



Geotechnical & Environmental Services, Inc.

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**GEOTECHNICAL EVALUATION
HOLYOAK HOMES – V97 PARCEL
NE OF 310 W AND HIGHWAY 9
VIRGIN, WASHINGTON COUNTY, UTAH**

**PROJECT NO. G20257471E1
MAY 13, 2025**



Prepared for:



Holyoak Homes.
2776 W 4000 N
Cedar City, UT 84721



May 13, 2025
Project No. G20257471E1

Brock Holyoak
Holyoak Homes
2776 W. 4000 N
Cedar City, Utah 84721

**RE: Geotechnical Evaluation
Holyoak Homes – V-97 Parcel
NE of 310 W and Highway 9
Virgin, Washington County, UT**

**GEOTECHNICAL &
ENVIRONMENTAL
SERVICES, INC.**

Dear Brock Holyoak:

Geotechnical & Environmental Services, Inc. (GES) is pleased to present the Geotechnical Evaluation report for the proposed project located at Parcel V-97 northeast of 310 W and Highway 9 in Virgin, Utah.

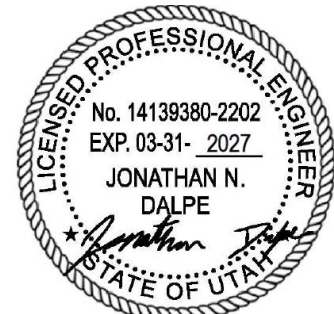
The Geotechnical Evaluation report includes the findings of a geologic review, the results of the field exploration and laboratory testing programs, conclusions, and design and construction related recommendations based on subsurface soil conditions.

We appreciate this opportunity to provide our professional services. If you have any questions or comments regarding this information, please feel free to contact our office.

Sincerely,

Geotechnical & Environmental Services, Inc.

- Geotechnical Engineering
- Construction Materials Testing & Inspections
- Environmental Services
- AASHTO Accredited Testing Laboratories
- IAS Accredited



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EXECUTIVE SUMMARY
HOLYOAK HOMES – V97 PARCEL
NE OF 310 W AND HIGHWAY 9
VIRGIN, WASHINGTON COUNTY, UTAH

This Executive Summary is for reference only and is not fully comprehensive of the findings and recommendations specified in this Geotechnical Evaluation. Click on the topics and underlined subjects to go to the appropriate section of the report.

Topic	Overview
Project Description	The proposed project will include the design and construction of three commercial buildings at the V-97 parcel. The structures are anticipated to be wood- or steel-framed, single-story buildings supported by conventional spread footings with slab-on-grade floors and without basements. We assume that wall loads will be less than 5 kips per lineal foot, and column loads will be less than 80 kips. We also assume that finish grades will generally be within 2 feet of existing grades.
Geotechnical Site Characterization	Approximately 4.5 to 9.5 feet of existing fill was encountered. Fill soils are primarily silty sand. Native soils are either silty sand with gravel or clayey sand with gravel. <u>Slightly Weathered Sandstone</u> rock was encountered at 6.0 feet below ground surface. <u>Groundwater</u> was not encountered during the test pit explorations. <u>Liquefaction potential</u> is low. <u>Seismic site class</u> D.
Earthwork	Excavate any existing uncontrolled fill, deleterious material, loose or disturbed native soils from improvement areas. On-site fill and native soils are anticipated to be suitable for <u>structural backfill</u> .
Spread Footing Foundations	Continuous and spread footings are acceptable. Maximum allowable bearing pressure = 4,000 psf. Estimated total settlement <1-inch.
Concrete Flatwork	4-inch minimum concrete thickness with 4-inch minimum aggregate base thickness. Concrete should contain Type V cement and have a design compressive strength of 4,500 psi.
Drainage	Positive drainage should be established and maintained away from the proposed structures.

GEOTECHNICAL EVALUATION
HOLYOAK HOMES – V97 PARCEL
NE OF 310 W AND HIGHWAY 9
VIRGIN, WASHINGTON COUNTY, UTAH

1. INTRODUCTION

This report presents the findings of a geotechnical study performed by Geotechnical & Environmental Services, Inc. (GES) for the Holyoak Homes V-97 Parcel located northeast of 310 W and Highway 9 in Virgin, Washington County, Utah. Figure A-1 presents a vicinity map showing the approximate location of the project site. This report includes the findings of the geologic review, the results of the field exploration and laboratory testing programs and presents geotechnical recommendations for design and construction of proposed project improvements.

1.1. PURPOSE AND RESOURCES

The purpose of this geotechnical evaluation is to provide general subsurface information for the proposed project area to aid in design and construction. The scope of this study included a review of referenced geologic literature and maps, subsurface exploration, soil sampling, laboratory testing of selected soil samples, engineering evaluations, and preparation of this report. The scope of work contained herein is provided in general accordance with our Work Order Authorization dated April 18, 2025.

1.2. PROJECT DESCRIPTION

Our understanding of the project is based on a review of aerial photographs, information received from the client and our experience with similar projects in the vicinity of the subject site. Our design recommendations are based on the 2024 International Building Code (IBC).

We understand that the proposed project will include the design and construction of three commercial buildings at the V-97 parcel. The structures are anticipated to be wood- or steel-framed, single-story buildings supported by conventional spread footings with slab-on-grade floors and without basements. We assume that wall loads will be less than 5 kips per lineal foot, and column loads will be less than 50 kips. We also assume that finish grades will generally be within 2 feet of existing grades.

1.3. SITE DESCRIPTION

The project site consists of one parcel approximately 1.03 acres in size. The V-97 parcel is located northeast of 310 W and Highway 9 in Virgin, Utah. The site generally slopes from northwest to southeast, was previously rough graded, and remains largely undeveloped. Fill stockpiles were observed on portions of the site.

A wash exists northeast of the parcel. Based on our discussions with Holyoak Homes, the wash previously ran through the parcel but was rerouted to flow east of the parcel. The project site is bordered by vacant land to the north, west and east with commercial developments to the south. The project site is bordered by Highway 9 on the south side.



Figure 1.3 Project Site

2. GEOTECHNICAL SITE CHARACTERIZATION

The following sections describe the geology, seismicity, liquefaction, mapped soil conditions, field exploration, laboratory testing, and subsurface materials and conditions for the project site.

2.1. GEOLOGY

The subject site is located within southwest Utah that lies in a physiographical transition zone between the Basin and Range Province to the west and the Colorado Plateau to the east. The Basin and Range is characterized by the earth's crust being pulled apart east to west creating generally north to northwest-trending parallel mountain ranges and an intervening basin with internal drainage. In contrast, the Colorado Plateau area is relatively stable and is underlain by unfaulted sedimentary rocks. In southwestern Utah, the western margin of the Colorado Plateau is broken by several north-trending faults that step down from the Colorado Plateau to the Basin and Range, creating a transition zone (Biek, et. al, 2010).

The largest earthquake recorded in southern Utah was a magnitude 6.5 earthquake in 1901 in Richfield at 165 miles northeast of the project area. Table 2.2 below lists known Quaternary aged faults near the project site.

Table 2.2: Nearby Quaternary Aged Faults*

Geologic Age	Fault	Distance from Project Site (miles)	Direction
Middle and late Quaternary	Volcano Mountain Fault	7.0	Southwest
	Kolob Terrace Fault	21.0	Northeast
Holocene (<11,700 years)	Hurricane Fault Zone, Anderson Junction section	3.9	West
	Washington Fault Zone, North section	18.0	Southwest
	Hurricane Fault Zone, Cedar City section	8.2	Northwest
Late Quaternary	Dutchman Draw Fault	17.8	Southwest
	Washington Fault Zone, Mokaac section	24.7	Southwest
	Servier/Toroweap Fault Zone	30	East

*Based on USGS Fault and Fold Data Base

2.3. LIQUEFACTION

Liquefaction is a phenomenon in which loose, saturated soils lose shear strength under short-term (dynamic) loading conditions. Ground shaking of sufficient duration results in the loss of grain-to-grain contact in potentially liquefiable soils due to a rapid increase in pore water pressure causing the soil to behave as a fluid for a short period of time.

To be potentially liquefiable, a soil is typically cohesionless with a grain-size distribution generally consisting of sand and silt. It is generally loose to medium dense and has a relatively high moisture content, which is typical near or below groundwater level. The potential for liquefaction decreases with increasing clay and gravel content, but increases as the ground acceleration and duration of shaking increase. Potentially liquefiable soils need to be subjected to sufficient magnitude and duration of ground shaking for liquefaction to occur.

Effects of liquefaction include relatively large total and differential settlements, flotation of subsurface structures, slope failures, lateral ground displacements (lateral spreading), surface subsidence, ground cracking, and sand boils.

Based on a review of the Utah Geologic Hazards Portal (Utah Geological Survey (UGS), updated 2020) the project site is in an area that is unmapped for liquefaction susceptibility. Based on information obtained from the test pits, which include shallow sandstone rock, and the historic depth to groundwater, it is our opinion that the potential for liquefaction is low.

2.4. MAPPED SOIL CONDITIONS

Based on review of the Utah Geologic Hazards Portal (Utah Geological Survey (UGS), updated 2020), the project site is located within an area labelled as “Low to Highly Susceptible Soil” for expansive potential. The area is also mapped as “Soil Units (Gypsum Bearing) Mapped by the Natural Resources Conservation Service (NRCS)” for Soluble Soil and Rock Susceptibility.

2.5. GROUNDWATER

Groundwater was not encountered during our test pit explorations. A review of historical water wells listed on the Utah Division of Water Rights website indicates that historical static near the site (approximately 0.5 miles southeast of the project site) was measured at elevations of about 20-feet below the ground surface (Well Log No. 81-3864, measured in 1999).

Groundwater levels should be anticipated to fluctuate due to seasonal precipitation, groundwater withdrawal and recharge, irrigation practices, and potential future dewatering efforts within and/or near the subject site. A detailed evaluation of possible groundwater fluctuations is beyond the scope of this study.

2.6. FIELD EXPLORATION

GES evaluated the subsurface conditions at the site on April 21, 2025. The subsurface evaluation consisted of observing subsurface conditions exposed in three test pits (TP-1 through TP-3) excavated by the contractor using a mini-excavator to depths of up to approximately 10 feet below the ground surface.

The approximate locations of the test pits are shown on Figure A-2. Test pit locations were determined in the field by a GES representative using a combination of field measurements and a hand-held GPS unit. Ground surface elevations were estimated using Google Earth Pro and are provided on the individual exploration logs.

