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DESIGN •GEOLOGY

GEOTECHNICAL ENGINEERING AND GEOLOGICAL RECONNAISSANCE STUDY

Proposed Hansen Property Subdivision

About 6875 East 1100 South Street
Huntsville, Weber County, Utah

CMT PROJECT NO. 19413

FOR:
Mr. Dave Hansen
6819 East 1100 South Street
Huntsville, Utah 84317

January 9, 2023

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Subject: Geotechnical Engineering and Geological Reconnaissance Evaluation
Proposed Hansen Property Subdivision
About 6875 East 1100 South Street
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Mr. Hansen;

Submitted herewith is the report of our geotechnical engineering and geological reconnaissance study for the subject site. This report contains the results of our findings and an interpretation of the results with respect to the available project characteristics. It also contains recommendations to aid in the design and construction of the earth related phases of this project.

CMT Technical Services (CMT) personnel supervised the excavation of three test pits extending to depths of 15.0 feet below the existing ground surface on the site. Soil samples were obtained during the field operations and were transported to our laboratory for further testing. Based upon the findings of this investigation conventional strip and spread footings may be utilized to support the proposed residences provided the recommendations within this report are followed. A detailed discussion of design and construction criteria is presented in this report. A slope stability cross section was also measured across site slopes and analyzed for existing slope grading with the assumption the home will be placed on the roughly 60-foot-wide portion of the lot which is moderately flat and at the top of the hillside directly north of 1100 South Street. A Professional Geologist visited the site and conducted a review of the site geological and related geological hazard conditions.

We appreciate the opportunity to work with you on this project. CMT offers a full range of Geotechnical Engineering, Geological, Material Testing, Special Inspection services, and Phase I and II Environmental Site Assessments. With offices throughout Utah, Idaho, Arizona, Colorado and Texas, our staff is capable of efficiently serving your project needs. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at (801) 590-0394. To schedule materials testing please call (801) 908-5859.

Sincerely,

CMT Engineering Technical Services

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APPENDIX

1.0 INTRODUCTION

1.1 General

CMT Technical Services (CMT) was retained by Mr. Dave Hansen to conduct a design level geotechnical engineering, and a reconnaissance level geological study for a proposed two-lot residential subdivision on a 2.13-acre property parcel, which is located at about 6875 East 1100 South Street in Huntsville, Weber County, Utah. The property is located as shown on attached **Figure 1**, **Vicinity Map**. **Figure 2, Site Plan** provides aerial coverage of the site and detail of the current (2021) layout of the site vicinity. Geological mapping of the site is included on **Figure 3, Geological Mapping**, and slope-terrain information is provided on **Figure 4, LiDAR Analysis**. The locations of our test pits for our subsurface evaluation, and our slope stability analysis cross section line are shown on **Figure 5, Site Evaluation**.

The property is presently an undeveloped property 2.13 acres in plan area and is within the northeast quarter of Section 24 (T6N, R1E, SLBM). The subject parcel and surrounding properties are zoned by Weber County as Forest Zone FV-3 (Forest Valley Zone - 3) land-use zone. According to the Weber County Code of Ordinances the *purpose of the Forest Valley Zone, FV-3 is to provide area for residential development in a forest setting at a low density, as well as to protect as much as possible the naturalistic environment of the development.* The prescribed minimum building lot area in the FV-3 Zone is 3 acres (excluding cluster type provision areas), with single family residences included as a permitted use.

1.2 Objectives and Scope

The objectives and scope of our study were planned in discussions between Mr. Dave Hansen and Mr. Andy Harris of CMT. In general, the objectives of this study were to:

> *Based on our understanding of the project and the anticipated subsurface conditions, CMT proposes to provide the necessary personnel, equipment, and materials to conduct a design level geotechnical investigation and reconnaissance level geological study for the proposed design and construction.*

To achieve these objectives our scope of work included:

1. To provide geological reconnaissance studies as specified by Weber County Code, Section 108-22 Natural Hazard Areas guidelines and standards (Weber County, 2022). The reconnaissance level geological study was performed to assess whether all or parts of the site are exposed to the hazards that are included in the code, including, but not limited to; alluvial fan processes including flash flooding and debris flow hazards, surface fault rupture hazards, liquefaction hazards, rockfall hazards, and avalanche hazards (snow avalanche). The geotechnical study was performed to define and evaluate the subsurface soil, and groundwater conditions on the site.
2. To provide appropriate foundation and earthwork recommendations as well as geoseismic information to be utilized in the design and construction of the proposed residence including a field program consisting of the excavating, logging, and sampling of three test pits, and a laboratory soils testing program.
3. An office program consisting of the correlation of available data, engineering and geological analyses, and the preparation of this summary report.

1.3 Authorization

Authorization was provided by Mr. Hansen by returning a signed copy of our Proposal dated October 10, 2022.

2.0 EXECUTIVE SUMMARY

The following is a brief summary of our findings and conclusions:

The results of our analyses indicate that the proposed residential structures may be supported upon conventional spread and/or continuous wall foundations established upon Suitable natural soil or structural fill extending to suitable natural soils.

The most significant geotechnical/geological aspects of the site are:

1. The site surface was found to be covered with fills and residual soils that were underlain by stiff to hard weathered bedrock of the Norwood Formation, and Quaternary landslide deposits as mapped by Utah Geological Survey (UGS) geologist (King and others, 2008). The surface fills encountered at test pits TP-2 and TP-3 extended to depths of about 7.0 feet below the existing surface, are undocumented, exhibit variable engineering characteristic, and considered to be non-engineered. The depth and lateral extend must be anticipated to vary across the site. The undocumented fills must be removed below the home footprint. This may be completed with the construction of a sublevel or by removing and replacing with structural fill.

2. Steep slope conditions and landslide deposits were encountered on the north side of the subject property, these areas should be avoided for any construction and site grading improvements for the proposed subdivision development and use.

The surface of the site slopes moderately to steeply (30.9 percent) to the north. Static groundwater is projected to be below project depths, approximately 15 to 20 feet for the site. The soils encountered in the test pits were generally comprised of fine-grained CLAY and silty/clayey fine SAND.

A site-specific slope stability analysis was conducted for the site to evaluate the existing site slopes along cross section A-A shown on **Figure 5 Site Evaluation.** The proposed home loading was placed along the roughly 60 foot wide, moderately flat area at the top of the lot directly north of 1100 South Street. Foundations near slopes must be embedded such that an imaginary line, no steeper than one horizontal to one vertical drawn from the outside edge of the footing, does not exit the adjacent slope and the edge of footing be a minimum 4 feet horizontal away from the slope face. Unbraced slopes at the site must not be steepened to more than about 4 horizontal to 1 vertical (4H:1V). All retaining walls at the site must be properly engineered. Rockery walls less than 4 feet in height with adjacent tiers separated by at least 2 times the height of the tallest wall, may be considered as landscaping walls.

Once the proposed home locations and associated grading design are completed, CMT must review these plans for consideration with the findings and recommendations provided in this report.

At the time of construction, a geotechnical engineer from CMT will need to verify that all non-engineered fill material and topsoil/disturbed soils have been completely removed and suitable natural soils encountered prior to the placement of structural fills, floor slabs, footings, or foundations.

In the following sections, detailed discussions pertaining to the proposed construction, field exploration, the geologic setting and mapped hazards, geoseismic setting of the site, earthwork, foundations, lateral pressure and resistance, floor slabs, slope stability and subdrains are provided.

3.0 DESCRIPTION OF PROPOSED CONSTRUCTION

The proposed project is to be the development of a two-lot residential subdivision on the 2.13-acre property parcel. The proposed residences will likely be of single-family use, and likely be of conventional wood-framed construction and founded on spread footings with basements. Maximum continuous wall and column loads are anticipated to be 1,000 to 3,000 pounds per lineal foot and 10,000 to 50,000 pounds, respectively.

Site development will require a moderate amount of earthwork in the form of site grading. A proposed grading plan was not provided; however, some fill had been spread over the surface of the property prior to our field investigation up to as much as about 7 feet at two of the field exploration locationss which are undocumented, exhibit variable engineering characteristics, and must be considered as non-engineered. If more than 2 feet of additional site grading fill is anticipated over the existing ground surface we should be notified and allowed to review our recommendations and make any appropriate changes as needed.

4.0 FIELD EXPLORATION

The subsurface soil conditions were explored by excavating three test pits on the site at the locations shown on **Figure 5**. The test pits were excavated using an 8-ton track-mounted excavator and extended to depths of 15.0 feet below the existing ground surface. During the course of the excavating operations, a continuous log of the subsurface conditions encountered was maintained. Within the test pits undisturbed block and disturbed bulk samples of the typical soils encountered were obtained for subsequent laboratory testing and examination. The representative soil samples were placed in sealed plastic bags prior to transport to the laboratory.

The soils exposed in the test pits were logged and described in the field based upon visual and textural examination in general accordance with ASTM standard 2488, packaged, and transported to our laboratory. These classifications have been supplemented by subsequent inspection and testing in our laboratory. The subsurface conditions encountered in the field exploration are discussed below in **Section 5.4, Subsurface Soil Conditions**, and are illustrated on **Figures 6 through 8**, **Log of Test Pits**. Sampling information and other pertinent data and observations are also included on the logs. In addition, a **Key to Symbols** defining the terms and symbols used on the logs is provided as **Figure 9** in this report.

Following completion of excavating and logging, each test pit was backfilled. However, the backfill was not placed in uniform lifts and compacted to a specific density and therefore must be considered as non-engineered backfill. Settlement of the backfill with time is likely to occur.

5.0 ENGINEERING GEOLOGY

5.1 General Geology

The site is located on the south margin of the Ogden Valley on the eastern flank of Mount Ogden, which western flank comprises the Wasatch Front. The Wasatch Front is marked by the Wasatch fault, which is 7.4 miles west of the site, and provides the basis of division between the Middle Rocky Mountain Physiographic on the east and the Basin and Range Physiographic Province on the west. The Basin and Range Physiographic Province is characterized by approximately north-south trending valleys and mountain ranges that have been formed by extensional tectonics and displacement along normal faults and extends from the Wasatch Range on the east to the Sierra Nevada Range on the west (Hunt, 1967).

The Middle Rocky Mountain province covers parts of Utah, Colorado, Wyoming, Idaho, and Montana. The geology of the province is an assemblage of sedimentary, igneous, and metamorphic rocks that have been folded, faulted, and uplifted. Mountain building (tectonic) activity commenced about 30 million years ago (Cretaceous time) and continues to the present. The province is characterized by mountainous terrain with deep canyons and broad intervening basins, with temperate semi-arid to mesic climatic conditions (Hunt, 1967).

