GEOTECHNICAL INVESTIGATION

DJC ST. ANTHONY COTTAGES

2200 East 600 North
St. Anthony, ID

PREPARED FOR:

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Idaho Division of Public Works
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PREPARED BY:

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January 10, 2023
E222593g
IDPW Project No.: 21725

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Atlas No. E222593g

Mr. Gary Groff
Idaho Division of Public Works
PO Box 83720
Boise, ID 83702

Subject: Geotechnical Investigation
DJC St. Anthony Cottages
2200 East 600 North
St. Anthony, ID

Dear Mr. Groff:

In compliance with your instructions, Atlas has conducted a soils exploration and foundation evaluation for the above referenced development. Fieldwork for this investigation was conducted on December 15, 2022. Data have been analyzed to evaluate pertinent geotechnical conditions. Results of this investigation, together with our recommendations, are to be found in the following report. We have provided a PDF copy for your review and distribution.

Often, questions arise concerning soil conditions because of design and construction details that occur on a project. Atlas would be pleased to continue our role as geotechnical engineers during project implementation.

If you have any questions, please call us at (208) 529-8242.

Respectfully submitted,

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1. INTRODUCTION

This report presents results of a geotechnical investigation and analysis in support of data utilized in design of structures as defined in the 2018 International Building Code (IBC). Information in support of groundwater and stormwater issues pertinent to the practice of Civil Engineering is included. Observations and recommendations relevant to the earthwork phase of the project are also presented. Revisions in plans or drawings for the proposed structures from those enumerated in this report should be brought to the attention of the soils engineer to determine whether changes in the provided recommendations are required. Deviations from noted subsurface conditions, if encountered during construction, should also be brought to the attention of the soils engineer.

1.1 Project Description

The proposed development is in the northwestern portion of the City of St. Anthony, Fremont County, ID, and occupies a portion of the NW¼NW¼ of Section 2, Township 7 North, Range 40 East, Boise Meridian. This project will consist of construction of three new cottages, each approximately 10,500 square-feet in size. Total settlements are limited to 1 inch. Loads of up to 4,000 pounds per lineal foot for wall footings, and column loads of up to 50,000 pounds were assumed for settlement calculations. Additionally, assumptions have been made for traffic loading of pavements. Retaining walls are not anticipated as part of the project. Atlas has not been informed of the proposed grading plan.

1.2 Authorization

Authorization to perform this exploration and analysis was given in the form of a written authorization to proceed from Mr. Gary Groff of Idaho Division of Public Works to Ethan Salove of Atlas Technical Consultants (Atlas), on November 22, 2022. Said authorization is subject to terms, conditions, and limitations described in the Professional Services Contract entered into between Idaho Division of Public Works and Atlas. Our scope of services for the proposed development has been provided in our proposal dated November 10, 2022 and repeated below.

1.3 Scope of Investigation

The scope of this investigation included review of geologic literature and existing available geotechnical studies of the area, visual site reconnaissance of the immediate site, subsurface exploration of the site, field and laboratory testing of materials collected, and engineering analysis and evaluation of foundation materials.

2. SITE DESCRIPTION

2.1 Site Access

Access to the site may be gained via U.S. Highway 20 to the St. Anthony exit. Proceed north on Bridge Street approximately 0.6 mile to its intersection with West 4th North. From this intersection, proceed west 1.6 miles where the site is located on the south side of the roadway. Presently the site exists as a juvenile correction center with associated outbuildings and minor street systems. The location is depicted on site map plates included in the **Appendix.**

2.2 Regional Geology

The site is located west of the city of St. Anthony in an area known as the Eastern Snake River Plain. Sediments deposited here are derived from Middle Pleistocene Granites and upper Pleistocene Rhyolitic Volcanics (Alt and Hyndman, 1998), which outcrop immediately south-southeast of Rexburg, and compose the bedrock throughout the region. Sediments were deposited during the Pleistocene Period (0.6 to 1.8 million years ago) and have been mapped as outwash fanglomerate and terrace gravels and consist of medium to coarse-grained river deposits (Bond, 1978). These sediments were deposited in a variety of geologic environments, which existed along the northeastern margin of the ancestral eastern Snake River Plain. Since their deposition, these formations have gradually been eroded away from the Rexburg Foothills.

2.3 General Site Characteristics

The entire property is approximately 42.0 acres in size, but only portions of this site are expected to be developed. The site consists of an existing juvenile corrections facility. Multiple structures and paved areas are found throughout the property. The northeast proposed building currently consists of landscaped area, while the southern and western proposed building areas have existing structures and landscaping currently in place. These existing buildings are expected to be demolished prior to construction of the new structures.

Vegetation throughout the site consists primarily of landscape trees, shrubs, and grasses adjacent to the existing structures. Mature trees are present on the property. The site is relatively flat and level.

Regional drainage is south towards the Henry's Fork River. Stormwater drainage for the site is achieved by both sheet runoff and percolation through surficial soils. Runoff predominates for the hardscape areas while percolation prevails across the landscaped areas. The site is situated so that it is unlikely that it will receive any drainage from off-site sources. Stormwater drainage collection systems are in place on the project site in the form of curb and gutter along the roadways.

2.4 Regional Site Climatology and Geochemistry

According to the Western Regional Climate Center (WRCC, 2006) the average precipitation for St. Anthony is on the order of 11 to 51 inches per year, with an annual snowfall of approximately 100 inches. The monthly mean daily temperatures range from 18° F to 65° F. Winds are generally from the southeast with an annual average wind speed of approximately 10 mph. Soils and sediments in the area are primarily derived from siliceous materials and exhibit low electro-chemical potential for corrosion of metals or concretes, and local aggregates are generally appropriate for Portland cement and lime cement mixtures. Surface waters, groundwater, and soils in the region typically have pH levels ranging from 7.1 to 8.9 (USGS, 2006).

3. SEISMIC SITE EVALUATION

3.1 Geoseismic Setting

Soils on site are classed as Site Class D in accordance with Chapter 20 of the American Society of Civil Engineers (ASCE) publication ASCE/SEI 7-16. Structures constructed on this site should be designed per IBC requirements for such a seismic classification. Our investigation did not reveal hazards resulting from potential earthquake motions including: slope instability, liquefaction, and surface rupture caused by faulting or lateral spreading. Incidence and anticipated acceleration of seismic activity in the area is low.

3.2 Seismic Design Parameter Values

The United States Geological Survey National Seismic Hazard Maps (2008), includes a peak ground acceleration map. The map for 2% probability of exceedance in 50 years in the Western United States in standard gravity (g) indicates that a peak ground acceleration of 0.241 is appropriate for the project site based on a Site Class D.

The following section provides an assessment of the earthquake-induced earthquake loads for the site based on the Risk-Targeted Maximum Considered Earthquake (MCE_R). The MCE_R spectral response acceleration for short periods, S_{MS}, and at 1-second period, S_{M1}, are adjusted for site class effects as required by the 2018 IBC. Design spectral response acceleration parameters as presented in the 2018 IBC are defined as a 5% damped design spectral response acceleration at short periods, S_{DS}, and at 1-second period, S_{D1}.

