RECEIVED 12-6-2021

Owner/Applicant Is Required
To Request A Final Inspection
For Approval Prior To Use

Earth Solutions NW LLC

Geotechnical Engineering
Construction Observation/Testing
Environmental Services

Important

Any Alteration Or Revisions To These Plans Requires A Separate Review Or Other Written Approval

Approved

JDorcas 2-8-2022

City Of Marysville
Building Official
All Work Subject To
Field Inspections, Correction
And Provisions Of Plan Review

GEOTECHNICAL ENGINEERING STUDY
PROPOSED RESIDENTIAL DEVELOPMENT
BALAM 6-PLEX
11118 45TH AVENUE NORTHEAST
MARYSVILLE, WASHINGTON

ES-7642

Job Copy

15365 N.E. 90th Street, Suite 100 Redmond, WA 98052
(425) 449-4704 Fax (425) 449-4711
www.earthsolutionsnw.com

B21-0590

PREPARED FOR

EAGLE COUNTRY CONSTRUCTION, INC.

January 14, 2021

Adam Z. Shier, L.G.
Project Geologist

01/14/2021

Raymond A. Coglas, P.E.
Principal Engineer

GEOTECHNICAL ENGINEERING STUDY
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11118 45TH AVENUE NORTHEAST
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Earth Solutions NW, LLC
15365 Northeast 90th Street, Suite 100
Redmond, Washington 98052
Phone: 425-449-4704 | Fax: 425-449-4711
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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 not 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 Not 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 not 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 not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org

Earth Solutions NW LLC
Geotechnical Engineering, Construction
Observation/Testing and Environmental Services

January 14, 2021
ES-7642

Eagle Country Construction, Inc.
P.O. Box 1304
Marysville, Washington 98270

Attention: Mr. Mike Hansen

Dear Mr. Hansen,

Earth Solutions NW, LLC (ESNW) is pleased to present this report titled "Geotechnical Engineering Study, Proposed Residential Development, Marzolf Property, 51st Avenue Northeast and 82nd Place Northeast, Marysville, Washington".

Based on the conditions observed during our fieldwork, the subject site is underlain primarily by sand recessional outwash deposits. Based on the results of our study, the proposed residential development is feasible from a geotechnical standpoint. The proposed structures can be supported on conventional spread and continuous foundations bearing on recompacted native soil or new structural fill placed directly on competent native soil. We recommend compacting exposed footing subgrade areas to a firm and unyielding condition.

This report provides recommendations for foundation subgrade preparation, foundation and retaining wall design parameters, drainage, the suitability of the on-site soils for use as structural fill, and other geotechnical recommendations.

The opportunity to be of service to you is appreciated. If you have any questions regarding the content of this geotechnical engineering study, please call.

Sincerely,

EARTH SOLUTIONS NW, LLC

Adam Z. Shier, L.G.
Project Geologist

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GEOTECHNICAL ENGINEERING STUDY
PROPOSED RESIDENTIAL DEVELOPMENT
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11118 45TH AVENUE NORTHEAST
MARYSVILLE, WASHINGTON

ES-7642

INTRODUCTION

General

This geotechnical engineering study (study) was prepared for the proposed residential development to be constructed at 11118 45th Avenue Northeast in Marysville, Washington. To complete the scope of services we performed the following:

- Test pits to characterize soil and groundwater conditions;
- Laboratory testing of soil samples collected at the test pit locations;
- Conducting engineering analyses, and;
- Preparation of this report.

The following documents and resources were reviewed as part of our report preparation:

- Geologic Map of the Marysville Quadrangle, Snohomish County, Washington, compiled by James P. Minard, dated 1985;
- Web Soil Survey (WSS) online resource, maintained by the Natural Resources Conservation Service under the United States Department of Agriculture;
- The city of Marysville Municipal Code;
- 2014 Stormwater Management Manual for Western Washington (SWMMWW), Volume III, provided by Washington State Department of Ecology, and;
- The city of Marysville Geologic Hazards Map (May 2014).

Project Description

It is our understanding that the subject site will be developed with a 6-plex residential structure and associated improvements. Grading plans were not available at the time this report was prepared; however, we anticipate grading activities will include cuts and fills of up to about four feet to establish building and roadway alignments. Site improvements will also include underground utility installations.

At the time this report was prepared, specific building load values were not available; however, we anticipate the proposed residential 6-plex structure will consist of relatively lightly loaded wood framing supported on conventional foundations. Based on our experience with similar developments, we estimate wall loads on the order of 1 to 2 kips per linear foot and slab-on-grade loading of 150 pounds per square foot (psf). With respect to stormwater management, we understand the use of infiltration devices will be pursued to the extent practicable. Otherwise, detention (or a combination of infiltration and detention) will likely be utilized.

If the above design assumptions are incorrect or change, ESNW should be contacted to review the recommendations in this report. ESNW should review the final design to verify the geotechnical recommendations provided in this report have been incorporated into the plans.