The surficial geology of the site vicinity is the result of the uplift and exposure of older pre-Cambrian rocks which forms the crest of Mount Ogden east of the site. This exposure was the result of movement along high-angle faults during late Tertiary and Quaternary age (Bryant, 1988). Bounding the east foothill flank of Mount Ogden are mid Tertiary units of the Norwood Formation that ramp along the base of the mountains south and west of the Ogden Valley floor. The Norwood Formation is described as "light-gray to light brown, altered tuff (claystone), tuffaceous siltstone, sandstone, and conglomerate" derived from volcanic ash deposition (King and others, 2008), and has been measured to be as much as 7000 feet thick in the vicinity of the site. The claystone, siltstone and sandstone occurrences of the formation are primarily a result of lacustrine (lake processes) redeposition of the volcanic ash. The site vicinity is largely underlain by Norwood Formation rock units which beds appear to slope gently down to the northeast across the site vicinity (King and others, 2008). The existing surface of the site and vicinity has been modified by Quaternary age erosion, and localized late-Quaternary stream deposits, lacustrine sediments and shorelines (Currey and Oviatt, 1985), residual soil weathering and development, and mass movement processes (King and others, 2008). The current geological mapping of the site vicinity drawn from King and others (2008) and modified herein, is shown on **Figure 3**.

5.2 Site Surface Conditions

The site geological and surface conditions were interpreted through an integrated compilation of data, including a review of literature and mapping from previous studies conducted in the area (Sorensen and Crittenden, 1979; Bryant, 1988; King and others, 2008; and Coogan and King, 2016); photogeologic analyses of 2012 and 2021 orthorectified imagery shown on **Figure 2** and **Figure 5**; historical stereoscopic imagery flown in 1946; GIS analyses of elevation and geoprocessed LiDAR terrain data as shown on **Figure 4**; field reconnaissance of the general site area; and the interpretation of the soils and geology within the test pits during our field program. Seismic hazards information was developed from United States Geologic Survey (USGS) databases (Petersen and others, 2014).

As shown on **Figure 2**, the site consists of an area of property 2.13 acres in size that is presently vacant and undeveloped. The topography of the site vicinity consists of gentle to moderately-steep sloping valley-margin foothill slopes. Vegetative cover at the site consists of open areas of grasses, weeds and sage brush with clustered wooded areas of scrub oak, alder and maple trees. The topography of the site consists of a north facing hillslope with flatter ground located on the south side of the property, that generally faces downward toward the north toward Ogden Valley. The site slopes developed from our LiDAR analysis were found to range from near level to over 30-percent as shown on **Figure 4**. For the 2.13 -acre property the slope gradients averaged 30.9 percent.

Topographically the site is located on base foothills on the northeast side of Mount Ogden, and overlooks Ogden Valley and the South Fork of the Ogden River floodplain, which is inundated by Pineview Reservoir waters, to the north of the site. The site, as shown on **Figure 2** is bordered on the north, south, and west by single-family homesites, with vacant undeveloped properties on the east, with 1100 South Street on the south frontage of the property.

5.3 Surficial Geology

The surficial geology of the site is presented on **Figure 3**, of this report and has been taken from mapping prepared by King and others (2008). A summary of the mapping units identified on the site vicinity and described by King and others (2008) are paraphrased below in relative age sequence (youngest-top to oldest bottom):

Qh - Human disturbance (Historical) - Obscures original deposits by cover or removal...

Qh/Qms - Human disturbance, fills (Historical) over landslide and slump |deposits (Holocene and Pleistocene) - Poorly sorted clay- to boulder-sized material...Human disturbance (Historical) - Obscures original deposits by |cover or removal...

Qh/Tn - Human disturbance, fills (Historical) over Norwood Formation (lower Oligocene and upper Eocene) - Typically light-gray to light brown, altered tuff (claystone), tuffaceous siltstone, sandstone, and conglomerate...

Qap - Lake Bonneville-age alluvium (upper Pleistocene) - Sand, silt, clay, |and gravel in stream and alluvial-fan; height above present drainages appears to be related to shorelines of Lake Bonneville...

Qmc - Landslide and slump, and colluvial deposits, undivided (Holocene and Pleistocene)...(slopewash and soil creep)...

Qmsy - Younger landslide and slump deposits (Holocene) - Poorly sorted clay- to boulder-sized material...

Qms - Landslide and slump deposits (Holocene and Pleistocene) - Poorly sorted clay- to boulder-sized material...

Qmso? - Older landslide and slump deposits (Pleistocene) - Poorly sorted clay- to boulder-sized material…

Qms?(Tn) - Block landslide and slump deposits (Pleistocene) - Comprised |of underlying Norwood Formation (lower Oligocene and upper Eocene) rocks...

Qlf/Tn – Lake Bonneville lacustrine fine grained deposits (Pleistocene) - over Norwood Formation rocks...

Tn- Norwood Formation (lower Oligocene and upper Eocene) - Typically light-gray to light brown, altered tuff (claystone), tuffaceous siltstone, sandstone, and conglomerate...

The property is shown on **Figure 3** to be located primarily upon **Tn**- Norwood Formation (lower Oligocene and upper Eocene) rocks, with **Qlf/Tn** lacustrine fine grained deposits (Pleistocene) over Norwood Formation (**Tn**) rocks, and **Qms** landslide and slump deposits (Holocene and Pleistocene) poorly sorted clay- to boulder-sized material on the north margin of the site. Roadway grading for the construction of 1100 South Street and leveling on the south side property has resulted in the placement of fills shown as **Qh/Tn** human disturbance, fills (Historical) over Norwood Formation (lower Oligocene and upper Eocene) on Figure 3.

The Norwood Formation (T**n**) bedrock that underlies the site has a notoriety of poor stability performance (particularly on steep slopes), and geotechnically challenging soils throughout the area (Mulvey, 1992).

5.4 Subsurface Soil Conditions

Subsurface conditions encountered in the three test pits were relatively consistent across the site. Surficial topsoil, roughly 4.0- to 8.0-inches thick was observed on the surface of the three test pits. Native soils encountered below the surface and extending to the approximate 15-foot depth of the excavations, consisted of light brown and gray brown Clay CL, and Silty Sand SM and Sandy SILT ML that was observed to be stiff and/or dense, and becoming indurated at depth. Fill soils compromised of light to dark brown Gravelly/Sandy Clay CL, which were medium stiff were observed in the upper about 7.0-feet of Test Pit TP-2, and the upper about 7.5-feet of Test Pit TP-3. These fill soils exhibit variable and poor to moderate engineering characteristics and must be considered as non-engineered fill.

For a detailed graphical description of the subsurface soils encountered, please refer to **Figures 6** through **8**, **Log of Test Pits**. A key to symbols defining the terms and symbols used on the logs is provided as **Figure 9** in this report.

5.5 Groundwater

Static groundwater was not observed in the test pits. The local static groundwater elevation is projected to be below project depths by about 15 to 20 feet for the site.

Future seasonal and longer-term groundwater fluctuations should be anticipated for the site, with the highest seasonal levels generally occurring during the late spring and summer months. Numerous other factors such as heavy precipitation, rapid snow-melt, and other unforeseen factors, may also influence ground water elevations at the site.

5.6 Site Subsurface Variations

Based on the results of the subsurface explorations and our experience, variations in the continuity and nature of subsurface conditions should be anticipated. Due to the heterogeneous characteristics of natural and fill soils, caution should be taken in interpolating or extrapolating subsurface conditions beyond the exploratory locations. Seasonal fluctuations in ground water conditions may also occur.

In addition, once the subsurface explorations were completed the test pits were backfilled with the excavated soils but little effort was made to compact these soils. Test pit backfill soils must be considered non-engineered. Settlement of the backfill in the test pits over time should be anticipated and caution should be exercised when constructing over these locations.

5.7 Seismic Setting

5.7.1 General

Utah has adopted the International Building Code (IBC) 2018. IBC 2018 determines the seismic hazard for a site based upon 2014 mapping of bedrock accelerations prepared by the USGS and the soil site class. The

USGS values are presented on maps incorporated into the IBC code and are also available based on latitude and longitude coordinates (grid points). For site class definitions, IBC 2018 (Section 1613.3.2) refers to Chapter 20, Site Classification Procedure for Seismic Design, of ASCE[1] 7.

5.7.2 Active Earthquake Faults

Based upon our review of available maps and literature, no active faults are known to pass through or immediately adjacent to the site. The nearest active (Holocene) earthquake fault to the site is the Weber segment of the Wasatch fault zone (UT2351E) which is located 7.4 miles west of the site, thus fault rupture hazards are not considered present on the site (Black and others, 2004). The Ogden Valley southwestern margin faults (UT2375) are located much closer to the site, approximately 1.8 miles to the west, however the most recent movement along this fault is estimated to be pre-Holocene (>15,000 ybp), and presently is not considered an active risk (Black and others, 1999).

5.7.3 Soil Class

Given the subsurface soils encountered at the site in our explorations, which only extended to a depth of about 15.0 feet, it is our opinion the site best fits Site Class D – Stiff Soil Profile (without data, or default), which we recommend for seismic structural design.

5.7.4 Strong Ground Motion

Strong ground motion originating from the Wasatch fault or other near-by seismic sources is capable of impacting the site. The Wasatch fault zone is considered active and capable of generating earthquakes as large as magnitude 7.3 (Arabasz and others, 1992). Based on probabilistic estimates (Petersen and others, 2014) queried for the site (41.2444º N., -111.7843º E.) the expected peak horizontal ground acceleration (PGA) on rock from a large earthquake with a ten-percent probability of exceedance in 50 years is as high as 0.16*g.* For the two-percent probability of exceedance in 50 years, the PGA is as high as 0.37*g* for the site.

The a ten-percent probability of exceedance in 50 years event has a return period of 475 years, and the 0.16*g* acceleration for this event corresponds to "strong" perceived shaking with "light" potential damage based on instrument intensity correlations. The two-percent probability of exceedance in 50 years event has a return period of 2475 years, and the 0.37*g* acceleration for this event corresponds to "severe" perceived shaking with "moderate to heavy" potential damage based on instrument intensity correlations (Wald and others, 1999).

Future ground accelerations greater than these are possible at the site but will have a lower probability of occurrence.

5.7.5 Seismic Design Category

The Seismic Design Categories in the International Residential Code (IRC 2018 Table R301.2.2.1.1) are based upon the Site Class as addressed in section **5.7.3**, **Soil Class**. For Site Class D (default) at site grid coordinates

[1]American Society of Civil Engineers

of 41.2442 degrees north latitude and 111.7838 degrees west longitude, $\mathbf{S_{DS}}$ is 0.662 and the **Seismic Design Category** is D_1.

5.7.6 Liquefaction

In conjunction with the ground shaking potential of large magnitude seismic events as discussed previously, certain soil units may also possess a potential for liquefaction during a large magnitude event. Liquefaction is a phenomenon whereby loose, saturated, granular soil units 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 settlements of overlying layers after an earthquake as excess pore water pressures are dissipated. Horizontally continuous liquefied layers may also have a potential to spread laterally where sufficient slope or free-face conditions exist. The primary factors affecting liquefaction potential of a soil deposit are: (1) magnitude and duration of seismic ground motions; (2) soil type and consistency; and (3) occurrence and depth to groundwater.

Liquefaction potential hazards have not been studied or mapped for the Ogden Valley area, as has occurred in other parts of northern Utah (Anderson and others 1994). Liquefaction commonly occurs in saturated non-cohesive soils such as stream alluvium, which conditions are not found on the site, consequently the conditions susceptible to liquefaction do not appear to be present at the site within the depths penetrated.

5.7.7 Tectonic Subsidence

Tectonic subsidence is surface tilting subsidence that occurs along the boundaries of normal faults in response to surface-faulting earthquakes (Keaton, 1986). Because the site is not located in near proximity to active earthquake faults, tectonic subsidence hazards are not considered a risk to the site.