The USGS National Seismic Hazards Mapping Project includes a program that provides values for ground motion at a selected site based on the same data that were used to prepare the USGS ground motion maps. The maps were developed using attenuation relationships for soft rock sites; the source model, assumptions, and empirical relationships used in preparation of the maps are described in Petersen and others (1996).

Table 1 – Seismic Design Values

Seismic Design Parameter	Design Value
Site Class	D "Default"
S_S	0.387 (g)
S_1	0.150 (g)
F_a	1.490
F_v	2.301
S_{MS}	0.577
S_{M1}	0.344
S_{DS}	0.385
S_{D1}	0.229

4. SOILS EXPLORATION

4.1 Exploration and Sampling Procedures

Field exploration conducted to determine engineering characteristics of subsurface materials included a reconnaissance of the project site and investigation by test pit. Test pit sites were located in the field by means of a Global Positioning System (GPS) device and are reportedly accurate to within ten feet. Upon completion of investigation, each test pit was backfilled with loose excavated materials. Re-excavation and compaction of these test pit areas are required prior to construction of overlying structures.

In addition, samples were obtained from representative soil strata encountered. Samples obtained have been visually classified in the field by professional staff, identified according to test pit number and depth, placed in sealed containers, and transported to our laboratory for additional testing. Subsurface materials have been described in detail on logs provided in the **Appendix**. Results of field and laboratory tests are also presented in the **Appendix**. Atlas recommends that these logs **not** be used to estimate fill material quantities.

4.2 Laboratory Testing Program

Along with our field investigation, a supplemental laboratory testing program was conducted to determine additional pertinent engineering characteristics of subsurface materials necessary in an analysis of anticipated behavior of the proposed structures. Laboratory tests were conducted in accordance with current applicable American Society for Testing and Materials (ASTM) specifications, and results of these tests are to be found in the **Appendix**. The laboratory testing program for this report included: Atterberg Limits Testing – ASTM D4318 and Grain Size Analysis – ASTM C117/C136.

4.3 Soil and Sediment Profile

The profile below represents a generalized interpretation for the project site. Note that on site soils strata, encountered between test pit locations, may vary from the individual soil profiles presented in the logs, which can be found in the **Appendix**.

Within test pits 4 and 5, silty sand fill materials were encountered. These materials were brown to dark brown, slightly moist, and medium dense, with fine to coarse-grained sand and fine gravel. Concrete, masonry, charcoal, and ash debris was found within these fill materials. Silty sand with gravel sediments were encountered at ground surface in test pits 1 and 2. Within test pits 3 and 6 silty clayey sand with gravel and clayey sand with gravel sediments were encountered at ground surface. These native sediments were brown to dark brown, slightly moist, and medium dense. Fine to coarse-grained sand and fine gravels were present throughout. Organic materials were measured to depths of roughly 0.5 foot.

Poorly graded gravel with silt and sand sediments were encountered beneath surficial sediments and fill materials within test pits 3 through 6. These sediments were brown to dark brown, slightly moist, and medium dense to dense. Fine to coarse-grained sand, fine to coarse gravel, and 4-inch minus cobbles was present in these horizons.

At depth in all test pits, poorly graded gravel with sand sediments were exposed. Poorly graded gravels were light brown to gray, slightly moist to saturated, and medium dense to dense. Fine to coarse-grained sand, fine to coarse gravel, and 4-inch minus cobbles were noted throughout.

Competency of test pit sidewalls varied little across the site. In general, soils above the water table remained stable while more granular sediments below the water table readily sloughed. However, moisture contents will also affect wall competency with saturated soils having a tendency to readily slough when under load and unsupported.

4.4 Volatile Organic Scan

No environmental concerns were identified prior to commencement of the investigation. Therefore, soils obtained during on-site activities were not assessed for volatile organic compounds by portable photoionization detector. Samples obtained during our exploration activities exhibited no odors or discoloration typically associated with this type of contamination. Groundwater encountered did not exhibit obvious signs of contamination.

5. SITE HYDROLOGY

Existing surface drainage conditions are defined in the **General Site Characteristics** section. Information provided in this section is limited to observations made at the time of the investigation. Either regional or local ordinances may require information beyond the scope of this report.

5.1 Groundwater

During this field investigation, groundwater was encountered in test pits at depths ranging from 11.9 to 12.8 feet bgs. However, groundwater was not encountered to depths of 13.5 and 13.8 feet bgs within test pits 3 and 4, respectively. Soil moistures in the test pits were generally slightly moist within surficial soils and poorly graded gravel with silt and sand sediments. Within the poorly graded gravel with sand sediments, soil moistures graded from slightly moist to saturated as the water table was approached and penetrated. In the vicinity of the project site, groundwater levels are controlled in large part by agricultural and commercial irrigation activity and leakage from nearby canals. Maximum groundwater elevations likely occur during the later portion of the irrigation season.

Atlas previously performed a geotechnical investigation on the project site in September 2015. During this investigation groundwater was encountered at depths ranging from 2.7 to 6.3 feet.

Furthermore, according to Idaho Department of Water Resources (IDWR) well log data within approximately ½-mile of the project site, groundwater was measured at depths ranging between 2 and 15 feet bgs. However, irrigation methods in recent years in the vicinity have changed from flood irrigation to pivot sprinkler irrigation. Pivot sprinkler irrigation often impacts groundwater levels less than flood irrigation, as more water is lost to evaporation and other factors. Based on this, Atlas assumes the groundwater levels may have receded in recent years.

It appears that changes in irrigation activities in the area have impacted groundwater levels in the past several years. Because of this, actual levels should be confirmed by periodic groundwater data collected from piezometers installed in all test pits. If desired, Atlas is available to perform this monitoring.

5.2 Soil Infiltration Rates

Soil permeability, which is a measure of the ability of a soil to transmit a fluid, was not tested in the field. Given the absence of direct measurements, for this report an estimation of infiltration is presented using generally recognized values for each soil type and gradation. Of soils comprising the generalized soil profile for this study, silty sand, clayey sand, and silty clayey sand sediments usually display rates of 2 to 6 inches per hour. Poorly graded gravel with silt and sand sediments typically display rates of 4 to 10 inches per hour. Poorly graded gravel with sand sediments typically exhibit infiltration values in excess of 12 inches per hour. Infiltration testing is generally not required within these sediments because of their free-draining nature.

It is recommended that infiltration facilities constructed on the site be extended into native relatively silt-free, poorly graded gravel with sand sediments. Excavation depths of roughly 2.0 to 6.0 feet bgs should be anticipated to expose these relatively silt-free poorly graded gravel with sand sediments. An infiltration rate of 8 inches per hour can be used in design. However, if groundwater is found to be at or near the bottom of infiltration facilities, infiltration rates will be significantly reduced. Actual infiltration rates should be confirmed at the time of construction.

6. FOUNDATION AND SLAB DISCUSSION AND RECOMMENDATIONS

Various foundation types have been considered for support of the proposed structures. Two requirements must be met in the design of foundations. First, the applied bearing stress must be less than the ultimate bearing capacity of foundation soils to maintain stability. Second, total and differential settlement must not exceed an amount that will produce an adverse behavior of the superstructure. Allowable settlement is usually exceeded before bearing capacity considerations become important; thus, allowable bearing pressure is normally controlled by settlement considerations.