SITE CONDITIONS

Surface

The subject site is located near the terminus of 45th Avenue Northeast, about 400 feet south of the intersection with 133th Place Northeast in Marysville, Washington, as illustrated on the Vicinity Map (Plate 1). The site consists of one residential tax parcel (Snohomish County parcel number 300509-004-043-00) totaling approximately 0.35 acres of land area. The site is generally undeveloped with grass areas with the exception of a parking lot located on the northern portion of the site. The topography of the site is relatively flat.

Subsurface

A representative of ENSW observed, logged, and sampled two test pits, excavated at accessible locations within the proposed development area, on December 14, 2020, using a mini-trackhoe and operator provided by the client. The test pits were completed for purposes of assessing soil conditions, classifying site soils, and characterizing near-surface groundwater conditions within the proposed development area. The approximate locations of the test pits are depicted on Plate 2 (Test Pit Location Plan). Please refer to the test pit logs provided in Appendix A for a more detailed description of subsurface conditions. Representative soil samples collected at the test pit locations were analyzed in general accordance with Unified Soil Classification System (USCS) and USDA methods and procedures.

Topsoil and Fill

Topsoil was observed extending to depths of approximately six to seven inches below existing grades. The topsoil thickness is variable and vegetation roots often extend below the topsoil zone into the underlying native soil. The topsoil was characterized by dark brown color and fine organic material. Topsoil is not suitable for use as structural fill nor should it be mixed with material to be used as structural fill. Topsoil or otherwise unsuitable material can be used in landscape areas if desired.

Fill was not encountered within the test pits. If fill is encountered during construction, ESNW should be consulted to verify the suitability for support of the proposed structures and/or reuse as structural fill.

Native Soil

Underlying the topsoil, native soils near surface consisting of poorly graded sand with silt (USCS: SP-SM). Poorly graded sand (USCS: SP) was observed starting at about one and one-half to two feet below the existing ground surface (bgs) and extended to the maximum exploration depth of eight feet bgs. Native soils were observed primarily in a moist condition. Overall soil relative density generally increased with depth.

Geologic Setting

The referenced geologic map resource identifies Marysville sand member recessional outwash (Qvrm) across the site and surrounding areas. As described on the geologic map, Marysville sand member is typically well-drained, stratified to massive outwash sand, some fine gravel, and some areas of silt and clay. The referenced WSS resource identifies Ragnar fine sandy loam (Map Unit Symbol: 57) across the site and surrounding areas. The Ragnar fine sandy loam was formed in outwash plains. Based on our field observations, native soils on site are generally consistent with sand recessional outwash.

Groundwater

Groundwater seepage was not observed at the test pit locations during the fieldwork (December, 2020). Groundwater seepage rates and elevations fluctuate depending on many factors, including precipitation duration and intensity, the time of year, and soil conditions. In general, groundwater flow rates are higher during the wetter, winter, spring, and early summer months. It should be noted that deeper utility installations may encounter the groundwater table during excavation. Given the high permeability of the sand deposits, excavation dewatering may be necessary where excavations are advanced below the groundwater table.

Geologically Hazardous Areas Assessment

We reviewed the geologically hazardous areas section of the City of Marysville Municipal Code, Code Chapter 22E.010, and the referenced map resources depicting geologically hazardous areas within Marysville. Based on the results of our review, no geologically hazardous areas are located within or immediately adjacent to the subject property.

DISCUSSION AND RECOMMENDATIONS

General

The proposed 6-plex residential structure can be supported on conventional spread and continuous foundations bearing on recompacted native soil or new structural fill placed directly on competent native soil. We recommend compacting exposed footing subgrade areas to a firm and unyielding condition. Slab-on-grade floors should be supported on competent native soil, re-compacted native soil, or new structural fill. Organic material exposed at subgrade elevations must be removed below design elevation and grades restored with structural fill. Where loose, organic or other unsuitable materials are encountered at or below the footing subgrade elevation, the material should be removed and replaced with structural fill, as necessary.

This study has been prepared for the exclusive use of Eagle Country Construction and their representatives. No warranty, expressed or implied, is made. This study has been prepared in a manner consistent with the level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area.

Site Preparation and Earthwork

Site preparation activities will consist of installing temporary erosion control measures and performing clearing and site stripping. Mass grading activities will likely consist of cuts and fills on the order four feet or less; deeper cuts may be necessary for utility excavations.

Temporary Erosion Control

Temporary construction entrances and drive lanes, consisting of at least six inches of quarry spalls, should be considered in order to minimize off-site soil tracking and to provide a temporary road surface. Woven geotextile below the quarry spalls would provide additional stability and can be considered. Temporary slopes and stockpiles should be covered when not in use. Silt fencing should be installed along the clearing limits. If construction occurs during periods of wet weather, methods to control surface water runoff will be necessary. Erosion control measures should conform to the Washington State Department of Ecology and Snohomish County standards.