5.8 Landslide and Slump Deposits

The nearest potentially active (Holocene-age) landslide units are mapped as **Qms** deposits by King and others (2008), and are located along the north margin of the site as shown on **Figure 3** and **Figure 5**. As located on the margin of the property upon steeper sloping areas, this landslide feature should be avoided for any construction and site grading improvements for the proposed subdivision development and use.

5.9 Sloping Surfaces

The surface slopes of the site vicinity developed from our LiDAR analysis and shown on **Figure 4** range from near-level to over 30-percent. For the subject property the average slope gradients were calculated to be 30.9 percent, with site slopes less than 25-percent primarily less than 25-percent occurring on the south side of the property. The limiting steep slope gradients for development considerations according to the Weber County Code is 25-percent (Weber County Code, 2022). The areas on the site in excess of 25-precent slope should be avoided for any construction and site grading improvements for the proposed subdivision development and use.

A geological cross sections was drawn for the critical/representative site slope to dimension the cross-sectional geology underlying the site and the steep slope and hazard areas. This cross section line location is shown on Figure 5 as line *A-A'*, and is illustrated on **Figure 14, Geologic Cross Section Line *A-A'***. This cross sections was used for the development of our slope stability modeling discussed in **Section 7.0** of this report.

5.10 Alluvial Fan - Debris Flow Processes

The nearest potential debris flow process deposits to the site are mapped as **Qafy** by King and others (2008), and occur approximately 2150 feet to the southwest of the site. As located these deposits and processes do not appear to be a potential impact to the proposed Lot 15R site.

5.11 Flooding Hazards

No significant water ways recognized by Federal Emergency Management (FEMA) pass in the vicinity of the site, and flood insurance rate mapping by Federal Emergency Management Agency for the site vicinity has not been prepared for this area at this time (FEMA, 2015).

Local sheet flow, slope wash, and seasonally perched soil water typical of sloping areas should be anticipated for the site, and site improvements.

5.12 Rockfall and Avalanche Hazards

The site is not located down-slope from steep slope areas where such hazards may originate.

6.0 LABORATORY TESTING

6.1 General

Selected samples of the subsurface soils were subjected to various laboratory tests to assess pertinent engineering properties, as follows:

1. Moisture Content, ASTM D-2216, Percent moisture representative of field conditions
2. Dry Density, ASTM D-2937, Dry unit weight representing field conditions
3. Atterberg Limits, ASTM D-4318, Plasticity and workability
4. Gradation Analysis, ASTM D-1140/C-117, Grain Size Analysis
5. One Dimension Consolidation, ASTM D-2435, Consolidation properties
6. Direct Shear Test, ASTM D-3080, Shear strength parameters

6.2 Lab Summary

Laboratory test results are presented in the following Lab Summary table:

Lab Summary Table

Test Pit	Depth (feet)	Sample Type	Soil Class	Moisture Content (%)	Dry Density (pcf)	Gradation			Atterberg Limits		
						Grav.	Sand	Fines	LL	PL	PI
TP-1	2.5	Bag	SM	12.5				28.5			NP
	5	Bag	ML	24.6				98.1			NP
TP-2	2.5	Block	Fill/CL	16	88			66.6			
	5	Block	Fill/CL	16.2	90						
	7.5	Block	SM/ML	21.4	83	2	52	45.7			NP
	10	Block	CL	22.2					40	19	21
TP-3	2	Block	Fill/CL	12	94						
	10	Bag	ML-SM	10.4				58.9			NP

6.3 Consolidation Tests

To provide data necessary for our settlement analyses, a consolidation test was performed on each of two representative samples of the existing fill soil sequence encountered at test pits TP2 and TP-3 within the upper about 5 feet.

The results of the tests indicate these soils are low to moderately over-consolidated, exhibit low to moderate strength characteristics and are moderate to high compressibility characteristics under additional loading indicative of variable and often poor engineering properties. Detailed results of the consolidation tests are maintained within our files and can be transmitted to you upon request.

6.4 Direct Shear Test

To determine the shear strength of the soils encountered at the site, a direct shear test was performed on two representative samples of the subsurface soil from the test pits.

During the direct shear test, the samples were evenly consolidated within the test ring, loaded, and saturated immediately after the load was applied. Loading was conducted at a slower rate to simulate saturated-drained condition. The results of the direct shear tests are presented in the following table:

Direct Shear Results

Sample Location	Sample Depth (feet)	Sample Type	Unified Soils Classification	Apparent Cohesion (psf)	Measured Internal Friction Angle (degrees)
TP-2	10	Remolded	CL	527	30.8
TP-3	4	Undisturbed	Fill/Sandy CL	481	35.4

7.0 SLOPE STATILITY

7.1 General

In conjunction with our study, a slope stability analysis was conducted on the above referenced cross sections A-A'. Groundwater was projected to be 15 to 20 feet below the ground surface across the site property in the analysis. A continuous building load of 1,500 pounds per square foot was also added across the roughly 60-foot-wide flat area along the south portion of the property directly north of 1100 South Street.

7.2 Input Parameters

Laboratory tests were completed on samples of the surface fill and natural soils encountered with our explorations. The properties of the natural soils encountered at the test pit locations were estimated using laboratory testing and our experience with similar soils. Accordingly, we estimated the following parameters for use in the stability analyses:

Material	Internal Friction Angle (degrees)	Apparent Cohesion (psf)	Unit Weight (pcf)*
TN Norwood Formation	30.8	450	125*
Undocumented Fill	35	200	120*
Qms	20*	200*	120*

* Estimated

To evaluate the slope stability under seismic (pseudostatic) conditions, the peak horizontal acceleration was queried for the site. For the seismic (pseudostatic) analysis, a peak horizontal ground acceleration of 0.45*g* after adjusting for Site Class D was obtained for site (grid) locations of 41.244239 degrees north latitude and 111.783874 degrees west longitude. A seismic (pseudostatic) horizontal acceleration was obtained by dividing the peak acceleration in half. Accordingly, a value of 0.225g was used as the pseudostatic coefficient for the stability analysis.

7.3 Stability Analyses

We evaluated the global stability of the referenced cross section A-A, shown as **Figure 10 Geologic Cross Section** and located on **Figure 5 Site Evaluation** using the computer program *SLIDE*. This program uses a limit equilibrium (Simplified Bishop) method for calculating factors of safety against sliding on an assumed failure surface and evaluates numerous potential failure surfaces, with the most critical failure surface identified as the one yielding the lowest factor of safety.

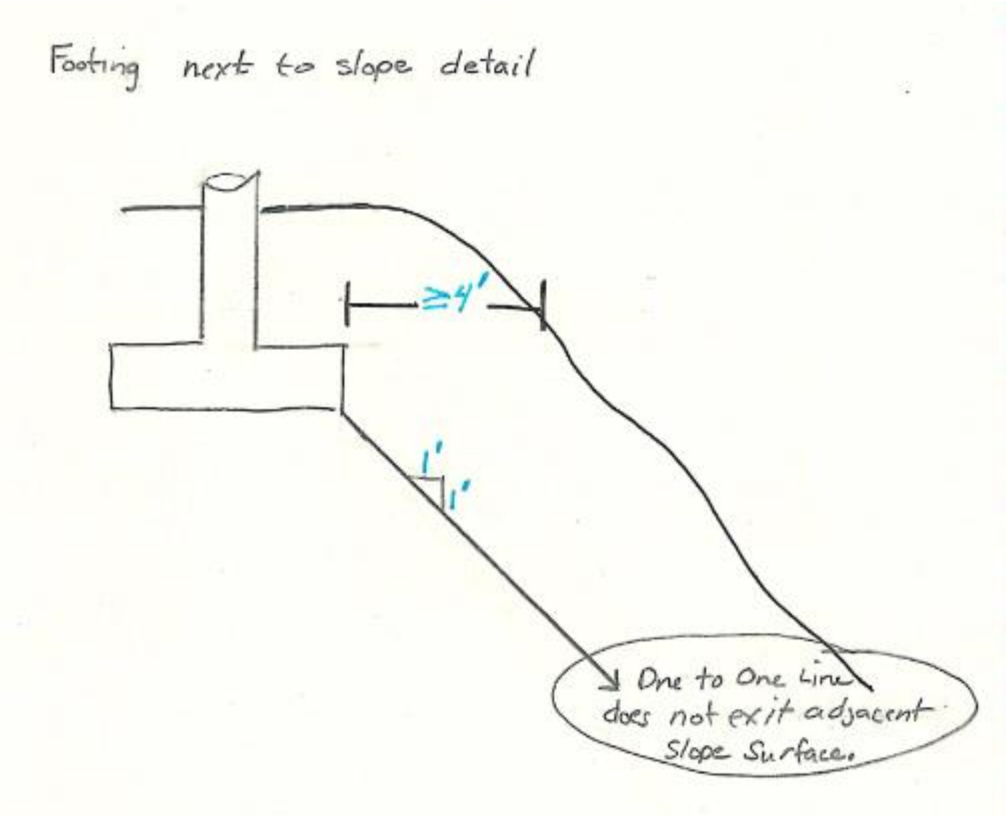
Typically, the required minimum factors of safety are 1.5 for static conditions and 1.0 for seismic (pseudostatic) conditions. The results of our analyses utilizing the estimated soil properties described previously, provides suitable stability for static and seismic conditions with respect to current planned grading. The results of our slope stability analyses are summarized below and graphically on the attached **Figures 11 and 12**.

For each cross section, the lowest factor of safety results are given in the following table below.

Slope Cross Section	Condition	Seismic Coefficient	Lowest Factor of Safety (F.S.)	Minimum Allowable F.S.
A-A	Static	---	2.204	1.5
A-A	Seismic	.225	1.151	1.0

Slope movements or even failure can occur if the slope soils are undermined or become saturated. Any retaining walls must be properly engineered and maintained to provide stability of the slopes. Home construction should be placed with the upper flat area along the south and roughly about 60 feet wide portion directly north of 1100 South Street.

Foundations near slopes must be embedded such that an imaginary line, no steeper than one horizontal to one vertical drawn from the outside edge of the footing, does not exit the adjacent slope and the edge of footing be a minimum 4 feet horizontal away from the slope face (see hand sketch below). Unbraced slopes at the site must not be steepened to more than about 4 horizontal to 1 vertical (4H:1V).



All retaining walls at the site must be properly engineered. Rockery walls less than 4 feet in height with adjacent tiers separated by at least 2 times the height of the tallest wall, may be considered as landscaping walls.

Prior to construction CMT must be provided with the building layouts and site grading information. In addition, during construction, CMT must observe grading to ensure suitable soil conditions are encountered and more particularly engineered retaining wall construction. Following grading at the site, we recommend the disturbed slope surface be revegetated as soon as possible to limit erosion.

8.0 SITE PREPARATION AND GRADING

8.1 Site Preparation

Initial site preparation will consist of the removal of surface vegetation, topsoil, and other deleterious materials from beneath an area extending out at least 3 feet from the perimeter of the proposed residence, and 2 feet beyond exterior flatwork areas. Surface vegetation and other deleterious materials should generally be removed from the site. Topsoil, although unsuitable for utilization as structural fill or site grading fill below foundations, floor slabs, or exterior concrete flatwork, may be stockpiled for subsequent landscaping purposes.

