability. Appropriate factors of safety were applied to the results consistent with industry standards and the accepted standard of care.

4.0 GENERALIZED SITE CONDITIONS

4.1 SURFACE CONDITIONS

The subject site is located at an elevation of approximately 5,060 feet above mean sea level. The site slopes down to the west. At the time of our subsurface investigation the site was vacant and undeveloped. The surface of the project area is mainly covered by grass and other low growing vegetation.

4.2 SUBSURFACE CONDITIONS

4.2.1 Earth Materials

Based on our observations the site has a 6- to 18-inch-thick layer of topsoil that visually classifies as SILT (ML) and Silty CLAY (CL-ML). Below the topsoil was fine-grained soil (CL, ML, CL-ML) and GRAVEL (GM, GC, GC-GM). A generalized description of each soil type encountered and the depths they can be found is presented below.

Topsoil – Lean CLAY (CL)

The topsoil was typically 6 to 18 inches thick across the site and was visually classified as SILT (ML) and Silty CLAY (CL-ML). This unit was described as stiff, dry to slightly moist, dark brown, and contained organic matter.

Alluvial Deposits

Within the alluvial deposits were two main soil units: *Collapsible Fine-Grained Soil* (ML, CL, CL-ML) and *GRAVEL* (GM, GC, GC-GM).

The *Collapsible Fine-Grained Soils* (ML and CL-ML) were observed in each test pit except TP-03. Depths for this unit extended until contact with a *GRAVEL* unit was made or the bottom of the test pit. These collapsible fine-grained soils were encountered as shallow as 2.5 ft (TP-01) and continued to the bottom of the test pit in TP-04, TP-06, and TP-07. Within these test pits the collapsible soils continued beyond the depth we were able to dig. This area of mostly fine-grained soil was observed in the southwest corner of the property, encompassing nearly half of the lots planned for the subdivision. This unit was typically described as stiff, slightly moist, light brown, and containing pinholes.

The *GRAVEL* Soils (GM, GC, GC-GM) were observed in TP-01, TP-02, and TP-05. The *GRAVEL* was described as dense, slightly moist, moderate brown, with subangular gravel. Occasionally the fine-grained matrix in this unit contained pinholes, however, due to the gravel content an undisturbed sample could not be collected.

Collapse testing was completed on several samples in the upper 8 feet below existing grade; however, pinholes were frequently observed throughout the soil unit down to 10 feet below existing grade, the full extent to which we could dig.

The stratification lines shown on the enclosed exploratory logs represent the approximate boundary between soil types (Figures A-4 to A-10). The actual in-situ transition may be gradual. Due to the nature and depositional characteristics of the native soils, care should be taken in interpolating subsurface conditions between and beyond the exploration locations. Additional descriptions of these soil units are presented on the exploratory logs (Figures A-4 through A-10 in Appendix A).

4.2.2 Groundwater

Groundwater was not encountered in any of the test pits completed. Seasonal fluctuations in precipitation, surface runoff from adjacent properties, or other on or offsite sources may increase moisture conditions. Groundwater conditions can be expected to rise or fall several feet seasonally depending on the time of year. Based on our field investigation, we anticipate that groundwater will not impact the proposed construction.

4.2.3 Pavement Subgrade Support

One California Bearing Ratio (CBR) test was competed on a sample of the near surface soils that will be used for pavement subgrade. Based on the test results of TP-7 sampled from 2 feet a CBR value of 9.7 was obtained at 0.2 inches of penetration on the subgrade soils indicating the material will provide relatively *fair* pavement support. The complete test results are provided in Appendix B.

4.2.4 Collapsible Soils

Collapse is a phenomenon where undisturbed soils exhibit volumetric strain and consolidation upon wetting. Collapsible soils can cause differential settling of structures and roadways. Collapsible soils do not necessarily preclude development and in some cases can be mitigated by over-excavating porous, potentially collapsible soils and replacing with structural fill and by controlling surface drainage and runoff. In more severe cases the use of deep foundations is preferred. Collapsible soils typically exhibit certain physical characteristics, such as a porous soil structure ("pinholes") and low dry unit weight. Collapsible soils typically consist of SILT (ML), Lean CLAY (CL), or Silty CLAY (CL-ML), however soils classifying as 'sand' or 'gravel' can also be susceptible to wetting-induced collapse.

Collapse/swell tests (ASTM D4546 Method B) were performed on relatively undisturbed samples. The results are summarized in the following table:

Table 4.2.4
Summary of Collapse Test Results

Location	Depth (ft)	Load at Inundation (psf)	Collapse (%)
TP-4	3.0	1,600	7.9
TP-4	6.0		11.2
TP-4	8.0		15.2
TP-6	3.0		7.6

The results of the test suggest that the native fine-grained soils will, in general, experience *high to very high* volumetric strain under increased moisture and loading conditions. More detailed results of the collapse testing are provided in Appendix B. Recommendations for mitigation are presented in Sections 6.2.3, 6.2.5, 6.3, and 6.8.

4.2.5 Corrosion Testing

Chemical testing was completed as a part of this investigation on a representative sample of the near-surface soils. The test results indicated that the sample tested has a minimum resistivity of 4,315 OHM-cm, soluble chloride content of less than 11 ppm, soluble sulfate content of less than 11 ppm and a pH of approximately 8.6.

5.0 GEOLOGIC CONDITIONS

5.1 LOCAL GEOLOGY

Surface sediments at the site are mapped as Coalesced Alluvial Fan Deposits (Holocene to Pliocene?) (map symbol QTfc) (Biek, 1991). This geologic soil unit is described as "brown to dark brown or gray; thin to thick bedded, commonly cross bedded; unconsolidated to semi-unconsolidated. This unit is described as consisting of silt, sand granules, pebbles, cobbles, and sparse boulders. Fluvial sediments, formed as a result of the overlap and interfingering of adjacent alluvial fans, form broad, low, sloping aprons at foot of adjacent highlands" (Biek, 1991). The earth materials observed as a part of our subsurface exploration are largely consistent with this description.

5.2 SEISMICITY

Following the criteria outlined in the 2018 International Building Code (IBC, 2018), spectral response at the site was evaluated for the risk-targeted *Maximum Considered Earthquake* (MCE_R), which represents the spectral response accelerations in the direction of maximum horizontal response represented by a 5% damped acceleration response spectrum that is expected to achieve a 1% probability of structural collapse within a 50-year period. The MCE_R spectral accelerations were determined based on the location of the site using the *ASCE-7 Hazard Tool*; this software incorporates seismic hazard maps depicting probabilistic ground motions and spectral response data developed for the United States by the U. S. Geological Survey. These maps have been incorporated into the *International Building Code* (IBC) (International Code Council, 2018).

To account for site effects, site coefficients that vary with the magnitude of spectral acceleration and *Site Class* are used. Site Class is a parameter that accounts for site amplification effects of soft soils and is based on the average shear wave velocity of the upper 100 feet (30 meters, Vs_{30}); site classifications are identified in Table 5.2A

Based on our field exploration and our understanding of the geology in this area, the site is underlain by alluvial deposits, and would likely classify as Site Class D. However, lacking site-specific shear wave velocity measurements, IBC requires a conservative approach, thus *default* values for Site Class D have been adopted. Based on the *default* Site Class D site coefficients, the short- and long-period *Design Spectral Response Accelerations* are presented in Table 5.2B. For geotechnical practice, the geo-mean peak ground acceleration (PGA_M)[1] is presented in Table 5.2C.

[1] The PGA_M is based on a uniform hazard approach and represents the probabilistic PGA with a 2% probability of exceedance in a 50-year period (2PE50) (as opposed to the risk-targeted MCE_R, which is based on a uniform risk approach).

Table 5.2A
Site Class Categories

Site Class	Earth Materials	Shear Wave Velocity Range (Vs_{30}) ft/s
A	Hard Rock	>5,000
B	Rock	2,500-5,000
C	Very Dense Soil/Soft Rock	1,200-2,500
D	Stiff Soil	600-1,200
E	Soft Soil	<600
F	Special Soils Requiring Site-Specific Evaluation (e.g. liquefiable)	n/a

It should be noted that, for certain structures, particularly those with a longer fundamental natural period, a site-specific seismic hazard analysis may be required; the Structural Engineer should review ASCE-7-16 11.4.8 to assess whether Exception #2 is applicable for the proposed structures. If the simplified approach and mapped spectral accelerations as allowed by Exception #2 are not applicable to this project, IGES should be contacted regarding the completion of a site-specific seismic hazard analysis, which would necessarily include on-site shear wave velocity measurements.

Table 5.2B

Spectral Accelerations for MCE, Risk-Targeted Values (Structural)

Mapped B/C Boundary S_a (g)		Site Coefficient (Site Class D*)		Design Sa (g)	
Ss	S_1	F_a	F_v	S_{DS}	S_{D1}
1.349	0.496	1.200	1.804	1.079	0.597

*default
1) T_L=8
2) Exception #2 taken, see ASCE-7-16 11.4.8-2, a site-specific ground-motion hazard analysis may be required for some structures

Table 5.2C
Spectral Accelerations for MCE, Geo-Mean Values (Geotechnical)

Mapped B/C Boundary PGA (g)	Site Coefficient F_{PGA} (Site Class D*)	PGA_M (g)
0.618	1.2	0.742

*default

5.3 GEOLOGIC HAZARDS

Geologic hazards can be defined as naturally occurring geologic conditions or processes that could present a danger to human life and property. These hazards must be considered before development of the site. There are several hazards in addition to seismicity and faulting that may be present at the site, and which should be considered in the design of roads and critical facilities such as water tanks and structures designed for human habitation. Selected geologic hazards that often impact developments along the Wasatch Front are discussed in the following paragraphs.

5.3.1 Liquefaction

Certain areas within the Intermountain region possess a potential for liquefaction during seismic events. Liquefaction is a phenomenon whereby loose, saturated, granular soil deposits lose a significant portion of their shear strength due to excess pore water pressure buildup resulting from dynamic loading, such as that caused by an earthquake. Among other effects, liquefaction can result in densification of such deposits causing settlement of overlying layers after an earthquake as excess pore water pressures are dissipated. The primary factors affecting liquefaction potential of a soil deposit are: (1) level and duration of seismic ground motions; (2) soil type and consistency; and (3) depth to groundwater.

Referring to the *Liquefaction Potential Map for Central Utah, Complete Technical Report* published by the Utah Geological Survey, the site is located within an area currently designated as "moderate" for liquefaction potential. The upper 10 feet consist primarily of slightly moist soil typically containing 20% or more fines. Groundwater is also not anticipated to be near the surface at this site. Based on these conditions, liquefaction is not anticipated to occur in the soils observed at this site. However, there may be deeper deposits that are susceptible to liquefaction and IGES cannot preclude the possibility that liquefaction could impact the development. A complete liquefaction study, which would include soil borings and/or CPT soundings to a depth of 50 feet, was not a part of our scope of work for this project and is typically beyond the standard of care for this type of development.

5.3.2 Surface Fault Rupture

An *active* fault is generally defined as a fault exhibiting movement within the Holocene (about 11,700 years before present). No active faults have been mapped on, or trending toward, the site (Hecker, 1993). The site is located approximately 500 feet west of a mid-valley splay of the Nephi segment of the Wasatch Fault Zone, the closest mapped active fault. Based on publicly available information, the reference splay does not continue through the site, and based on the splay orientation, appears that, if continued would be located outside of the project boundary (approximately 40-200 feet from the northwest corner) The next nearest mapped fault is the Levan section of the Wasatch Fault, and it is approximately 1.7 miles south of the project site. Based on this data, the potential for surface fault rupture impacting the site is considered low to moderate.

6.0 ENGINEERING CONCLUSIONS AND RECOMMENDATIONS

6.1 GENERAL CONCLUSIONS

Based on the subsurface conditions encountered at the site, the subject site is suitable for the proposed development provided that the recommendations presented in this report are incorporated into the design and construction of the project. We recommend that as part of the site grading process any undocumented fill (created from test pit backfill), topsoil, or otherwise unsuitable soils currently present at the site be removed from beneath proposed footings, or footings be deepened to extend below the unsuitable soils.

Highly collapsible soil was observed to a depth of approximately 10 feet, and could extend deeper below existing grade since this was the deepest IGES could explore. To completely remove the risk of collapsible soils impacting the proposed structures, deep foundations such as helical pier, push piers or micro-piles should be installed to transfer the foundation loads to a suitable granular layer. This would impact the southwest portion of the subdivision, encompassing approximately half of the planned lots.

In addition, the native collapsible soils beneath concrete slabs-on-grade and pavements should be established on at least 24 inches of structural fill that is comprised of moisture conditioned reworked native soils to create a low permeability barrier against infiltration; see Section 6.2.3 for Over-Excavation recommendations.

Because of the high collapse potential, the client should closely follow the moisture protection and surface drainage recommendations contained in Section 6.8 of this report to minimize the potential for water to infiltrate underlying soils. We also recommend that IGES be on site at key points during construction to see that the recommendations in this report are implemented.

The following sub-sections present our recommendations for general site grading, design of foundations, slabs-on-grade, lateral earth pressures, pavement design, moisture protection and preliminary soil corrosion.