All test pits were backfilled with soil cuttings upon completion.

Table 2.6 Field Exploration Summary

Exploration ID	Depth (ft)	Latitude	Longitude	Approximate Ground Elevation (ft)	Equipment
TP-1	4.5	37.203949	-113.193535	3553	Backhoe
TP-2	10.0	37.203943	-113.193786	3553	Backhoe
TP-3	6.3	37.204258	-113.19395	3557	Backhoe

A GES representative directed and supervised the subsurface explorations, maintaining a detailed log of the subsurface conditions, classifying the soils encountered, and obtaining soil samples. The soils encountered were classified in general accordance with the Unified Soil Classification System (USCS). A Key to Symbols and Terms utilized on the test pit logs is presented on Figure A-3. The test pit logs are presented in Appendix A.

2.7. LABORATORY TESTING

The laboratory testing program consisted of tests to classify the on-site soils and to evaluate engineering and physical properties. The test results are presented on the exploration logs in Appendix A and on test reports presented in Appendix B. Detailed descriptions of the laboratory tests performed are also presented in Appendix B.

2.8. SUBSURFACE MATERIALS AND CONDITIONS

The following sections describe the existing soils encountered in the test pits. Detailed information regarding subsurface materials and conditions are presented on the test pit logs in Appendix A.

2.8.1. FILL

Fill materials were encountered at the site between 4.5 and 9.5 feet below ground surface during our field explorations. The fill consisted of silty sand with gravel, cobbles, and boulders. The consistency of fill materials was dry to slightly moist.

Documentation for the initial fills encountered was not provided during our study, therefore the Owner removed them from within the building pad area. Fill placed without documentation to indicate that the fill soils were not placed under the supervision of a Geotechnical Engineer are considered uncontrolled. The term uncontrolled fill soils refer to artificial fill which was placed without engineering observation, testing, or documentation and is considered unsuitable for the support of project improvements.

2.8.2. NATIVE SOIL

The native soil material generally consisted of dry to slightly moist sand with varying amounts of silt and gravel. The density of native soils were generally noted as loose to dense and moderately cemented for the sand material. Rock was also encountered in our test pits at depths of approximately 6-feet below ground surface and consisted of sandstone. Detailed information regarding subsurface materials and conditions, are presented on the exploration logs in Appendix A.

Moderately cemented soils were encountered at TP-3 at 2.5 feet below ground surface (bgs). Sandstone bedrock was also encountered at TP-3 at 6 feet bgs. GES notes that cemented soils or rock may be encountered beyond or between our test pit locations. Weakly and moderately cemented soil refers to cemented soil that will crumble or break with little or considerable finger pressure, respectively. Strongly cemented soil refers to rock-like soil that will not crumble or break at any finger pressure. In general, weakly to moderately cemented soils can be excavated with a backhoe, although with a corresponding reduction in excavation production as degree of cementation increases. Moderately cemented soils can be excavated with a ripper tooth or by a backhoe with extreme difficulty. However, to excavate strongly cemented rock-like materials, a heavy-duty excavator or trencher, Caterpillar D-10 Dozer or larger (or equivalent) with ripper, hoe-ram, headache ball, rock-saw or similar rock excavation technique is recommended and will likely be needed. Due to the depth of rock encountered, excavation may be difficult and may require specialty rock excavation equipment or blasting when performing excavations for the parking garage structure.

Oversize material is anticipated to be generated during excavation of rock and strongly cemented materials. These materials will need to be crushed prior to being used as backfill or removed from the site and disposed of in a suitable manner.

The contractor should be aware of the potential for (and take adequate precautions to reduce the potential for) vibrational damage to adjacent or nearby structures, and take appropriate precautions, when using heavy impact equipment during removal of cemented soils or rock. Pre-construction documentation of existing distress to structures near construction areas, and monitoring of these structures and ground motions generated, should be considered to reduce the potential for damage and construction-related claims.

A detailed excavatability or rippability evaluation was beyond the scope of this study. The contractor should perform the independent investigations necessary to determine the type of equipment required for grading and excavation operations. If the contractor(s) have any questions regarding site conditions, site preparation, or the recommendations provided, they should contact a representative of GES for any needed clarifications prior to submitting earthwork bids. It is the express responsibility of the contractor to perform independent evaluations of the rippability of cemented soils or rock prior to preparing their bid. GES is not an earthwork or underground contractor.

3. FINDINGS

Based on the results of our field exploration and laboratory testing programs, it is our opinion that there are no known geologic or geotechnical conditions that would prevent the planned development at the project site. It is also our opinion that there are some geotechnical considerations that will affect site development. A summary of geotechnical considerations is described below.

- Fill materials were encountered within our test pits, up to a depth of approximately 9.5-feet. Documentation indicating placement and compaction of the fill encountered was not available for review as part of our study. Fill materials should be considered undocumented fill unless documentation of their placement and compaction is provided. The term “undocumented fill” refers to fill which was placed without engineering observation, testing, or documentation and is considered unsuitable in its present condition and needs to be excavated from structural areas.
- Rock materials were encountered within the explorations at the site. Moderately cemented soils were also encountered. Cemented soils may be encountered at different depths and locations between and beyond our explorations. The presence of cemented soils needs to be considered by the contractors in preparing their bids. Information regarding subsurface materials and conditions is presented on the exploration logs in Appendix A. A detailed excavatability and rippability evaluation is beyond the scope of this study. The earthwork and underground contractors should perform the independent investigations necessary to determine the type of equipment required to perform the work before preparing bids for work associated with this project.

- Based on the results of swell testing performed on representative soils at or near foundation bearing elevation, we do not expect the structures to be adversely affected by expansive soils.
- Based on the consistency of the on-site soils and the historic depth to groundwater, it is our opinion that the potential for liquefaction at the site is low.
- Based on the results of our review of available literature and the distance to mapped faults and fissures, it is our opinion that the potential for fault-related surface rupture at the site is low. Due to the relatively flat grades proposed at the site, it is our opinion that the risk of slope instability is low.
- Given that a boring exploration program was not conducted for the project, a default Site Class D is assumed for the project site.
- The tested soils at the site have a sulfate exposure class of S2 as defined in Table 19.3.1.1 of American Concrete Institute (ACI) Publication 318-14. Based upon our experience with projects in the area, we recommend concrete in contact with on-site soils along the subsurface walls up to 12 inches above finished grade contain Type V cement, have a minimum design compressive strength of 4,500 pounds per square inch (psi) and a maximum water to cement ratio of 0.45.
- Based on the laboratory test results, the solubility of the tested on-site soils is considered low.
- The tested native on-site soils have soluble soil chloride content of less than 500 ppm as determined by AWWA Standard Test Method SM4500-Cl B. Imported materials and excavated on-site fill materials used for structural fill should contain 500 parts per million (ppm) or less chlorides, unless appropriate design criteria for mitigation is incorporated into the structural design elements for the project.
- When available, the project geotechnical evaluation, grading and foundation plans prepared by the Engineers of Record should be reviewed by the owner's geotechnical consultant to evaluate consistency with the geotechnical design criteria presented in this report.

4. RECOMMENDATIONS

The following sections present design and construction recommendations for the proposed commercial structures. These recommendations are based upon our understanding of the project, the engineering properties of the tested soils, the geologic conditions that are presented in this report, and the assumption that an adequate number of tests and observations will be made during construction to evaluate compliance with these recommendations. Earthwork and site preparation for the proposed project should be performed in general accordance with the recommendations presented in this report.

4.1. EARTHWORK

Based on the results of our field exploration and laboratory testing programs, and our stated understanding of the proposed project, it is our opinion that the following earthwork recommendations are applicable to the project.

4.1.1. SITE PREPARATION

Any uncontrolled fill, deleterious material, and loose, soft or wet native soil encountered in improvement areas should be removed to expose dense to very dense native soil or sandstone rock. Care should be taken to completely remove all organics from the areas of improvement including root bulbs from the existing trees and vegetation. These excavated soils may be stockpiled for later use as structural fill or backfill pending evaluation of compliance with the recommendations for structural fill provided in this report.

During construction the geotechnical consultant should observe exposed materials, after recommended removals of unsuitable materials, to evaluate whether additional removal down to competent materials is needed. After removal of materials, the exposed soils should be scarified to 12-inches or more, moisture conditioned to near optimum moisture content and compacted to a firm and unyielding state. The exposed subgrade may be observed and acceptable if probing yields 1-inch or less penetration into the subgrade. Scarification may terminate on exposed rock or strongly cemented soils, as evaluated by the geotechnical consultant. Cemented soil and rock considerations are provided in Section 4.2.2 of this report. If both rock/cemented soil and uncemented materials are present at the bottom elevation of foundations, the rock/cemented material should be removed to a depth of at least 12-inches below bottom of foundations and replaced with compacted structural fill. Cobbles and boulders that become dislodged during scarification should be removed and replaced with structural fill as specified below.

The soil preparation area should extend laterally a minimum of 5 feet beyond the edges of buildings and exterior foundations. For exterior concrete flatwork and pavement, the soil preparation area should extend laterally 2 feet, or more, beyond the edges. If lot lines limit the lateral extent, soil preparation may be reduced at the discretion of the geotechnical engineer. We should be contacted to provide additional recommendations if this condition occurs. The vertical and lateral extent of the recommended excavations should be evaluated under the direction of the geotechnical consultant.

Excavated native on-site soils may be used as structural fill after processing in areas underlying foundations, post-tensioned concrete slabs-on-grade, or other improvements, provided that the excavated soils are suitable as specified in Section 4.1.2.

4.1.2. STRUCTURAL FILL AND BACKFILL SUITABILITY

Samples of materials proposed for use as structural fill should be submitted to the geotechnical consultant for testing and evaluation prior to being transported to the site. Imported materials and on-site materials that have been excavated, stockpiled, and processed for use as structural fill should satisfy the following recommendations:

Table 4.1.2. Imported and/or On-site Structural Fill Recommendations

Description	Recommendation
4-inch Sieve Gradation**	100 Percent Passing
¾ -inch Gradation	100-70 Percent Passing
No. 200 Sieve Gradation**	<40 Percent Passing
Liquid Limit	<40
Plasticity Index	<12
Remolded Swell Potential	≤4.0% as determined by ASTM D4829*
Dry Weight Soluble Solids	<2.0% as determined by American Water Works Association (AWWA) Standard Method (SM) 2540 C
Dry Weight Soluble Sulfate	<2.0% by dry weight soluble sulfate as determined by AWWA SM 4500 SO4 E
Soluble Soil Chloride Content	<500 ppm as determined by AWWA SM 4500-CL B unless appropriate corrosion protection is utilized in the design of proposed structures

Imported fill materials and excavated on-site material should be free of debris, organic materials, and other deleterious materials.