Non-engineered fills was observed at the surface of test pits TP-2 and TP-3 up to 7.5 feet thick. All non-engineered fill must be removed below footing and floor slab areas, but may remain below exterior flatwork areas if: free of debris and deleterious materials, properly prepared, and subsequent structural site grading fills placed over the prepared existing fill are not more than about 2 feet thick. Proper preparation of existing fills below pavements/flatwork will consist of removal of the upper 12 inches, scarification of the exposed surface to a minimum depth of 8 inches, moisture conditioning to within ±2% of optimum moisture and re-compacting the scarified soils to the requirements for structural fill given in **Section 7.4**, below. The removed 12 inches, if meeting the criteria given above, may then be replaced in similarly compacted lifts. Even with proper preparation, flat work over some remaining thickness of non-engineered fill may experience some settlement over time. If this is not acceptable, then more conservative efforts such as deeper preparation and/or the entire sequence of non-engineered removed and replaced with structural fill.

Subsequent to stripping and prior to the placement of structural site grading fill, driveways, and garage slabs on grade, the prepared subgrade must be proof rolled by passing moderate-weight rubber tire-mounted construction equipment over the surface at least twice. If excessively soft or loose soils are encountered below footings they must be completely removed. If required removal depth below footings is greater than 2 feet CMT must be notified to provide further recommendations. Below driveways and slabs on grade, they must be removed to a maximum depth of 2 feet and replaced with structural fill. Existing fills must be handled as described above.

The site should be examined by a CMT geotechnical engineer to assess that suitable natural soils have been exposed and any deleterious materials, loose and/or disturbed soils/undocumented fill have been removed/properly prepared, prior to placing site grading fills, footings, and slabs.

8.2 Temporary Excavations

Temporary excavations up to 8 feet deep in fine-grained cohesive soils, above the water table, may be constructed with side slopes no steeper than one-half horizontal to one vertical (0.5H:1V).

For granular (cohesionless) soils, construction excavations above the water table, not exceeding 4 feet, should be no steeper than one-half horizontal to one vertical (0.5H:1V). For excavations up to 8 feet, in granular soils and above the water table, the slopes should be no steeper than one horizontal to one vertical (1H:1V). Excavations encountering saturated cohesionless soils will be very difficult and will require very flat side slopes and/or shoring, bracing, and dewatering. Excavations deeper than about 8 feet are not anticipated at the site.

To reduce disturbance of the natural soils during excavation, we recommend that smooth edge or short teeth buckets/blades be utilized.

All excavations must be inspected periodically by qualified personnel. If any signs of instability or excessive sloughing are noted, immediate remedial action must be initiated. All excavations should be made following OSHA safety guidelines.

8.3 Structural Fill Material

Structural fill is defined as all fill which will ultimately be subjected to structural loadings, such as imposed by footings, floor slabs, pavements, etc. Structural fill will be required as backfill over foundations and utilities, as site grading fill, and possibly as replacement fill below footings. All structural fill must be free of sod, rubbish, topsoil, frozen soil, and other deleterious materials.

The following table contains our recommendations for the various fill types we anticipate will be used at this site:

Fill Material Type	Description/Recommended Specification
Select Structural Fill	Placed below structures, flatwork and pavement. Imported structural fill should consist of well-graded sand/gravel mixture, with maximum particle size of 4 inches, a minimum 70% passing 3/4-inch sieve, a maximum 20% passing the No. 200 sieve, and a maximum Plasticity Index of 10.
Site Grading Fill	Placed over larger areas to raise the site grade. Sandy to gravelly soil, with a maximum particle size of 6 inches, a minimum 70% passing 3/4-inch sieve, and a maximum 50% passing No. 200 sieve.
Non-Structural Fill	Placed below non-structural areas, such as landscaping. On-site soils or imported soils, with a maximum particle size of 8 inches, including silt/clay soils not containing excessive amounts of degradable/organic material.
Stabilization Fill	Placed to stabilize soft areas prior to placing structural fill and/or site grading fill. Coarse angular gravels and cobbles 1 inch to 8 inches in size. May also use 1.5- to 2.0-inch gravel placed on stabilization fabric, such as Mirafi RS280i, or equivalent (see **Section 8.6**).

Natural soils (except topsoil) and existing fill soils may be used as site grading fill outside of the residence footprint and as non-structural fill if free of deleterious material and processed to meet the criteria provided herein. Please note that fine grained soils are inherently difficult to properly moisture prepare and compact as structural fill. This may be extremely difficult to near impossible during cold and wet periods of the year.

All fill material should be approved by a CMT geotechnical engineer prior to placement.

8.4 Fill Placement and Compaction

The various types of compaction equipment available have their limitations as to the maximum lift thickness that can be compacted. For example, hand operated equipment is limited to lifts of about 4 inches and most "trench compactors" have a maximum, consistent compaction depth of about 6 inches. Large rollers, depending on soil and moisture conditions, can achieve compaction at 8 to 12 inches. The full thickness of each lift should be compacted to at least the following percentages of the maximum dry density as determined by ASTM D-1557 (or AASHTO[2] T-180) in accordance with the following recommendations:

Location	Total Fill Thickness (feet)	Minimum Percentage of Maximum Dry Density
Beneath an area extending at least 3 feet beyond the perimeter of structures, and 2 feet beyond flatwork and pavement (applies to structural fill and site grading fill)	0 to 5 5 to 10	95 98
Site grading fill outside area defined above	0 to 5 5 to 10	92 95
Utility trenches within structural areas	--	96
Existing fill preparation	0-18 inches	93
Roadbase and subbase	-	96
Non-structural fill	0 to 5 5 to 10	90 92

Structural fills greater than 10 feet thick are not anticipated at the site. For best compaction results, we recommend that the moisture content for structural fill/backfill be within 2% of optimum. Field density tests should be performed on each lift as necessary to verify that proper compaction is being achieved.

8.5 Utility Trenches

For the bedding zone around the utility, we recommend utilizing sand bedding fill material that meets current APWA[3] requirements.

[2] American Association of State Highway and Transportation Officials
[3] American Public Works Association

Most utility companies and local governments are requiring Type A-1a or A-1b (AASHTO Designation) soils (sand/gravel soils with limited fines) be used as backfill over utilities within public rights of way, and the backfill be compacted over the full depth above the bedding zone to at least 96% of the maximum dry density as determined by AASHTO T-180 (ASTM D-1557).

Where the utility does not underlie structurally loaded facilities and public rights of way, on-site fill and natural soils may be utilized as trench backfill above the bedding layer, provided they are properly moisture conditioned and compacted to the minimum requirements stated above in **Section 8.4**.

8.6 Stabilization

The fine-grained soils at this site will likely be susceptible to rutting and pumping. The likelihood of disturbance or rutting and/or pumping of the existing natural soils is a function of the soil moisture content, the load applied to the surface, as well as the frequency of the load. Consequently, rutting and pumping can be minimized by avoiding concentrated traffic, minimizing the load applied to the surface by using lighter equipment and/or partial loads, by working in drier times of the year, or by providing a working surface for the equipment. Rubber-tired equipment particularly, because of high pressures, promotes instability in moist/wet, soft soils.

To stabilize soft subgrade conditions (if encountered), a mixture of coarse, clean, angular gravels and cobbles and/or 1.5- to 2.0-inch clean gravel should be utilized, as indicated above in **Section 6.3**. This coarse material may be placed and worked into the soft soils until firm and non-yielding or the soft soils removed an additional, minimum of 18 inches, and backfilled with the clean stabilizing fill. A test area should be implemented to achieve a proper stabilization strategy. Often the amount of gravelly material can be reduced with the use of a geotextile fabric such as Mirafi RS280i or equivalent. Its use will also help avoid mixing of the subgrade soils with the gravelly material. After excavating the soft/disturbed soils, the fabric should be spread across the bottom of the excavation and up the sides a minimum of 18 inches. Otherwise, it should be placed in accordance with the manufacturer's recommendation, including proper overlaps. The gravel material can then be placed over the fabric in compacted lifts as described above.

9.0 LATERAL EARTH PRESSURES

We project that basement walls up to 10 feet tall may be constructed at this site. The lateral earth pressure values given below anticipate that existing soils will be used as backfill material, placed and compacted in accordance with the recommendations presented herein. If other soil types will be used as backfill, we should be notified so that appropriate modifications to these values can be provided, as needed.

The lateral pressures imposed upon subgrade facilities will depend upon the relative rigidity and movement of the backfilled structure. Following are the recommended lateral pressure values, which also assume that the soil surface behind the wall is horizontal and that the backfill within 3 feet of the wall will be compacted with hand-operated compacting equipment. Where we do not anticipate proposed wall to be greater than 12 feet high, employing a seismic at-rest lateral earth pressure for design is not needed.

CONDITION	STATIC (psf/ft)*	SEISMIC (psf/ft)**
Active Pressure (wall is allowed to yield, i.e. move away from the soil, with a minimum 0.001H movement/rotation at the top of the wall, where "H" is the total height of the wall)	40	21
At-Rest Pressure (wall is not allowed to yield)	60	N/A
Passive Pressure (wall moves into the soil)	250	115

*Equivalent Fluid Pressure (applied at 1/3 Height of Wall)
**Equivalent Fluid Pressure (added to static and applied at 1/3 Height of Wall)

10.0 FOUNDATION RECOMMENDATIONS

The following recommendations have been developed on the basis of the previously described project characteristics, including the maximum loads discussed in **Section 3.0 Description of Proposed Construction**, the subsurface conditions observed in the field and the laboratory test data, and standard geotechnical engineering practice.

10.1 Foundation Design

Based on our geotechnical engineering analyses, the proposed residential structure may be supported upon conventional spread and/or continuous wall foundations constructed on suitable natural, stable soils or select structural fill extending to suitable natural soils. Footings may be designed using a net bearing pressure of 1,500 psf.

The term "net bearing pressure" refers to the pressure imposed by the portion of the structure located above lowest adjacent final grade, thus the weight of the footing and backfill to lowest adjacent final grade need not be considered. The allowable bearing pressure may be increased by 1/2 for temporary loads such as wind and seismic forces.

We also recommend the following:

1. Exterior footings subject to frost should be placed at least 30 inches below final grade.
2. Interior footings not subject to frost should be placed at least 16 inches below grade.
3. Continuous footing widths should be maintained at a minimum of 18 inches.
4. Spot footings should be a minimum of 24 inches wide.

10.2 Installation

Under no circumstances shall the footings be established upon non-engineered fills, loose or disturbed soils, topsoil, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water. If unsuitable soils are encountered, they must be completely removed and replaced with compacted, select structural fill.

The width of structural replacement fill below footings should be equal to the width of the footing plus one foot for each foot of fill thickness. For instance, if the footing width is 2 feet and the structural fill depth beneath the footing is 2 feet, the fill replacement width should be 4 feet, centered beneath the footing.

Foundations near slopes must be embedded such that an imaginary line, no steeper than one horizontal to one vertical drawn from the outside edge of the footing, does not exit the adjacent slope and the edge of footing be a minimum 4 feet horizontal away from the slope face.

10.3 Estimated Settlement

Foundations designed and constructed in accordance with our recommendations could experience some settlement, but we anticipate that total settlements of footings founded as recommended above will not exceed 1 inch. We expect approximately 50% of the total settlement to initially take place during construction.