6.2 EARTHWORK

Prior to the placement of foundations and pavement, general site grading is recommended to provide proper support for foundations, exterior concrete flatwork, and concrete slabs-on-grade. Site grading is also recommended to provide proper drainage and moisture control on the subject property.

6.2.1 General Site Preparation

The surficial topsoil should be grubbed to a depth of 12 inches to remove the majority of the organic matter and fine roots. Any existing utilities should be re-routed or protected in-place. An IGES representative should observe the site preparation and grading operations to assess whether the recommendations presented in this report have been complied with.

6.2.2 Excavations

Excavations or reworked soil beneath foundations should extend a minimum of 1-foot laterally for every foot of depth of over-excavation. Excavations should extend laterally at least two feet beyond slabs-on-grade and pavements.

6.2.3 Over-Excavations

Due to the presence of highly collapsible soils, over-excavating, moisture conditioning and recompacting should be completed. Table 6.2.3 summarizes the minimum recommended amount of over excavation below different improvements. For the foundations where no significant gravel layer was observed above 10 feet in depth, deep foundations should be constructed and over-excavation is not necessary. IGES should observe all excavations in order to provide appropriate recommendations.

Table 6.2.3A
Minimum Recommended Over Excavations

Improvement Element	Minimum Over Excavation Depth
Strip or Spot Footings*	N/A - Verify 4 feet of gravel is present or deep foundations recommended
Slabs on Grade**	24 inches
Flexible or Rigid Pavements**	24 inches

* A minimum of two test pits at opposite corners of the structure should be completed to show the thickness of the granular soils.

**If granular soils (GC or GM) are exposed in the subgrade with a minimum thickness of 12 inches then no over-excavation is required.

Following the over-excavation, IGES recommends that the exposed subgrade soils be scarified, moisture conditioned and compacted until relatively firm prior to placing structural fill as recommended in Section 6.2.5 of this report.

6.2.4 Excavation Stability

The contractor is responsible for site safety, including all temporary slopes and trenches excavated at the site and design of any required temporary shoring. The contractor is responsible for providing the "competent person" required by OSHA standards to evaluate soil conditions. Soil types are expected to consist of *Type B* soils (soils with unconfined compressive strength between 0.5 tsf and 1.5 tsf) in the top 12 feet. Close coordination between the competent person and IGES should be maintained to facilitate construction while providing safe excavations.

Based on Occupational Safety and Health (OSHA) guidelines for excavation safety, trenches with vertical walls up to 5 feet in depth may be occupied. Where very moist soil conditions or groundwater is encountered, or when the trench is deeper than 5 feet, we recommend a trench-shield or shoring be used to protect workers in the trench. Sloping of the sides at 1H:1V (45 degrees) in *Type B* soils may be used as an alternative to shoring or shielding.

6.2.5 Structural Fill and Compaction

All fill placed for the support of structures, flatwork or pavements, should consist of structural fill. Structural fill should consist of the on-site native soils or an approved imported material. Fill placed below foundations, pavements and concrete slabs-on-grade should consist of reworked native soils to provide a low permeability barrier above the collapsible soils left in place. This native soil barrier must be well processed to remove any collapse structure and moisture conditioned to the optimum moisture content, or beyond, as determined by ASTM D-1557 (Modified Proctor). If imported structural fill is used, it should have a minimum fines content of 35 percent, be free of vegetation and debris and contain no rocks larger than 4 inches in nominal size (6 inches in greatest dimension).

All structural fill should be placed in maximum 6-inch loose lifts if compacted by small hand-operated compaction equipment, maximum 8-inch loose lifts if compacted by light-duty rollers, and maximum 12-inch loose lifts if compacted by heavy duty compaction equipment that is capable of efficiently compacting the entire thickness of the lift. These values are *maximums*; the Contractor should be aware that thinner lifts may be necessary to achieve the required compaction criteria and we expect that processing the on-site native fine-grained soils as structural fill will require thinner lifts on the order of 8 inches loose, or less. We recommend that all structural fill be compacted on a horizontal plane, unless otherwise approved by IGES. Structural fill placed beneath footings and pavements should be compacted to at least 95 percent of the maximum dry density (MDD) as determined by ASTM D-1557. The moisture content should be at or slightly above (maximum of 2%) the optimum moisture content (OMC) for all structural fill – compacting dry of optimum is discouraged. Any imported fill materials should be approved by IGES prior to importing. Also, prior to placing any fill, the excavations should be observed by IGES to confirm that unsuitable materials have been removed. In addition, proper grading should precede placement of fill, as described in the General Site Preparation and Grading subsection of this report.

All utility trenches backfilled below pavement sections, curb and gutter and concrete flatwork, should be backfilled with structural fill compacted to at least 95 percent of the MDD as determined by ASTM D-1557. All other trenches, including landscape areas, should be backfilled and compacted to a minimum of 90 percent of the MDD (ASTM D-1557).

Backfill around foundations should be placed in 12-inch loose lifts or thinner and compacted to 90 percent of the MDD at or slightly above the OMC as determined by ASTM D1557. If the soils will be covered by pavement, concrete or other structural elements the compaction should be increased to 95 percent. Specifications from governing authorities having their own precedence for backfill and compaction should be followed where applicable.

6.3 FOUNDATIONS

Based on our field observations and our analysis, soils with a potential for high volumetric strain (collapse) are present in the southwest portion of the site and may exist in other areas. For foundations in this area, we recommend deep foundations such as helical piers, push piers or micro piles be used. As part of the deep foundation design we recommend additional borings be completed to at least 30 feet or until a suitable gravel layer is encountered into which the deep foundations can bear. This gravel layer should be a minimum of 4 feet thick.

In the other areas of the site where granular soils were identified in the test pits (northeastern portion), we recommend that all of the footings for the proposed structure be founded *entirely* on granular soils (GC or GM) having a minimum thickness of 4feet. If 4 feet of granular soil cannot be established then deep foundations should be considered.

Shallow spread or continuous wall footings constructed on structural fill as described previously may be proportioned utilizing a maximum net allowable bearing pressure of **2,000 pounds per square foot (psf)**. Grade beams constructed between deep foundation elements should be proportioned using a maximum allowable bearing pressure of 1,100 psf. The net allowable bearing value presented above is for dead load plus live load conditions; a one-third increase may be used for transient loads such as wind or seismic.

All footings exposed to the full effects of frost should be established at a minimum depth of 30 inches below the lowest adjacent final grade. Interior footings, not subjected to the full effects of frost (i.e., a continuously heated structure), may be established at higher elevations, however, a minimum depth of embedment of 18 inches is recommended for confinement purposes. The minimum recommended footing width is 18 inches for continuous wall footings and 36 inches for isolated spread footings.

6.4 SETTLEMENT

Static settlement of properly designed and constructed conventional foundations or deep foundations, founded as described above, are anticipated to be on the order of 1 inch or less. Differential settlement is expected to be half of total settlement over a distance of 30 feet. However, leaving collapsible soils in place below foundation elements does increase the risk of adverse settlement of up to several inches.

6.5 EARTH PRESSURES AND LATERAL RESISTANCE

Lateral forces imposed upon conventional foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the footing and the supporting soils. In determining the frictional resistance, a coefficient of friction of 0.30 should be used for concrete in contact with native soils.

In general, foundations that are fixed at the top should be designed using at-rest lateral earth pressures. However, according to the IBC foundation walls for buried or partially buried structures may also be designed for active pressures if no more than 8 feet of the wall extends below grade and laterally supported by flexible diaphragms.

Ultimate lateral earth pressures from backfill acting against conventional footings may be computed from lateral pressure coefficients or equivalent fluid densities. Based on an estimated internal angle of friction of 30º, the ultimate lateral earth pressures for native fine-grained soils acting against buried structures may be computed from the lateral pressure coefficients or equivalent fluid densities presented in Table 6.5A:

Table 6.5A
Recommended Lateral Earth Pressure Coefficients

Condition	Lateral Pressure Coefficient	Equivalent Fluid Density (pounds per cubic foot)
Active*	0.33	40
At-rest**	0.50	60
Passive*	3.00	360

* Based on Coulomb's equation

** Based on Jaky

These values should be used with an appropriate factor of safety against overturning and sliding. A value of 1.5 is typically used. Additionally, if passive resistance is used in conjunction with frictional resistance, the passive resistance should be reduced by ½.

The coefficients and densities presented in the tables above for static and dynamic conditions assume a vertical wall face, flat back slope and no buildup of hydrostatic pressures. The force of the water should be added to the presented values if hydrostatic pressures are anticipated. Proper grading and other drainage recommendations provided previously in this report will help to reduce the potential for buildup of hydrostatic pressures if implemented.

Clayey soils drain poorly and may swell upon wetting, thereby greatly increasing lateral pressures acting on earth retaining structures; therefore, clayey soils with a potential for swelling should not be used as retaining wall backfill.

6.6 CONCRETE SLAB-ON-GRADE CONSTRUCTION

Prior to constructing the concrete slab on grade, a minimum of 24 inches of the native material should be over-excavated and replaced as structural fill as recommended in Section 6.2.3. If fine-grained soils are exposed in the excavation; structural fill may then be placed in accordance with section 6.2.5. To minimize settlement and cracking of slabs, and to provide a capillary break beneath the concrete floor slabs, all concrete slabs should be founded on a minimum 4-inch layer of compacted gravel overlying undisturbed suitable native subgrade soils. The gravel should consist of a free draining gravel with a 3/4-inch maximum particle size and no more than 5 percent passing the No. 200 mesh sieve. The slab may be designed with a Modulus of Subgrade Reaction of **175 psi/inch**.

All concrete slabs should be designed to minimize cracking as a result of shrinkage. Consideration should be given to reinforcing the slab with a welded wire fabric, re-bar, or fiber mesh. Slab reinforcement should be designed by the structural engineer. We recommend that concrete be tested to assess that the slump and air content is in compliance with the plans and specifications. If slump or air content are measured above the recommendations contained in the plans and specifications, the concrete may not perform as desired. We recommend that concrete be placed in general accordance with the requirements of the American Concrete Institute (ACI).

Our experience indicates that use of reinforcement in slabs and foundations can generally reduce the potential for drying and shrinkage cracking. However, some cracking can be expected as the concrete cures. Minor cracking is considered normal; however, it is often aggravated by a high water/cement ratio, high concrete temperature at the time of placement, small nominal aggregate size, and rapid moisture loss due to hot, dry, and/or windy weather conditions during placement and curing. Cracking due to temperature and moisture fluctuations can also be expected. The use of low slump concrete can reduce the potential for shrinkage cracking; saw cuts in the concrete at strategic locations can help to control and reduce undesirable shrinkage cracks.

6.7 PAVEMENT

Based on a CBR value of 9.7, near-surface soils at the site can be expected to provide relatively fair pavement support. Due to the collapse potential at this site, it is recommended that 24 inches of exposed native subgrade soil be removed as recommended in Section 6.2.3 if fine-grained soils are exposed as the subgrade. The fine-grained soils should be processed, moisture conditioned and replaced as structural fill in accordance with section 6.2.5, prior to constructing the pavement section. Anticipated traffic volumes were not available at the time this report was prepared, however, IGES has assumed an equivalent single axle load (ESAL) of 150,000 over a 30-year design life for the proposed parking lot. IGES has assumed that the majority of construction traffic has already occurred. Based on the information provided, the above-mentioned assumptions and our analysis, IGES has prepared the following pavement section to be used to support anticipated traffic loads for the subdivision roads and are summarized in the following table.

Table 6.7A
Flexible (Asphalt) Pavement Section

Asphalt Concrete (in.)	Untreated Base Course (in.)	Zone of Structural Fill* (in.)
3.5	**8**	**24**

*See Sections 6.2.3 and 6.2.5 for detailed recommendations

Asphalt has been assumed to be a high stability plant mix, base course material should be composed of crushed stone with a minimum CBR of 70. Asphalt should be compacted to a minimum density of 96% of the Marshall value; base course and all structural fill placed below pavement should be compacted to at least 95% of the MDD as determined by ASTM D-1557. All undocumented fill located beneath the pavement area should have been removed or reworked in place as structural fill.

It is our experience that pavement in areas where vehicles frequently turn around, stop, backup, load and unload, including the entrance and exit areas and dumpster areas often experience more distress. If the owner wishes to prolong the life of the pavement in these areas, consideration should be given to using a Portland cement concrete (rigid) pavement in these areas. For the rigid pavement section design, IGES has assumed a flexural strength of the concrete at 28 days of at least 600 psi, road base with a minimum CBR value of 70 and a load transfer coefficient of 2.7 for doweled joints with edge support. Concrete should consist of a low slump, low water cement ratio mix, with a minimum 28-day compressive strength of 4,000 psi. The base course should be compacted to at least 95% of the MDD as determined by ASTM D-1557 place in maximum 5-inch lifts. Table 6.7B presents our recommendation for a rigid pavement section.

Table 6.7B
Rigid Pavement Section – Heavy Traffic Areas

Concrete (in.)	Untreated Base Course (in.)	Zone of Structural Fill (in.)
5	**8**	**24***

*See Sections 6.2.3 and 6.2.5 for detailed recommendations

Concrete should consist of a low slump, low water cement ratio mix, with a minimum 28-day compressive strength of 4,000 psi. The base course should be compacted to at least 95% of the MDD as determined by ASTM D-1557.