*Under 1 ksf loading

**Materials used as retaining wall backfill, which should have 10 percent, or less, of material passing the No. 200 sieve and 100 percent passing the 4-inch sieve.

Based on laboratory tests conducted for the project, the onsite soils are anticipated to meet these recommendations. Should further laboratory results result in values that do not meet these recommendations, materials not meeting the recommendations may be mixed with other on-site soils or blended with imported soils to meet these specifications. A trial blending ratio of 2:1 (on-site:import) may be considered for planning purposes. Testing should be conducted during construction and the blending ratio modified as needed.

4.1.3. FILL PLACEMENT

Areas to receive structural fill should be prepared prior to fill placement as described in Section 4.1.1 of this report. Structural fill placement should be conducted in accordance with the Washington County Construction Design Standards – Section 4.3. Structural fill should be uniformly moisture conditioned to within 2% of optimum moisture content (or 2% to 5% above optimum for fine-grained soils), placed in horizontal, loose lifts up to 8 inches thick, and compacted to at least 95 percent of the maximum dry density, as determined by ASTM D1557. The optimal lift thickness of fill will depend on the type of soil and compaction equipment used but should generally not exceed approximately 8 inches in loose thickness.

4.1.4. OBSERVATION AND TESTING

A qualified geotechnical consultant should perform appropriate observation and testing services during grading and construction operations. These services should include observation of removal of soft, loose, or otherwise unsuitable soils, evaluation of subgrade conditions where soil removals are performed, and performance of observation and testing services during placement and compaction of structural fill and backfill soils. In-place density and moisture tests should be performed in accordance with ASTM D6938 or, alternatively, in accordance with ASTM D1556. The test frequency should be every 500 cubic yards (13,500 cubic feet) of fill or every vertical foot, whichever is more. Additional field tests may also be performed in structural and non-structural areas at the discretion of the geotechnical consultant.

4.2. EXCAVATION CONSIDERATIONS

The following sections provide recommendations to aid in the successful performance of excavations at the project site and include recommendations regarding temporary excavations and cemented soil considerations.

It is the responsibility of the contractor to perform the independent investigations necessary to determine the type of equipment required to perform the work. The contractor should perform a pre-construction survey to establish a baseline survey prior to excavating.

4.2.1. TEMPORARY EXCAVATIONS

Temporary slope surfaces should be kept moist to retard raveling and sloughing. Water should not be allowed to flow over the top of excavations in an uncontrolled manner. Stockpiled material and/or equipment should be kept back from the top of excavations a distance equivalent to the depth of the excavation or more. Workers should be protected from falling debris, sloughing, and raveling in accordance with Occupational Safety and Health Administration (OSHA) regulations.

Temporary excavations should be observed by the project's geotechnical consultant so that appropriate additional recommendations may be provided based on the actual field conditions. Temporary excavations are time sensitive, and failures are possible.

Excavations greater than 4 feet in depth into uncemented soils are not anticipated to stand vertically. Excavations greater than 4 feet in depth should be sloped back in accordance with the maximum allowable slope ratios presented in Appendix B to Subpart P of OSHA for the Construction Industry 29 Code of Federal Regulations (CFR), State of Nevada, Division of Occupational Safety and Health, Part 1926. The soil type definitions in Appendix A to Subpart P of OSHA 29 CFR, Part 1926 should be applied to soils encountered in excavations to determine the maximum allowable slope ratio. As an alternative to sloped excavation sidewalls, excavations could be shored and braced. Shoring and bracing should be designed in accordance with Appendices C and D to Subpart P of OSHA 29 CFR, Part 1926. Safety of construction personnel is the responsibility of the contractor.

4.2.2. ROCK AND CEMENTED SOIL CONSIDERATIONS

Rock was encountered in our explorations at the project site in TP-3 at 6 feet bgs. Moderately cemented soils were encountered within our explorations in TP-3 at 2.5 feet bgs. Cemented soils may be encountered beyond or between our test pit locations. Weakly and moderately cemented soil refers to cemented soil that will crumble or break with little or considerable finger pressure, respectively. Strongly cemented soil refers to rock-like soil that will not crumble or break at any finger pressure. In general, weakly to moderately cemented soils can be excavated with a backhoe, although with a corresponding reduction in excavation production as degree of cementation increases. Moderately cemented soils can be excavated with a ripper tooth or by a backhoe with extreme difficulty. However, to excavate rock and strongly cemented materials, a heavy-duty excavator or trencher, Caterpillar D-10 Dozer or larger (or equivalent) with ripper, hoe-ram, headache ball, rock-saw or similar rock excavation technique is recommended and will likely be needed. Due to the depth of rock encountered, excavation may be difficult and may require specialty rock excavation equipment or blasting when performing excavations for the warehouse footings and related subsurface structures.

Oversize material is anticipated to be generated during excavation of rock and strongly cemented materials. These materials will need to be crushed prior to being used as backfill or removed from the site and disposed of in a suitable manner.

The contractor should be aware of the potential for (and take adequate precautions to reduce the potential for) vibrational damage to adjacent or nearby structures, and take appropriate precautions, when using heavy impact equipment during removal of cemented soils or rock. Pre-construction documentation of existing distress to structures near construction areas, and monitoring of these structures and ground motions generated, should be considered to reduce the potential for damage and construction-related claims.

A detailed excavatability or rippability evaluation was beyond the scope of this study. The contractor should perform the independent investigations necessary to determine the type of equipment required for grading and excavation operations. If the contractor(s) have any questions regarding site conditions, site preparation, or the recommendations provided, they should contact a representative of GES for any needed clarifications prior to submitting earthwork bids. It is the express responsibility of the contractor to perform independent evaluations of the rippability of cemented soils or rock prior to preparing their bid. GES is not an earthwork or underground contractor.

4.3. UNDERGROUND UTILITIES

Excavated native and on-site soils may be used for on-site utility trench backfill provided they meet the specifications for trench backfill outlined in the Washington County Construction Design Standards. Soils used for on-site trench backfill should be moisture conditioned and compacted as recommended for structural fill in this report. Suitability and compaction of trench backfill should be evaluated during construction. In-place density and moisture tests of on-site trench backfill should be performed in general accordance with ASTM D6938; the test frequency should be at least one test per 200 linear feet of fill material placed per each vertical foot of compacted fill.

Due to the nature of the on-site soils, ponding or jetting of utility trench backfill will not be acceptable. Trench backfill should be compacted by mechanical means only.

4.4. FOUNDATIONS

The following sections present recommendations for spread footing and conventionally reinforced slabs-on-grade.

4.4.1. SPREAD FOOTINGS

Continuous footings (generally having a length to width ratio greater than 10) and spot footings supporting columns and other ancillary structures should be supported entirely on compacted structural fill or entirely on native subgrade. Continuous and spot footings should be established at least 18 inches below the lowest adjacent final compacted subgrade. Continuous and spot footings should be at least 12 inches wide and should be reinforced in accordance with the project structural engineer's recommendations.

Footings may be designed based on an allowable net dead plus sustained live load bearing pressure of 2,300 pounds per square foot (psf). The allowable bearing pressure for conventional spread footings may be increased by 1,200 psf for each additional foot of embedment depth and/or increased by 500 psf for each additional foot of width up to a maximum allowable bearing pressure of 4,000 psf. The allowable bearing pressures may be increased by one-third for temporary wind or seismic loads. The allowable bearing pressure presented above includes a factor of safety against generalized bearing capacity failure of 3.0. Provided earthwork recommendations presented are followed, and loads are less than 50 kips for isolated footings and less than 5 kips per lineal foot for continuous footings, total and differential settlements are not anticipated to exceed 1-inch and ½-inch, respectively.

Resistance to lateral loads may be estimated using both passive lateral earth support and friction developing between footings and underlying soil. Passive resistance may be used if foundation backfill soils in front of the foundation are level and compacted to 95 percent, or more, of the maximum laboratory dry density (ASTM D1557). The upper 12 inches below the ground surface should be neglected if passive resistance is used unless confined by concrete slab-on-grade or pavement. The passive lateral earth support for subsurface walls may be estimated based on an equivalent fluid density of 400 pounds per cubic foot (pcf) up to a maximum passive lateral pressure of 2,700 psf. A coefficient of friction of 0.39 may be used for the interface between the footing and underlying properly compacted structural fill. The values for passive equivalent fluid density and base coefficient of friction are ultimate values. An appropriate factor of safety should be applied.

4.4.2. CONVENTIONALLY REINFORCED SLABS-ON-GRADE

Conventionally reinforced slabs-on-grade should be at least 4 inches thick. Actual thickness and reinforcing requirements should be determined by an experienced structural engineer based on the anticipated loading conditions. Aggregate base course materials beneath the floor slab-on-grade should be 4 inches or thicker and should consist of Type II Aggregate Base materials, or other similar material acceptable to the geotechnical consultant, and be uniformly placed and compacted to 95 percent, or more, of the maximum laboratory dry density (ASTM D1557). A vertical modulus of subgrade reaction (k_v) of 150 pounds per cubic inch, applicable for a 1-foot square area, may be used for design of the slab-on-grade. The k_v value should be reduced based on the actual loading conditions and geometry of the slab-on-grade.

If moisture-sensitive floor coverings are not used, a vapor retarder is not required. However, when moisture-sensitive floor coverings are used, a vapor retarder is recommended beneath slabs-on-grade and should consist of 10-mil minimum sheet plastic overlain by at least 4 inches of Type II Aggregate Base materials or other similar material approved by the Geotechnical Engineer. The vapor retarder should comply with the Class A rating as set forth in ASTM E1745. Installation of the vapor retarder should be performed in accordance with ASTM E1643.

4.5. SEISMIC SITE CLASS

A default Seismic Site Class D was assigned to the project site. The following seismic design parameters were developed using the recommended Site Class and representative coordinates of 37.203943 degrees latitude and -113.193786 degrees longitude with an assumed Risk Category of II and may be utilized for design of project structures.