In-Situ Soils

The majority of the soils encountered during our subsurface exploration have a low to moderate sensitivity to moisture and were generally in a damp to moist condition at the time of the exploration on December 14, 2020. Soils encountered during site excavations that are excessively over the optimum moisture content will require aeration or treatment prior to placement and compaction. Conversely, soils that are substantially below the optimum moisture content will require moisture conditioning through the addition of water prior to use as structural fill. An ESNW representative should determine the suitability of in-situ soils for use as structural fill at the time of construction.

Structural Fill

Structural fill is defined as compacted soil placed in foundation, slab-on-grade, roadway, permanent slope, retaining wall, and utility trench areas. Soils placed in structural areas should be placed in loose lifts of 12 inches or less and compacted to a relative compaction of at least 90 percent, based on the laboratory maximum dry density as determined by the Modified Proctor Method (ASTM D-1557). For soil placed in utility trenches underlying structural areas, compaction requirements are dictated by the local city, county, or utility district and are typically specified to a relative compaction of at least 95 percent.

Excavations and Slopes

Excavation activities are likely to expose medium dense native soil. Based on the soil conditions observed at the test pit locations, the following allowable temporary slope inclinations, as a function of horizontal to vertical (H:V) inclination, may be used. The applicable Federal Occupation Safety and Health Administration and Washington Industrial Safety and Health Act soil classifications are also provided:

- Native (recessional outwash) soil deposits 1.5H:1V (Type C)
- Areas containing groundwater seepage 1.5H:1V (Type C)

Permanent slopes should be planted with vegetation to enhance stability and to minimize erosion, and should maintain a gradient of 2H:1V or flatter. The presence of perched groundwater may cause localized sloughing of temporary slopes. An ESNW representative should observe temporary and permanent slopes to confirm the slope inclinations are suitable for the exposed soil conditions and to provide additional excavation and slope recommendations as necessary. If the recommended temporary slope inclinations cannot be achieved, temporary shoring may be necessary to support excavations.

Foundations

The proposed residential structure can be supported on conventional spread and continuous footings bearing on recompacted native soil or new structural fill placed directly on competent native soil. We recommend compacting exposed footing subgrade areas to a firm and unyielding condition. Where loose or unsuitable soil conditions are observed at foundation subgrade elevations, compaction of the soils to the specifications of structural fill, or overexcavation and replacement with granular structural fill will be necessary. Organic material exposed at foundation subgrade elevations must be removed and grades restored with structural fill.

Provided the structures will be supported as described above, the following parameters can be used for design of the new foundations:

- Allowable soil bearing capacity 2,500 psf
- Passive earth pressure 300 pcf (equivalent fluid)
- Coefficient of friction 0.40

A one-third increase in the allowable soil bearing capacity can be assumed for short-term wind and seismic loading conditions.

With structural loading as expected, total settlement in the range of one inch is anticipated, with differential settlement of about one-half inch. The majority of the settlements should occur during construction, as dead loads are applied.

Seismic Design Considerations

The 2015 International Building Code recognizes the American Society of Civil Engineers (ASCE) for seismic site class definitions. Based on the soil conditions observed at the test pit locations, in accordance with Table 20.3-1 of the ASCE Minimum Design Loads for Buildings and Other Structures manual, Site Class D should be used for design.

The referenced liquefaction susceptibility map indicates the site and surrounding areas maintain a low to moderate liquefaction susceptibility. Liquefaction is a phenomenon where saturated and loose clean sandy soils suddenly lose internal strength and behave as a fluid. This behavior is in response to increased pore water pressures resulting from an earthquake or other intense ground shaking. In our opinion, site susceptibility to liquefaction may be considered low. The soil relative density and the absence of an established shallow groundwater table are the primary bases for this opinion.

Slab-on-Grade Floors

Slab-on-grade floors for the proposed residential structures should be supported on a firm and unyielding subgrade. Unstable or yielding areas of the subgrade should be recompacted, or overexcavated and replaced with suitable structural fill, prior to construction of the slab.

A capillary break consisting of a minimum of four inches of free-draining crushed rock or gravel should be placed below the slab. The free-draining material should have a fines content of 5 percent or less (percent passing the Number 200 sieve, based on the minus three-quarter-inch fraction). In areas where slab moisture is undesirable, installation of a vapor barrier below the slab should be considered. If a vapor barrier is to be utilized, it should be a material specifically designed for use as a vapor barrier and should be installed in accordance with the specifications of the manufacturer.