The pavement section thicknesses above assume that there is no mixing over time between the road base and structural fill or native subgrade below. IGES recommends placing a lightweight non-woven geotextile before placing road base to improve life of the pavement section such as Mirafi 160N if the subgrade is the native lean clay.

6.8 MOISTURE PROTECTION AND SURFACE DRAINAGE

Due to the highly collapsible soils at the site, moisture should not be allowed to infiltrate into the soils within at least 10 feet of foundation elements. As such, design strategies to minimize ponding and infiltration near structures should be implemented as follows:

1. Due to the presence of highly collapsible soils, we do not recommend landscaping be completed immediately against or within 5 feet of the building. These areas should be hardscaped, desert landscaped or xeriscaped with no irrigation. All sprinkler heads should point away from these areas.
2. Backfill around foundations should consist of the native soils placed in maximum 12-inch loose lifts, moisture conditioned to near the OMC and compacted to approximately 90 percent of the MDD as established by the Modified Proctor (ASTM

D1557) in landscaped areas and a minimum of 95 percent beneath concrete slabs or other structural elements. This will help provide a low-permeability barrier against infiltration.

3. Compacting by means of injecting water or "jetting" is not recommended.
4. Rain gutters should be installed to collect and discharge all roof runoff a minimum of 10-feet from foundation elements or as far away as is practically possible.
5. The ground surface within 10-feet of the foundations should be sloped to drain away from the structure with a minimum fall of 6 inches (5%); 2% is acceptable if the area is hardscaped.
6. If any detention/retention basins are used at the site we recommend that they be placed as far away from structures, sidewalks and pavement as possible.
7. Prior to backfilling trenches that have been excavated for utilities running into or out of structures, a clay dam, or other relatively impermeable barrier be constructed to prevent water from flowing towards structures. IGES does not anticipate that the clay dam will need to be constructed in other areas such roads and landscaped areas. The clay dam or other relatively impermeable barrier could include concrete, lean concrete, compacted fine-grained soils such as silt or clay with a high percentage of fines (a minimum of 85% passing the #200 sieve). The dam should be a minimum of 18 inches thick and extend 12 inches beyond the edge of the utility excavation and be constructed on each utility running into or out of the structure at a distance between 5 and 10 feet from the foundation wall on the exterior of the structure.

6.9 PRELIMINARY SOIL CORROSION POTENTIAL

Corrosion testing was completed as a part of this investigation on a representative sample of the near-surface soils. The test results are discussed in Section 4.2.5 of this report and are presented in Appendix B. Based on the test results, the following recommendations are made:

- Site soils are expected to exhibit *moderate corrosivity* with respect to steel in direct contact with site soils. Consideration should be given to retaining the services of a qualified corrosion engineer to provide an assessment of any metal that will be in contact with native soils.

- Site soils are expected to exhibit *low potential for sulfate attack* with respect to concrete in direct contact with site soils. Conventional Type I/II Portland cement may be used for all concrete in contact with site soils.

7.0 CLOSURE

7.1 LIMITATIONS

The concept of risk is a significant consideration of geotechnical analyses. The analytical means and methods used in performing geotechnical analyses and development of resulting recommendations do not constitute an exact science. Analytical tools used by geotechnical engineers are based on limited data, empirical correlations, engineering judgment and experience. As such the solutions and resulting recommendations presented in this report cannot be considered risk-free and constitute IGES's best professional opinions and recommendations based on the available data and other design information available at the time they were developed. IGES has developed the preceding analyses, recommendations and designs, at a minimum, in accordance with generally accepted professional geotechnical engineering practices and care being exercised in the project area at the time our services were performed. No warrantees, guarantees or other representations are made.

The information contained in this report is based on limited field testing and understanding of the project. The subsurface data used in the preparation of this report were obtained largely from the explorations made for this project. It is very likely that variations in the soil, rock, and groundwater conditions exist between and beyond the points explored. The nature and extent of the variations may not be evident until construction occurs and additional explorations are completed. If any conditions are encountered at this site that are different from those described in this report, IGES must be immediately notified so that we may make any necessary revisions to recommendations contained in this report. In addition, if the scope of the proposed construction or grading changes from those described in this report, our firm must also be notified.

This report was prepared for our client's exclusive use on the project identified in the foregoing. Use of the data, recommendations or design information contained herein for any other project or development of the site not as specifically described in this report is at the user's sole risk and without the approval of IGES, Inc. It is the client's responsibility to see that all parties to the project including the designer, contractor, subcontractors, etc. are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk.

7.2 ADDITIONAL SERVICES

We recommend that IGES be retained to review the final design plans, grading plans and specifications to assess whether our engineering recommendations have been properly incorporated in the project plans and specifications. We also recommend that IGES be retained to evaluate construction performance and other geotechnical aspects of the project as construction initiates and progresses through its completion.

8.0 REFERENCES CITED

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Biek, R. F., 1991, Provisional Geologic Map of the Nephi Quadrangle, Juab County, Utah, Utah Geological Survey Map 137

Black, B.D., Hecker, S., Hylland, M.D., Christenson, G.E., and McDonald, G.N., 2003, Quaternary Fault and Fold Database and Map of Utah: Utah Geological Survey Map 193DM.

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Hintze, L.F., 1993, Geologic History of Utah, Brigham Young University Studies, Special Publication 7, 202p.

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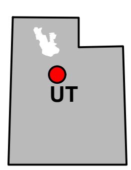
APPENDIX A

Base Map:
USGS *Nephi UT* 7.5-Minute
Quadrangle (2020)



Map Location

N

0' 1,000' 2,000' 4,000'

SCALE: 1"=2,000'

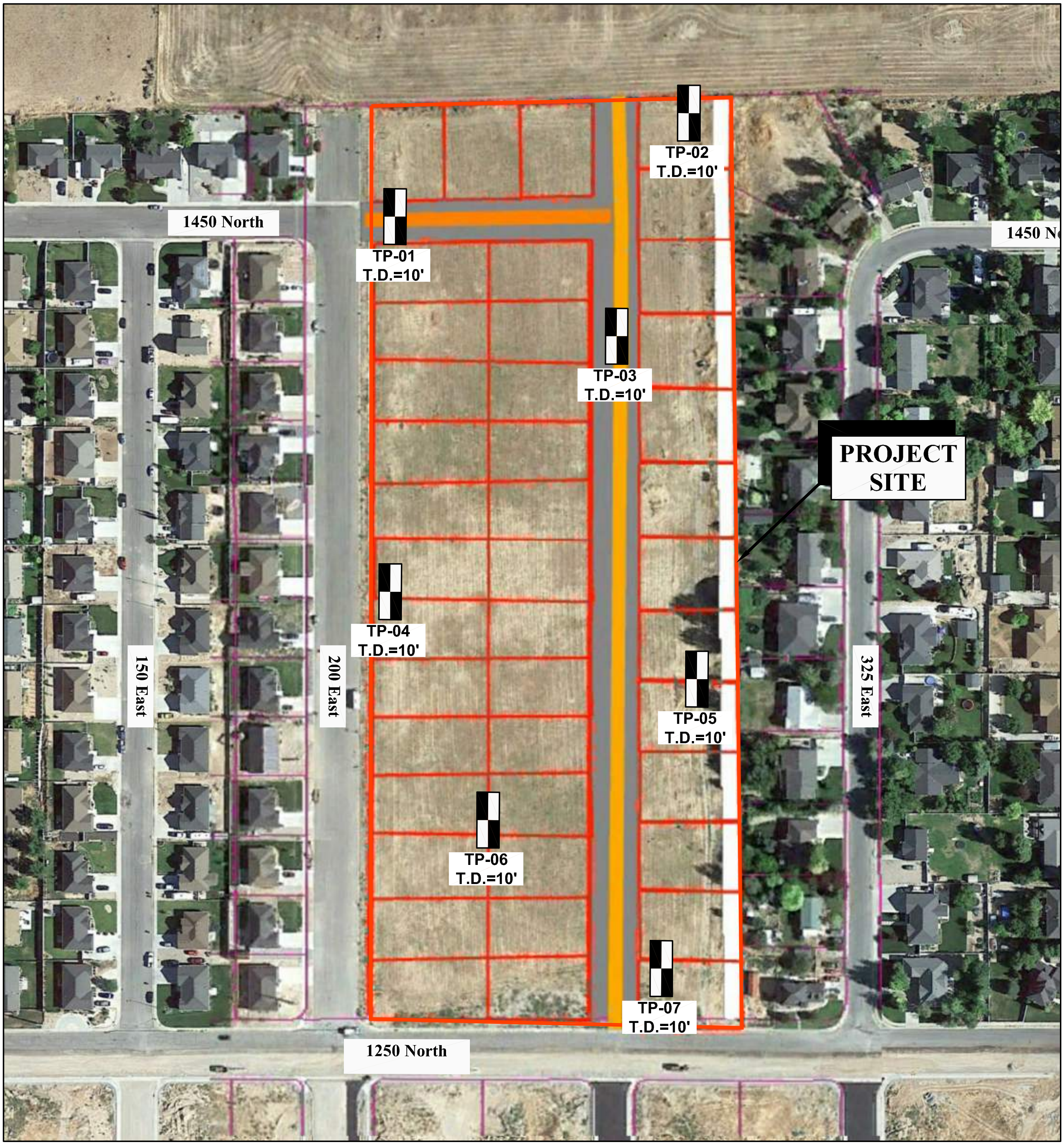
Project No. 03992-002

Geotechnical Investigation
Proposed Residential Development
200 East 1250 North
Nephi, Utah

SITE VICINITY MAP

Figure

A-1



BASE MAP

Google Earth Imagery August 2019 and Parcel Map provided by the client, unnamed, undated

LEGEND

APPROXIMATE TEST PIT LOCATION

T.D. = 10' TOTAL DEPTH EXPLORED

N

0' 100' 200' 300'

SCALE: 1"=200'

IGES

Project No. 03992-002

Geotechnical Investigation
Proposed Residential Development
200 East 1250 North
Nephi, Utah

GEOTECHNICAL MAP

Figure

A-2

Photos Taken on May 2nd, 2022

Project No. 003992-002

Geotechnical Investigation
Proposed Residential Subdivision
200 East 1250 North
Nephi, Utah

SITE PHOTOS

Figure

A-3

DATE	
STARTED:	5/6/22
COMPLETED:	5/6/22
BACKFILLED:	5/6/22

Geotechnical Investigation
Proposed Residential Development
200 East 1250 North
Nephi, Utah

Project Number 03992-002

IGES Rep: PQL
Rig Type: Case CX75 Csr

TEST PIT NO: **TP-01**

Sheet 1 of 1

LOCATION

LATITUDE 39.72971 LONGITUDE -111.83196 ELEVATION 5,133

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
	0			CL-ML	Topsoil - Sitly CLAY - stiff, slightly moist, dark brown, and organics					
	0.5			CL-ML	Native - Silty CLAY with gravel - stiff, slightly moist, light brown, and trace organics					
	1.5–2	3" O.D. thin-walled hand sampler				92.4	10.3			
	2.5			GC	Clayey Gravel - dense, slightly moist, light brown, with cobbles Gravel was subangular					
5130	4–4.5	Grab sample					5.9	33.7		
	7–7.5	Grab sample			12 inch boulders observed		5.6			
5125										
	10				Bottom of test pit No groundwater observed					

Moisture Content and Atterberg Limits

Plastic Limit — Moisture Content — Liquid Limit

10 20 30 40 50 60 70 80 90

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:
Location and elevation are approximate

Figure A-4

DATE		
STARTED:	5/6/22	
COMPLETED:	5/6/22	
BACKFILLED:	5/6/22	

Geotechnical Investigation
Proposed Residential Development
200 East 1250 North
Nephi, Utah

Project Number 03992-002

IGES Rep: PQL
Rig Type: Case CX75 Csr

TEST PIT NO: **TP-02**
Sheet 1 of 1

LOCATION
LATITUDE 39.73010 LONGITUDE -111.83053 ELEVATION 5,159

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
	0			CL-ML	Topsoil - Sitly CLAY - stiff, dry to slightly moist, dark brown, and organics					
	1			GC	Native - Clayey Gravel with sand - dense to very dense, slightly moist, and light grey Gravel was subangular					
	2.5–3	Grab sample					4.7	33.1		
5155	4	3" O.D. thin-walled hand sampler		CL-ML	Silty CLAY with gravel - stiff, slightly moist, light to moderate brown, and trace organics Gravel was subangular					
	6	3" O.D. thin-walled hand sampler								
	7.5			GC	Clayey GRAVEL - dense to very dense, slightly moist, and light brown Gravel was subangular with boulders					
5150	9.5–10	Grab sample					6.8	35.7		
	10				Bottom of test pit No groundwater observed					

Moisture Content and Atterberg Limits
Plastic Limit — Moisture Content — Liquid Limit
10 20 30 40 50 60 70 80 90

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:
Location and elevation are approximate

Figure A-5

DATE	
STARTED:	5/6/22
COMPLETED:	5/6/22
BACKFILLED:	5/6/22

Geotechnical Investigation
Proposed Residential Development
200 East 1250 North
Nephi, Utah
Project Number 03992-002