Considering subsurface conditions and the proposed construction, it is recommended that the structures be founded upon conventional spread footings and continuous wall footings. Total settlements should not exceed 1 inch if the following design and construction recommendations are observed.

6.1 Foundation Design Recommendations

Based on data obtained from the site and test results from various laboratory tests performed, Atlas recommends the following guidelines for the net allowable soil bearing capacity:

Table 2 – Soil Bearing Capacity

Footing Depth	ASTM D1557 Subgrade Compaction	Net Allowable Soil Bearing Capacity
Footings must bear on competent, undisturbed, native poorly graded gravel with silt and sand sediments, poorly graded gravel with sand sediments, or compacted structural fill. Existing silty sand, silty clayey sand, clayey sand, and fill materials must be completely removed from below foundation elements.[1] Excavation depths of roughly 2.5 feet bgs should be anticipated to expose proper bearing soils.[2]	Not Required for Native Soil 95% for Structural Fill	3,000 lbs/ft^2 A ⅓ increase is allowable for short-term loading, which is defined by seismic events or designed wind speeds.

[1]It will be required for Atlas personnel to verify the bearing soil suitability for each structure at the time of construction.
[2]Depending on the time of year construction takes place, the subgrade soils may be unstable because of high moisture contents. If unstable conditions are encountered, over-excavation and replacement with granular structural fill and/or use of geotextiles may be required.

A sliding frictional coefficient value of 0.45 should be used for footings bearing on granular structural fill. A passive lateral earth pressure of 356 pounds per square foot per foot (psf/ft) should be used for silty sand sediments. For compacted sandy gravel fill, a passive lateral earth pressure of 496 psf/ft should be used.

Footings should be proportioned to meet either the stated soil bearing capacity or the 2018 IBC minimum requirements. Total settlement should be limited to approximately 1 inch, and differential settlement should be limited to approximately ½ inch. Objectionable soil types encountered at the bottom of footing excavations should be removed and replaced with structural fill. Excessively loose or soft areas that are encountered in the footings subgrade will require over-excavation and backfilling with structural fill.

To minimize the effects of slight differential movement that may occur because of variations in the character of supporting soils and seasonal moisture content, Atlas recommends continuous footings be suitably reinforced to make them as rigid as possible. For frost protection, the bottom of external footings should be 32 inches below finished grade. Based on the soil types encountered onsite, foundation drains are not needed.

6.2 Floor Slab-on-Grade

Uncontrolled fill, which contained debris, was encountered in portions of the site and is expected to be encountered after demolition of the existing structures. Atlas recommends that any fill materials generated as a result of demolition activities be completely removed. Atlas recommends that existing site fill materials be removed to a depth of at least 1½ feet below existing grade. If existing fill materials remain after excavation, any remaining charcoal or ash debris must be removed, followed by compacting the exposed subgrade to at least 95 percent of the maximum dry density as determined by ASTM D1557. The excavated fill materials can be replaced in accordance with the **Structural Fill** section provided that all organic material and/or debris is completely removed. Once final grades have been determined, Atlas is available to provide additional recommendations.

Organic, loose, or obviously compressive materials must be removed prior to placement of concrete floors or floor-supporting fill. In addition, the remaining subgrade should be treated in accordance with guidelines presented in the **Earthwork** section. Areas of excessive yielding should be excavated and backfilled with structural fill. Fill used to increase the elevation of the floor slab should meet requirements detailed in the **Structural Fill** section. Fill materials must be compacted to a minimum 95 percent of the maximum dry density as determined by ASTM D1557.

A free-draining granular mat should be provided below slabs-on-grade to provide drainage and a uniform and stable bearing surface. This should be a minimum of 4 inches in thickness and properly compacted. The mat should consist of a sand and gravel mixture, complying with Idaho Standards for Public Works Construction (ISPWC) specifications for ¾-inch (Type 1) crushed aggregate. The granular mat should be compacted to no less than 95 percent of the maximum dry density as determined by ASTM D1557. A moisture-retarder should be placed beneath floor slabs to minimize potential ground moisture effects on moisture-sensitive floor coverings. The moisture-retarder should be at least 15-mil in thickness and have a permeance of less than 0.01 US perms as determined by ASTM E96. Placement of the moisture-retarder will require special consideration with regard to effects on the slab-on-grade and should adhere to recommendations outlined in the ACI 302.1R and ASTM E1745 publications. Upon request, Atlas can provide further consultation regarding installation.

7. PAVEMENT DISCUSSION AND RECOMMENDATIONS

Atlas has made assumptions for traffic loading variables based on the character of the proposed construction. The Client shall review and understand these assumptions to make sure they reflect intended use and loading of pavements both now and in the future. Based on experience with soils in the region, a subgrade California Bearing Ratio (CBR) value of 6 has been assumed for near-surface silty/clayey sand sediments on site. The following are minimum thickness requirements for assured pavement function. Depending on site conditions, additional work, e.g. soil preparation, may be required to support construction equipment. These have been listed within the **Soft Subgrade Soils** section.

7.1 Flexible Pavement Sections

The American Association of State Highway and Transportation Officials (AASHTO) design method has been used to calculate the following pavement sections. Calculation sheets provided in the **Appendix** indicate the soils constant, traffic loading, traffic projections, and material constants used to calculate the pavement sections. Atlas recommends that materials used in the construction of asphaltic concrete pavements meet requirements of the ISPWC Standard Specification for Highway Construction. Construction of the pavement section should be in accordance with these specifications and should adhere to guidelines recommended in the section on **Construction Considerations**.

Table 3 – AASHTO Flexible Pavement Specifications

Pavement Section Component	Driveways and Parking Light Duty	Driveways and Parking Moderate Duty
Asphaltic Concrete	2.5 Inches	2.5 Inches
Crushed Aggregate Base	4.0 Inches	4.0 Inches
Structural Subbase	6.0 Inches	8.0 Inches
Compacted Subgrade	See **Pavement Subgrade Preparation** Section	See **Pavement Subgrade Preparation** Section

[1]It will be required for Atlas personnel to verify subgrade competency at the time of construction.

- Asphaltic Concrete: Asphalt mix design shall meet the requirements of ISPWC, Section 810. Materials shall be placed in accordance with ISPWC Standard Specifications for Highway Construction.
- Aggregate Base: Material complying with ISPWC Standards for Crushed Aggregate Materials.
- Structural Subbase: Granular structural fill material complying with the requirements detailed in the **Structural Fill** section of this report except that the maximum material diameter is no more than $^{2}/_{3}$ the component thickness. Gradation and suitability requirements shall be per ISPWC Section 801, Table 1.

7.2 Pavement Subgrade Preparation

Uncontrolled fill, which contained debris, was encountered in portions of the site. Atlas recommends that these fill materials be removed to a depth of at least 1½ feet below existing grade. <u>If fill materials remain after excavation, any remaining charcoal or ash debris must be removed, followed by compacting the exposed subgrade to at least 95 percent of the maximum dry density as determined by ASTM D698 for flexible pavements.</u> The excavated fill materials can be replaced in accordance with the **Structural Fill** section provided that all organic material and/or debris is completely removed. However, the existing fill materials are not suitable for use as either the base or subbase components of the recommended pavement section. Once final grades have been determined, Atlas is available to provide additional recommendations.