Retaining Walls

Retaining walls must be designed to resist earth pressures and applicable surcharge loads. The following parameters can be used for retaining wall design:

- Active earth pressure (unrestrained condition) 35 pcf
- At-rest earth pressure (restrained condition) 55 pcf
- Traffic surcharge (passenger vehicles) 70 psf (rectangular distribution)
- Passive earth pressure 300 pcf
- Coefficient of friction 0.40
- Seismic surcharge 6H*

**Where H equals the retained height*

The passive earth pressure and coefficient of friction values include a safety factor of 1.5. Additional surcharge loading from adjacent foundations, sloped backfill, or other loads should be included in the retaining wall design. Drainage should be provided behind retaining walls such that hydrostatic pressures do not develop. If drainage is not provided, hydrostatic pressures should be included in the wall design.

Retaining walls should be backfilled with free-draining material that extends along the height of the wall, and a distance of at least 18 inches behind the wall; a drainage mat can be considered in lieu of the free-draining material. The upper one foot of the wall backfill can consist of a less permeable soil, if desired. A perforated drain pipe should be placed along the base of the wall, and connected to an approved discharge location. A typical retaining wall drainage detail is provided on Plate 3.

Drainage

Zones of perched groundwater seepage should be anticipated in site excavations depending on the time of year grading operations take place. Temporary measures to control surface water runoff and groundwater during construction would likely involve passive elements such as interceptor trenches and sumps. ESNW should be consulted during preliminary grading to identify areas of seepage and to provide recommendations to reduce the potential for instability related to seepage effects. It should also be noted that deeper utility installations may encounter the groundwater table during excavation. Given the high permeability of the sand deposits, excavation dewatering may be necessary where excavations are advanced below the groundwater table.

Finish grades must be designed to direct surface drain water away from structures and slopes. The grade adjacent to buildings should be sloped away from the buildings at a gradient of at least 2 percent for a horizontal distance of at least 10 feet or more as setbacks allow. Water must not be allowed to pond adjacent to structures or slopes. The site is underlain by native Marysville sand member (Qvrm). As documented in the attached test pit logs, relatively clean sand was predominant during the subsurface exploration. Because the native soils are free draining, it is our opinion the elimination of footing drains is acceptable from a geotechnical standpoint, provided ESNW confirms suitable soils during construction. A typical foundation drain detail is provided on Plate 4.

Infiltration Evaluation

Our infiltration evaluation was completed in general accordance with the 2014 Surface Water Management Manual for Western Washington (SWMMWW), as adopted by the city of Marysville. As indicated in the *Subsurface* section of this study, native soils encountered during our fieldwork were characterized primarily as sand recessional outwash deposits. The following recommendations pertaining to infiltration feasibility can be considered for this project:

- The results of USDA textural analyses performed on representative soil samples indicate native soils at depth consist primarily of slightly gravelly sand with fines contents ranging from 1.2 to 3.5 percent.

- Based on applicable correction factors and using the SWMMWW Soil Grain Size Analysis Method for non-glacially consolidated soils, we recommend a long-term design infiltration rate of 2.0 inches per hour be used for preliminary sizing of proposed infiltration devises.

It should be noted that although the groundwater table was not identified at our test locations, it can reasonably be assumed (for design purposes) that the seasonal high level for the site is at a depth of 6 feet below existing grade. In any case, ESNW should review final infiltration design plans and provide supplement recommendations for design, as necessary. Additionally, if overflow provisions are not included in facility designs, the design infiltration rate specified above should be reduced by half. The infiltration recommendations provided in this section should be confirmed during the appropriate phase of design and/or construction through direct observation of the exposed soil conditions and in-situ testing, if deemed necessary by the engineer.

Utility Support and Trench Backfill

In our opinion, the soils observed at the test pit locations are generally suitable for support of utilities. The native sand deposits are expected to generally be suitable for reuse as structural backfill within utility trench alignments. It should be noted that deeper utility installations may encounter the groundwater table during excavation. Given the high permeability of the sand deposits, excavation dewatering may be necessary where excavations are advanced below the groundwater table. Utility trench backfill should be placed and compacted to the specifications of structural fill provided in this report, or to the applicable requirements of presiding jurisdiction. It should also be noted that the governing jurisdiction may require crushed rock backfill within the right-of-way and frontage improvement areas.

Pavement Sections

The performance of site pavements is largely related to the condition of the underlying subgrade. To ensure adequate pavement performance, the subgrade should be in a firm and unyielding condition when subjected to proofrolling with a loaded dump truck. Structural fill in pavement areas should be compacted to the specifications detailed in the *Site Preparation and Earthwork* section of this report. It is possible that soft, wet, or otherwise unsuitable subgrade areas may still exist after base grading activities. Areas of unsuitable or yielding subgrade conditions may require remedial measures such as overexcavation and replacement with structural fill or thicker crushed rock sections prior to pavement.

For relatively lightly loaded pavements subjected to automobiles and occasional truck traffic, the following sections can be considered for preliminary design:

- Three inches of hot mix asphalt (HMA) placed over four inches of crushed rock base (CRB), or;

- Two inches of HMA placed over three inches of asphalt treated base (ATB).