IGES Rep: PQL
Rig Type: Case CX75 Csr

TEST PIT NO:
TP-03
Sheet 1 of 1

LOCATION
LATITUDE 39.72920 LONGITUDE -111.83092 ELEVATION 5,154

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
	0			CL-ML	Topsoil - Sitly CLAY - stiff, dry to slightly moist, dark brown, and organics					
	1			GC	Native - Clayey Gravel - dense to very dense, slightly moist, and light brown Gravel was subangular with cobbles					
	3	Grab sample					5.0	33.3		
5150	4									
	6	3" O.D. thin-walled hand sampler		CL	Sandy CLAY with gravel - stiff, slightly moist, light to moderate brown, and trace organics Gravel was subangular		5.4	55.0		
	7	3" O.D. thin-walled hand sampler		GC	Clayey GRAVEL - very dense, partially cemented, slightly moist, and light brown Gravel was subangular with boulders					
	8	Grab sample					3.8			
5145	9									
	10				Bottom of test pit No groundwater observed					
	11									

Moisture Content and Atterberg Limits
Plastic Limit — Moisture Content — Liquid Limit
10 20 30 40 50 60 70 80 90

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:
Location and elevation are approximate

Figure A-6

DATE	
STARTED:	5/6/22
COMPLETED:	5/6/22
BACKFILLED:	5/6/22

Geotechnical Investigation
Proposed Residential Development
200 East 1250 North
Nephi, Utah

Project Number 03992-002

IGES Rep: PQL
Rig Type: Case CX75 Csr

TEST PIT NO: **TP-04**
Sheet 1 of 1

LOCATION
LATITUDE 39.72853 LONGITUDE -111.83207 ELEVATION 5,136

ELEVATION	DEPTH (FEET)	SAMPLES	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
	0		ML	Topsoil - SILT - stiff, dry, dark brown, and organics					
5135	1		ML	Native - SILT - stiff, dry, and light brown to tan Contained pinholes					
	2								
	3	3" O.D. Thin-walled hand sampler			84.1	7.0			
	4								
	5								
5130	6	3" O.D. Thin-walled hand sampler		Decrease in pinholes (trace pinholes)	84.7	5.8			
	7			Increase in moisture (dry to slighly moist)					
	8	3" O.D. Thin-walled hand sampler			82.5	6.2			
	9	Grab sample		Small increase in gravel content		6.0			
	10			Bottom of test pit No groundwater observed					
5125	11								

Moisture Content and Atterberg Limits
Plastic Limit — Moisture Content — Liquid Limit
10 20 30 40 50 60 70 80 90

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:
Location and elevation are approximate

Figure A-7

DATE			
STARTED:	5/6/22		
COMPLETED:	5/6/22		
BACKFILLED:	5/6/22		

Geotechnical Investigation
Proposed Residential Development
200 East 1250 North
Nephi, Utah

Project Number 03992-002

IGES Rep: PQL

Rig Type: Case CX75 Csr

TEST PIT NO:
TP-05
Sheet 1 of 1

LOCATION

LATITUDE 39.72822 LONGITUDE -111.83048 ELEVATION 5,159

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
	0 – 1.5			CL-ML	Topsoil - Silty CLAY with gravel - stiff, slightly moist, dark brown, and organics Contained pinholes					
	1.5 – 4.5	Grab sample (2 – 2.5)		ML	Native - Sandy SILT with trace gravel - stiff, slightly mosit, moderate brown, and organics Contained pinholes		8.5	53.7		
5155 (at 4 ft)	4.5 – 6			GM	Silty GRAVEL - dense, slighly moist, and moderate brown Gravel was subangular					
5150 (at 9 ft)	6 – 10	Grab sample (6.5 – 7)		GC-GM	Silty Clayey GRAVEL with sand - medium dense, slightly moist, moderate brown Contained trace pinholes Gravel was subangular		5.8	32.3	21	4
	10				Bottom of test pit No groundwater observed					

Moisture Content and Atterberg Limits

Plastic Limit — Moisture Content — Liquid Limit

10 20 30 40 50 60 70 80 90

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:
Location and elevation are approximate

Figure

A-8

DATE		
STARTED:	5/6/22	
COMPLETED:	5/6/22	
BACKFILLED:	5/6/22	

Geotechnical Investigation
Proposed Residential Development
200 East 1250 North
Nephi, Utah

Project Number 03992-002

IGES Rep: PQL
Rig Type: Case CX75 Csr

TEST PIT NO: **TP-06**
Sheet 1 of 1

LOCATION
LATITUDE 39.72759 LONGITUDE -111.83155 ELEVATION 5,141

ELEVATION	DEPTH (FEET)	SAMPLES	WATER LEVEL	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
	0			ML	Topsoil - SILT - stiff, dry to slightly moist, and dark brown					
5140	1			ML	Native - SILT with sand- stiff, dry, light brown to tan, and trace organics Contained pinholes					
	2									
	3	3" O.D. thin-walled hand sampler				85.8	6.6	72.3		
	4									
	5									
5135	6				Increase in moisture (dry to slighly moist) Decrease in pinholes (trace pinholes)					
	7	3" O.D. thin-walled hand sampler			Increase in gravel content (gravel was subangular)					
	8									
	9									
	10				Bottom of test pit No groundwater observed					
5130	11									

Moisture Content and Atterberg Limits
Plastic Limit — Moisture Content — Liquid Limit
10 20 30 40 50 60 70 80 90

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:
Location and elevation are approximate

Figure A-9

DATE		Project		Test Pit
STARTED: 5/6/22	Geotechnical Investigation	IGES Rep: PQL	TEST PIT NO:
COMPLETED: 5/6/22	Proposed Residential Development	Rig Type: Case CX75 Csr	TP-07
BACKFILLED: 5/6/22	200 East 1250 North Nephi, Utah Project Number 03992-002		Sheet 1 of 1

LOCATION

LATITUDE 39.72689 LONGITUDE -111.83072 ELEVATION 5,148

ELEVATION	DEPTH FEET	SAMPLES	WATER LEVEL	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
	0			ML	Topsoil - SILT - stiff, dry, dark brown, and organics					
	1			ML	Native - SILT with sand - stiff, dry, and light brown to tan Contained pinholes					
	2	3" O.D. thin-walled hand sampler								
5145	3				Trace organics					
	4									
	5				Increase in moisture content (dry to slightly moist)					
	6	Grab sample			Trace pinholes		5.9	76.7		
	7				Little to no pinholes					
5140	8									
	9	Grab sample					6.2			
	10				Bottom of test pit No groundwater observed					
	11									

Moisture Content and Atterberg Limits

Plastic Limit — Moisture Content — Liquid Limit

10 20 30 40 50 60 70 80 90

SAMPLE TYPE

- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL

- MEASURED
- ESTIMATED

NOTES:

Location and elevation are approximate

Figure A-10

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			USCS SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS (More than half of material is larger than the #200 sieve)	GRAVELS (More than half coarse fraction is larger than the #4 sieve)	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH OVER 12% FINES	GM	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS (More than half coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			SP	POORLY-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH OVER 12% FINES	SM	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
			SC	CLAYEY SANDS SAND-GRAVEL-CLAY MIXTURES
FINE GRAINED SOILS (More than half of material is smaller than the #200 sieve)	SILTS AND CLAYS (Liquid limit less than 50)		ML	INORGANIC SILTS & VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (Liquid limit greater than 50)		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY
HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

LOG KEY SYMBOLS

BORING SAMPLE LOCATION

TEST-PIT SAMPLE LOCATION

WATER LEVEL (level after completion)

WATER LEVEL (level where first encountered)

CEMENTATION

DESCRIPTION	DESCRIPTION
WEAKELY	CRUMBLES OR BREAKS WITH HANDLING OR SLIGHT FINGER PRESSURE
MODERATELY	CRUMBLES OR BREAKS WITH CONSIDERABLE FINGER PRESSURE
STRONGLY	WILL NOT CRUMBLE OR BREAK WITH FINGER PRESSURE

OTHER TESTS KEY

C	CONSOLIDATION	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	DS	DIRECT SHEAR
UC	UNCONFINED COMPRESSION	T	TRIAXIAL
S	SOLUBILITY	R	RESISTIVITY
O	ORGANIC CONTENT	RV	R-VALUE
CBR	CALIFORNIA BEARING RATIO	SU	SOLUBLE SULFATES
COMP	MOISTURE/DENSITY RELATIONSHIP	PM	PERMEABILITY
CI	CALIFORNIA IMPACT	-200	% FINER THAN #200
COL	COLLAPSE POTENTIAL	Gs	SPECIFIC GRAVITY
SS	SHRINK SWELL	SL	SWELL LOAD

MODIFIERS

DESCRIPTION	%
TRACE	<5
SOME	5 - 12
WITH	>12

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
DRY	ABSENCE OF MOISTURE, DUSTY, DRY TO THE TOUCH
SLIGHTLY MOIST	CONTAINING A MINIMAL AMOUNT OF MOISTURE, NOT DRY OR DAMP
MOIST	DAMP BUT NO VISIBLE WATER
WET	VISIBLE FREE WATER, USUALLY SOIL BELOW WATER TABLE

STRATIFICATION

DESCRIPTION	THICKNESS
SEAM	1/16-1/2"
LAYER	1/2-12"

DESCRIPTION	THICKNESS
OCCASIONAL	ONE OR LESS PER FOOT OF THICKNESS
FREQUENT	MORE THAN ONE PER FOOT OF THICKNESS

GENERAL NOTES

1. Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual.
2. No warranty is provided as to the continuity of soil conditions between individual sample locations.
3. Logs represent general soil conditions observed at the point of exploration on the date indicated.
4. In general, Unified Soil Classification designations presented on the logs were evaluated by visual methods only. Therefore, actual designations (based on laboratory tests) may vary.

APPARENT / RELATIVE DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPT (blows/ft)	MODIFIED CA. SAMPLER (blows/ft)	CALIFORNIA SAMPLER (blows/ft)	RELATIVE DENSITY (%)	FIELD TEST
VERY LOOSE	<4	<4	<5	0 - 15	EASILY PENETRATED WITH 1/2-INCH REINFORCING ROD PUSHED BY HAND
LOOSE	4 - 10	5 - 12	5 - 15	15 - 35	DIFFICULT TO PENETRATE WITH 1/2-INCH REINFORCING ROD PUSHED BY HAND
MEDIUM DENSE	10 - 30	12 - 35	15 - 40	35 - 65	EASILY PENETRATED A FOOT WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER
DENSE	30 - 50	35 - 60	40 - 70	65 - 85	DIFFICULT TO PENETRATE 12" WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER
VERY DENSE	>50	>60	>70	85 - 100	PENETRATED ONLY FEW INCHES WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER

CONSISTENCY - FINE-GRAINED SOIL		TORVANE	POCKET PENETROMETER	FIELD TEST
CONSISTENCY	SPT (blows/ft)	UNTRAINED SHEAR STRENGTH (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	
VERY SOFT	<2	<0.125	<0.25	EASILY PENETRATED SEVERAL INCHES BY THUMB. EXUDES BETWEEN THUMB AND FINGERS WHEN SQUEEZED BY HAND.
SOFT	2 - 4	0.125 - 0.25	0.25 - 0.5	EASILY PENETRATED ONE INCH BY THUMB. MOLDED BY LIGHT FINGER PRESSURE.
MEDIUM STIFF	4 - 8	0.25 - 0.5	0.5 - 1.0	PENETRATED OVER 1/2 INCH BY THUMB WITH MODERATE EFFORT. MOLDED BY STRONG FINGER PRESSURE.
STIFF	8 - 15	0.5 - 1.0	1.0 - 2.0	INDENTED ABOUT 1/2 INCH BY THUMB BUT PENETRATED ONLY WITH GREAT EFFORT.
VERY STIFF	15 - 30	1.0 - 2.0	2.0 - 4.0	READILY INDENTED BY THUMBNAIL.
HARD	>30	>2.0	>4.0	INDENTED WITH DIFFICULTY BY THUMBNAIL.