7.3 Common Pavement Section Construction Issues

The subgrade upon which above pavement sections are to be constructed must be properly stripped, compacted (if indicated), inspected, and proof-rolled. Proof rolling of subgrade soils should be accomplished using a heavy rubber-tired, fully loaded, tandem-axle dump truck or equivalent. Verification of subgrade competence by Atlas personnel at the time of construction is required. Fill materials on the site must demonstrate the indicated compaction prior to placing material in support of the pavement section. Atlas anticipated that pavement areas will be subjected to moderate traffic. Atlas does not anticipate pumping material to become evident during compaction, but subgrade clays and silts near and above optimum moisture contents may tend to pump. Pumping or soft areas must be removed and replaced with structural fill.

Fill material and aggregates in support of the pavement section must be compacted to no less than 95 percent of the maximum dry density as determined by ASTM D698 for flexible pavements and by ASTM D1557 for rigid pavements. If a material placed as a pavement section component cannot be tested by usual compaction testing methods, then compaction of that material must be approved by observed proof rolling. Minor deflections from proof rolling for flexible pavements are allowable. Deflections from proof rolling of rigid pavement support courses should not be visually detectable.

Atlas recommends that rigid concrete pavement be provided for heavy garbage receptacles. This will eliminate damage caused by the considerable loading transferred through the small steel wheels onto asphaltic concrete. Rigid concrete pavement should consist of Portland Cement Concrete Pavement (PCCP) generally adhering to ITD specifications for Urban Concrete. PCCP should be 6 inches thick on a 4-inch drainage fill course (see **Floor Slab-on-Grade** section), and should be reinforced with welded wire fabric. Control joints must be on 12-foot centers or less.

8. CONSTRUCTION CONSIDERATIONS

Recommendations in this report are based upon structural elements of the project being founded on competent, native poorly graded gravel with silt and sand sediments, poorly graded gravel with sand sediments, or compacted structural fill. Structural areas should be stripped to an elevation that exposes these soil types.

8.1 Earthwork

Excessively organic soils, deleterious materials, or disturbed soils generally undergo high volume changes when subjected to loads, which is detrimental to subgrade behavior in the area of pavements, floor slabs, structural fills, and foundations. Mature trees, landscape bushes, and grasses with associated root systems were noted at the time of our investigation. It is recommended that organic or disturbed soils, if encountered, be removed to depths of 1 foot (minimum), and wasted or stockpiled for later use. However, in areas where trees are/were present, deeper excavation depths should be anticipated. Stripping depths should be adjusted in the field to assure that the entire root zone or topsoil are removed prior to placement and compaction of structural fill materials. Exact removal depths should be determined during grading operations by Atlas personnel, and should be based upon subgrade soil type, composition, and firmness or soil stability. If underground storage tanks, underground utilities, wells, or septic systems are discovered during construction activities, they must be decommissioned then removed or abandoned in accordance with governing Federal, State, and local agencies. Excavations developed as the result of such removal must be backfilled with structural fill materials as defined in the **Structural Fill** section.

Atlas should oversee subgrade conditions (i.e., moisture content) as well as placement and compaction of new fill (if required) after native soils are excavated to design grade. Recommendations for structural fill presented in this report can be used to minimize volume changes and differential settlements that are detrimental to the behavior of footings, pavements, and floor slabs. Sufficient density tests should be performed to properly monitor compaction. For structural fill beneath building structures, one in-place density test per lift for every 5,000 square feet is recommended. In parking and driveway areas, this can be decreased to one test per lift for every 10,000 square feet.

8.2 Dry Weather

If construction is to be conducted during dry seasonal conditions, many problems associated with soft soils may be avoided. However, some rutting of subgrade soils may be induced by shallow groundwater conditions related to springtime runoff or irrigation activities during late summer through early fall. Solutions to problems associated with soft subgrade soils are outlined in the **Soft Subgrade Soils** section. Problems may also arise because of lack of moisture in native and fill soils at time of placement. This will require the addition of water to achieve near-optimum moisture levels. Low-cohesion soils exposed in excavations may become friable, increasing chances of sloughing or caving. Measures to control excessive dust should be considered as part of the overall health and safety management plan.

8.3 Wet Weather

If construction is to be conducted during wet seasonal conditions (commonly from mid-November through May), problems associated with soft soils must be considered as part of the construction plan. During this time of year, fine-grained soils such as silts and clays will become unstable with increased moisture content, and eventually deform or rut. Additionally, constant low temperatures reduce the possibility of drying soils to near optimum conditions.

8.4 Soft Subgrade Soils

Shallow fine-grained subgrade soils that are high in moisture content should be expected to pump and rut under construction traffic. Throughout construction, soft areas may develop after the existing asphalt is removed and heavy rubber-tired equipment drives over the site. In addition, areas where significant cracking has occurred will likely have soft subgrade soils because of moisture infiltration and will be prone to pumping and rutting. During periods of wet weather, construction may become very difficult if not impossible. The following recommendations and options have been included for dealing with soft subgrade conditions:

- Track-mounted vehicles should be used to strip the subgrade of root matter and other deleterious debris and used to remove the existing asphalt and to perform any other necessary excavations. Heavy rubber-tired equipment should be prohibited from operating directly on the native subgrade and areas in which structural fill materials have been placed. Construction traffic should be restricted to designated roadways that do not cross, or cross on a limited basis, proposed roadway or parking areas.
- Soft areas can be over-excavated and replaced with granular structural fill.
- Construction roadways on soft subgrade soils should consist of a minimum 2-foot thickness of large cobbles of 4 to 6 inches in diameter with sufficient sand and fines to fill voids. Construction entrances should consist of a 6-inch thickness of clean, 2-inch minimum, angular drain-rock and must be a minimum of 10 feet wide and 30 to 50 feet long. During the construction process, top dressing of the entrance may be required for maintenance.
- Scarification and aeration of subgrade soils can be employed to reduce the moisture content of wet subgrade soils. After stripping is complete, the exposed subgrade should be ripped or disked to a depth of 1½ feet and allowed to air dry for 2 to 4 weeks. Further disking should be performed on a weekly basis to aid the aeration process.
- Alternative soil stabilization methods include use of geotextiles, lime, and cement stabilization. Atlas is available to provide recommendations and guidelines at your request.

8.5 Frozen Subgrade Soils

Prior to placement of structural fill materials or foundation elements, frozen subgrade soils must either be allowed to thaw or be stripped to depths that expose non-frozen soils and wasted or stockpiled for later use. Stockpiled materials must be allowed to thaw and return to near-optimal conditions prior to use as structural fill.

The onsite, shallow silty and clayey soils are susceptible to frost heave during freezing temperatures. For exterior flatwork and other structural elements, adequate drainage away from subgrades is critical. Compaction and use of structural fill will also help to mitigate the potential for frost heave. Complete removal of frost susceptible soils for the full frost depth, followed by replacement with a non-frost susceptible structural fill, can also be used to mitigate the potential for frost heave. Atlas is available to provide further guidance/assistance upon request.