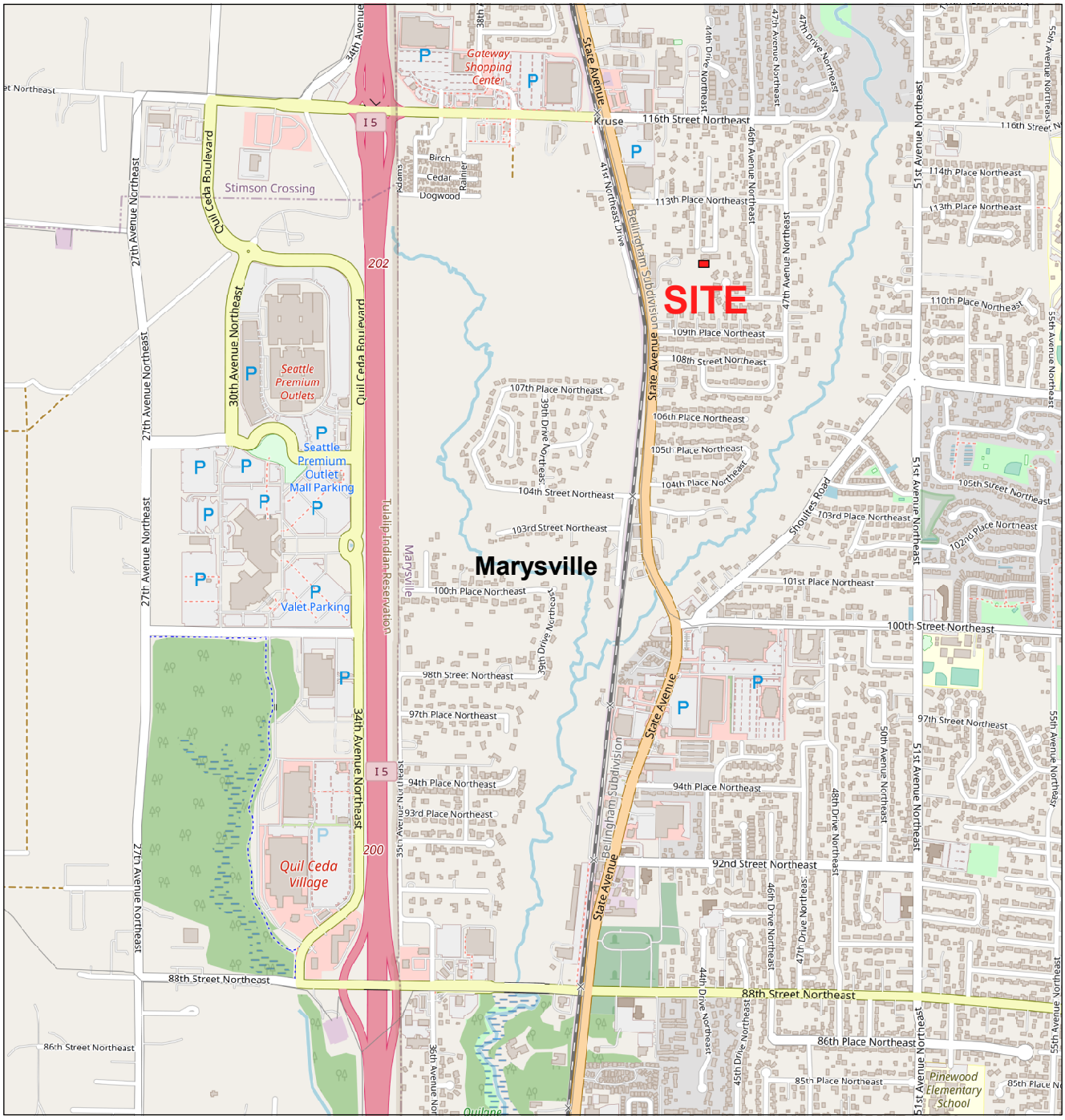
If required, recommendations for heavy traffic areas can be provided upon request. The HMA, CRB and ATB materials should conform to WSDOT specifications. City of Marysville pavement requirements may supersede our recommendations and may require thicker pavement sections.

LIMITATIONS

The recommendations and conclusions provided in this geotechnical engineering study are professional opinions consistent with the level of care and skill that is typical of other members in the profession currently practicing under similar conditions in this area. A warranty is not expressed or implied. Variations in the soil and groundwater conditions observed at the test locations may exist, and may not become evident until construction. ESNW should reevaluate the conclusions in this geotechnical engineering study if variations are encountered.

Additional Services

ESNW should have an opportunity to review the final design with respect to the geotechnical recommendations provided in this report. ESNW should also be retained to provide testing and consultation services during construction.