Table 4.5. Spectral Response Accelerations and Site Coefficients – Site Class D

Spectral Response Acceleration at Short Periods, S_s	Spectral Response Acceleration at 1-Second Period, S_1	Spectral Response Coefficient at Short Periods, SD_s	Spectral Response Coefficient at 1-Second Period, SD_1	Site Modified Peak Ground Acceleration, $PGAm$
0.574g	0.189g	0.513g	0.279g	0.343

4.6. LATERAL EARTH PRESSURES ON RETAINING WALLS

Retaining elements, if needed for the project, should be designed according to the recommendations in this report. Lateral active earth pressures induced by adjacent uniform surface surcharge loads should be estimated as a uniformly distributed lateral load with a magnitude equal to the magnitude of the surface surcharge load multiplied by an appropriate earth pressure coefficient. GES is presenting earth pressure coefficients for “active” and “at-rest” wall conditions. In the “active” condition the wall is able to deflect such that stresses from the retained soils are lessened. The “at rest” condition considers the walls to be rigid, or restrained, such that the walls do not deflect to lessen stresses from retained soils. Retaining walls with level backfill should be designed to resist the lateral earth pressures for the appropriate conditions presented in Figure C-1.

The values presented in Figure C-1 assume that the build-up of hydrostatic pressure will be prevented. To reduce the build-up of hydrostatic pressure, a wall drainage system, including weep-holes or a footing drainage system, leading to an appropriate outlet should be installed behind retaining walls. The wall drainage system should consist of Mirafi 140N (or equivalent) geotextile wrapped around drain rock, or a DrainStar Drain Board (or equivalent). The drain board should be used in conjunction with DrainStar Stripdrain by Tremco Barrier Solutions, Inc., or equivalent. The Stripdrain should be a minimum of 12-inches in height and placed continuously along the bottom of the retaining wall. Figure C-2 presents a diagram of the wall drainage systems described herein. Walls where hydrostatic pressure cannot be prevented should be designed for hydrostatic pressures.

Resistance to lateral loads may be estimated using both passive lateral earth support and friction developing between the wall footing and underlying soil. Passive resistance may be used if foundation backfill soils in front of the wall are compacted to at least 95 percent of the maximum laboratory dry density (ASTM D1557) or if the foundation is cast against undisturbed medium dense to very dense native soils, and if the ground surface in front of the wall is level. The upper 12-inches below the ground surface should be neglected if passive resistance is used. The passive lateral earth support for subsurface walls may be estimated based on an equivalent fluid density of 400 pcf up to a maximum passive lateral pressure of 2,700 psf. A coefficient of friction of 0.39 may be used for the interface between the footing and underlying dense to very dense native soil or for properly compacted structural fill. The values for the equivalent fluid density and coefficient of friction presented above do not include a factor of safety.

Backfill placed behind retaining walls or subsurface walls should consist of structural fill meeting the criteria presented in this report. Backfill placed behind retaining walls should be placed in 8-inch maximum vertical lifts and should be compacted to between 90 and 95 percent of the maximum laboratory dry density as determined per ASTM D1557. Over-compaction adjacent to retaining walls or subsurface walls should be avoided. The lateral earth pressures shown on Figure C-1 assume that compaction behind retaining walls or subsurface walls will be accomplished with relatively light compaction equipment.

4.7. EXTERIOR CONCRETE FLATWORK CONSTRUCTION

Concrete flatwork with light loads, including exterior slabs-on-grade, should be at least 4 inches in thickness. Aggregate base course materials beneath concrete flatwork should be at least 4 inches in thickness and should consist of Type II aggregate base. The aggregate base should be uniformly placed, moisture conditioned to within 2% of optimum, and compacted to at least 95 percent of the maximum laboratory dry density (ASTM D1557).

The subgrade soils beneath concrete flatwork should be prepared as recommended as described in Section 4.1 of this report prior to the placement of supportive aggregate base.

To facilitate curing of slabs, aggregate base materials should be kept moist prior to placement of concrete. Excessive slump (due to a high water-cement ratio) of the concrete and/or improper curing procedures could lead to excessive shrinkage, cracking or curling of slabs-on-grade and exterior concrete flatwork. Concrete placement and curing operations should be performed in accordance with the American Concrete Institute (ACI) Manual of Concrete Practice.

4.8. SOIL CORROSIVITY

Based on the results of the reviewed chemical testing, the tested on-site soils have a sulfate exposure of S2 as described in Table 19.3.1.1 of American Concrete Institute (ACI) Publication 318-14. Based upon our experience with projects in the area we recommend concrete in contact with on-site soils along with subsurface walls up to 12 inches above finished grade be designed for an S2 sulfate exposure:

Table 4.8. Concrete Recommendations for S2 Sulfate Exposure

Description	Recommendation per ACI 318-14
Cement Type	Type V
28- Day Design Compressive Strength	4,500 psi Min.
Water to Cement Ratio	0.45 Max.
Slump	4-inch

In addition, it is recommended that reinforcing bars in cast-against-grade concrete, with the exception of slab-on-grade floors and exterior concrete flatwork, be covered by 3 inches or more of concrete. Structural concrete should be placed in accordance with American Concrete Institute and project specifications.

We recommend that a Corrosion Engineer be consulted for protection recommendations for any buried metal pipe. Metal pipe may be protected by using cathodic protection or pipe coatings and wrappings, or, as an alternative, PVC pipe may be used if allowed by jurisdictional building codes.

4.9. ON-SITE FLEXIBLE PAVEMENT SECTIONS

To form a basis for design of non-dedicated paved parking and driveways, we have assumed the following:

- Traffic index of 6.5
- 85 percent reliability
- 0.45 standard deviation.
- 4.2 initial serviceability.
- 2.0 terminal serviceability.
- 0.35 structural coefficient – asphalt, 0.12 structural coefficient – aggregate base
- Resilient modulus (MR) of 18,800 pounds per square inch (psi) for an R-value of 60.

Table 4.9 Recommended Minimum Asphalt Concrete Pavement Sections

Traffic Condition	Traffic Index	Structural Number	Asphalt Thickness (Inches)	Type II Aggregate Base Thickness (Inches)
Parking & Drives	6.5	1.35	3	6

The recommended pavement sections assume subgrade soils will have an R-value of 60 or more. If soils with R-values less than 60 are present as subgrade beneath pavement sections, the recommended pavement sections will need to be reevaluated.

Prior to the placement of Type II Aggregate Base, the subgrade soils should be scarified to a depth of at least 12-inches, uniformly moisture conditioned to approximately optimum moisture content, and compacted to at least 90 percent of the maximum dry density. Type II Aggregate Base should be compacted to at least 95 percent of the maximum dry density.

4.10. DRAINAGE AND MOISTURE PROTECTION

Infiltration of water into subsurface soils can lead to soil movement and associated distress, and chemically and physically related deterioration of concrete structures. To reduce the potential for infiltration of moisture into subsurface soils at the site, we recommend the following:

- Positive drainage should be established and maintained away from proposed structures. Positive drainage may be established by sloping the ground immediately adjacent to foundations away from building(s) with a slope of at least 2 percent for a distance of at least 10 feet measured perpendicular to the building wall from building foundations. Where physical obstructions prohibit 10-feet of horizontal distance from foundations, a 2 percent slope should be provided to an alternate method of diverting water away from foundations such as swales parallel to the foundations with a flow line slope of at least 1 percent. Impervious surfaces should have a surface gradient of 2 percent or more. Adequate surface drainage should be provided to channel surface water away from on-site structures and to a suitable outlet such as a storm drain or the street. Adequate surface drainage may be enhanced by utilization of graded swales, area drains, and other drainage devices. Surface run-off should not be allowed to pond near structures.
- Adequate surface drainage should be provided to channel surface water away from on-site structures and to a suitable outlet such as a storm drain or the street. Adequate surface drainage may be enhanced by utilization of graded swales, area drains, and other drainage devices. Surface run-off should not be allowed to pond near structures.
- Building roof drains should have downspouts tight lined to an appropriate outlet, such as a storm drain or the street. If tight lining of the downspouts is not practicable, they should discharge 5 feet or more away from the building or onto concrete flatwork or asphalt that slopes away from the structure. Downspouts should not be allowed to discharge onto the ground surface adjacent to building foundations.

- Low-water use (drip irrigated) landscaping is recommended for use on-site, particularly within 5 feet of the building and exterior site improvements, including areas of concrete flatwork and masonry block walls.
- Irrigation heads should be oriented so that they spray away from building and block wall surfaces.
- A relatively impermeable barrier should be placed against retaining structures where retained soil is in contact with the retaining wall so that unsightly staining of the exposed wall face and potential for degradation of the wall will be reduced.
- Graded slopes may be subject to erosion, surface runoff over slopes should be controlled. To reduce the potential for erosion caused by surficial drainage over slopes, swales and/or interceptor drains as described in Section J109 of the 2018 IBC (ICC, 2017) may be placed at the top of the slope.
- The face of slopes should be prepared and maintained to control erosion. Erosion controls should be installed as soon as practical after grading. Erosion control may include ground cover, hardscaping, and/or lightweight, deep rooted landscaping requiring low water use. Whether erosion control measures are used or not, periodic maintenance of slopes will likely be required.
- Paved areas should have a surface gradient of 2 percent, or more. In addition, surface runoff from surrounding areas should be intercepted, collected, and not permitted to flow onto the pavement or to infiltrate the base and subgrade. We recommend that perimeter swales, edge drains, curbs and gutters, or combination of drainage devices, be construed to reduce the adverse effects of surface water runoff.

4.11. PLAN REVIEW

The recommendations presented in this report are based on preliminary design information for the proposed project and on the findings of our geotechnical evaluation. When finished, project grading and foundation plans should be reviewed by the Geotechnical Engineer to evaluate whether the project grading and foundation plans are consistent with the geotechnical design criteria presented in this report.

4.12. PRE-CONSTRUCTION MEETING

We recommend that a pre-construction meeting be held. The owner or the owner's representative, the architect/engineer of record, the contractor, material testing firm, and the geotechnical consultant should be in attendance to discuss the plans and the project.

4.13. CONTINUITY

GES, Inc. is an IAS Accredited Special Inspection Agency and an approved Quality Assurance Agency that can provide construction materials testing and observations services during the construction of this project. Consideration should be given to the benefit from continuity in service that is provided when the owner's geotechnical consultant is involved in both the design and construction of the project.