8.6 Structural Fill

Soils recommended for use as structural fill are those classified as GW, GP, SW, and SP in accordance with the Unified Soil Classification System (USCS) (ASTM D2487). Use of silty soils (USCS designation of GM, SM, and ML) as structural fill may be acceptable. However, use of silty soils (GM, SM, and ML) as structural fill below footings is prohibited. These materials require very high moisture contents for compaction and require a long time to dry out if natural moisture contents are too high and may also be susceptible to frost heave under certain conditions. Therefore, these materials can be quite difficult to work with as moisture content, lift thickness, and compactive effort becomes difficult to control. If silty soil is used for structural fill, lift thicknesses should not exceed 6 inches (loose), and fill material moisture must be closely monitored at both the working elevation and the elevations of materials already placed. Following placement, silty soils must be protected from degradation resulting from construction traffic or subsequent construction.

Recommended granular structural fill materials, those classified as GW, GP, SW, and SP, should consist of a 6-inch minus select, clean, granular soil with no more than 50 percent oversize (greater than ¾-inch) material and no more than 12 percent fines (passing No. 200 sieve). These fill materials should be placed in layers not to exceed 12 inches in loose thickness. Prior to placement of structural fill materials, surfaces must be prepared as outlined in the **Construction Considerations** section. Structural fill material should be moisture-conditioned to achieve optimum moisture content prior to compaction. For structural fill below footings, areas of compacted backfill must extend outside the perimeter of the footings for a distance equal to the thickness of fill between the bottom of foundation and underlying soils, or 5 feet, whichever is less. All fill materials must be monitored during placement and tested to confirm compaction requirements, outlined below, have been achieved.

Each layer of structural fill must be compacted, as outlined below:

- Below Structures and Rigid Pavements: A minimum of 95 percent of the maximum dry density as determined by ASTM D1557.
- Below Flexible Pavements: A minimum of 92 percent of the maximum dry density as determined by ASTM D1557 or 95 percent of the maximum dry density as determined by ASTM D698.

The ASTM D1557 test method must be used for samples containing up to 40 percent oversize (greater than ¾-inch) particles. If material contains more than 40 percent but less than 50 percent oversize particles, compaction of fill must be confirmed by proof rolling each lift with a 10-ton vibratory roller (or equivalent) until the maximum density has been achieved. Density testing must be performed after each proof rolling pass until the in-place density test results indicate a drop (or no increase) in the dry density, defined as maximum density or "break over" point. The number of required passes should be used as the requirements on the remainder of fill placement. Material should contain sufficient fines to fill void spaces, and must not contain more than 50 percent oversize particles.

8.7 Backfill of Walls

Backfill materials must conform to the requirements of structural fill, as defined in this report. For wall heights greater than 2.5 feet, the maximum material size should not exceed 4 inches in diameter. Placing oversized material against rigid surfaces interferes with proper compaction, and can induce excessive point loads on walls. Backfill shall not commence until the wall has gained sufficient strength to resist placement and compaction forces. Further, retaining walls above 2.5 feet in height shall be backfilled in a manner that will limit the potential for damage from compaction methods and/or equipment. It is recommended that only small hand-operated compaction equipment be used for compaction of backfill within a horizontal distance equal to the height of the wall, measured from the back face of the wall.

Backfill should be compacted in accordance with the specifications for structural fill, except in those areas where it is determined that future settlement is not a concern, such as planter areas. In nonstructural areas, backfill must be compacted to a firm and unyielding condition.

8.8 Excavations

Shallow excavations that do not exceed 4 feet in depth may be constructed with side slopes approaching vertical. Below this depth, it is recommended that slopes be constructed in accordance with Occupational Safety and Health Administration (OSHA) regulations, Section 1926, Subpart P. Based on these regulations, on-site soils are classified as type "C" soil, and as such, excavations within these soils should be constructed at a maximum slope of 1½ feet horizontal to 1 foot vertical (1½:1) for excavations up to 20 feet in height. Excavations in excess of 20 feet will require additional analysis. <u>Note that these slope angles are considered stable for short-term conditions only, and will not be stable for long-term conditions.</u>

During the subsurface exploration, test pit sidewalls generally exhibited little indication of collapse; however, sloughing of native granular sediments from test pit sidewalls was observed after penetration of the water table. For deep excavations, native granular sediments cannot be expected to remain in position. These materials are prone to failure and may collapse, thereby undermining upper soil layers. This is especially true when excavations approach depths near the water table. Care must be taken to ensure that excavations are properly backfilled in accordance with procedures outlined in this report.

8.9 Groundwater Control

Groundwater was encountered during the investigation but is anticipated to be below the depth of most construction. Excavations below the water table will require a dewatering program. Dewatering will be required prior to placement of fill materials. Placement of concrete can be accomplished through water by the use of a treme. It may be possible to discharge dewatering effluent to remote portions of the site, to a sump, or to a pit. This will essentially recycle effluent, thus eliminating the need to enter into agreements with local drainage authorities. Should the scope of the proposed project change, Atlas should be contacted to provide more detailed groundwater control measures.

Special precautions may be required for control of surface runoff and subsurface seepage. It is recommended that runoff be directed away from open excavations. Silty soils may become soft and pump if subjected to excessive traffic during time of surface runoff. Ponded water in construction areas should be drained through methods such as trenching, sloping, crowning grades, nightly smooth drum rolling, or installing a French drain system. Additionally, temporary or permanent driveway sections should be constructed if extended wet weather is forecasted.

9. GENERAL COMMENTS

Based on the subsurface conditions encountered during this investigation and available information regarding the proposed structures, the site is adequate for the planned construction. When plans and specifications are complete, and if significant changes are made in the character or location of the proposed structures, consultation with Atlas must be arranged as supplementary recommendations may be required. Suitability of subgrade soils and compaction of structural fill materials must be verified by Atlas personnel prior to placement of structural elements. Additionally, monitoring and testing should be performed to verify that suitable materials are used for structural fill and that proper placement and compaction techniques are utilized.

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Appendix I WARRANTY AND LIMITING CONDITIONS

Atlas warrants that findings and conclusions contained herein have been formulated in accordance with generally accepted professional engineering practice in the fields of foundation engineering, soil mechanics, and engineering geology only for the site and project described in this report. These engineering methods have been developed to provide the client with information regarding apparent or potential engineering conditions relating to the site within the scope cited above and are necessarily limited to conditions observed at the time of the site visit and research. Field observations and research reported herein are considered sufficient in detail and scope to form a reasonable basis for the purposes cited above.

Exclusive Use

This report was prepared for exclusive use of the property owner(s), at the time of the report, and their retained design consultants ("Client"). Conclusions and recommendations presented in this report are based on the agreed-upon scope of work outlined in this report together with the Contract for Professional Services between the Client and Atlas Technical Consultants ("Consultant"). Use or misuse of this report, or reliance upon findings hereof, by parties other than the Client is at their own risk. Neither Client nor Consultant make representation of warranty to such other parties as to accuracy or completeness of this report or suitability of its use by such other parties for purposes whatsoever, known or unknown, to Client or Consultant. Neither Client nor Consultant shall have liability to indemnify or hold harmless third parties for losses incurred by actual or purported use or misuse of this report. No other warranties are implied or expressed.

Report Recommendations are Limited and Subject to Misinterpretation

There is a distinct possibility that conditions may exist that could not be identified within the scope of the investigation or that were not apparent during our site investigation. Findings of this report are limited to data collected from noted explorations advanced and do not account for unidentified fill zones, unsuitable soil types or conditions, and variability in soil moisture and groundwater conditions. To avoid possible misinterpretations of findings, conclusions, and implications of this report, Atlas should be retained to explain the report contents to other design professionals as well as construction professionals.