Reference:
Snohomish County, Washington
OpenStreetMap.org

NORTH

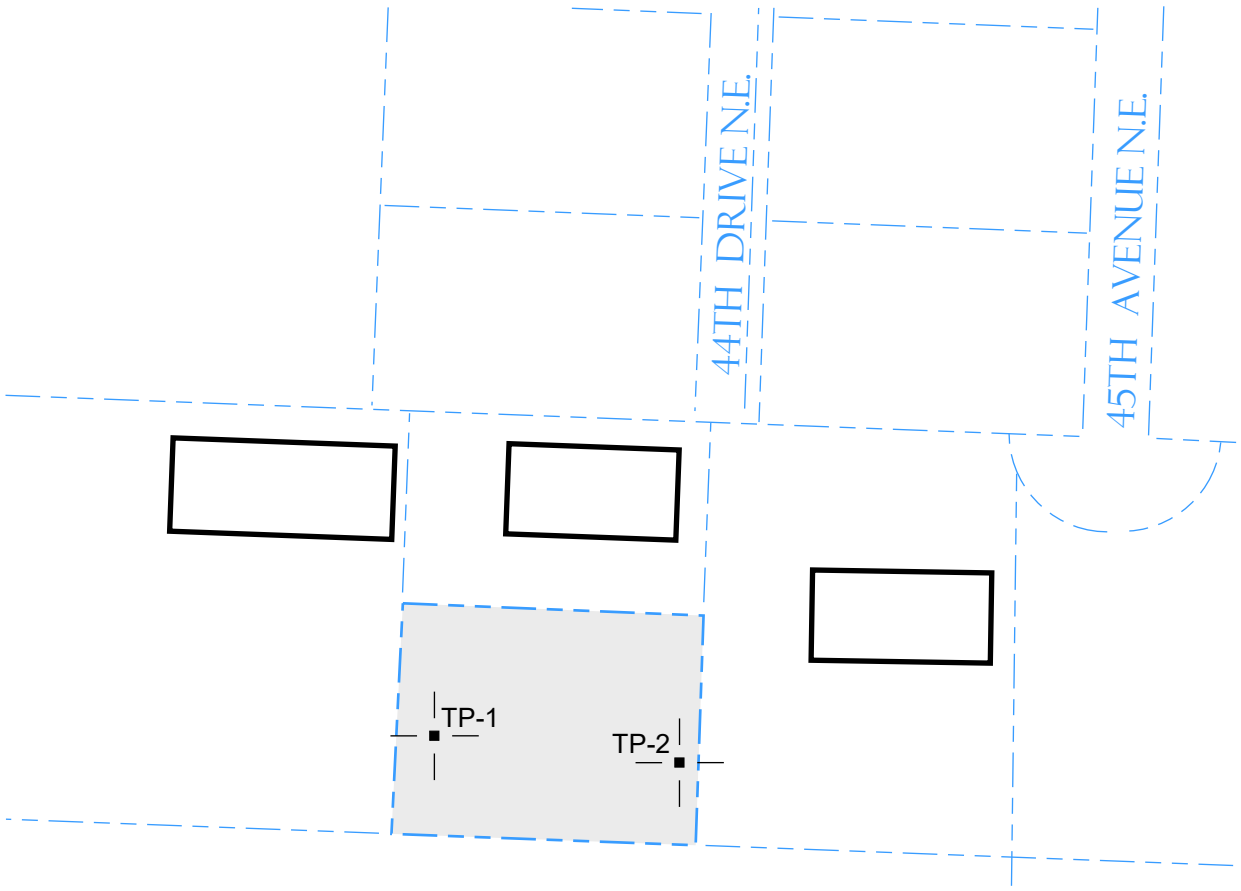
NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

Earth Solutions NW LLC

Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Vicinity Map
Balam 6-Plex
Marysville, Washington

Drwn. MRS	Date 01/06/2021	Proj. No. 7642
Checked AZS	Date Jan. 2021	Plate 1



LEGEND

TP-1 — Approximate Location of ESNW Test Pit, Proj. No. ES-7642, Dec. 2020

Subject Site

Existing Building

NORTH

NOT - TO - SCALE

NOTE: The graphics shown on this plate are not intended for design purposes or precise scale measurements, but only to illustrate the approximate test locations relative to the approximate locations of existing and / or proposed site features. The information illustrated is largely based on data provided by the client at the time of our study. ESNW cannot be responsible for subsequent design changes or interpretation of the data by others.