10.4 Lateral Resistance

Lateral loads imposed upon foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the footings and the supporting soils. In determining frictional resistance, a coefficient of 0.3 may be utilized for natural soils and 0.4 for imported, select granular structural fill. Passive resistance provided by properly placed and compacted granular structural fill above the water table may be considered equivalent to a fluid with a density of 250 pounds per cubic foot.

A combination of passive earth resistance and friction may be utilized provided that the passive component of the total is divided by 1.5.

11.0 FLOOR SLABS

Floor slabs may be established upon suitable, undisturbed, natural soils and/or on structural fill extending to suitable natural soils (same as for foundations). Under no circumstances shall floor slabs be established directly on any topsoil, undocumented fills, loose or disturbed soils, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water.

In order to facilitate curing of the concrete, it is recommended that floor slabs be directly underlain by at least 4 inches of “free-draining” fill, such as “pea” gravel or three-quarters to one-inch minus clean gap-graded gravel. To help control normal shrinkage and stress cracking, the floor slabs may include the following features:

1. Adequate reinforcement for the anticipated floor loads with the reinforcement continuous through interior floor joints;
2. Frequent crack control joints; and
3. Non-rigid attachment of the slabs to foundation walls and bearing slabs.

12.0 DRAINAGE RECOMMENDATIONS

12.1 General Drainage Recommendations

It is very important to the long-term performance of foundations and floor slabs that water not be allowed to collect near the foundation walls and infiltrate into the underlying soils. We recommend the following:

1. All areas around the proposed residence should be sloped to provide drainage away from the foundations. We recommend a minimum slope of 6 inches in the first 10 feet away from the structure.

2. All roof drainage should be collected in rain gutters with downspouts designed to discharge at least 10 feet from the foundation walls or well beyond the backfill limits, whichever is greater.

3. Adequate compaction of the foundation backfill should be provided. We suggest a minimum of 90% of the maximum laboratory density as determined by ASTM D-1557. Water consolidation methods should not be used under any circumstances.

4. Sprinklers should be aimed away and kept at least 4 feet from the foundation walls. The sprinkling systems should be designed with proper drainage and be well-maintained. Over watering should be avoided.

5. Other precautions may become evident during construction.

12.2 Subdrains

12.2.1 General

Due to the potential for random perched groundwater conditions within the layered subsurface soil sequence, and the sublevel located on a general sloping area, and water that could migrate in more permeable subsurface soil layers, which may occur against sublevel foundations, it is recommended that a foundation drain be installed around the home.

12.2.2 Foundation Subdrains

Foundation subdrains should consist of a 4-inch diameter perforated or slotted plastic or PVC pipe enclosed in clean gravel comprised of three-quarter- to one-inch minus gap graded gravel and/or “pea” gravel. The invert of a subdrain should be at least 18 inches below the top of the lowest adjacent habitable floor slab. The gravel portion of the drain should extend 2 inches laterally and below the perforated pipe and at least 1 foot above the top of the lowest adjacent floor slab. The gravel zone must be installed immediately adjacent to the perimeter footings and the foundation walls. To reduce the possibility of plugging, the gravel must be wrapped with a geotextile, such as Mirafi 140N or equivalent.

Above the foundation subdrain, a minimum 12-inch-wide zone of “free-draining” clean sand or gravel (chimney) should be placed adjacent to the foundation walls and extend to within 2 feet of final grade. The sand/gravel fill must be separated from adjacent native or backfill soils with geotextile fabric (Mirafi 140N or equivalent). The upper 2 feet of soils should consist of a compacted clayey soil cap to reduce surface water infiltration into the drain. As an alternative to the zone of permeable sand or gravel, a prefabricated "drainage board," such as Miradrain or equivalent, may be placed against the exterior below-grade walls. Prior to the installation of the footing subdrain, the below-grade walls should be damp proofed. The slope of the subdrain should be at least 0.3 percent. The foundation subdrains shall be discharged to down-gradient location well away from the home.

13.0 QUALITY CONTROL

We recommend that CMT be retained to as part of a comprehensive quality control testing and observation program to help facilitate implementation of our recommendations and to address any subsurface conditions encountered which vary from those described in this report saving both time and expense. Without such a program CMT cannot be responsible for application of our recommendations to subsurface conditions which may vary from those described herein. This may include but not necessarily be limited to the following:

13.1 Field Observations

Observations should be completed during all phases of construction such as site preparation, foundation excavation, structural fill placement and concrete placement.

13.2 Fill Compaction

Compaction testing by CMT is required for all structural supporting fill materials. Maximum Dry Density (Modified Proctor/ASTM D-1557) tests should be requested by the contractor immediately after delivery of any granular fill materials. The maximum density information should then be used for field density tests on each lift as necessary to ensure that the required compaction is being achieved.

14.0 LIMITATIONS

The recommendations provided herein were developed by evaluating the information obtained from the test pits and site exploration. The exploration data reflects the subsurface conditions only at the specific locations at the particular time designated on the test pit logs. Soil and ground water conditions may differ from conditions encountered at the actual exploration locations. The nature and extent of any variation in the explorations may not become evident until during the course of construction. If variations do appear, it may become necessary to re-evaluate the recommendations of this report after we have observed the variation.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

We appreciate the opportunity to be of service to you on this project. CMT offers a full range of Geotechnical Engineering, Geological, Material Testing, Special Inspection services, and Phase I and II Environmental Site Assessments. With four offices throughout Northern Utah, and in Arizona, our staff is capable of efficiently serving your project needs. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at (801) 590-0394. To schedule materials testing please call (801) 908-5859.

15.0 REFERENCES

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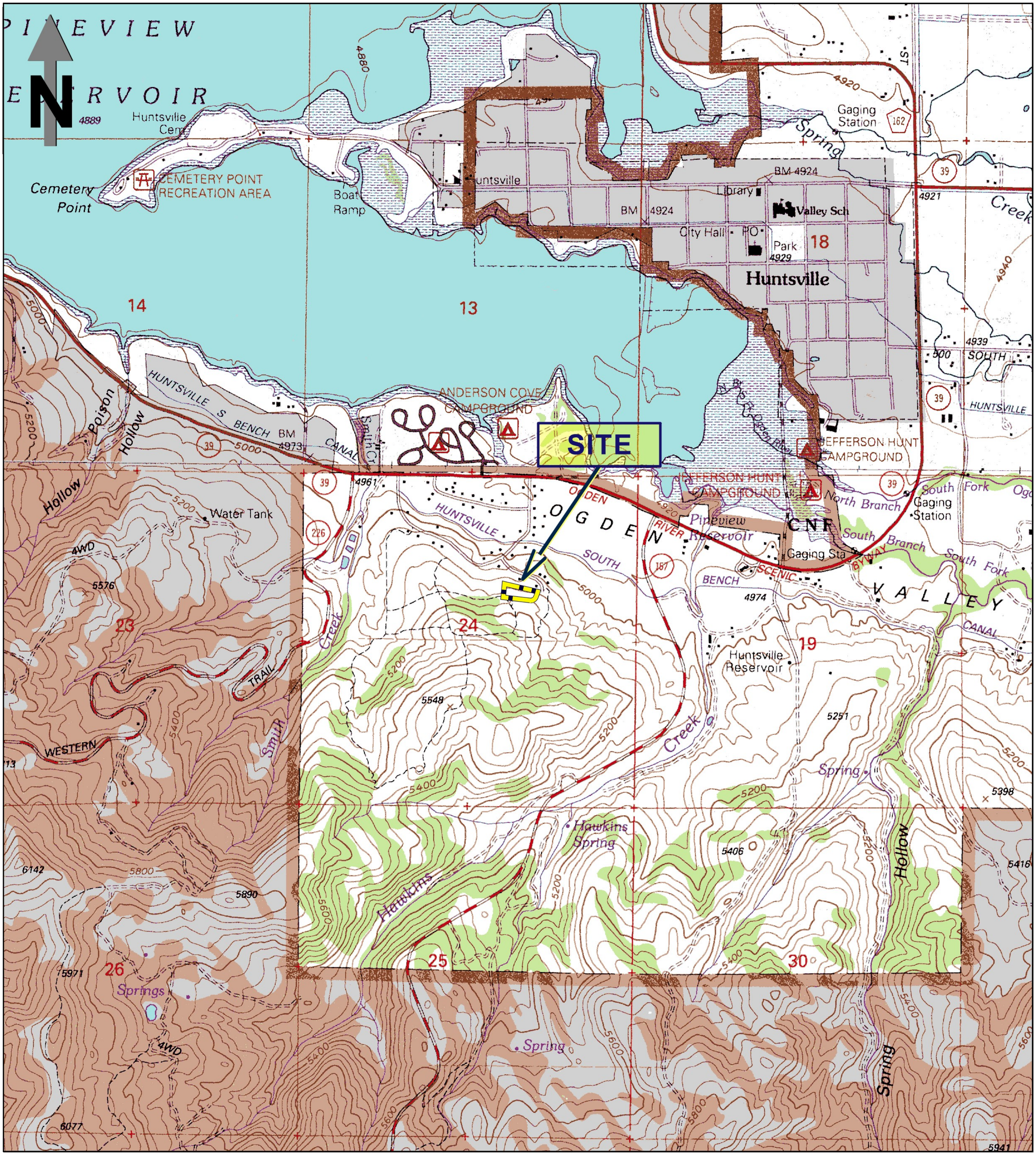
APPENDIX