Since actual subsurface conditions on the site can only be verified by earthwork, note that construction recommendations are based on general assumptions from selective observations and selective field exploratory sampling. Upon commencement of construction, such conditions may be identified that require corrective actions, and these required corrective actions may impact the project budget. Therefore, construction recommendations in this report should be considered preliminary, and Atlas should be retained to observe actual subsurface conditions during earthwork construction activities to provide additional construction recommendations as needed.

Since geotechnical reports are subject to misinterpretation, **do not** separate the soil logs from the report. Rather, provide a copy of, or authorize for their use, the complete report to other design professionals or contractors. Locations of exploratory sites referenced within this report should be considered approximate locations only. For more accurate locations, services of a professional land surveyor are recommended.

This report is also limited to information available at the time it was prepared. In the event additional information is provided to Atlas following publication of our report, it will be forwarded to the client for evaluation in the form received.

Environmental Concerns

Comments in this report concerning either onsite conditions or observations, including soil appearances and odors, are provided as general information. These comments are not intended to describe, quantify, or evaluate environmental concerns or situations. Since personnel, skills, procedures, standards, and equipment differ, a geotechnical investigation report is not intended to substitute for a geoenvironmental investigation or a Phase II/III Environmental Site Assessment. If environmental services are needed, Atlas can provide, via a separate contract, those personnel who are trained to investigate and delineate soil and water contamination.

Vicinity Map

Figure 1

MAP NOTES:

- Not to Scale

LEGEND

Approximate Site Location

DJC St. Anthony Cottages

2220 E 600 N
St. Anthony, ID

Modified by: EJS
January 6, 2023
Drawing: E222593g

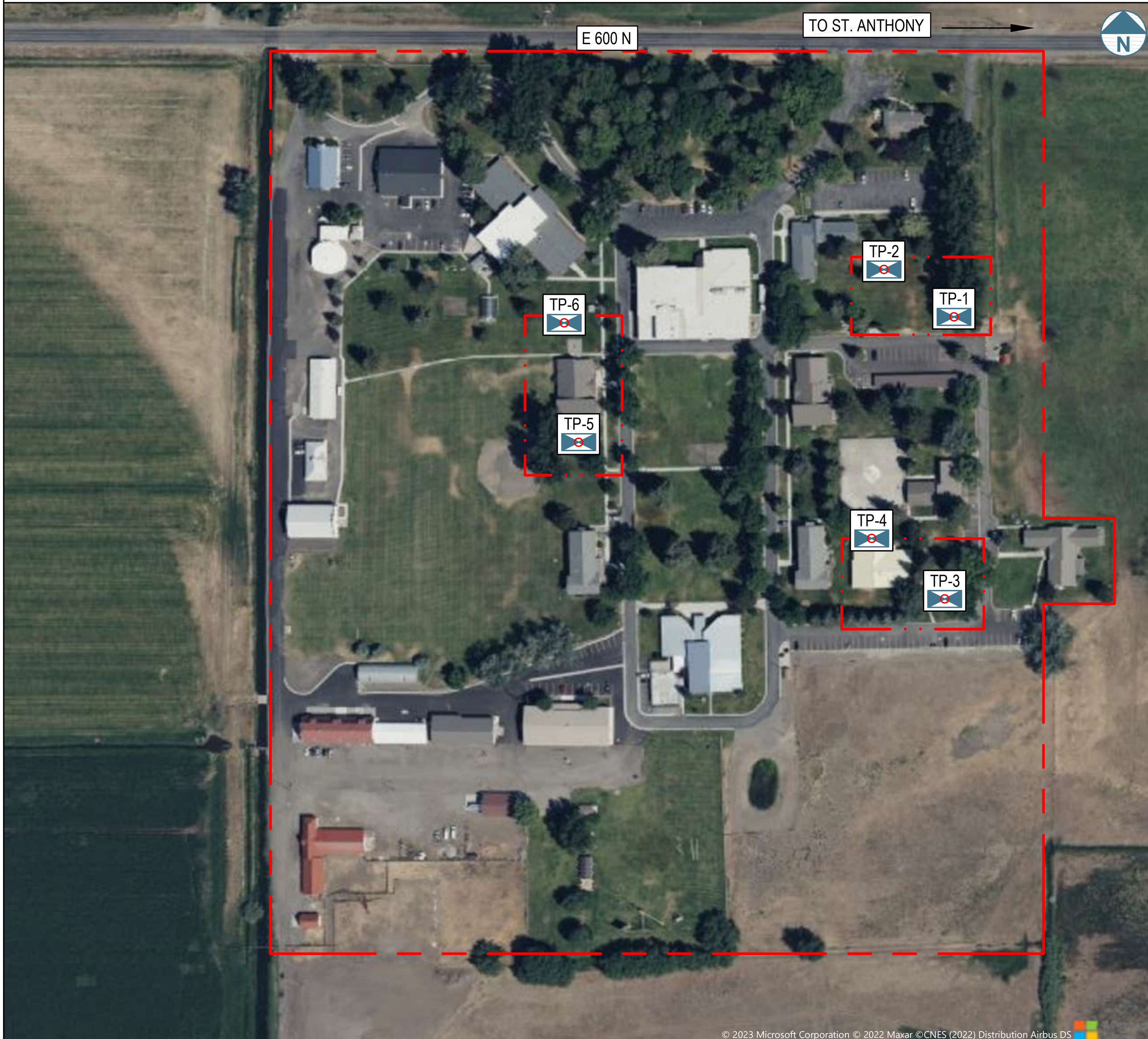
ATLAS

1778 East Precision Drive
Idaho Falls, ID 83401

Phone: (208) 529-8242
Fax: (208) 529-6911
Web: oneatlas.com

Site Map

Figure 2



NOTES:

- Not to Scale

LEGEND

Approximate Property Boundary

Approximate Development Boundaries

Approximate Atlas Test Pit Location with Piezometer

DJC St. Anthony Cottages

2220 E 600 N
St. Anthony, ID

Modified by: EJS
January 6, 2023
Drawing: E222593g

ATLAS

1778 East Precision Drive
Idaho Falls, ID 83401

Phone: (208) 233-9500
Fax: (208) 233-9900
Web: oneatlas.com

Appendix IV GEOTECHNICAL INVESTIGATION TEST PIT LOG

Test Pit Log #: TP-1
Date Advanced: December 15, 2022
Excavated by: Cardinal Excavation
Logged by: Robert Jenson, EI

Latitude: 43.969153
Longitude: -111.713621
Depth to Water Table: 12.8 feet bgs
Total Depth: 13.5 feet bgs

Depth (feet bgs)	Field Description and USCS Soil and Sediment Classification	Sample Type	Sample Depth (feet bgs)	Qp	Lab Test ID
0.0-2.0	Silty Sand with Gravel (SM): Brown to dark brown, slightly moist, medium dense, with fine to coarse-grained sand and fine gravel. --Organic material to a depth of 0.5 foot. --Frozen to a depth of 0.5 foot.				
2.0-13.5	Poorly Graded Gravel with Sand (GP): Light brown to gray, slightly moist to saturated, medium dense to dense, with fine to coarse-grained sand, fine to coarse gravel, and 4-inch-minus cobbles. --Sidewall sloughing noted below water table.				