5. LIMITATIONS

The recommendations contained in this report are based on field exploration, laboratory testing, research of pertinent maps and literature, and our understanding of the proposed project. The soil data used in the preparation of this report was obtained from a total of three (3) test pits performed at the site. It is possible that variations in the soil conditions will exist beyond or between the locations explored. Therefore, if any soil conditions are encountered at the site that are different from those outlined in this report, Geotechnical & Environmental Services, Inc. should be immediately notified so that we may review the situation that exists and make supplementary recommendations as needed. In addition, if the scope of the proposed construction, including the types of structures, anticipated loads and maximum cut and fill depths, changes from what is described in this report, our firm should be notified. A detailed excavatability or rippability evaluation is beyond the scope of this study.

The recommendations presented in this report assume that an adequate number of tests and observations will be made during site construction to evaluate compliance with the recommendations. These tests and observations should be provided under the direction of a qualified Geotechnical Engineer. Such testing and observations should include but not be limited to the following:

- Review of Site Construction Plans for conformance with the geotechnical evaluation.
- Observation and testing during site preparation, grading, and placement of fill.
- Consultation as may be required during construction.

Our services were performed using that degree of care and skill ordinarily exercised under similar circumstances by reputable engineering firms in this or similar localities. No other warranties, either express or implied, are included or intended in this report.

6. REFERENCES

American Association of State Highway and Transportation Officials (AASHTO), 1993, AASHTO Guide for Design of Pavement Structures

American Concrete Institute (ACI), 2014, ACI Manual of Concrete Practice

American Society for Testing and Materials (ASTM), 2011, Annual Book of ASTM Standards, Section 4 – Construction Volumes 04.02, 04.08, and 04.09

Geotechnical & Environmental Services, Inc., proprietary in-house data

Google Earth, Imagery date September, 2024 at approximate location 37.203943° latitude and -113.193786° longitude, accessed on May 2, 2025

Robert F. Biek, Peter D. Rowley, Janice M. Hayden, David B. Hacker, Grant C. Willis, Lehi F. Hintze, R. Ernest Anderson, and Kent D. Brown, 2009, Geologic map of the St. George and East Part of the Clover Mountains 30' X 60' Quadrangle, Washington County and Iron Counties, Utah, Utah Geologic Survey, scale 1:100,000

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Utah Department of Transportation (UDOT), 2022, Geotechnical Manual of Instruction

Utah Department of Transportation (UDOT), 2024, UDOT Pavement Design Manual

Utah Division of Water Rights, 2023, Well Information Map: <https://maps.waterrights.utah.gov/EsriMap/map.asp?layersToAdd=wellsearch>

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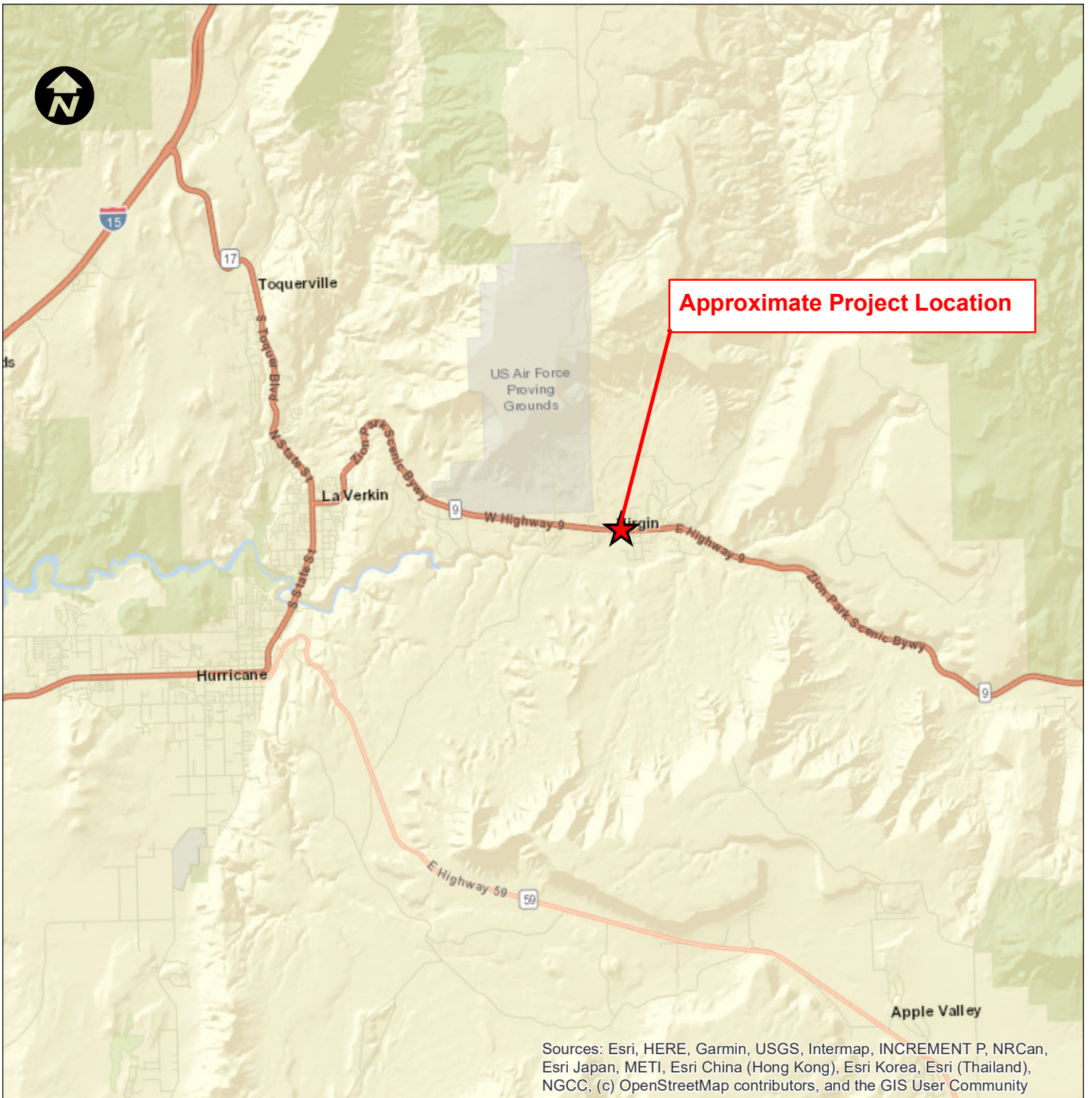
Utah Groundwater Data Hub (UGDA), 2013, Groundwater Studies: https://gwdatahub.geology.utah.gov/?page=Groundwater-Studies&views=DATA#data_s=id%3AdataSource_29-18e1a64ed33-layer-37%3A24

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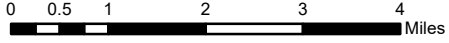
APPENDIX A – SUBSURFACE STUDY



Approximate Project Location

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

Legend
 ★ Approximate Project Location

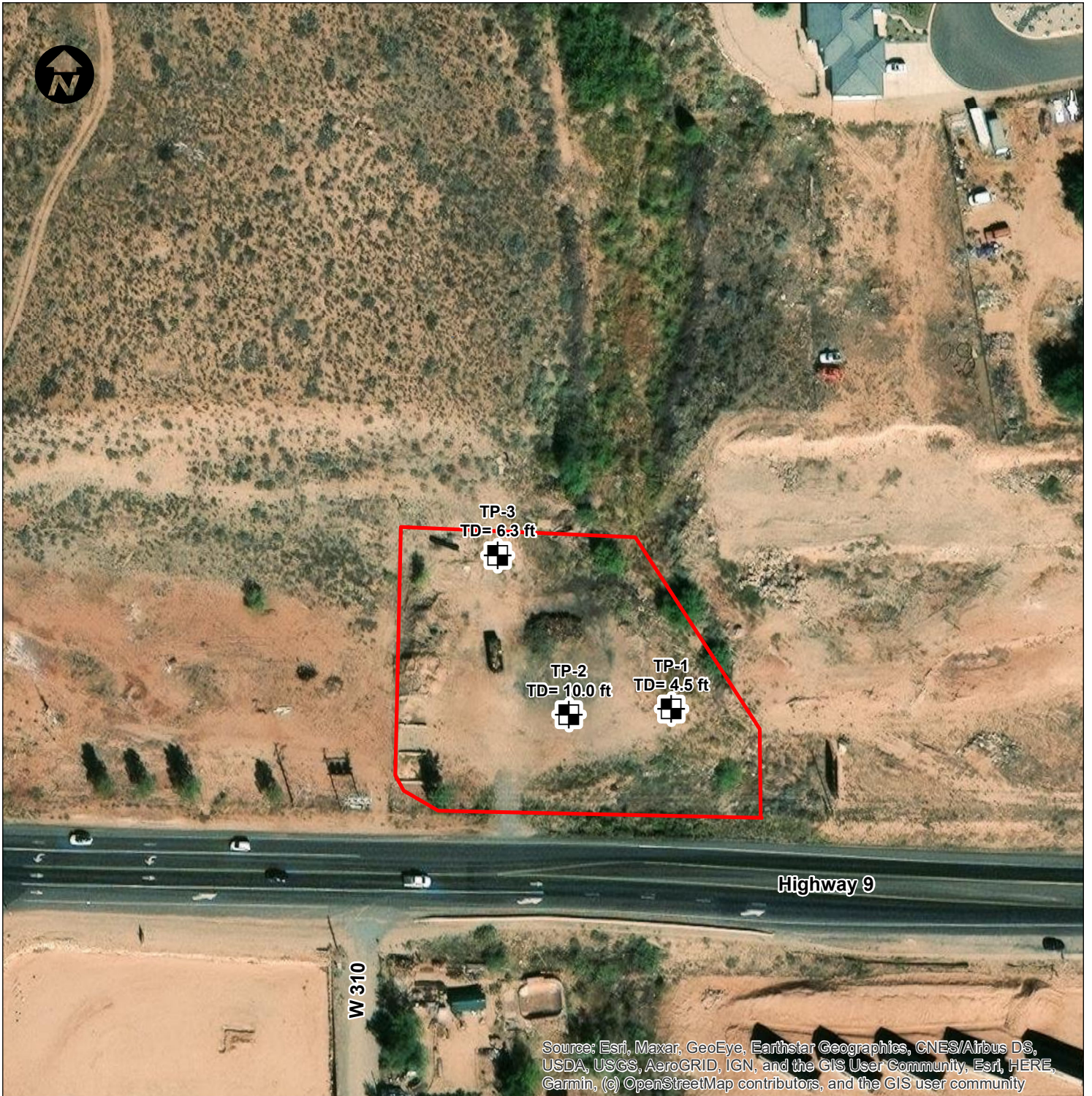


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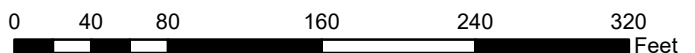
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VICINITY MAP
 HOLYOAK HOMES – V97 PARCEL
 NE OF 310 W AND HIGHWAY 9
 VIRGIN, WASHINGTON COUNTY, UTAH



Drawn By: HRH	Date Drawn: 05/08/2025
Project No. G20257471E1	Figure No. A-1



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community, Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community



Legend

-  TP-3 Approximate Test Pit Location
-  Approximate Site Boundary



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NOTE: Data presented on this map is a compilation of GIS Metadata extracted from a variety of sources. Major Streets, Airports, and Railroads is data obtained from the Southern Nevada GIS Management Office. This data is downloaded by GES for incorporation into drawings generated by GES. Data contained within this page is to be used for informational purposes only. GES has not modified the data contained herein and uses it as it is acquired from the respective agency.