APPENDIX B

Water Content and Unit Weight of Soil

(In General Accordance with ASTM D7263 Method B and D2216)

Project: **200 to 300 E 1250 to 1450 N**
No: **03992-002**
Location: **200 to 300 E 1250 to 1450 N, Nephi**
Date: 5/17/2022
By: FB

Sample Info.	Boring No.	TP-1	TP-1	TP-3	TP-4	TP-7			
	Sample								
	Depth	1.5'	7.0'	8.0'	10.0'	10.0'			
	Split	No	No	No	No	No			
	Split sieve								
	Total sample (g)								
	Moist coarse fraction (g)								
	Moist split fraction (g)								
Unit Weight Data	Sample height, H (in)	4.107							
	Sample diameter, D (in)	2.412							
	Mass rings + wet soil (g)	739.20							
	Mass rings/tare (g)	237.35							
	Moist unit wt., γ_m (pcf)	101.9							
	Wet soil + tare (g)								
	Dry soil + tare (g)								
	Tare (g)								
	Water content (%)								
Water Content Data	Wet soil + tare (g)	626.55	5222.4	2313.38	1774.15	1512.13			
	Dry soil + tare (g)	580.04	4980.6	2240.65	1700.30	1441.45			
	Tare (g)	127.57	699.09	315.02	466.92	310.32			
	Water content (%)	10.3	5.6	3.8	6.0	6.2			
	Water Content, w (%)	**10.3**	**5.6**	**3.8**	**6.0**	**6.2**			
	Dry Unit Wt., γ_d (pcf)	**92.4**							

Entered by:___________
Reviewed:___________

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Liquid Limit, Plastic Limit, and Plasticity Index of Soils

(ASTM D4318)

Project: 200 to 300 E 1250 to 1450 N
No: 03992-002
Location: 200 to 300 E 1250 to 1450 N, Nephi
Date: 5/19/2022
By: BRR
Grooving tool type: Plastic
Liquid limit device: Mechanical
Rolling method: Hand

Boring No.: TP-5
Sample:
Depth: 6.5'
Description: Brown silty clay
Preparation method: Air Dry
Liquid limit test method: Multipoint
Screened over No.40: Yes
Larger particles removed: Dry sieved

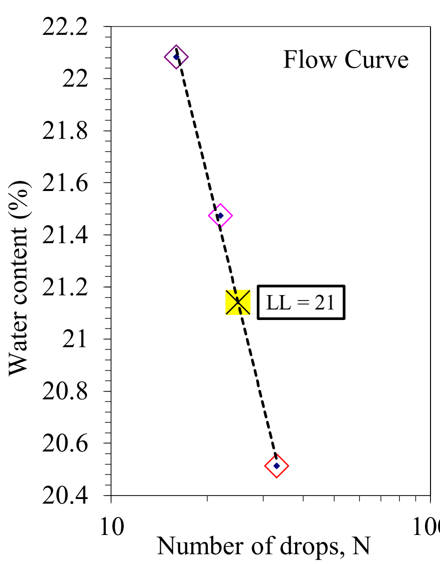
Plastic Limit

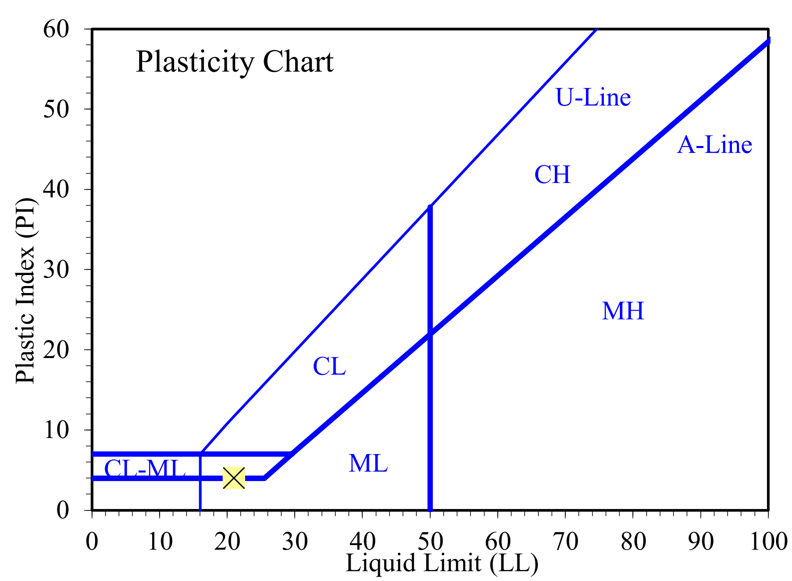
Determination No	1	2				
Wet Soil + Tare (g)	15.64	14.23				
Dry Soil + Tare (g)	14.46	13.30				
Water Loss (g)	1.18	0.93				
Tare (g)	7.51	7.62				
Dry Soil (g)	6.95	5.68				
Water Content, w (%)	16.98	16.37				

Liquid Limit

Determination No	1	2	3			
Number of Drops, N	33	22	16			
Wet Soil + Tare (g)	15.06	14.68	16.25			
Dry Soil + Tare (g)	13.78	13.34	14.66			
Water Loss (g)	1.28	1.34	1.59			
Tare (g)	7.54	7.10	7.46			
Dry Soil (g)	6.24	6.24	7.20			
Water Content, w (%)	20.51	21.47	22.08			
One-Point LL (%)		21				

Liquid Limit, LL (%)	**21**
Plastic Limit, PL (%)	**17**
Plasticity Index, PI (%)	**4**





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Reviewed:___________

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

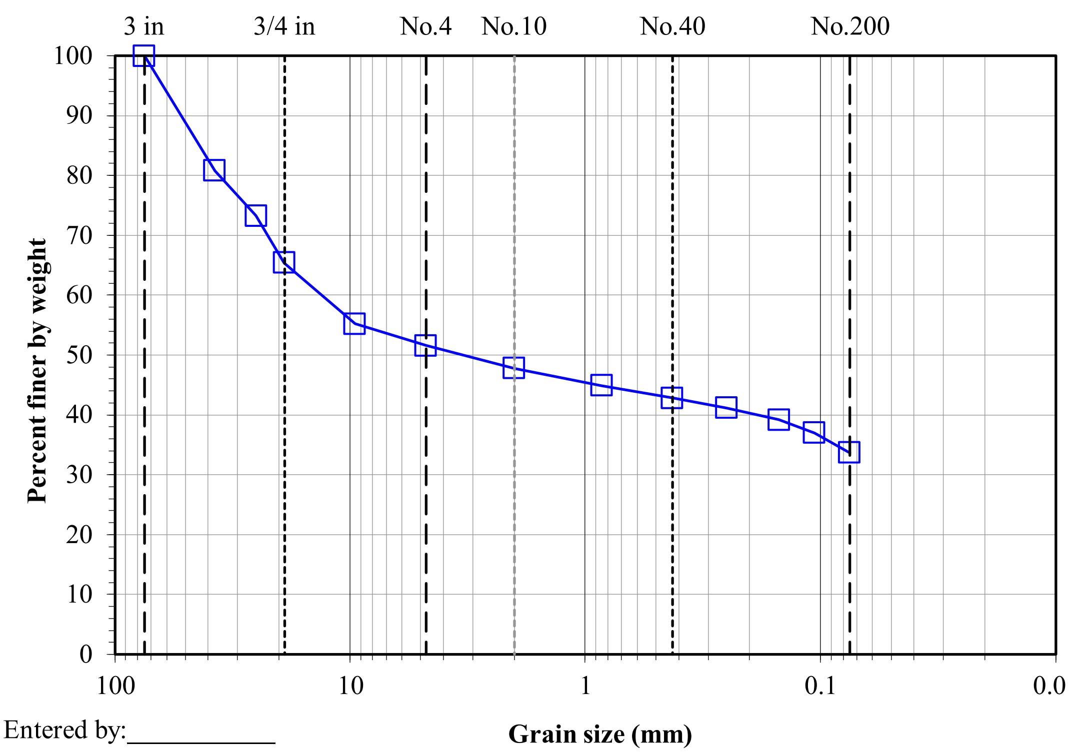
Project: **200 to 300 E 1250 to 1450 N**
No: **03992-002**
Location: **200 to 300 E 1250 to 1450 N, Nephi**
Date: 5/18/2022
By: BSS

Boring No.: **TP-1**
Sample:
Depth: **4.0'**
Description: Brown silty gravel with sand

Split:	Yes	
Split sieve:	3/8"	
	Moist	Dry
Total sample wt. (g):	4972.1	4693.6
+3/8" Coarse fraction (g):	2152.20	2102.72
-3/8" Split fraction (g):	264.39	242.92
Split fraction:	0.552	

Water content data	C.F.(+3/8")	S.F.(-3/8")
Moist soil + tare (g):	2704.74	392.50
Dry soil + tare (g):	2653.23	371.03
Tare (g):	464.08	128.11
Water content (%):	2.4	8.8

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
6"	-	150	-	
4"	-	100	-	
3"	-	75	100.0	
1.5"	900.62	37.5	80.8	
1"	1254.69	25	73.3	
3/4"	1624.50	19	65.4	
3/8"	2102.72	9.5	55.2	←Split
No.4	16.04	4.75	51.6	
No.10	32.65	2	47.8	
No.20	45.39	0.85	44.9	
No.40	54.60	0.425	42.8	
No.60	61.77	0.25	41.2	
No.100	70.52	0.15	39.2	
No.140	80.04	0.106	37.0	
No.200	94.55	0.075	33.7	



Gravel (%): 48.4
Sand (%): 17.8
Fines (%): 33.7

Comments:
These results are in nonconformance with Method D6913 because the minimum dry mass was not met.

Entered by:___________
Reviewed:___________

Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

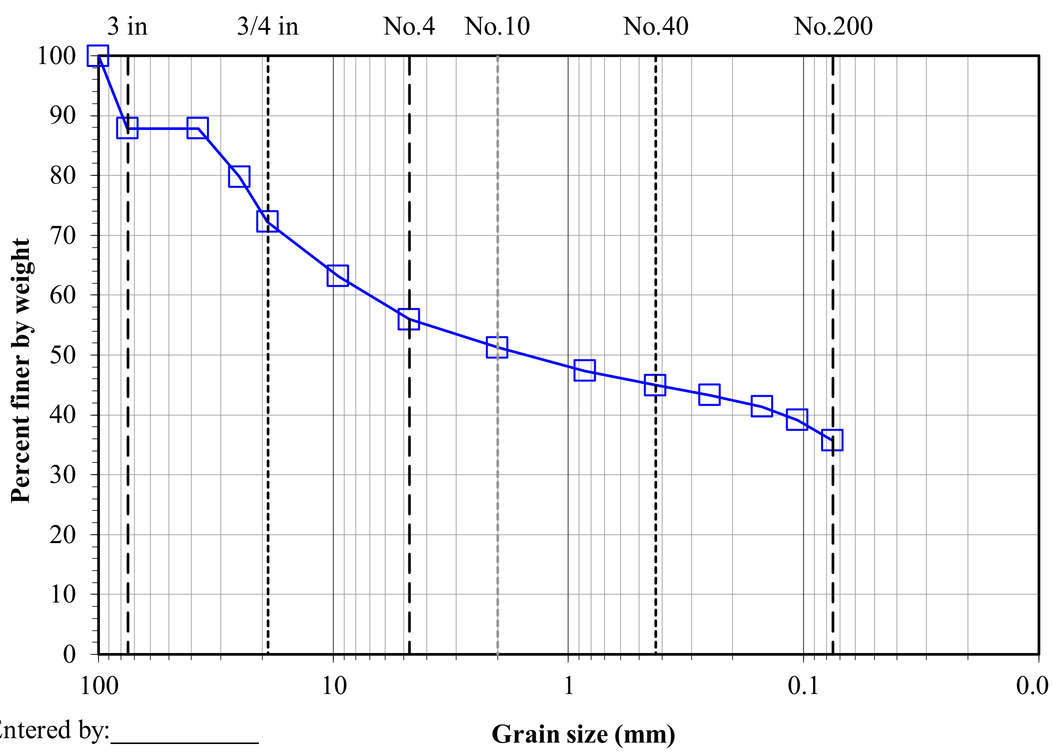
Project: 200 to 300 E 1250 to 1450 N
No: 03992-002
Location: 200 to 300 E 1250 to 1450 N, Nephi
Date: 5/18/2022
By: FB

Boring No.: TP-2
Sample:
Depth: 10.0'
Description: Reddish brown silty gravel with sand

Split:	Yes	
Split sieve:	3/8"	
	Moist	Dry
Total sample wt. (g):	4684.16	4386.88
+3/8" Coarse fraction (g):	1653.03	1615.77
-3/8" Split fraction (g):	250.63	229.13
Split fraction:	0.632	

Water content data	C.F.(+3/8")	S.F.(-3/8")
Moist soil + tare (g):	2140.87	372.94
Dry soil + tare (g):	2101.83	351.44
Tare (g):	408.93	122.31
Water content (%):	2.3	9.4

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
6"	-	150	-	
4"	-	100	100.0	
3"	532.06	75	87.9	
1.5"	532.06	37.5	87.9	
1"	886.91	25	79.8	
3/4"	1217.83	19	72.2	
3/8"	1615.77	9.5	63.2	←Split
No.4	26.10	4.75	56.0	
No.10	43.27	2	51.2	
No.20	57.45	0.85	47.3	
No.40	66.13	0.425	44.9	
No.60	72.09	0.25	43.3	
No.100	79.13	0.15	41.4	
No.140	87.11	0.106	39.2	
No.200	99.46	0.075	35.7	



Gravel (%): 44.0
Sand (%): 20.2
Fines (%): 35.7

Comments:
These results are in nonconformance with Method D6913 because the minimum dry mass was not met.