SUPPORTING DOCUMENTATION

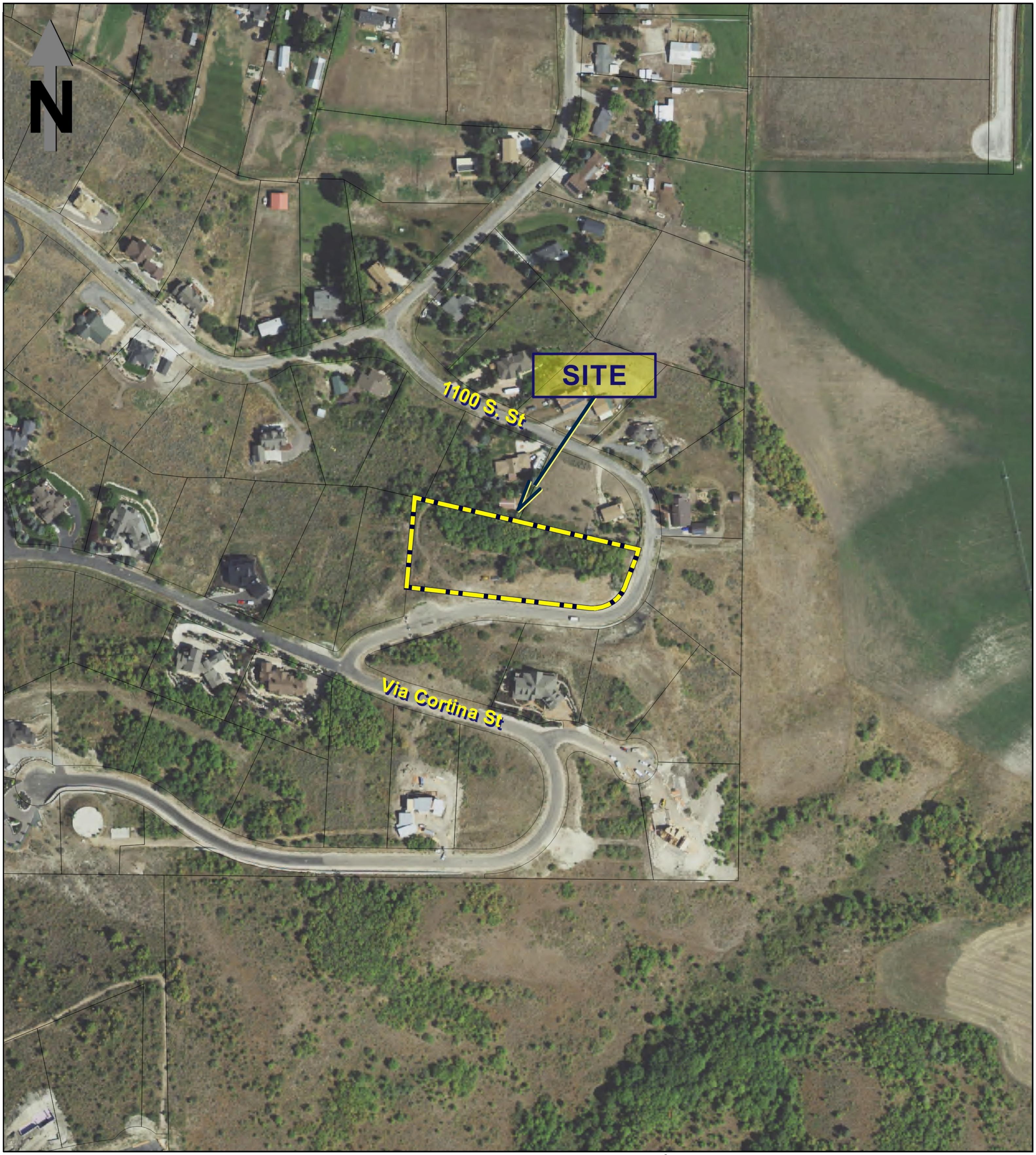


Base:
1998 7.5 Minute USGS Toporgraphic Maps
Titled Snowbasin, Utah, and Huntsville, Utah.

0 2000 4000 ft

1:24,000

Hansen Property 6875 East 1100 South Huntsville, Weber County, Utah	CMT ENGINEERING LABORATORIES Vicinity Map	Date: 21 Dec.-22 CMT No.: 19413	Figure 1

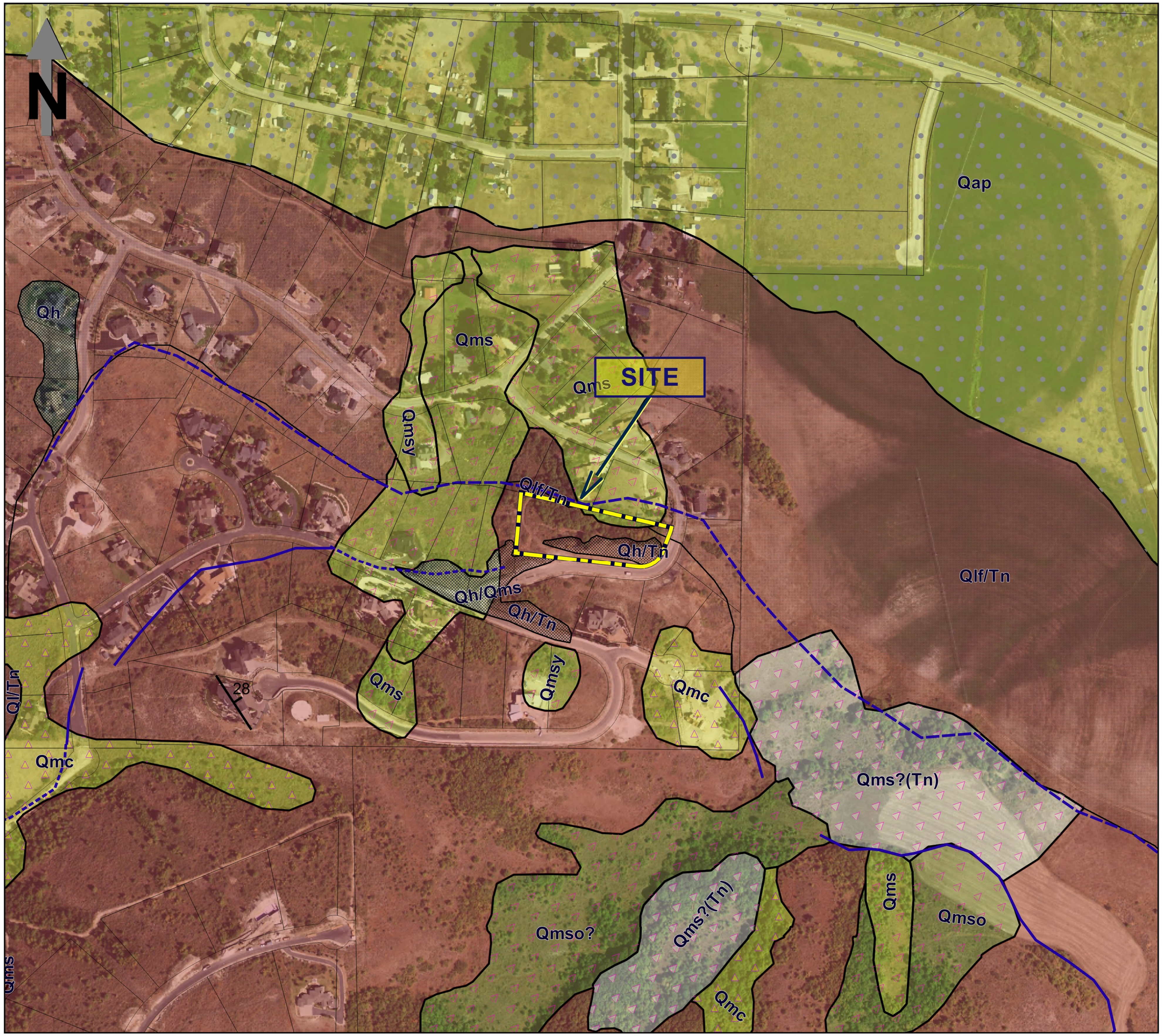


Base:
2021 0.6m NAIP Orthoimagery
from Utah UGRC; http://gis.utah.gov/

0 300 600 ft

1:3,600

Hansen Property 6875 East 1100 South Huntsville, Weber County, Utah	CMT ENGINEERING LABORATORIES Site Plan	Date: 21 Dec.-22 CMT No.: 19413	Figure 2



Explanation

(Mapping after King and others, 2008)

- Qh - Human disturbance (Historical) - Obscures original deposits by cover or removal...
- Qh/Qms - Human disturbance, fills (Historical) over landslide and slump deposits (Holocene and Pleistocene) - Poorly sorted clay- to boulder-sized material...Human disturbance (Historical) - Obscures original deposits by cover or removal...
- Qh/Tn - Human disturbance, fills (Historical) over Norwood Formation (lower Oligocene and upper Eocene) - Typically light-gray to light brown, altered tuff (claystone), tuffaceous siltstone, sandstone, and conglomerate...
- Qap - Lake Bonneville-age alluvium (upper Pleistocene) — Sand, silt, clay, and gravel in stream and alluvial-fan; height above present drainages appears to be related to shorelines of Lake Bonneville...
- Qmc - Landslide and slump, and colluvial deposits, undivided (Holocene and Pleistocene)...(slopewash and soil creep)...
- Qmsy - Younger landslide and slump deposits (Holocene) - Poorly sorted clay- to boulder-sized material...
- Qms - Landslide and slump deposits (Holocene and Pleistocene) - Poorly sorted clay- to boulder-sized material...
- Qmso? - Older landslide and slump deposits (Pleistocene) - Poorly sorted clay- to boulder-sized material...
- Qms?(Tn) - Block landslide and slump deposits (Pleistocene) - Comprised of underlying Norwood Formation (lower Oligocene and upper Eocene) rocks...
- Qlf/Tn - Lacustrine fine grained deposits (Pleistocene) - over Norwood Formation rocks...
- Tn- Norwood Formation (lower Oligocene and upper Eocene) - Typically light-gray to light brown, altered tuff (claystone), tuffaceous siltstone, sandstone, and conglomerate...

Shorelines

- Lake Bonneville Shoreline
- Lake Bonneville Shoreline - Inferred or Concealed
- Transgressional Lake Bonneville Shoreline

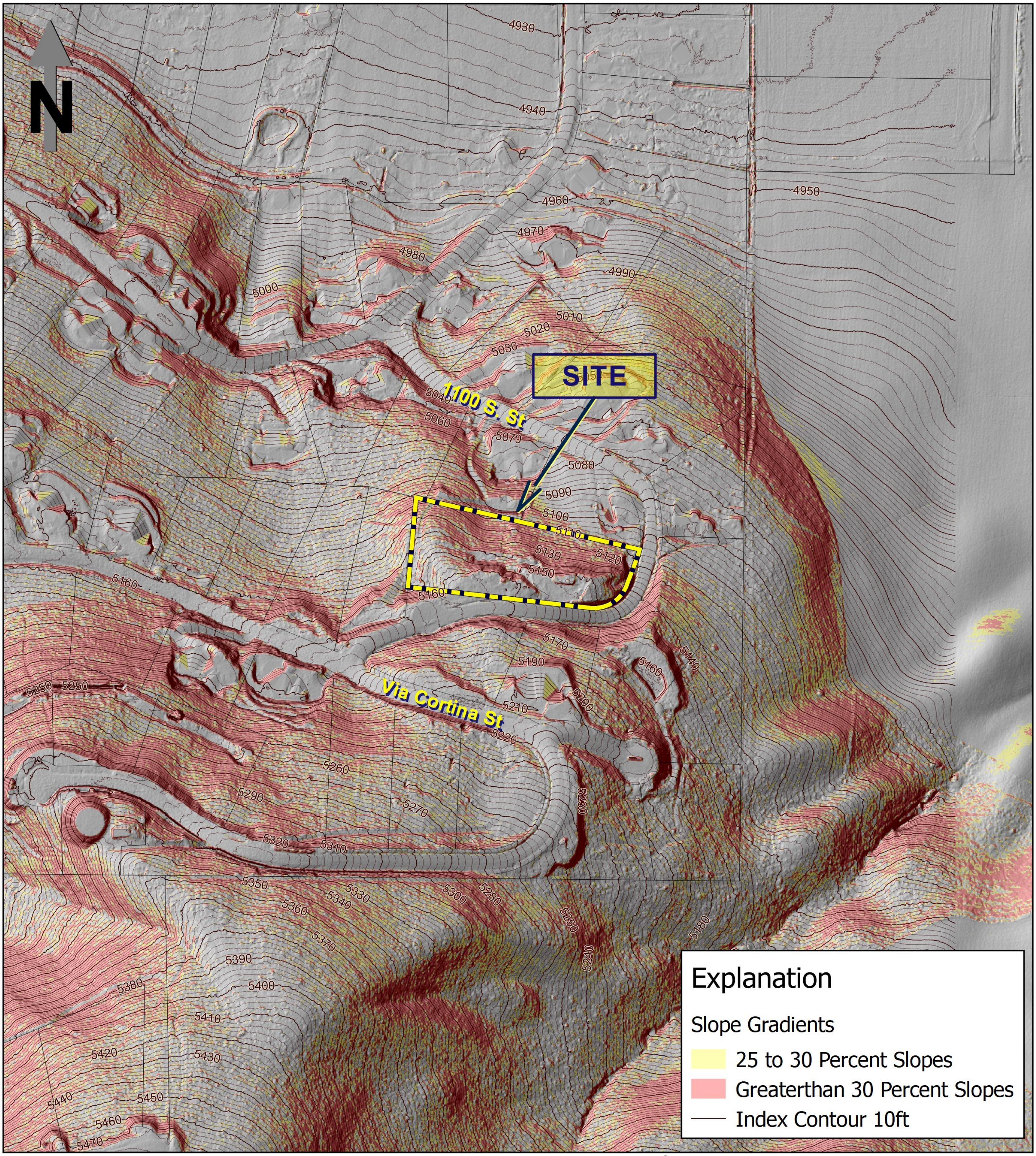
Strike and Dip of Beds

Base:
2021 0.6m NAIP Orthoimagery
from Utah UGRC; http://gis.utah.gov/

0 400 800 ft

1:4,800

CMT TECHNICAL SERVICES	Hansen Property 6875 East 1100 South Huntsville, Weber County, Utah	GEOLOGIC MAPPING	Date: 21 Dec.-22 CMT No.: 19413	Figure 3