**EXPLORATION LOCATION MAP
 HOLYOAK HOMES – V97 PARCEL
 NE OF 310 W AND HIGHWAY 9
 VIRGIN, WASHINGTON COUNTY, UTAH**

Drawn By: HRH	Date Drawn: 05/12/2025
Project No. G20257471E1	Figure No. A-2

KEY TO SYMBOLS AND TERMS

Terms used according to the Unified Soil Classification System

Consistency or Condition of Soils

Fine-Grained Soils (Silt and Clay): Major portion passing #200 sieve

California Sampler* (blows/foot)	SPT** (blows/foot)	Relative Consistency	Unconfined Compressive Strength (tsf)	Manual Manipulation
< 2	< 2	Very Soft	< 0.25	Thumb will penetrate soil more than 1 in.
2-5	2-4	Soft	0.25-0.50	Thumb will penetrate soil about 1 in.
5-10	4-8	Firm	0.50-1.00	Thumb will penetrate soil about ¼ in.
10-20	8-15	Stiff	1.00-2.00	Thumb will not indent soil but readily indented with thumbnail.
20-40	15-30	Very Stiff	>2.00	Thumbnail will not indent soil.
>40	>30	Hard	>2.00	Thumbnail will not indent soil.

*ASTM D3550 using a 140-pound hammer falling 30 inches.

**ASTM D1586-18

Coarse-Grained Soils (Sand and Gravel): Major portion retained on #200 sieve

California Sampler* (blows/foot)	SPT** (blows/foot)	Relative Density	Behavior of ½-inch Diameter Probe Rod
0-7	0-4	Very Loose	Easily penetrated when pushed by hand.
7-18	4-10	Loose	Firmly penetrated when pushed by hand.
18-50	10-30	Medium Dense	Easily penetrated when driven by 1 lb. hammer.
50-70	30-50	Dense	Penetrated less than 1 inch when driven with a 1 lb. hammer.
>70	>50	Very Dense	Penetrated less than ¼ inch when driven with a 1 lb. hammer.

*ASTM D3550 using a 140-pound hammer falling 30 inches.

**ASTM D1586-18

Cementation	Characteristic
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

Hardness	Characteristic
Moderately Hard	Can be readily scratched by a knife blade; scratch leaves a heavy trace of dust and scratch is readily visible after the powder has been blown away.
Hard	Can be scratched with difficulty; scratch produces little powder and is often faintly visible; traces of the knife steel may be visible.
Very Hard	Cannot be scratched with pocket knife. Leave knife steel marks on surface.

Laboratory Testing Acronyms & Abbreviations

AL = Atterberg Limits

Corr = Corrosion Suite

MD = Moisture Content/ Dry Density

R-Val = R-Value

Consol = Consolidation

DS = Direct Shear

OC = Organic Content

SA = Sieve Analysis

CBR = California Bearing Ratio




MC = Moisture Content

PROC = Proctor

SPG = Specific Gravity

UU = Unconsolidated Undrained Triaxial Test

Misc. Symbols

	Exploration continues
	Initial groundwater depth
	Measured groundwater depth (after 24 hours or more)

Constituent Percentages

Trace - < 5%
Few - 5 to 10%
Little - 15-25%
Some - 30-45%
Mostly - 50-100%


















Moisture Condition

Dry - Visible absence of moisture, dusty, dry to the touch
Moist - Damp but no visible water
Wet - Visible free water, usually soil is below water table







Notes

- Subsurface explorations were performed using the equipment listed on the exploration logs.
- Subsurface explorations were performed on the date(s) shown on the exploration logs.
- Soil sampler(s) were driven with a 140 pound hammer falling 30 inches (unless otherwise noted in the text of this report).
- The transitions between soil types shown on the exploration logs as occurring abruptly at particular depths in actuality may be a gradual progression from one soil type to the next.
- Exploration logs are subject to the limitations, conclusions, and recommendations presented in this report.
- DR = Drilling Rate (min/ft)

Strata Group Symbols

	AC - Asphalt Concrete
	PCC - Portland Cement Concrete
	CL - Low plasticity clay
	CH - High plasticity clay
	CL-ML - Silty low plasticity clay
	ML - Silt
	MH - Elastic silt
	SC - Clayey sand
	SM - Silty sand
	SP - Poorly graded sand
	SW - Well - graded sand
	GC - Clayey Gravel
	GM - Silty gravel
	GP - Poorly graded gravel
	GW - Well - graded gravel
	CSG - Cemented sand and gravel
	CALI - Caliche

Soil Sampler Symbols

	Air Knife
	Bulk Sample
	California Sampler
	Standard Penetration Test
	Core Barrel
	Shelby Tube




Disclaimer

This Key to Symbols and Terms is part of a report prepared by Geotechnical & Environmental Services, Inc. and should be used with the report. The descriptions on the exploration logs apply only at the specific exploration locations and at the time the explorations were made. They are not warranted to be representative of subsurface conditions at other locations or times.

Figure No. A-3

GENERAL BH/TP/WELL - GES - GES - GEOTECHNICAL - STD.GDT - 5/12/25 09:41 - \\FS01\COMPANY\GES\CLIENTS\TRI-STATE REGIONIST - GEORGE OFFICE\PROJECTS\2025\G20257471 - HOLYOAK V-97 PARCELE1\GINTGINT G20257471E1.GPJ

PROJECT NAME Holyoak Homes V-97 Parcel **CLIENT** Holyoak Homes
PROJECT NUMBER G20257471E1 **PROJECT LOCATION** N of Highway 9 & W 310
DATE STARTED 4/21/25 **COMPLETED** 4/21/25 **GROUND ELEVATION** 3553 ft **TEST PIT SIZE** 2'x8' feet
EXCAVATION CONTRACTOR Client **GROUND WATER LEVELS:**
EXCAVATION METHOD Backhoe **AT TIME OF EXCAVATION** Not Encountered
LOGGED BY N. Ormond **DRILLER** Client **AT END OF EXCAVATION** N/A
LAT. 37.203949 **LONG.** -113.193535 **AFTER EXCAVATION** N/A

DEPTH (ft)	BULK SAMPLE	RECOVERY %	REMARKS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			Excavated in previously filled diverted wash.			
2.5	✕	100		FILL		FILL: Brown silty SAND with gravel and cobbles, mixed organics, slightly moist and dense. ... loose to medium dense with rounded to subrounded gravel.
4.5	✕	100				... boulders encountered, 2 to 3 feet in diameter.

Bottom of test pit at 4.5 feet.

3548.5

PROJECT NAME Holyoak Homes V-97 Parcel **CLIENT** Holyoak Homes
PROJECT NUMBER G20257471E1 **PROJECT LOCATION** N of Highway 9 & W 310
DATE STARTED 4/21/25 **COMPLETED** 4/21/25 **GROUND ELEVATION** 3553 ft **TEST PIT SIZE** 2'x8' feet
EXCAVATION CONTRACTOR Client **GROUND WATER LEVELS:**
EXCAVATION METHOD Backhoe **AT TIME OF EXCAVATION** Not Encountered
LOGGED BY N. Ormond **DRILLER** Client **AT END OF EXCAVATION** N/A
LAT. 37.203943 **LONG.** -113.193786 **AFTER EXCAVATION** N/A

DEPTH (ft)	BULK SAMPLE	RECOVERY %	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0						
2.5		100				FILL: Brown silty SAND with gravel and cobbles, fine to medium, dry to slightly moist and dense, boulders encountered. ... loose to medium dense and slightly moist. ... decreasing gravel and cobbles.
5.0		100				
7.5						
10.0		100	LL = NP PL = NP Fines = 34%	SM		NATIVE: Brown silty SAND with subrounded gravel, carbonate cementation, slightly moist and medium dense, cobbles and boulders encountered. Bottom of test pit at 10.0 feet.

GENERAL BH/TP/WELL - GES - GES - GEOTECHNICAL - STD.GDT - 5/12/25 09:41 - \\FS01\COMPANY\GES\CLIENTS\TRI-STATE REGIONIST - GEORGE OFFICE\PROJECTS\2025\G20257471E1 - HOLYOAK V-97 PARCELE1\GINTGINT G20257471E1.GPJ

Soils were classified in general accordance with ASTM D2488
 The descriptions contained within this exploration log apply only at the specific exploration location and at the time the exploration was made.
 It is not intended to be representative of subsurface conditions at other locations or times.