Entered by:___________
Reviewed:___________

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Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

(ASTM D6913)

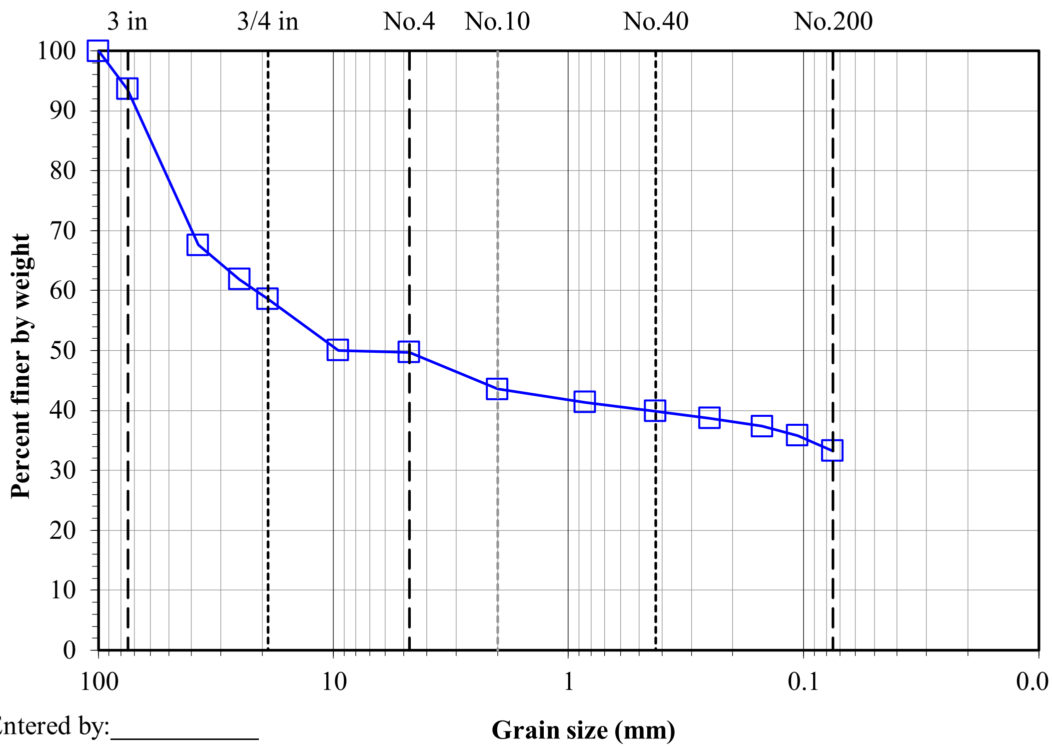
Project: 200 to 300 E 1250 to 1450 N
No: 03992-002
Location: 200 to 300 E 1250 to 1450 N, Nephi
Date: 5/19/2022
By: BSS

Boring No.: TP-3
Sample:
Depth: 3.0'
Description: Brown clayey gravel with sand

Split:	Yes	
Split sieve:	3/8"	
	Moist	Dry
Total sample wt. (g):	4937.27	4702.34
+3/8" Coarse fraction (g):	2387.81	2349.21
-3/8" Split fraction (g):	244.78	225.93
Split fraction:	0.500	

Water content data	C.F.(+3/8")	S.F.(-3/8")
Moist soil + tare (g):	2840.42	366.06
Dry soil + tare (g):	2801.10	347.21
Tare (g):	407.85	121.28
Water content (%):	1.6	8.3

Sieve	Accum. Wt. Ret. (g)	Grain Size (mm)	Percent Finer	
6"	-	150	-	
4"	-	100	100.0	
3"	301.08	75	93.6	
1.5"	1522.77	37.5	67.6	
1"	1791.05	25	61.9	
3/4"	1946.48	19	58.6	
3/8"	2349.21	9.5	50.0	←Split
No.4	1.60	4.75	49.7	
No.10	29.19	2	43.6	
No.20	39.08	0.85	41.4	
No.40	45.95	0.425	39.9	
No.60	51.09	0.25	38.7	
No.100	57.13	0.15	37.4	
No.140	64.31	0.106	35.8	
No.200	75.72	0.075	33.3	



Gravel (%): 50.3
Sand (%): 16.4
Fines (%): 33.3

Comments:
These results are in nonconformance with Method D6913 because the minimum dry mass was not met.

Entered by:___________
Reviewed:___________

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Amount of Material in Soil Finer than the No. 200 (75µm) Sieve

(ASTM D1140)

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Project: 200 to 300 E 1250 to 1450 N
No: 03992-002
Location: **200 to 300 E 1250 to 1450 N, Nephi**
Date: 5/19/2022
By: FB/BSS/EH/SR

Sample Info.	Boring No.	TP-2	TP-3	TP-5	TP-5	TP-6	TP-7		
	Sample								
	Depth	2.5'	6.0'	2.0'	6.5'	3.0'	6.0'		
	Split	Yes	Yes	Yes	Yes	No	No		
	Split Sieve*	3/8"	3/8"	3/8"	3/8"				
	Method	B	B	B	B	B	B		
Specimen soak time (min)		1390	500	550	460	510	480		
Moist total sample wt. (g)		4515.36	505.00	1255.44	4779.47	160.48	214.22		
Moist coarse fraction (g)		1940.65	65.55	78.48	1824.24				
Moist split fraction + tare (g)		353.13	351.40	387.32	501.76				
Split fraction tare (g)		126.65	127.70	126.83	212.10				
Dry split fraction (g)		211.68	211.27	239.21	267.09				
Dry retained No. 200 + tare (g)		212.75	204.71	228.42	336.41	166.20	226.63		
Wash tare (g)		126.65	127.70	126.83	212.10	124.50	179.60		
No. 200 Dry wt. retained (g)		86.10	77.01	101.59	124.31	41.70	47.03		
Split sieve* Dry wt. retained (g)		1905.12	64.10	76.12	1791.74				
Dry total sample wt. (g)		4311.58	479.13	1156.93	4516.70	150.62	202.22		
Coarse Fraction	Moist soil + tare (g)	2387.32	185.71	200.47	844.80				
	Dry soil + tare (g)	2351.79	184.26	198.11	832.47				
	Tare (g)	446.67	120.16	121.99	152.79				
	Water content (%)	1.86	2.26	3.10	1.81				
Split Fraction	Moist soil + tare (g)	353.13	351.40	387.32	501.76	284.98	393.82		
	Dry soil + tare (g)	338.33	338.97	366.04	479.19	275.12	381.82		
	Tare (g)	126.65	127.70	126.83	212.10	124.50	179.60		
	Water content (%)	6.99	5.88	8.90	8.45	6.55	5.93		
Percent passing split sieve* (%)		**55.8**	**86.6**	**93.4**	**60.3**				
Percent passing No. 200 sieve (%)		**33.1**	**55.0**	**53.7**	**32.3**	**72.3**	**76.7**		
Comments:		These results are in nonconformance with Method D1140 because the minimum dry mass was not met.	These results are in nonconformance with Method D1140 because the minimum dry mass was not met.	These results are in nonconformance with Method D1140 because the minimum dry mass was not met.	These results are in nonconformance with Method D1140 because the minimum dry mass was not met.				

Entered by:___________

Reviewed:___________

Laboratory Compaction Characteristics of Soil

(ASTM D698 / D1557)

Project: **200 to 300 E 1250 to 1450 N**
No: **03992-002**
Location: **200 to 300 E 1250 to 1450 N, Nephi**
Date: 5/18/2022
By: FB

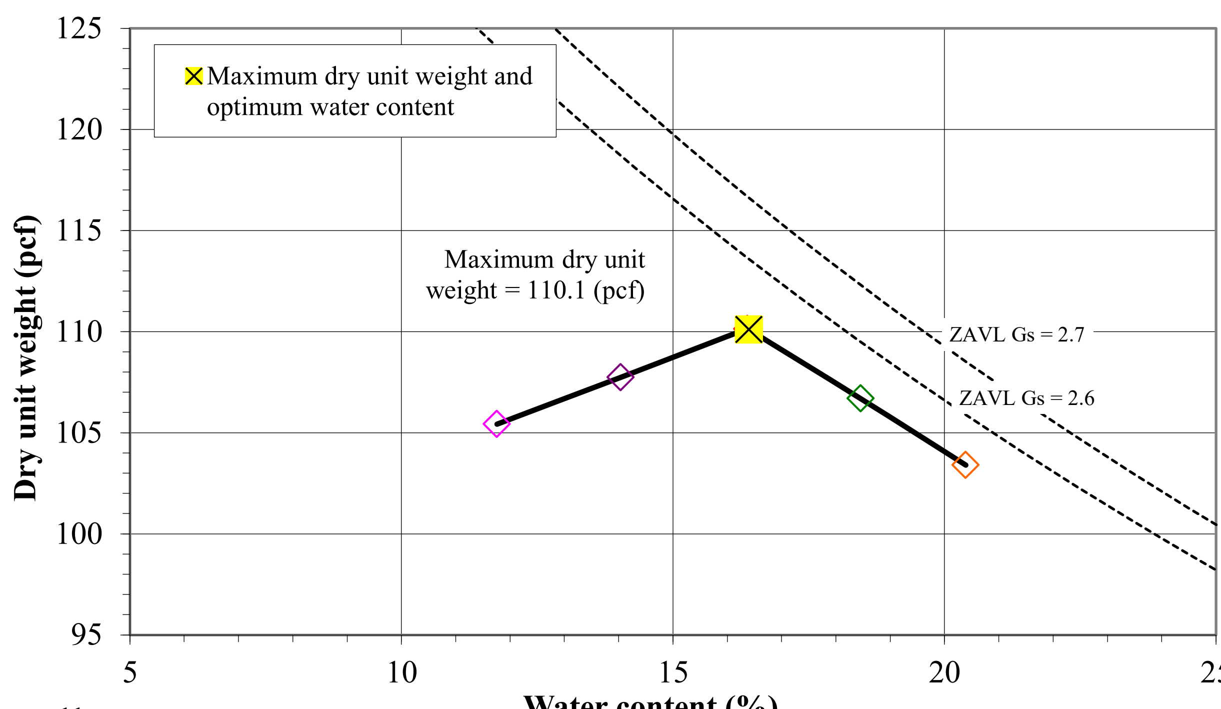
Boring No.: **TP-7**
Sample:
Depth: **2.0'**
Sample Description: Brown sandy clay
Engineering Classification: Not requested
As-received water content (%): Not requested

Method: ASTM D698 B
Mold Id. INC 1
Mold volume (ft^3): 0.0333

Preparation method: Moist
Rammer: Mechanical-circular face
Rock Correction: No

Optimum water content (%): **16.4**
Maximum dry unit weight (pcf): **110.1**

Point Number	+6%	+8%	+10%	+4%	+12%			
Wt. Sample + Mold (g)	6079.0	6159.1	6132.3	6002.9	6103.6			
Wt. of Mold (g)	4223	4223	4223	4223	4223			
Wet Unit Wt., γ_m (pcf)	122.9	128.2	126.4	117.8	124.5			
Wet Soil + Tare (g)	659.98	592.11	804.19	595.38	531.80			
Dry Soil + Tare (g)	594.56	526.83	714.06	554.90	465.61			
Tare (g)	128.38	127.97	225.59	210.57	140.97			
Water Content, w (%)	**14.0**	**16.4**	**18.5**	**11.8**	**20.4**			
Dry Unit Wt., γ_d (pcf)	**107.7**	**110.1**	**106.7**	**105.4**	**103.4**			



Entered by:___________

Reviewed:___________

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California Bearing Ratio
(ASTM D 1883)

Project: **200 to 300 E 1250 to 1450 N**
Number: **03992-002**
Location: **200 to 300 E 1250 to 1450 N, Nephi**
Date: 5/24/2022
By: FB

Maximum Dry Unit Weight (pcf): 110.1
Optimum Water Content (%): 16.4
Relative Compaction (%): 100.3
0.1 in. Corrected CBR (%): 7.4
0.2 in. Corrected CBR (%): 9.7

Boring No.: TP-7
Sample:
Depth: 2.0'
Original Method: ASTM D698 B
Engineering Classification: Not requested
Condition of Sample: Soaked
Scalp and Replace: No

As Compacted Data				Before	After
Mold Id.	B	Wet Soil + Tare (g)		1021.66	1018.12
Wt. of Mold + Sample (g)	11559.1	Dry Soil + Tare (g)		910.39	916.27
Wt. of Mold (g)	7194.3	Tare (g)		223.35	288.33
Dry Unit Weight (pcf)	110.4	Water Content (%)		16.2	16.2
After Soaking Data				**Average**	**Top 1 in.**
Wt. of Mold + Sample (g)	11599.7	Wet Soil + Tare (g)		971.34	648.05
Dry Unit Weight (pcf)	110.3	Dry Soil + Tare (g)		854.11	574.70
		Tare (g)		167.10	167.61
		Water Content (%)		17.1	18.0