Base:
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from Utah UGRC; http://gis.utah.gov/

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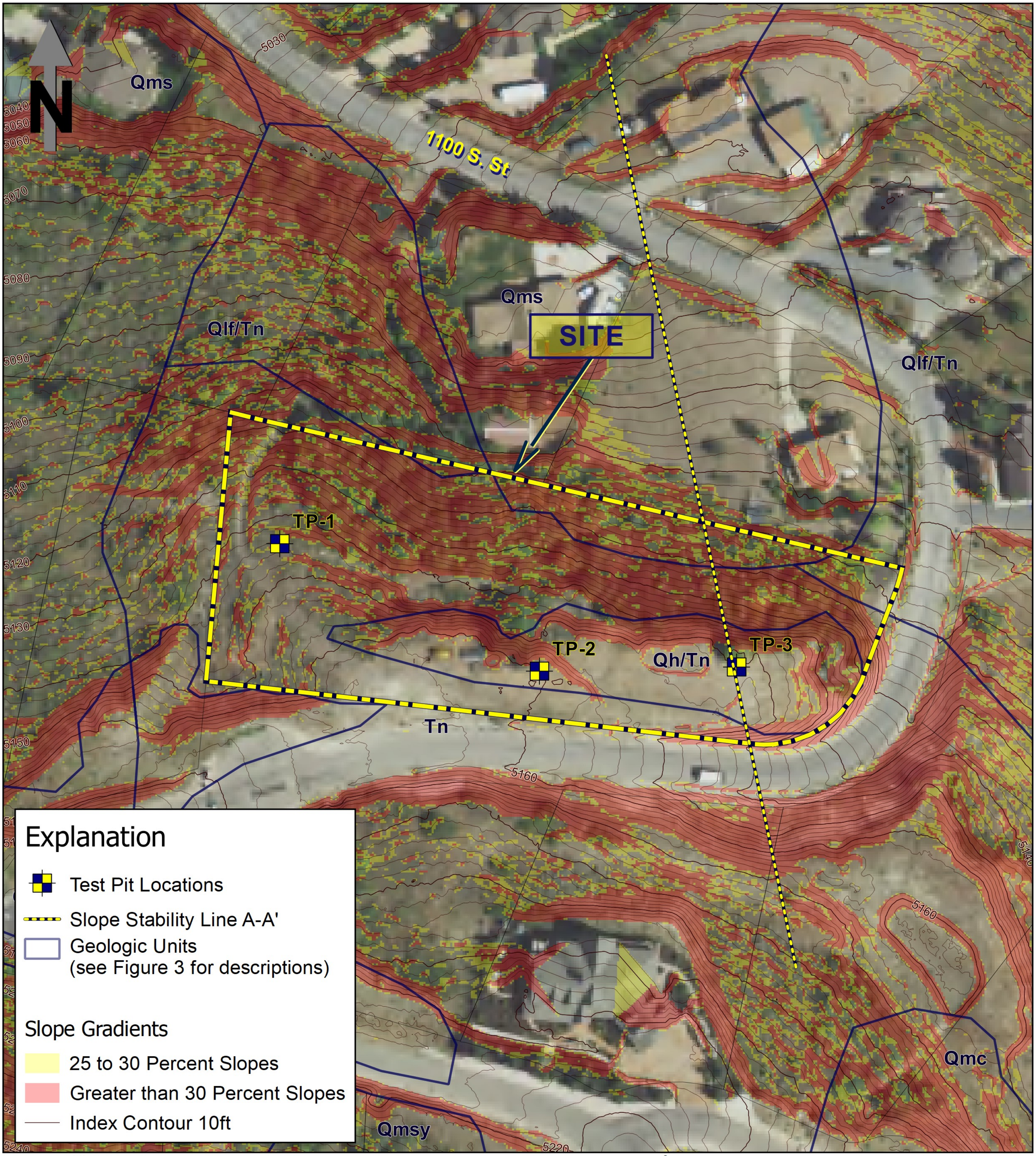
Hansen Property 6875 East 1100 South Huntsville, Weber County, Utah	CMT ENGINEERING LABORATORIES LiDAR Analysis	Date: 21 Dec.-22 CMT No.: 19413	Figure 4



Base:
2021 0.6m NAIP Orthoimagery
from Utah UGRC; http://gis.utah.gov/

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1:1,200

Hansen Property 6875 East 1100 South Huntsville, Weber County, Utah	CMT TECHNICAL SERVICES		Figure 5
	Site Evaluation	Date: 21 Dec.-22 CMT No.: 19413	

Hansen Property

About 6875 East 1100 South, Huntsville, Utah

Test Pit Log TP-1

Total Depth: 15'
Water Depth: (see Remarks)

Date: 10/24/22
Job #: 19413

Depth (ft)	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation: Gravel %	Sand %	Fines %	Atterberg: LL	PL	PI
0	Topsoil; brown silty sand with organics and roots										
1	Norwood Formation; Brown Silty Sand										
2	medium dense to dense		1	12.5				28.5		NP	NP
5	Brown SILT (ML) dry, stiff		2	24.6				98.1		NP	NP
13	Brown Cemented Silt and Sand (ML-SM) dry, hard										
14.5			3								
15	END AT 15'										

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Rubber Tire Backhoe
Excavated By: Blaine Hone
Logged By: Steve Laird

CMT TECHNICAL SERVICES

Figure: 6

Hansen Property

About 6875 East 1100 South, Huntsville, Utah

Test Pit Log — TP-2

Total Depth: 15'
Water Depth: (see Remarks)

Date: 10/24/22
Job #: 19413

Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation: Gravel %	Sand %	Fines %	Atterberg: LL	PL	PI
Topsoil; brown silty sand with organics and roots										
Fill; dark brown sandy clay with some gravel and roots — slightly moist, medium stiff										
		4	16	88			66.6			
		5	16.2	90						
Norwood Formation; Brown Silty Sand/Sandy Silt (— medium dense										
		6	21.4	83	2	52	45.7		NP	NP
Gray Brown Silty CLAY (CL) with sand — slightly moist, stiff										
		7	22.2					40	19	21
Brown Silty SAND (SM)										
		8								
END AT 15'										

Depth (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Rubber Tire Backhoe
Excavated By: Blaine Hone
Logged By: Steve Laird

CMT TECHNICAL SERVICES

Page: 1 of 1

Figure: 7

Hansen Property

About 6875 East 1100 South, Huntsville, Utah

Test Pit Log — TP-3

Total Depth: 15'
Water Depth: (see Remarks)

Date: 10/24/22
Job #: 19413

Depth (ft)	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation: Gravel %	Gradation: Sand %	Gradation: Fines %	Atterberg: LL	Atterberg: PL	Atterberg: PI
0	Topsoil; brown silty sand with organics and roots										
1	Fill; light brown to tan silty sandy clay with gravel and roots; dry, medium dense to dense										
2		■	9	11.9	94						
4	Fill; dark brown silty clay with gravel and roots; slightly moist, hard	■	10								
7.5	Norwood Formation; Brown Fine sandy Silt/Silty Fine Sand; dry, medium dense to dense										
10		◢	11	10.4				58.9		NP	NP
15	END AT 15'										

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Rubber Tire Backhoe
Excavated By: Blaine Hone
Logged By: Steve Laird

CMT TECHNICAL SERVICES

Figure: 8

Hansen Property

About 6875 East 1100 South, Huntsville, Utah

Key to Symbols

Date: 10/24/22

Job #: 19413

① Depth (ft)	② GRAPHIC LOG	③ Soil Description	④ Sample Type	⑤ Sample #	⑥ Moisture (%)	⑦ Dry Density(pcf)	⑧ Gradation: Gravel %	Sand %	Fines %	Atterberg: LL	PL	PI

COLUMN DESCRIPTIONS

Depth (ft.): Depth (feet) below the ground surface (including groundwater depth - see below right).

Graphic Log: Graphic depicting type of soil encountered (see below).

Soil Description: Description of soils, including Unified Soil Classification Symbol (see below).

Sample Type: Type of soil sample collected; sampler symbols are explained below-right.

Sample #: Consecutive numbering of soil samples collected during field exploration.

Moisture (%): Water content of soil sample measured in laboratory (percentage of dry weight).

Dry Density (pcf): The dry density of a soil measured in laboratory (pounds per cubic foot).

Gradation: Percentages of Gravel, Sand and Fines (Silt/Clay), obtained from lab test results of soil passing the No. 4 and No. 200 sieves.

Atterberg: Individual descriptions of Atterberg Tests are as follows:

LL = Liquid Limit (%): Water content at which a soil changes from plastic to liquid behavior.

PL = Plastic Limit (%): Water content at which a soil changes from liquid to plastic behavior.

PI = Plasticity Index (%): Range of water content at which a soil exhibits plastic properties (= Liquid Limit - Plastic Limit).

STRATIFICATION	
Description	**Thickness**
Seam	Up to ½ inch
Lense	Up to 12 inches
Layer	Greater than 12 in.
Occasional	1 or less per foot
Frequent	More than 1 per foot

MODIFIERS
Trace
<5%
Some
5-12%
With
> 12%

MOISTURE CONTENT
Dry: Absence of moisture, dusty, dry to the touch.
Moist: Damp / moist to the touch, but no visible water.
Wet: Visible water, usually soil below groundwater.