Figure No. A-5

PROJECT NAME Holyoak Homes V-97 Parcel **CLIENT** Holyoak Homes
PROJECT NUMBER G20257471E1 **PROJECT LOCATION** N of Highway 9 & W 310
DATE STARTED 4/21/25 **COMPLETED** 4/21/25 **GROUND ELEVATION** 3557 ft **TEST PIT SIZE** 2'x8' feet
EXCAVATION CONTRACTOR Client **GROUND WATER LEVELS:**
EXCAVATION METHOD Backhoe **AT TIME OF EXCAVATION** Not Encountered
LOGGED BY N. Ormond **DRILLER** Client **AT END OF EXCAVATION** N/A
LAT. 37.204258 **LONG.** -113.19395 **AFTER EXCAVATION** N/A

DEPTH (ft)	BULK SAMPLE	RECOVERY %	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	ELEVATION
0.0							
0.0 - 0.5	X	100		SM		NATIVE: Brown silty SAND with gravel, organic roots, dry to slightly moist and loose.	
0.5 - 1.0	X	100	... slightly moist and loose to medium dense.				
1.0 - 2.5	X	100	... decreasing fines.				
2.5 - 4.0	X	100	... increasing fines, medium dense and moderately cemented.				
4.0 - 5.0	X	100	LL = NP PL = NP Fines = 24% Swell = 1%	SC		... medium dense to dense.	3553.0
5.0 - 6.0	X	100					
6.0 - 6.3				BEDROCK		BEDROCK: Grayish brown SANDSTONE, dry, hard, and slightly weathered.	3550.8

Bottom of test pit at 6.3 feet.

GENERAL_BH/TP/WELL - GES - GES - GEOTECHNICAL - STD.GDT - 5/12/25 09:41 - \\FS01\COMPANY\GES\CLIENTS\TRI-STATE REGIONIST - GEORGE OFFICE\PROJECTS\2025\G20257471 - HOLYOAK V-97 PARCELE1\GINTGINT G20257471E1.GPJ

Soils were classified in general accordance with ASTM D2488
 The descriptions contained within this exploration log apply only at the specific exploration location and at the time the exploration was made.
 It is not intended to be representative of subsurface conditions at other locations or times.

Figure No. A-6



APPENDIX B – LABORATORY TEST RESULTS

GEOTECHNICAL EVALUATION
HOLYOAK HOMES – V97 PARCEL
NE OF 310 W AND HIGHWAY 9
VIRGIN, WASHINGTON COUNTY, UTAH

Laboratory tests were conducted on representative soil samples for the purpose of classification and to evaluate their engineering and physical properties. The amount and selection of the types of testing for a given study are based on the geotechnical conditions of the project. A summary of the various laboratory tests conducted for this project is presented below and in Figure B-1.

1. GRAIN SIZE DISTRIBUTION

Two grain size distribution tests were performed by sieve analysis in general accordance with ASTM D6913. The soil sample was oven dried to a constant weight and sorted by a number of different sized sieves. The amount of material retained on each sieve is measured and the percent of material passing each sieve is computed. The test results are presented as particle size distribution curves in Figure B-2.

2. ATTERBERG LIMITS

Two samples were tested to evaluate Atterberg limits in general accordance with ASTM D4318. The liquid limit (LL) and plastic limit (PL) of tested samples were evaluated. The difference between the liquid limit and the plastic limit is the plasticity index (PI) and represents the range of water content over which the soil behaves in a plastic state. The term NP refers to non-plastic and the term NV refers to no value. Test results are presented on the test pit logs in Appendix A and on Figure B-3.

3. SWELL POTENTIAL

One sample was tested to evaluate swell potential. A vertical confining pressure of approximately 1,000 pounds per square foot was applied to oven-dried samples and then the samples were inundated with water. The deformation of samples was recorded until 3 consecutive readings were the same or for a period of 24 hours of soaking, whichever occurred first. The result of potential swell performed by GES was recorded and presented on the lab summary presented on Figure B-1.

4. CHEMICAL TESTS

Two suites of tests were performed on a selected soil sample to determine the contents of soluble sulfate, total soluble solids (i.e. solubility), and soluble soil chlorides. The tests were performed by Silver State Analytical, Inc. The results are shown on Figure B-4.

PROJECT NAME Holyoak Homes V-97 Parcel

CLIENT Holyoak Homes

PROJECT NUMBER G20257471E1

PROJECT LOCATION N of Highway 9 & W 310

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Classification	Water Content (%)	Dry Density (pcf)	Swell (%)
TP-2	9.5	NV	NP	NP	50	34	SM	--	--	--
TP-3	3.5	NV	NP	NP	25	24	SM	--	--	1

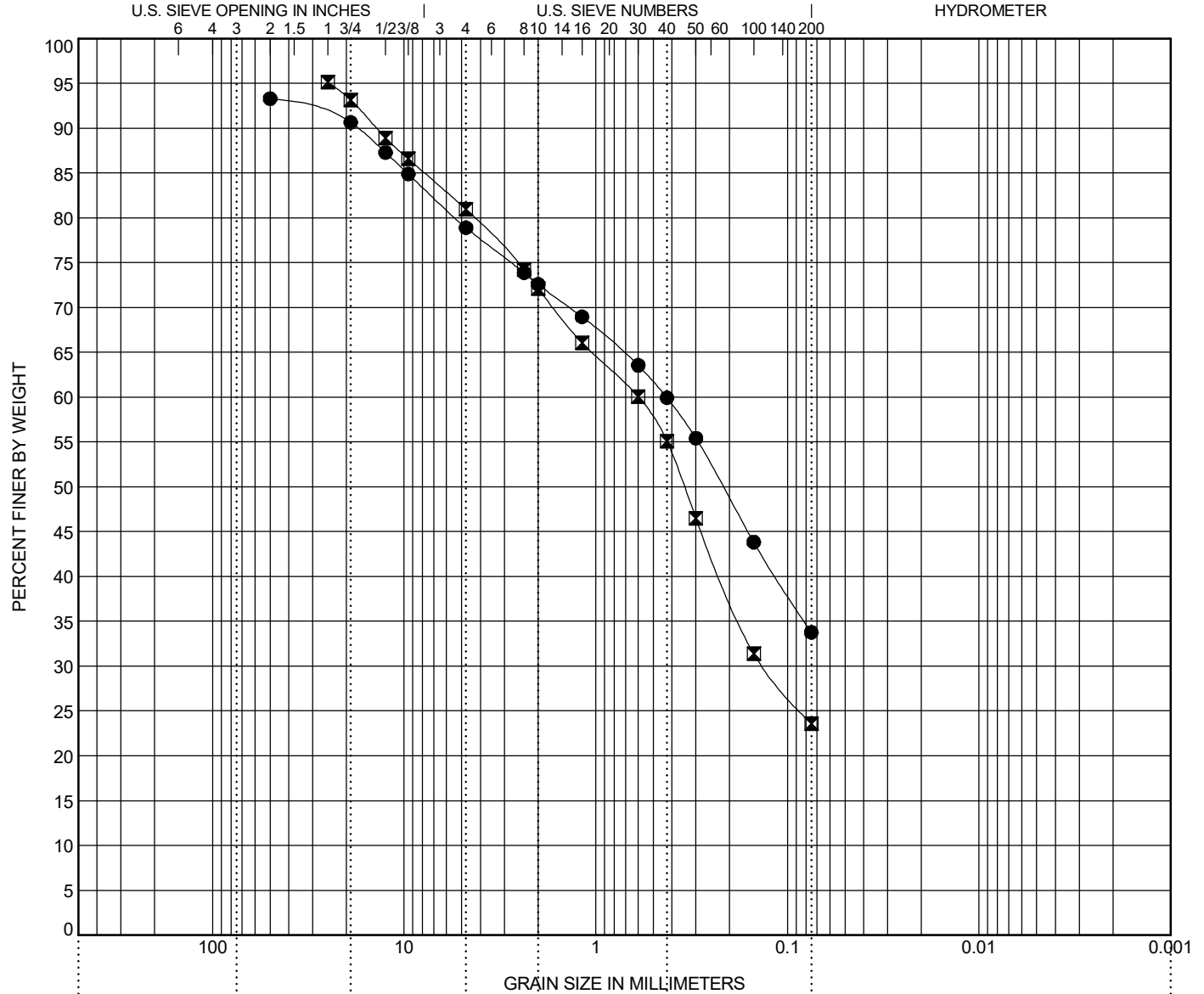
LAB SUMMARY - GES - GEOTECHNICAL - STD.GDT - 5/8/25 14:30 - \\FS01\COMPANY\GES\CLIENTS\TRI-STATE REGIONIST. GEORGE OFFICE\PROJECTS\2025\G20257471 - HOLYOAK V-97 PARCEL\1\GINT\GINT G20257471E1.GPJ

CLIENT Holyoak Homes

PROJECT NAME Holyoak Homes V-97 Parcel

PROJECT NUMBER G20257471E1

PROJECT LOCATION N of Highway 9 & W 310



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Location	Classification	LL	PL	PI
● TP-2 9.5'	SILTY SAND with GRAVEL (SM)	NV	NP	NP
☒ TP-3 3.5'	SILTY SAND with GRAVEL (SM)	NV	NP	NP

Location	D100	D60	D30	D10	Cc	Cu	%Gravel	%Sand	%Silt	%Clay
● TP-2 9.5'	50	0.427	--	--	--	--	14.4	45.1	33.8	
☒ TP-3 3.5'	25	0.597	--	--	--	--	14.2	57.4	23.6	

SIEVE - GES_CM_STD.GDT - 5/8/25 14:22 - \\FS01\COMPANY\GES\CLIENTS\TRI-STATE REGIONIST_GEOGE OFFICE\PROJECTS\2025\G20257471 - HOLYOAK V-97 PARCELE\1\GINT\GINT G20257471E1.GPJ



SGS Silver State Analytical Laboratories
 3626 E. Sunset Road, Suite 100
 Las Vegas, NV 89120
 (702) 873-4478
 www.ssalabs.com

Analytical Report

Workorder#: 25041303
 Date Reported: 5/1/2025

Client: GES
 Project Name: G20247471E1
 PO #:

Sampled By: Client

Laboratory Accreditation Number: NV930/CA3029

Laboratory ID	Client Sample ID	Date/Time Sampled	Date Received
25041303-01	TP-2 @ 9.5'		4/30/2025

Parameter	Method	Result	Units	PQL	Analyst	Date/Time Analyzed	Data Flag
Chloride	SM 4500 CL- B	25	mg/Kg	10	KK	05/01/2025 10:40	
Solubility	SM 2540 C	0.540	%	0.01	KK	05/01/2025 9:20	
Sulfate	SM 4500SO4 E	0.330	%	0.01	KK	05/01/2025 10:45	

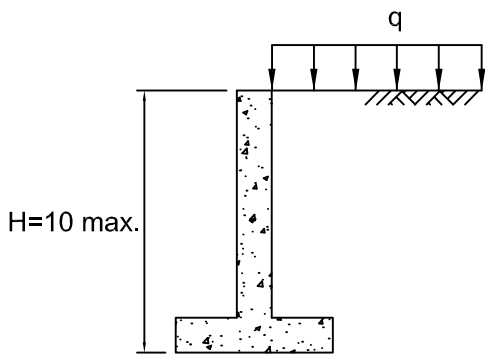
Laboratory Accreditation Number: NV930/CA3029