Notes: See Site Map for test pit location.
Piezometer installed to a depth of 13.5 feet bgs.

GEOTECHNICAL INVESTIGATION TEST PIT LOG

Test Pit Log #: TP-2
Date Advanced: December 15, 2022
Excavated by: Cardinal Excavation
Logged by: Robert Jenson, EI

Latitude: 43.969287
Longitude: -111.713969
Depth to Water Table: 12.2 feet bgs
Total Depth: 13.2 feet bgs

Depth (feet bgs)	Field Description and USCS Soil and Sediment Classification	Sample Type	Sample Depth (feet bgs)	Qp	Lab Test ID
0.0-2.2	Silty Sand with Gravel (SM): Brown to dark brown, slightly moist, medium dense, with fine to coarse-grained sand and fine gravel. --Organic material to a depth of 0.5 foot. --Frozen to a depth of 0.5 foot.	GS	1.0-1.5		A
2.2-13.2	Poorly Graded Gravel with Sand (GP): Light brown to gray, slightly moist to saturated, medium dense to dense, with fine to coarse-grained sand, fine to coarse gravel, and 4-inch-minus cobbles. --Sidewall sloughing noted below water table..				

Notes: See Site Map for test pit location.
Piezometer installed to a depth of 13.2 feet bgs.

Lab Test ID	Moisture (%)	LL	PI	Sieve Analysis (% Passing)				
				#4	#10	#40	#100	#200
A	12.5	NP	NP	79	73	44	29	21.4

GEOTECHNICAL INVESTIGATION TEST PIT LOG

Test Pit Log #: TP-3
Date Advanced: December 15, 2022
Excavated by: Cardinal Excavation
Logged by: Robert Jenson, EI

Latitude: 43.967824
Longitude: -111.713585
Depth to Water Table: Not Encountered
Total Depth: 13.5 feet bgs

Depth (feet bgs)	Field Description and USCS Soil and Sediment Classification	Sample Type	Sample Depth (feet bgs)	Qp	Lab Test ID
0.0-2.7	Silty Clayey Sand with Gravel (SC-SM): Brown to dark brown, slightly moist, medium dense, with fine to coarse-grained sand and fine gravel. --Organic material to a depth of 0.5 foot. --Frozen to a depth of 0.5 foot.	GS	1.0-1.5		B
2.7-6.0	Poorly Graded Gravel with Silt and Sand (GP-GM): Brown to dark brown, slightly moist, medium dense to dense, with fine to coarse-grained sand, fine to coarse gravel, and 4-inch-minus cobbles.				
6.0-13.5	Poorly Graded Gravel with Sand (GP): Light brown to gray, slightly moist to moist, medium dense to dense, with fine to coarse-grained sand, fine to coarse gravel, and 4-inch-minus cobbles.				

Notes: See Site Map for test pit location.
Piezometer installed to a depth of 13.5 feet bgs.

Lab Test ID	Moisture (%)	LL	PI	Sieve Analysis (% Passing)				
				#4	#10	#40	#100	#200
B	6.1	23	7	76	72	44	27	19.8

GEOTECHNICAL INVESTIGATION TEST PIT LOG

Test Pit Log #: TP-4
Date Advanced: December 15, 2022
Excavated by: Cardinal Excavation
Logged by: Robert Jenson, EI

Latitude: 43.968088
Longitude: -111.714001
Depth to Water Table: Not Encountered
Total Depth: 13.8 feet bgs

Depth (feet bgs)	Field Description and USCS Soil and Sediment Classification	Sample Type	Sample Depth (feet bgs)	Qp	Lab Test ID
0.0-2.5	Silty Sand Fill (SM-FILL): Brown to dark brown, slightly moist, medium dense, with fine to coarse-grained sand and minor fine gravel. --Organic material to a depth of 0.5 foot. --Frozen to a depth of 0.5 foot. --Masonry and concrete debris encountered from 1.0 to 2.5 feet bgs.				
2.5-4.3	Poorly Graded Gravel with Silt and Sand (GP-GM): Brown to dark brown, slightly moist, medium dense to dense, with fine to coarse-grained sand, fine to coarse gravel, and 4-inch-minus cobbles.				
4.3-13.8	Poorly Graded Gravel with Sand (GP): Light brown to gray, slightly moist to moist, medium dense to dense, with fine to coarse-grained sand, fine to coarse gravel, and 4-inch-minus cobbles.				

Notes: See Site Map for test pit location.
Piezometer installed to a depth of 13.8 feet bgs.

GEOTECHNICAL INVESTIGATION TEST PIT LOG

Test Pit Log #: TP-5
Date Advanced: December 15, 2022
Excavated by: Cardinal Excavation
Logged by: Robert Jenson, EI

Latitude: 43.968535
Longitude: -111.715871
Depth to Water Table: 11.9 feet bgs
Total Depth: 12.9 feet bgs

Depth (feet bgs)	Field Description and USCS Soil and Sediment Classification	Sample Type	Sample Depth (feet bgs)	Qp	Lab Test ID
0.0-2.0	Silty Sand Fill (SM-FILL): Brown to dark brown, slightly moist, medium dense, with fine to coarse-grained sand and minor fine gravel. --Organic material to a depth of 0.5 foot. --Frozen to a depth of 0.5 foot. --Charcoal and ash debris encountered from 1.0 to 1.5 feet bgs.				
2.0-4.5	Poorly Graded Gravel with Silt and Sand (GP-GM): Brown to dark brown, slightly moist, medium dense to dense, with fine to coarse-grained sand, fine to coarse gravel, and 4-inch-minus cobbles.				
4.5-12.9	Poorly Graded Gravel with Sand (GP): Light brown to gray, slightly moist to saturated, medium dense to dense, with fine to coarse-grained sand, fine to coarse gravel, and 4-inch-minus cobbles. --Sidewall sloughing noted below water table.				

Notes: See Site Map for test pit location.
Piezometer installed to a depth of 12.9 feet bgs.

GEOTECHNICAL INVESTIGATION TEST PIT LOG

Test Pit Log #: TP-6
Date Advanced: December 15, 2022
Excavated by: Cardinal Excavation
Logged by: Robert Jenson, EI

Latitude: 43.969063
Longitude: -111.715925
Depth to Water Table: 12.1 feet bgs
Total Depth: 13.5 feet bgs

Depth (feet bgs)	Field Description and USCS Soil and Sediment Classification	Sample Type	Sample Depth (feet bgs)	Qp	Lab Test ID
0.0-2.2	Clayey Sand with Gravel (SC): Brown to dark brown, slightly moist, medium dense, with fine to coarse-grained sand and fine gravel. --Organic material to a depth of 0.5 foot. --Frozen to a depth of 0.5 foot.	GS	1.0-2.0		C
2.2-3.2	Poorly Graded Gravel with Silt and Sand (GP-GM): Brown to dark brown, medium dense to dense, slightly moist, with fine to coarse-grained sand, fine to coarse gravel, and 4-inch-minus cobbles.				
3.2-13.5	Poorly Graded Gravel with Sand (GP): Light brown to gray, slightly moist to saturated, medium dense to dense, with fine to coarse-grained sand, fine to coarse gravel, and 4-inch-minus cobbles. --Sidewall sloughing noted below water table.				