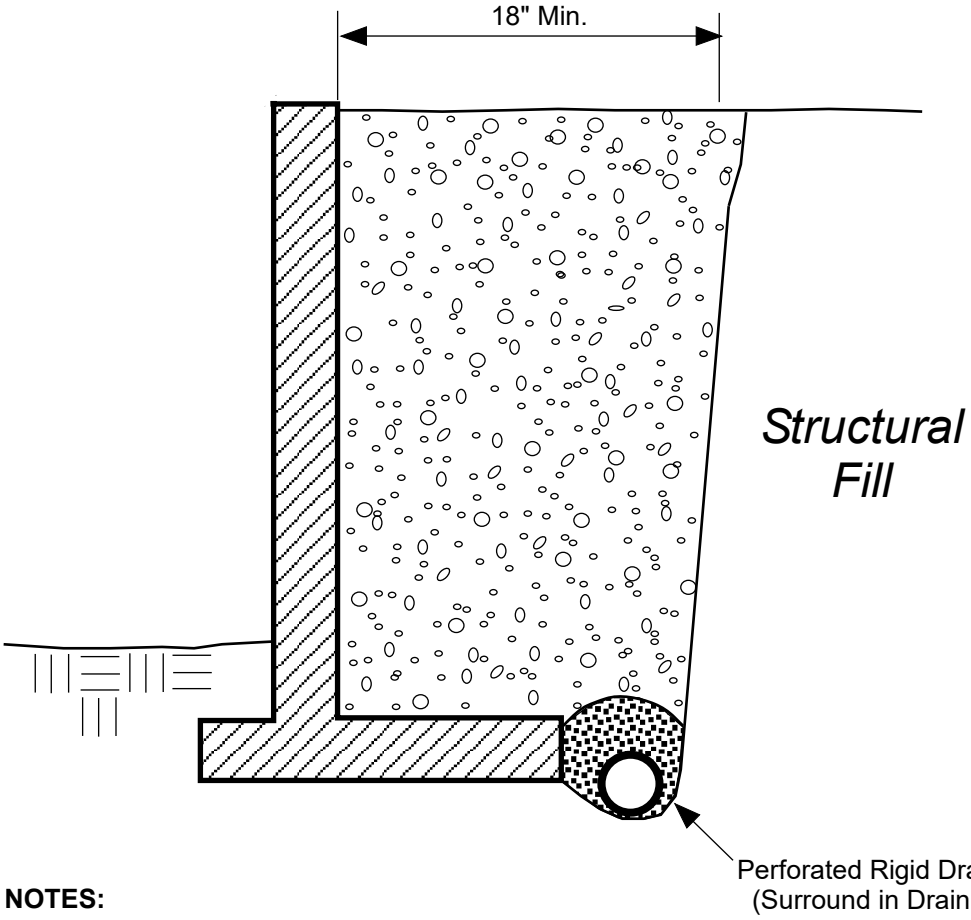
NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

Earth Solutions NW LLC

Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Test Pit Location Plan
Balam 6-Plex
Marysville, Washington

Drwn. MRS	Date 01/06/2021	Proj. No. 7642
Checked AZS	Date Jan. 2021	Plate 2



NOTES:

- Free-draining Backfill should consist of soil having less than 5 percent fines. Percent passing No. 4 sieve should be 25 to 75 percent.
- Sheet Drain may be feasible in lieu of Free-draining Backfill, per ESNW recommendations.
- Drain Pipe should consist of perforated, rigid PVC Pipe surrounded with 1-inch Drain Rock.

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

LEGEND:

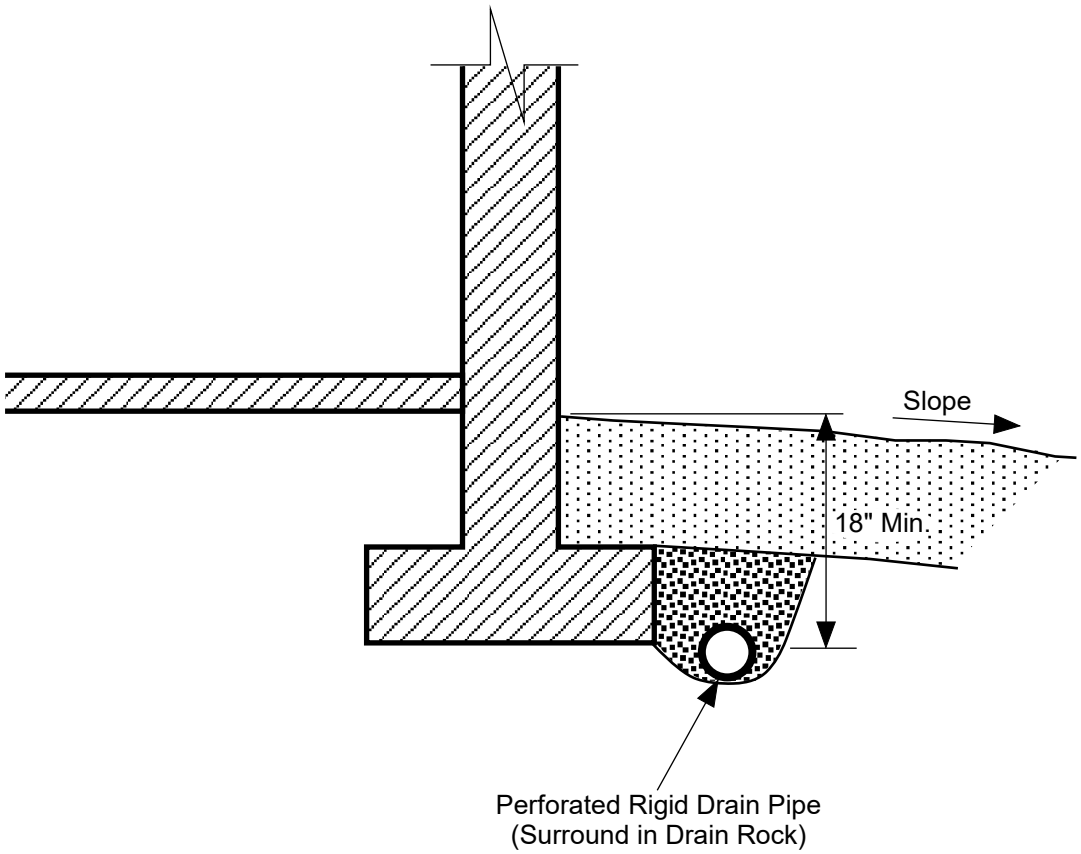
Free-draining Structural Backfill

1-inch Drain Rock

Earth Solutions NW LLC
Geotechnical Engineering Construction Observation/Testing and Environmental Services

Retaining Wall Drainage Detail
Balam 6-Plex
Marysville, Washington

Drwn. MRS	Date 01/06/2021	Proj. No. 7642
Checked AZS	Date Jan. 2021	Plate 3



NOTES:

- Do NOT tie roof downspouts to Footing Drain.
- Surface Seal to consist of 12" of less permeable, suitable soil. Slope away from building.

LEGEND:

Surface Seal: native soil or other low-permeability material.

1-inch Drain Rock

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

Earth Solutions NW LLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Footing Drain Detail
Balam 6-Plex
Marysville, Washington

Drwn. MRS	Date 01/06/2021	Proj. No. 7642
Checked AZS	Date Jan. 2021	Plate 4

Appendix A

Subsurface Exploration
Test Pit Logs

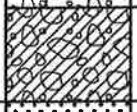
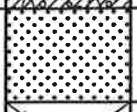
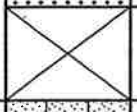
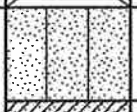
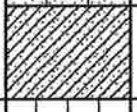
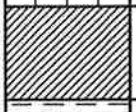
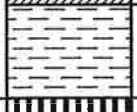
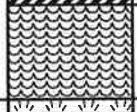
ES-7642

The subsurface conditions at the site were explored by excavating two test pits at the approximate locations illustrated on Plate 2 of this report. The test pits were advanced to a maximum depth of eight feet bgs. The test pit logs are provided in this Appendix. The subsurface exploration was completed on December 14, 2020.

Logs of the test pits excavated by ESNW are presented in Appendix A. The final logs represent the interpretations of the field logs and the results of laboratory analyses. The stratification lines on the logs represent the approximate boundaries between soil types. In actuality, the transitions may be more gradual.

Earth Solutions NW LLC

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

DUAL SYMBOLS are used to indicate borderline soil classifications.

The discussion in the text of this report is necessary for a proper understanding of the nature of the material presented in the attached logs.

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TEST PIT NUMBER TP-1

PROJECT NUMBER ES-7642 **PROJECT NAME** Balam 6-Plex

DATE STARTED 12/14/20 **COMPLETED** 12/14/20 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR Client Provided **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ ▽ **AT TIME OF EXCAVATION** ---

LOGGED BY AZS **CHECKED BY** RAC **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 6": grass **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	0.5	Dark brown TOPSOIL
		MC = 12.9%	SP-SM	2.0	Brown poorly graded SAND with silt, loose to medium dense, moist
		MC = 12.6% Fines = 3.5%	SP		Gray poorly graded SAND, medium dense, moist [USDA Classification: slightly gravelly SAND]
5		MC = 9.0%			
		MC = 2.7%		8.0	Test pit terminated at 8.0 feet below existing grade. No groundwater encountered during excavation. No caving observed.

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TEST PIT NUMBER TP-2

PROJECT NUMBER ES-7642 **PROJECT NAME** Balam 6-Plex

DATE STARTED 12/14/20 **COMPLETED** 12/14/20 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR Client Provided **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ ▽ **AT TIME OF EXCAVATION** ---

LOGGED BY AZS **CHECKED BY** RAC **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 7": grass **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	0.6	Dark brown TOPSOIL
		MC = 10.6% Fines = 9.1%	SP-SM	1.5	Brown poorly graded SAND with silt, loose to medium dense, moist [USDA Classification: slightly gravelly SAND]
		MC = 7.6%	SP		Gray poorly graded SAND, medium dense, moist
5					
		MC = 8.8% Fines = 1.2%		8.0	[USDA Classification: slightly gravelly SAND]
					Test pit terminated at 8.0 feet below existing grade. No groundwater encountered during excavation. No caving observed.