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS			USCS SYMBOLS	TYPICAL DESCRIPTIONS
COARSE-GRAINED SOILS More than 50% of material is larger than No. 200 sieve size.	GRAVELS The coarse fraction retained on No. 4 sieve.	CLEAN GRAVELS (< 5% fines)	GW	Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
			GP	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
		GRAVELS WITH FINES (≥ 12% fines)	GM	Silty Gravels, Gravel-Sand-Silt Mixtures
			GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	SANDS The coarse fraction passing through No. 4 sieve.	CLEAN SANDS (< 5% fines)	SW	Well-Graded Sands, Gravelly Sands, Little or No Fines
			SP	Poorly-Graded Sands, Gravelly Sands, Little or No Fines
		SANDS WITH FINES (≥ 12% fines)	SM	Silty Sands, Sand-Silt Mixtures
			SC	Clayey Sands, Sand-Clay Mixtures
FINE-GRAINED SOILS More than 50% of material is smaller than No. 200 sieve size.	SILTS AND CLAYS Liquid Limit less than 50%		ML	Inorganic Silts and Sandy Silts with No Plasticity or Clayey Silts with Slight Plasticity
			CL	Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
			OL	Organic Silts and Organic Silty Clays of Low Plasticity
	SILTS AND CLAYS Liquid Limit greater than 50%		MH	Inorganic Silts, Micacious or Diatomacious Fine Sand or Silty Soils
			CH	Inorganic Clays of High Plasticity, Fat Clays
			OH	Organic Silts and Organic Clays of Medium to High Plasticity
HIGHLY ORGANIC SOILS			PT	Peat, Soils with High Organic Contents

Note: Dual Symbols are used to indicate borderline soil classifications (i.e. GP-GM, SC-SM, etc.).

SAMPLER SYMBOLS

Block Sample

Bulk/Bag Sample

Modified California Sampler

3.5" OD, 2.42" ID D&M Sampler

Rock Core

Standard Penetration Split Spoon Sampler

Thin Wall (Shelby Tube)

WATER SYMBOL

Encountered Water Level

Measured Water Level

(see Remarks on Logs)

1. The results of laboratory tests on the samples collected are shown on the logs at the respective sample depths.
2. The subsurface conditions represented on the logs are for the locations specified. Caution should be exercised if interpolating between or extrapolating beyond the exploration locations.
3. The information presented on each log is subject to the limitations, conclusions, and recommendations presented in this report.

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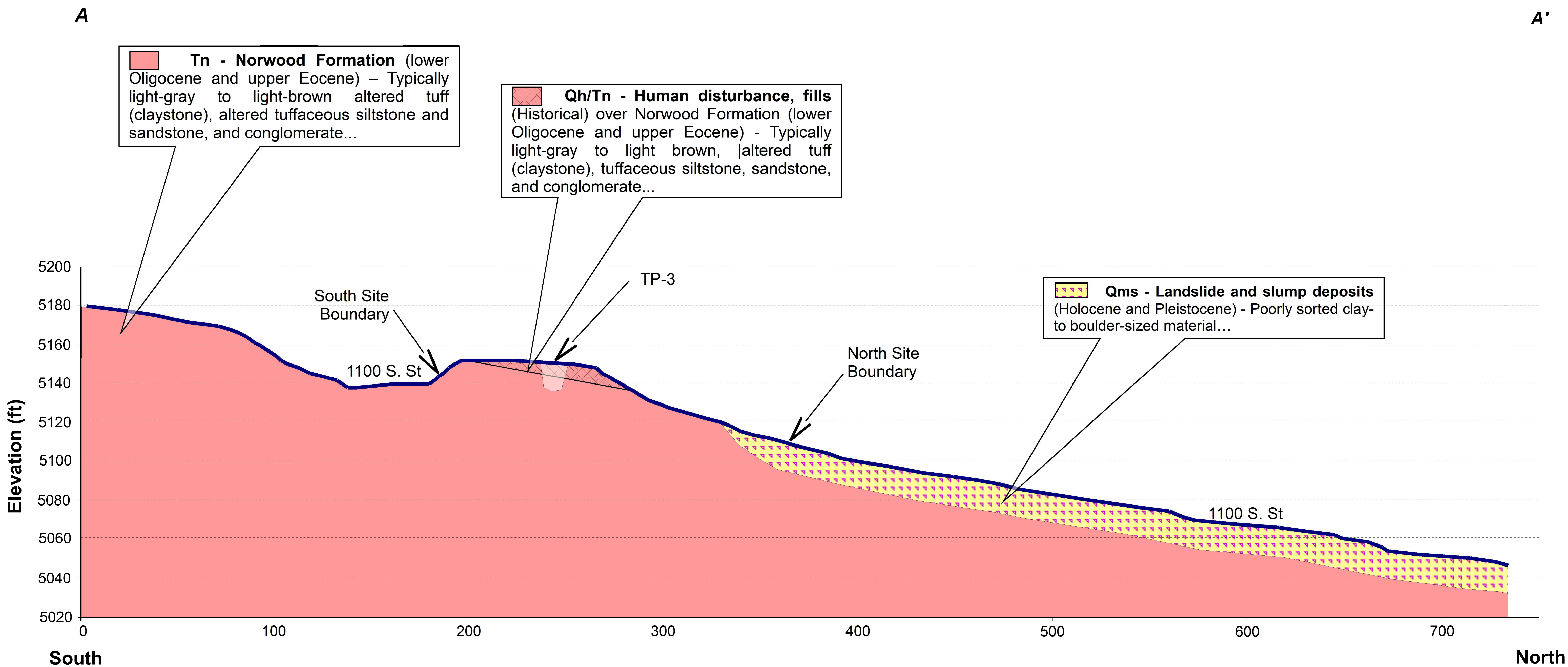


CMT TECHNICAL SERVICES

Hansen Property
6875 East 1100 South
Huntsville, Weber County, Utah

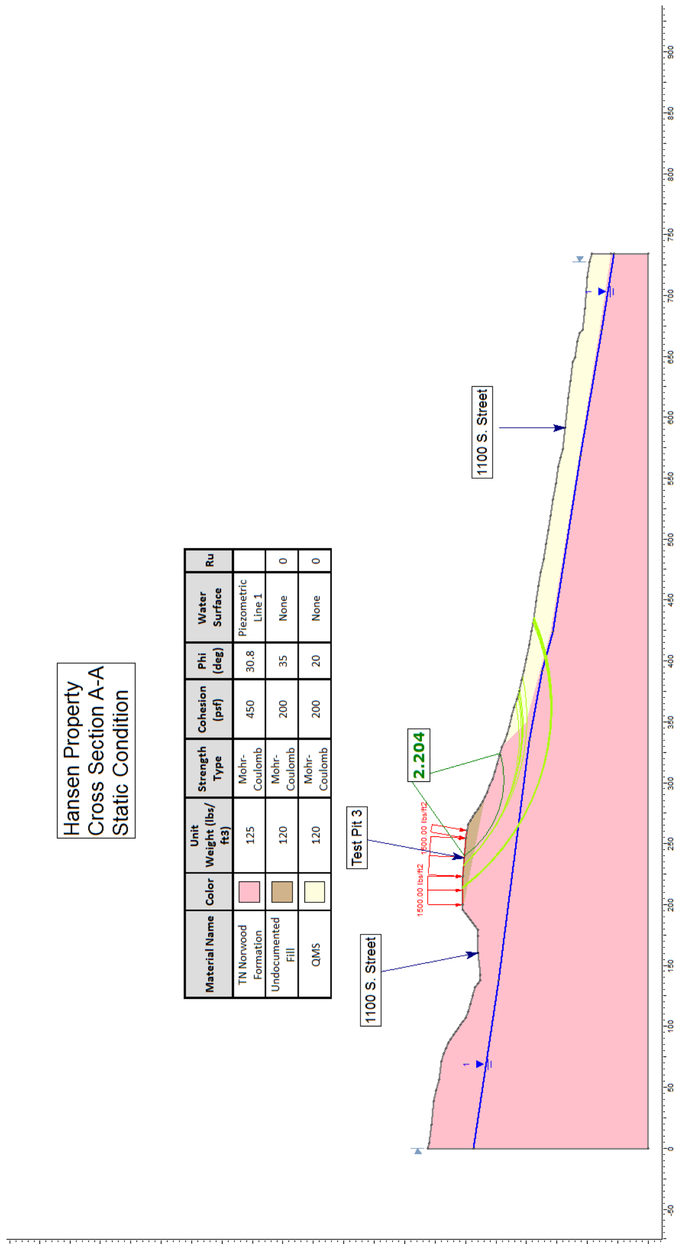
Geologic Cross Section
Line *A-A'*

Date:	21 Dec.-22
CMT No.:	19413

Figure **10**

STABILITY RESULTS

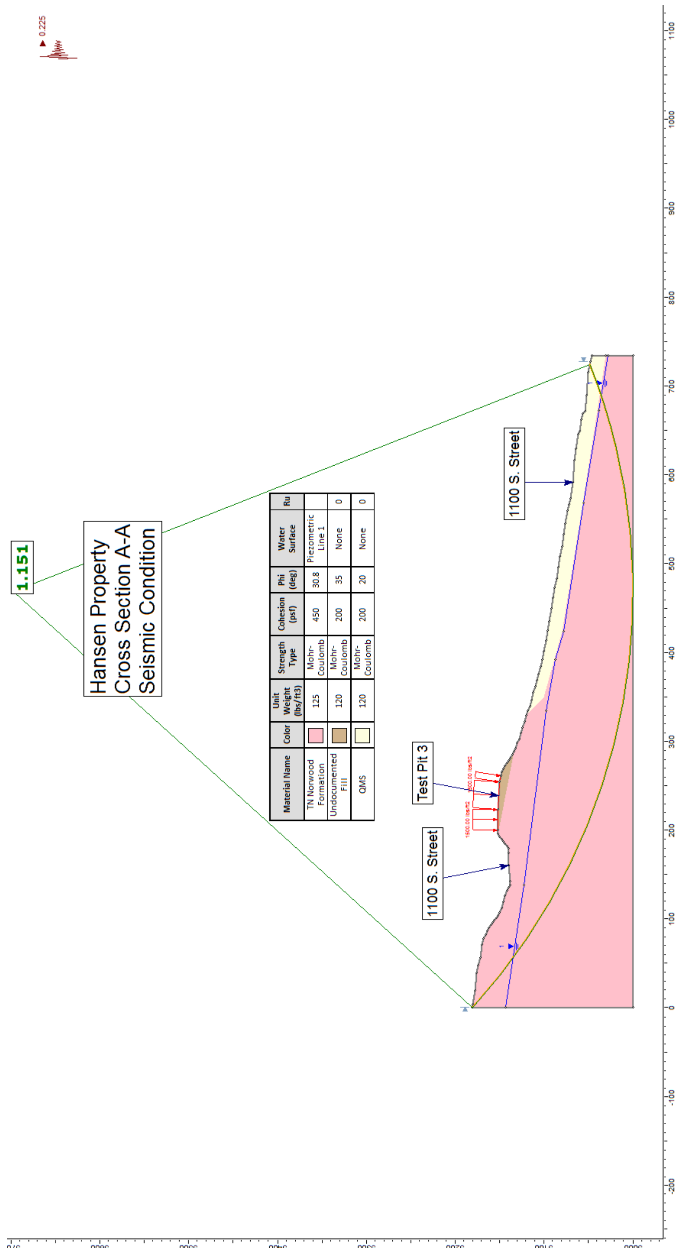
Hansen Property
Cross Section A-A
STATIC



PROJECT NO.: 19413	CMT TECHNICAL SERVICES	FIGURE NO.: 11

STABILITY RESULTS

Hansen Property
Cross Section A-A
SEISMIC



PROJECT NO.: 19413	CMT TECHNICAL SERVICES	**FIGURE NO.:** 12