Notes: See Site Map for test pit location.
Piezometer installed to a depth of 13.5 feet bgs.

Lab Test ID	Moisture (%)	LL	PI	Sieve Analysis (% Passing)				
				#4	#10	#40	#100	#200
C	9.1	29	9	74	68	42	26	17.1

Appendix V GEOTECHNICAL GENERAL NOTES

Unified Soil Classification System			
Major Divisions		**Symbol**	**Soil Descriptions**
Coarse-Grained Soils < 50% passes No.200 sieve	Gravel & Gravelly Soils < 50% coarse	GW	Well-graded gravels; gravel/sand mixtures with little or no fines
		GP	Poorly-graded gravels; gravel/sand mixtures with little or no fines
		GM	Silty gravels; poorly-graded gravel/sand/silt mixtures
		GC	Clayey gravels; poorly-graded gravel/sand/clay mixtures
	Sand & Sandy Soils > 50% coarse fraction	SW	Well-graded sands; gravelly sands with little or no fines
		SP	Poorly-graded sands; gravelly sands with little or no fines
		SM	Silty sands; poorly-graded sand/gravel/silt mixtures
		SC	Clayey sands; poorly-graded sand/gravel/clay mixtures
Fine-Grained Soils > 50% passes No.200 sieve	Silts & Clays LL < 50	ML	Inorganic silts; sandy, gravelly or clayey silts
		CL	Lean clays; inorganic, gravelly, sandy, or silty, low to medium-plasticity clays
		OL	Organic, low-plasticity clays and silts
	Silts & Clays LL > 50	MH	Inorganic, elastic silts; sandy, gravelly or clayey elastic silts
		CH	Fat clays; high-plasticity, inorganic clays
		OH	Organic, medium to high-plasticity clays and silts
Highly Organic Soils		PT	Peat, humus, hydric soils with high organic content

Relative Density and Consistency Classification	
Coarse-Grained Soils	**SPT Blow Counts (N)**
Very Loose:	< 4
Loose:	4-10
Medium Dense:	10-30
Dense:	30-50
Very Dense:	> 50
Fine-Grained Soils	**SPT Blow Counts (N)**
Very Soft:	< 2
Soft:	2-4
Medium Stiff:	4-8
Stiff:	8-15
Very Stiff:	15-30
Hard:	> 30

Moisture Content and Cementation Classification	
Description	**Field Test**
Dry	Absence of moisture, dry to touch
Slightly Moist	Damp, but no visible moisture
Moist	Visible moisture
Wet	Visible free water
Saturated	Soil is usually below water table
Description	**Field Test**
Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

Particle Size	
Boulders:	> 12 in.
Cobbles:	12 to 3 in.
Gravel:	3 in. to 5 mm
Coarse-Grained Sand:	5 to 0.6 mm
Medium-Grained Sand:	0.6 to 0.2 mm
Fine-Grained Sand:	0.2 to 0.075 mm
Silts:	0.075 to 0.005 mm
Clays:	< 0.005 mm

Acronym List	
GS	grab sample
LL	Liquid Limit
M	moisture content
NP	non-plastic
PI	Plasticity Index
Q_p	penetrometer value, unconfined compressive strength, tsf
V	vane value, ultimate shearing strength, tsf

Appendix VI AASHTO PAVEMENT DESIGN

Pavement Section Design Location: DJC St. Anthony Cottages, Light Duty

Average Daily Traffic Count:	50	All Lanes & Both Directions		
Design Life:	20	Years		
Percent of Traffic in Design Lane:	50%			
Terminal Seviceability Index (Pt):	2.5			
Level of Reliability:	95			
Subgrade CBR Value:	6		**Subgrade Mr:**	9,000

Calculation of Design-18 kip ESALs

	Daily Traffic	Growth Rate	Load Factors	Design ESALs
Passenger Cars:	14	2.0%	0.0008	99
Buses:	0	2.0%	0.6806	0
Panel & Pickup Trucks:	9	2.0%	0.0122	974
2-Axle, 6-Tire Trucks:	1	2.0%	0.1890	1,676
Emergency Vehicles:	1.0	2.0%	4.4800	39,731
Dump Trucks:	0	2.0%	3.6300	0
Tractor Semi Trailer Trucks:	0	2.0%	2.3719	0
Double Trailer Trucks	0	2.0%	2.3187	0
Heavy Tractor Trailer Combo Trucks:	0	2.0%	2.9760	0
Average Daily Traffic in Design Lane:	25			

Total Design Life 18-kip ESALs:	42,480
Actual Log (ESALs):	4.628
Trial SN:	2.10
Trial Log (ESALs):	4.705
Pavement Section Design SN:	2.21

	Design Depth Inches	**Structural Coefficient**	**Drainage Coefficient**
Asphaltic Concrete:	2.50	0.42	n/a
Asphalt-Treated Base:	0.00	0.25	n/a
Cement-Treated Base:	0.00	0.17	n/a
Crushed Aggregate Base:	4.00	0.14	1.0
Subbase:	6.00	0.10	1.0
Special Aggregate Subgrade:	0.00	0.09	0.9

AASHTO PAVEMENT DESIGN

Pavement Section Design Location: DJC St. Anthony Cottages, Moderate Duty

Average Daily Traffic Count:	50	All Lanes & Both Directions
Design Life:	20	Years
Percent of Traffic in Design Lane:	50%	
Terminal Seviceability Index (Pt):	2.5	
Level of Reliability:	95	
Subgrade CBR Value:	6	**Subgrade Mr:** 9,000

Calculation of Design-18 kip ESALs

	Daily Traffic	Growth Rate	Load Factors	Design ESALs
Passenger Cars:	12	2.0%	0.0008	85
Buses:	2	2.0%	0.6806	12,072
Panel & Pickup Trucks:	5	2.0%	0.0122	541
2-Axle, 6-Tire Trucks:	4	2.0%	0.1890	6,705
Emergency Vehicles:	1.0	2.0%	4.4800	39,731
Dump Trucks:	1	2.0%	3.6300	32,193
Tractor Semi Trailer Trucks:	0	2.0%	2.3719	0
Double Trailer Trucks	0	2.0%	2.3187	0
Heavy Tractor Trailer Combo Trucks:	0	2.0%	2.9760	0
Average Daily Traffic in Design Lane:	25			

Total Design Life 18-kip ESALs:	91,326
Actual Log (ESALs):	4.961
Trial SN:	2.33
Trial Log (ESALs):	4.974
Pavement Section Design SN:	2.41

	Design Depth Inches	**Structural Coefficient**	**Drainage Coefficient**
Asphaltic Concrete:	2.50	0.42	n/a
Asphalt-Treated Base:	0.00	0.25	n/a
Cement-Treated Base:	0.00	0.17	n/a
Crushed Aggregate Base:	4.00	0.14	1.0
Subbase:	8.00	0.10	1.0
Special Aggregate Subgrade:	0.00	0.09	0.9

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:
- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:
- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept* *responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are <u>not</u> final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are <u>Not</u> Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will <u>not</u> of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are <u>not</u> building-envelope or mold specialists.***

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