Laboratory ID	Client Sample ID	Date/Time Sampled	Date Received
25041303-02	TP-3 @ 3.5'		4/30/2025

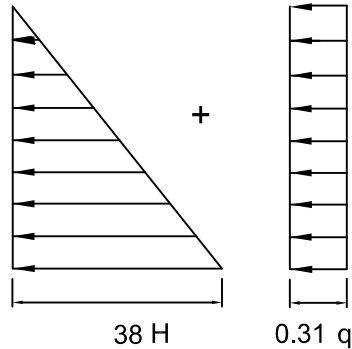
Parameter	Method	Result	Units	PQL	Analyst	Date/Time Analyzed	Data Flag
Chloride	SM 4500 CL- B	ND	mg/Kg	10	KK	05/01/2025 10:40	
Solubility	SM 2540 C	0.0600	%	0.01	KK	05/01/2025 9:20	
Sulfate	SM 4500SO4 E	0.0300	%	0.01	KK	05/01/2025 10:45	



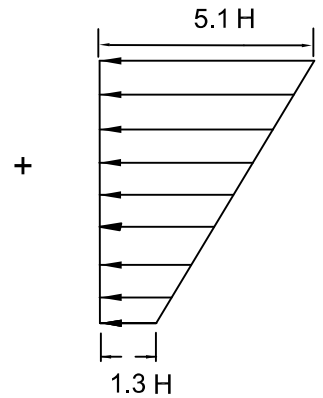
APPENDIX C – DESIGN FIGURES



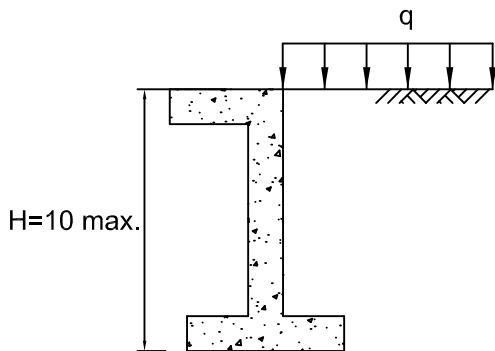
Static Earth Pressure



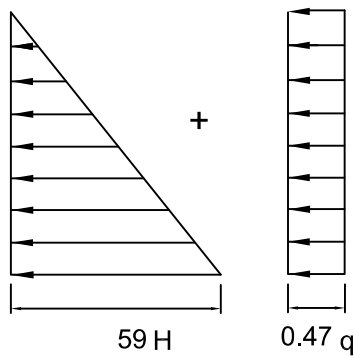
Seismic Earth Pressure



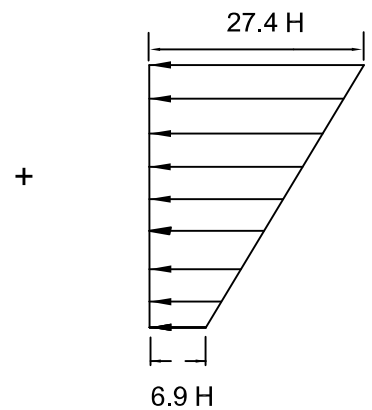
Active Condition



Static Earth Pressure



Seismic Earth Pressure



At-Rest Condition

Notes:

H is height of wall in feet.

q is magnitude of uniform surcharge load in pounds per square foot (psf).

Earth pressures are in psf.

Earth pressures shown assume that no hydrostatic pressure is exerted on the wall.

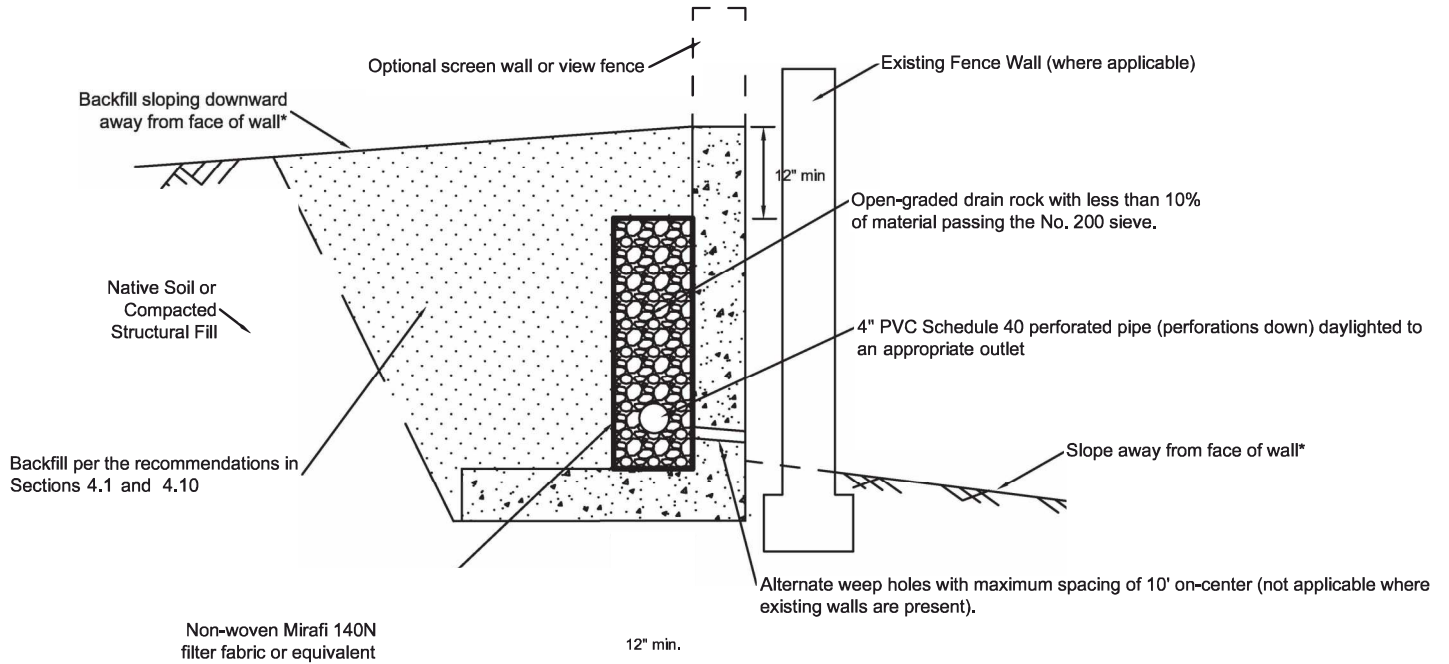
NOT TO SCALE

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.
 (702) 365-1001
 7150 Placid Street
 Las Vegas, NV 89119
 www.gesnevada.com

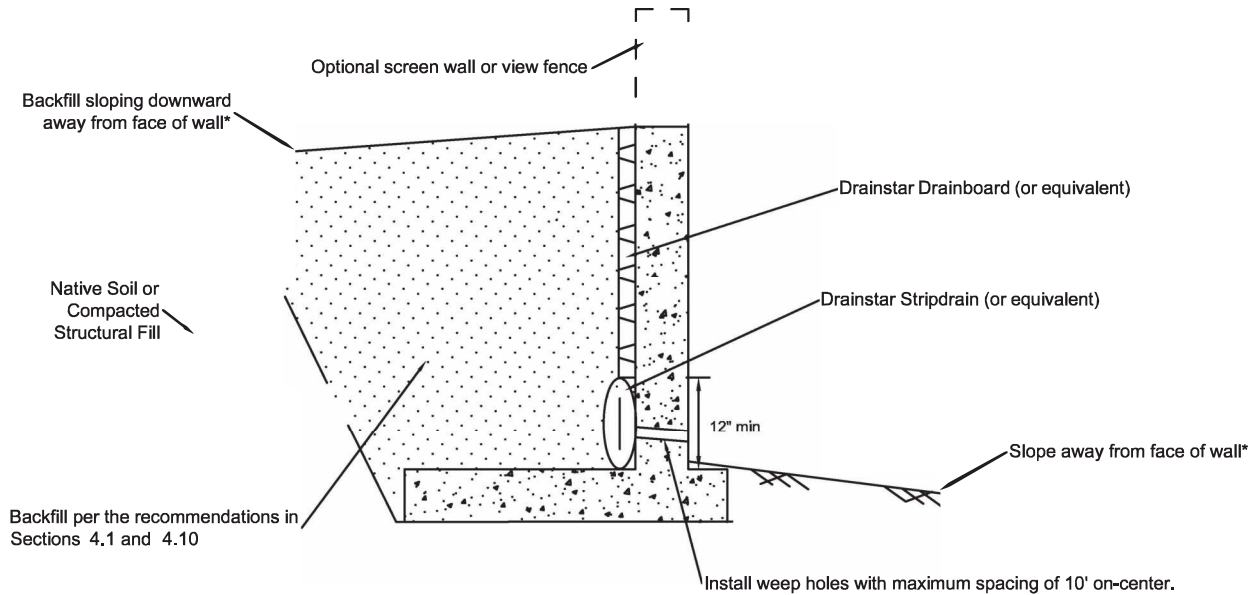
LATERAL EARTH PRESSURE DIAGRAM
 HOLYOAK HOMES – V97 PARCEL
 NE OF 310 W AND HIGHWAY 9
 VIRGIN, WASHINGTON COUNTY, UTAH

DRAWN BY:	REVIEWED BY:	DATE DRAWN:
HRH	JND	05/02/2025
PROJECT NO.		FIGURE NO.
G20257471E1		C-1

TYPICAL RETAINING WALL DRAINAGE DETAIL INCLUDING NEW WALLS AT EXISTING FENCE WALLS



ALTERNATE TYPICAL RETAINING WALL DRAINAGE DETAIL



*Per the recommendations in Section 4.12

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RETAINING WALL DRAINAGE DETAIL

HOLYOAK HOMES – V97 PARCEL
NE OF 310 W AND HIGHWAY 9
VIRGIN, WASHINGTON COUNTY, UTAH

DRAWN BY: HRH REVIEWED BY: DATE DRAWN:

HRH

05/08/2025

PROJECT NO.:
G20257471E1

FIGURE NO.:
C-2