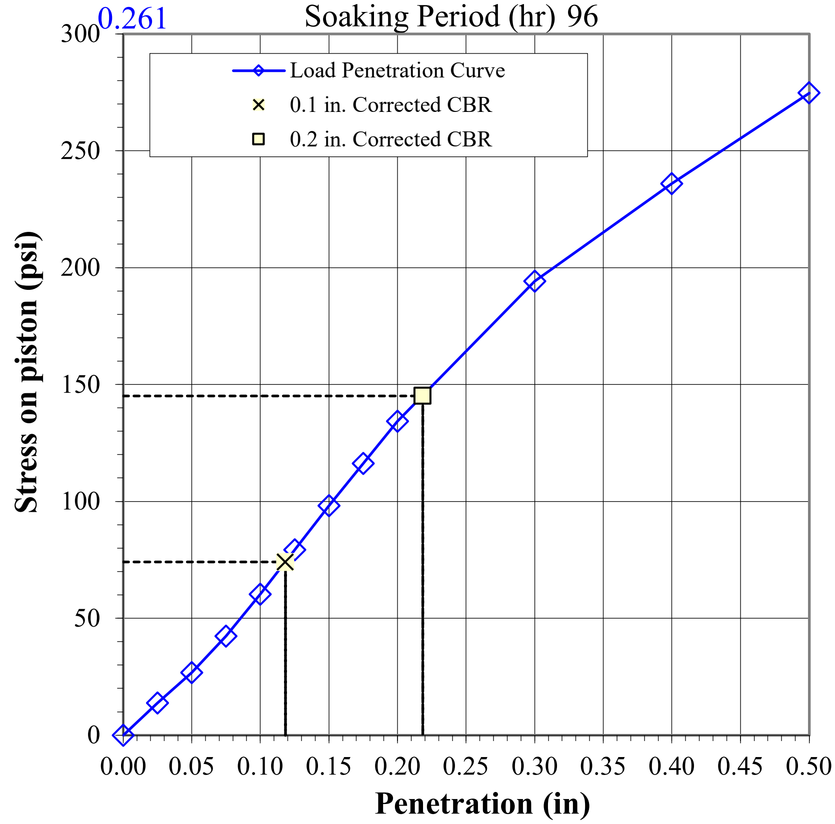
Swell Data

Date	Time	Dial	
5/19/2022	10:23	0.258	Surcharge (psf) 50
5/23/2022	10:24	0.261	Swell (%) 0.07
			Soaking Period (hr) 96

Penetration Data | Piston ID CBR T1

Zero load (lb) = 0
Area of Piston (in^2) = 3.0

Penetration (in.)	Raw Load (lb)	Piston Stress (psi)	Std. Stress (psi)
0.000	0	0	
0.025	41	14	
0.050	80	27	
0.075	127	42	
0.100	181	60	1000
0.125	238	79	1125
0.150	295	98	1250
0.175	349	116	1375
0.200	403	134	1500
0.300	583	194	1900
0.400	708	236	2300
0.500	824	275	2600



Entered By:___________
Reviewed:___________

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Collapse/Swell Potential of Soils

(ASTM D4546 Method B)

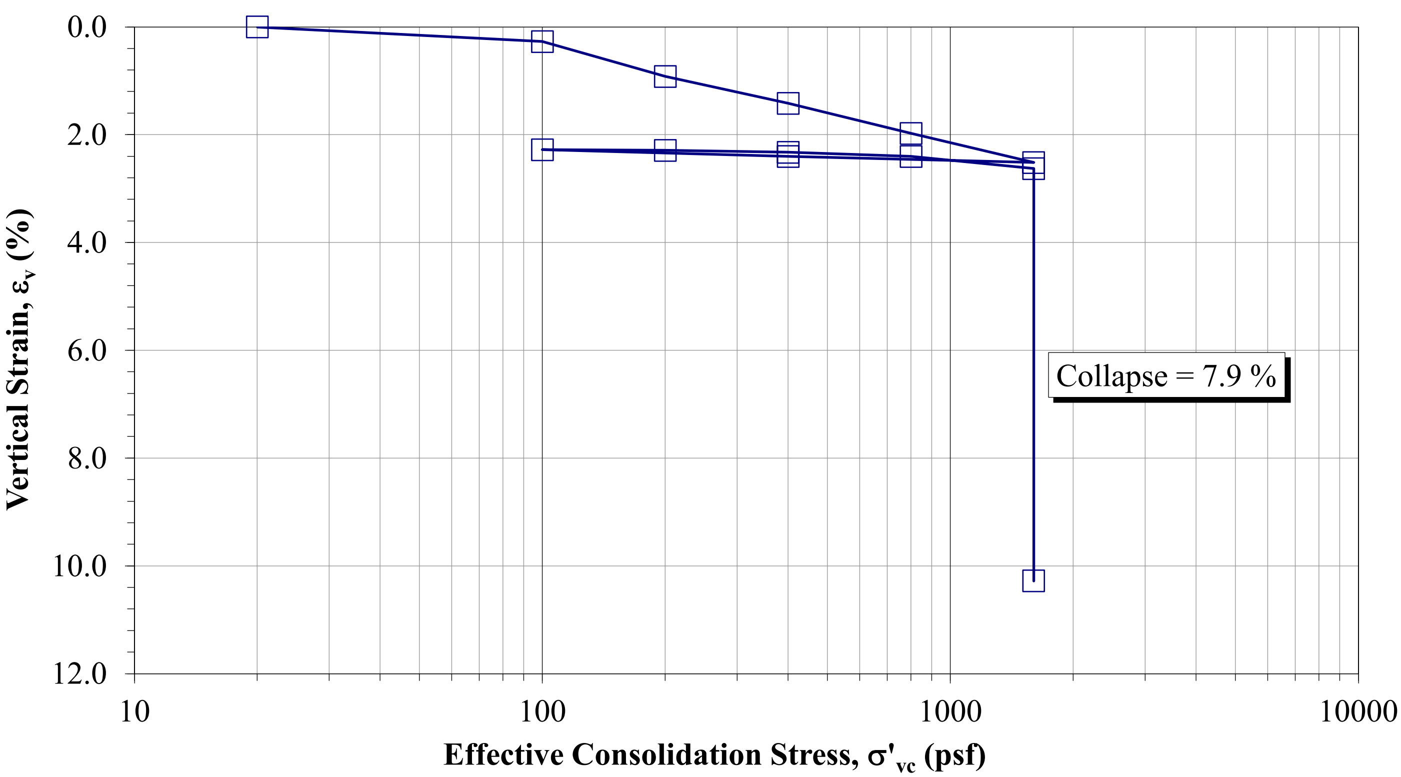
Project: **200 to 300 E 1250 to 1450 N**
No: **03992-002**
Location: 200 to 300 E 1250 to 1450 N, Nephi
Date: 5/18/2022
By: BSS

Boring No.: **TP-4**
Sample:
Depth: **3.0'**
Sample Description: Brown clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from thin-wall

Consolidometer No.:	2	
Specific gravity, G_s	2.70	Assumed
Collapse (%)	7.9	
Collapse stress (psf)	1600	
Water type used for inundation	Tap	

	Initial (o)	Final (f)
Sample height, H (in.)	0.923	0.828
Sample diameter, D (in.)	2.420	2.420
Mass rings + wet soil (g)	145.10	162.16
Mass rings/tare (g)	44.85	44.85
Moist unit wt., γ_m (pcf)	89.96	117.32
Wet soil + tare (g)	273.61	238.42
Dry soil + tare (g)	264.05	215.24
Tare (g)	127.69	123.34
Water content, w (%)	7.0	25.2
Dry unit wt., γ_d (pcf)	84.1	93.7
Saturation	18.8	85.2

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.00000	0.00	0.9230	1.005
20	0.00000	0.00	0.9230	1.005
100	0.00250	0.27	0.9205	1.000
200	0.00850	0.92	0.9145	0.987
400	0.01310	1.42	0.9099	0.977
800	0.01825	1.98	0.9048	0.965
1600	0.02320	2.51	0.8998	0.955
400	0.02220	2.41	0.9008	0.957
100	0.02105	2.28	0.9020	0.959
200	0.02115	2.29	0.9019	0.959
400	0.02145	2.32	0.9016	0.958
800	0.02220	2.41	0.9008	0.957
1600	0.02425	2.63	0.8988	0.952
1600	0.09485	10.28	0.8282	0.799



Entered: ________
Reviewed: ________

Collapse/Swell Potential of Soils
(ASTM D4546 Method B)

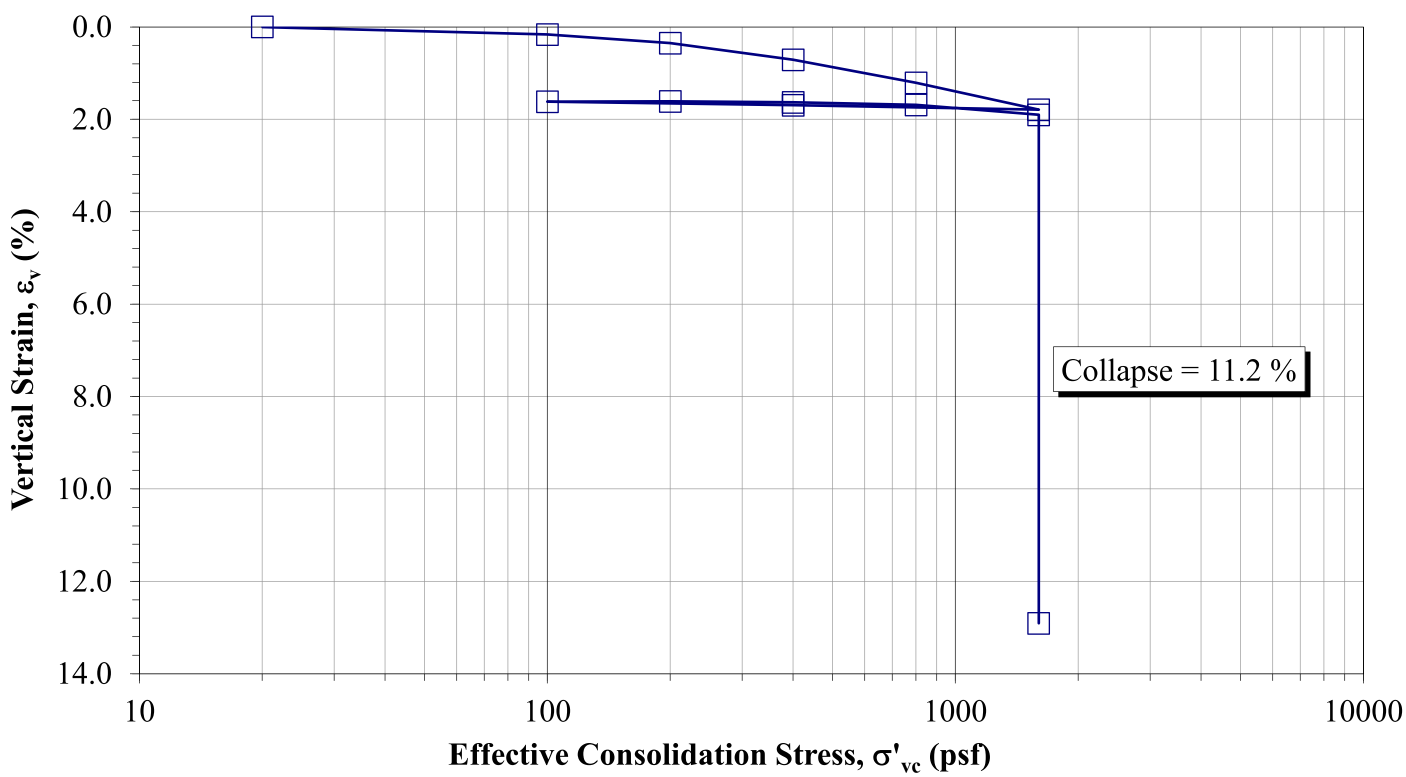
Project: 200 to 300 E 1250 to 1450 N
No: 03992-002
Location: 200 to 300 E 1250 to 1450 N, Nephi
Date: 5/18/2022
By: BSS

Boring No.: TP-4
Sample:
Depth: 6.0'
Sample Description: Brown clay with sand
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from thin-wall

Consolidometer No.: 3
Specific gravity, G_s: 2.70 Assumed
Collapse (%): 11.2
Collapse stress (psf): 1600
Water type used for inundation: Tap

	Initial (o)	Final (f)
Sample height, H (in.)	0.917	0.799
Sample diameter, D (in.)	2.415	2.415
Mass rings + wet soil (g)	144.52	160.77
Mass rings/tare (g)	45.70	45.70
Moist unit wt., γ_m (pcf)	89.62	119.83
Wet soil + tare (g)	289.58	239.78
Dry soil + tare (g)	280.71	218.59
Tare (g)	128.80	127.42
Water content, w (%)	5.8	23.2
Dry unit wt., γ_d (pcf)	84.7	97.2
Saturation	15.9	85.5

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.00000	0.00	0.9170	0.990
20	0.00000	0.00	0.9170	0.990
100	0.00150	0.16	0.9155	0.987
200	0.00320	0.35	0.9138	0.984
400	0.00655	0.71	0.9105	0.976
800	0.01110	1.21	0.9059	0.966
1600	0.01640	1.79	0.9006	0.955
400	0.01555	1.70	0.9015	0.957
100	0.01485	1.62	0.9022	0.958
200	0.01480	1.61	0.9022	0.958
400	0.01495	1.63	0.9021	0.958
800	0.01550	1.69	0.9015	0.957
1600	0.01745	1.90	0.8996	0.953
1600	0.11835	12.91	0.7987	0.734



Entered: ________
Reviewed: ________

Collapse/Swell Potential of Soils

(ASTM D4546 Method B)

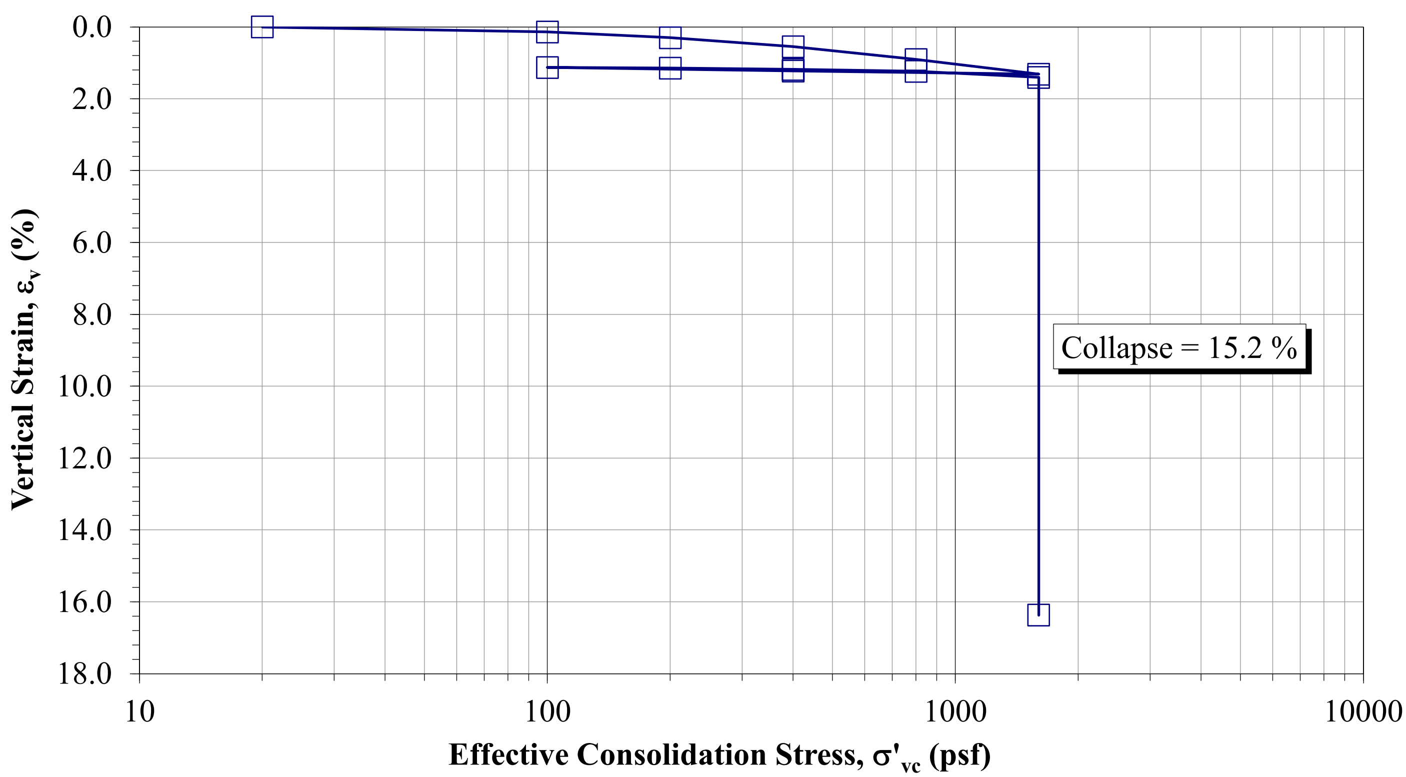
Project: 200 to 300 E 1250 to 1450 N
No: 03992-002
Location: 200 to 300 E 1250 to 1450 N, Nephi
Date: 5/18/2022
By: BSS

Boring No.: TP-4
Sample:
Depth: 8.0'
Sample Description: Brown clay
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from thin-wall

Consolidometer No.: 4
Specific gravity, G_s: 2.70 Assumed
Collapse (%): 15.2
Collapse stress (psf): 1600
Water type used for inundation: Tap

	Initial (o)	Final (f)
Sample height, H (in.)	0.925	0.774
Sample diameter, D (in.)	2.426	2.426
Mass rings + wet soil (g)	140.75	156.88
Mass rings/tare (g)	42.43	42.43
Moist unit wt., γ_m (pcf)	87.60	121.92
Wet soil + tare (g)	302.01	240.19
Dry soil + tare (g)	291.65	218.71
Tare (g)	123.70	127.63
Water content, w (%)	6.2	23.6
Dry unit wt., γ_d (pcf)	82.5	98.7
Saturation	16.0	89.9

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.00000	0.00	0.9250	1.043
20	0.00000	0.00	0.9250	1.043
100	0.00130	0.14	0.9237	1.040
200	0.00275	0.30	0.9223	1.037
400	0.00510	0.55	0.9199	1.032
800	0.00835	0.90	0.9167	1.024
1600	0.01220	1.32	0.9128	1.016
400	0.01135	1.23	0.9137	1.018
100	0.01040	1.12	0.9146	1.020
200	0.01060	1.15	0.9144	1.019
400	0.01095	1.18	0.9141	1.019
800	0.01145	1.24	0.9136	1.018
1600	0.01300	1.41	0.9120	1.014
1600	0.15140	16.37	0.7736	0.708



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Collapse/Swell Potential of Soils
(ASTM D4546 Method B)

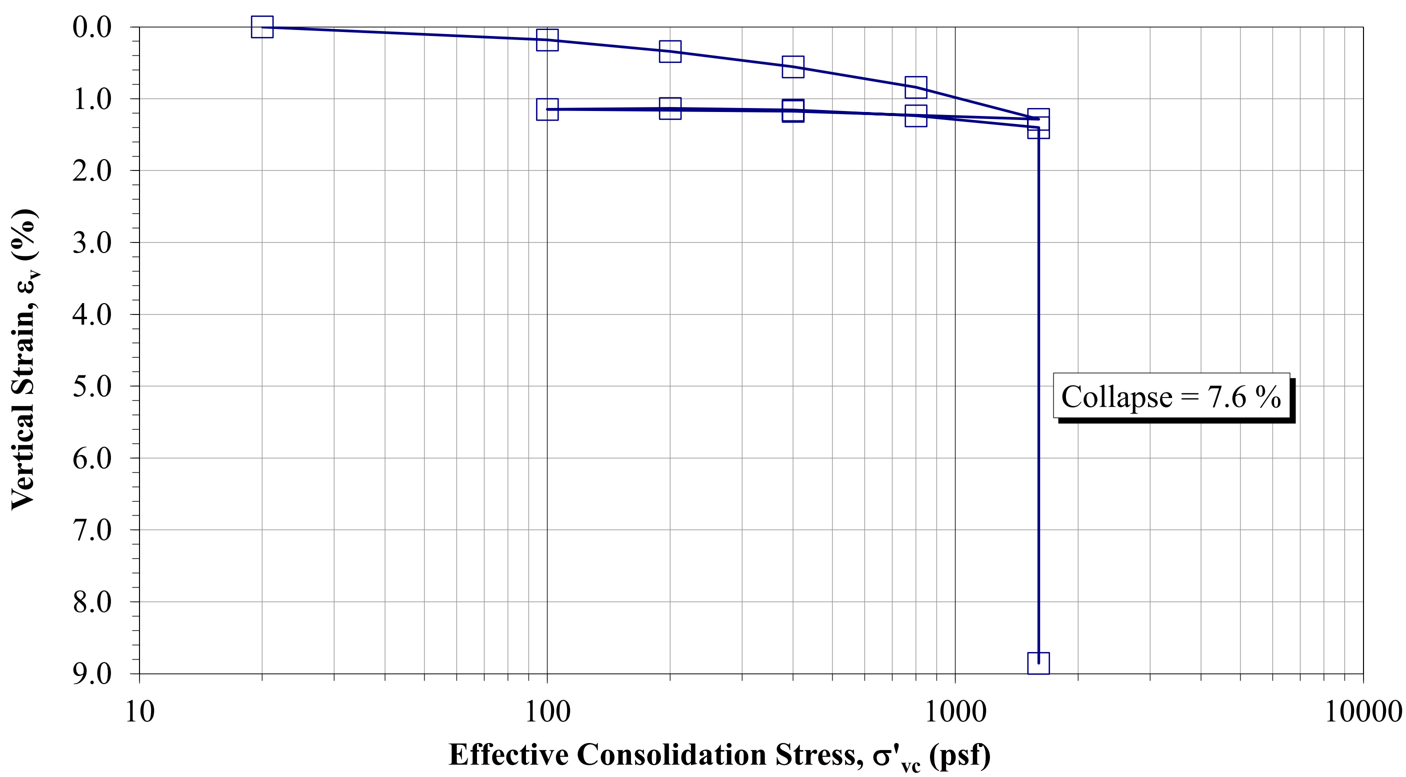
Project: 200 to 300 E 1250 to 1450 N
No: 03992-002
Location: 200 to 300 E 1250 to 1450 N, Nephi
Date: 5/19/2022
By: BSS

Boring No.: TP-6
Sample:
Depth: 3.0'
Sample Description: Reddish brown clay with sand
Engineering Classification: Not requested
Sample type: Undisturbed-trimmed from thin-wall

Consolidometer No.:	5	
Specific gravity, G_s	2.70	Assumed
Collapse (%)	7.6	
Collapse stress (psf)	1600	
Water type used for inundation	Tap	

	Initial (o)	Final (f)
Sample height, H (in.)	0.921	0.839
Sample diameter, D (in.)	2.427	2.427
Mass rings + wet soil (g)	144.95	163.01
Mass rings/tare (g)	42.73	42.73
Moist unit wt., γ_m (pcf)	91.39	117.99
Wet soil + tare (g)	284.98	245.64
Dry soil + tare (g)	275.12	221.62
Tare (g)	124.50	126.94
Water content, w (%)	6.5	25.4
Dry unit wt., γ_d (pcf)	85.8	94.1
Saturation	18.3	86.6

Stress (psf)	Dial (in.)	1-D ε_v (%)	H_c (in.)	e
Seating	0.00000	0.00	0.9210	0.965
20	0.00000	0.00	0.9210	0.965
100	0.00165	0.18	0.9194	0.961
200	0.00315	0.34	0.9179	0.958
400	0.00510	0.55	0.9159	0.954
800	0.00775	0.84	0.9133	0.948
1600	0.01185	1.29	0.9092	0.940
400	0.01080	1.17	0.9102	0.942
100	0.01055	1.15	0.9105	0.942
200	0.01045	1.13	0.9106	0.943
400	0.01065	1.16	0.9104	0.942
800	0.01140	1.24	0.9096	0.941
1600	0.01290	1.40	0.9081	0.937
1600	0.08155	8.85	0.8395	0.791



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Reviewed: ________

Minimum Laboratory Soil Resistivity, pH of Soil for Use in Corrosion Testing, and Ions in Water by Chemically Suppressed Ion Chromatography *(AASHTO T 288, T 289, ASTM D4327, and C1580)*

Project: 200 to 300 E 1250 to 1450 N
No: 03992-002
Location: 200 to 300 E 1250 to 1450 N, Nephi
Date: 5/24/2022
By: CJ

Sample info.	Boring No.	TP-7							
	Sample								
	Depth	2.0'							
Water content data	Wet soil + tare (g)	49.12							
	Dry soil + tare (g)	46.65							
	Tare (g)	23.66							
	Water content (%)	10.7							
Chem. data	pH*	8.6							
	Soluble chloride* (ppm)	<11							
	Soluble sulfate** (ppm)	<11							
Resistivity data	Pin method	2							
	Soil box	Miller Small							
		Approximate Soil condition (%)	Resistance Reading (Ω)	Soil Box Multiplier (cm)	Resistivity (Ω-cm)	Approximate Soil condition (%)	Resistance Reading (Ω)	Soil Box Multiplier (cm)	Resistivity (Ω-cm)
		As is	17100	0.67	11457				
		+3	12610	0.67	8449				
		+6	7620	0.67	5105				
		+9	6440	0.67	4315				
		+12	7020	0.67	4703				
	Minimum resistivity (Ω-cm)	**4315**							

* Performed by AWAL using EPA 300.0

** Performed by AWAL using ASTM C1580

Entered by:___________

Reviewed:___________

APPENDIX C

ASCE 7 Hazards Report

Address:
No Address at This Location

Standard: ASCE/SEI 7-16
Risk Category: II
Soil Class: D - Default (see Section 11.4.3)

Elevation: 5144.06 ft (NAVD 88)
Latitude: 39.728064
Longitude: -111.831186

Seismic

Site Soil Class: D - Default (see Section 11.4.3)

Results:

S_S :	1.349	S_{D1} :	N/A
S_1 :	0.496	T_L :	8
F_a :	1.2	PGA :	0.618
F_v :	N/A	PGA_M :	0.742
S_{MS} :	1.619	F_{PGA} :	1.2
S_{M1} :	N/A	I_e :	1
S_{DS} :	1.079	C_v :	1.37

Ground motion hazard analysis may be required. See ASCE/SEI 7-16 Section 11.4.8.

Data Accessed: Thu May 05 2022

Date Source: [USGS Seismic Design Maps]