Earth Solutions NW LLC

Geotechnical Engineering
Construction Observation/Testing
Environmental Services

GEOTECHNICAL ENGINEERING STUDY
PROPOSED RESIDENTIAL DEVELOPMENT
SERENITY TRAILS
3209 – 83RD AVENUE NORTHEAST
MARYSVILLE, WASHINGTON

ES-8702.01

15365 NE 90th Street, Suite 100 • Redmond, WA 98052 • (425) 449-4704
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PREPARED FOR

KEYSTONE LAND, LLC

April 16, 2024

Brian C. Snow, L.G.
Project Geologist

04/16/2024

Henry T. Wright, P.E.
Associate Principal Engineer

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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 <u>not</u> 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 <u>not</u> be adequate to develop geotechnical design recommendations for the project.

Do <u>not</u> 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 <u>not</u> rely on an executive summary. Do <u>not</u> read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

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

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

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

This Report's Recommendations Are Confirmation-Dependent

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

This Report Could Be Misinterpreted

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

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

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

Give Constructors a Complete Report and Guidance

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

Read Responsibility Provisions Closely

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

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

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

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

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

GEOPROFESSIONAL BUSINESS ASSOCIATION

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Earth Solutions NW LLC

Geotechnical Engineering, Construction
Observation/Testing and Environmental Services

April 16, 2024
ES-8702.01

Keystone Land, LLC
13805 Smokey Point Boulevard, Suite 102
Marysville, Washington 98271

Attention: Joe Long

Greetings:

Earth Solutions NW, LLC (ESNW), is pleased to present this report to support the proposed residential development to be located at 3209 – 83rd Avenue Northeast in Marysville, Washington. We understand the subject site will be developed with 14 new residential lots, an access drive, a stormwater detention pond, and associated improvements including the widening of 32nd Place Northeast and 32nd Street Northeast. Based on the results of our investigation, the proposed development is feasible from a geotechnical standpoint.

Our field observations indicate the site is underlain primarily by medium dense to very dense silty sand with gravel glacial till deposits. Light to moderate groundwater seepage was observed at all exploration sites advanced during the April 2024 exploration.

In our opinion, the proposed residential structures may be supported on conventional continuous and spread footing foundations bearing on competent native soil, recompacted native soil, or new structural fill placed directly atop a competent subgrade surface. In general, competent native soil suitable for support of foundations will likely be encountered beginning at depths of roughly one to three feet below the existing ground surface.

Based on our observations of a relatively shallow depth to very dense, weakly cemented, unweathered glacial till deposits, full stormwater infiltration is not considered feasible for this site.

This report provides geotechnical analyses and recommendations for the proposed residential development. 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

Brian C. Snow, L.G.
Project Geologist

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INTRODUCTION

General

This geotechnical engineering study was prepared for the proposed residential development to be constructed at 3209 – 83rd Avenue Northeast in Marysville, Washington. To complete our scope of services, ESNW performed the following:

- Subsurface exploration to characterize the soil and groundwater conditions.
- Laboratory testing of representative soil samples collected on site.
- Engineering analyses and recommendations for the proposed residential development.
- Preparation of this report.

Project Description

We understand the subject site will be developed with 14 new residential lots, an access drive, a stormwater detention pond, and associated improvements including the widening of 32nd Place Northeast and 32nd Street Northeast.

At the time of report submission, specific building load values were not available for review; however, we anticipate the proposed residential structures will consist of relatively lightly loaded wood framing supported on conventional foundations. Based on our experience with similar developments, we estimate wall loads of about 1 to 2 kips per linear foot, column loading of up to about 20 kips, and slab-on-grade loading of 150 pounds per square foot (psf) will be incorporated into the final design.

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

SITE CONDITIONS

Surface

The subject site is located at 3209 – 83rd Avenue Northeast in Marysville, Washington. The site is located on the east side of 83rd Avenue Northeast in the general area between the intersections with 31st Place Northeast and 32nd Place Northeast. The approximate site location is depicted on Plate 1 (Vicinity Map). The site consists of one tax parcel (Snohomish County Parcel No. 00590700028500) totaling about 2.07 acres of land area.

Per the referenced existing conditions map, the site gently descends from east to west for a total of about 24 feet of topographic relief within the property boundaries. The property is currently undeveloped and vacant, surfaced with grasses, mature trees, shrubs, and other vegetation. The site is generally surrounded by existing residential development and is bordered on the west side by 83rd Avenue Northeast.

Subsurface

An ESNW representative observed, logged, and sampled five test pits advanced at accessible locations within the property boundaries on April 2, 2024, using a machine and operator provided by the client. The test pits were completed to assess and classify the site soils and to characterize the groundwater conditions within areas proposed for new development. The maximum exploration depth was approximately nine-and-one-half feet below the existing ground surface (bgs).

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 exploration sites were analyzed in general accordance with Unified Soil Classification System (USCS) and United States Department of Agriculture (USDA) methods and procedures.

Topsoil and Fill

Topsoil was generally encountered within the upper 10 to 12 inches of existing grades at the test pit locations. Deeper pockets of topsoil may be encountered locally across the site. The topsoil was characterized by its dark brown color, the presence of fine organic material, and small root intrusions.

Isolated and minor fills were encountered at two of the test pit excavations (TP-103 and TP-104) and extended to a maximum observed depth of about three feet bgs. The fill primarily consisted of topsoil with minor amounts of crushed rock, washed rock gravel, and/or silty sand material associated with gravel driveway and site drainage improvements. Significant, widespread fills were not encountered and are not anticipated to be present at this site based on the subsurface exploration.

Native Soil

Underlying the topsoil and fill, native soil consisting primarily of silty sand with gravel (USCS: SM) was observed, consistent with the typical make-up of glacial till deposits. The glacial till soil was observed in a light to moderately weathered and medium dense condition near surface, transitioning to a dense and unweathered condition beginning at depths of approximately one to three feet bgs. Iron oxide staining and weak cementation were observed within each of the subsurface explorations.

Based on the results of our laboratory analyses, the native glacial till soil contains between about 36 to 43 percent fines, and was chiefly encountered in a moist to wet condition during the April 2024 exploration.

Geologic Setting

Geologic mapping of the area identifies Vashon till (Qvt) as the primary geologic unit underlying the site. As reported on the geologic map resource, glacial till is a non-sorted mixture of clay, silt, sand, and gravel (diamicton), resembling a low-strength concrete mix. The glacial till was deposited directly beneath the glacier as it advanced over bedrock and older Quaternary deposits.

The referenced Web Soil Survey (WSS) identifies Tokul gravelly medial loam as the primary soil unit underlying the site. Tokul series soils were formed over glacial till and volcanic ash. The referenced USDA soil survey characterizes this soil unit with slow surface water runoff and a slight hazard of water erosion.

In our opinion, the soils observed during the subsurface exploration are generally representative of glacial till deposits, consistent with the geologic and soils mapping resources outlined in this section.

Groundwater

Light to moderate groundwater seepage was observed in all five test pits excavated during the April 2024 subsurface exploration. The groundwater was commonly encountered within the upper two to five feet (generally correlating with the transition to hardpan glacial till conditions) and was observed as deep as about seven feet bgs.

Zones of perched groundwater seepage are typical of glacial till deposits and should be expected within site excavations at depth, particularly during the wet season. Groundwater seepage rates and elevations may 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 winter, spring, and early summer months.

Geologic Hazard Areas Assessment

ESNW reviewed Marysville Municipal Code (MMC), Chapter 22E.10 Article IV – Geologic Hazard Areas, to evaluate the presence of geologic hazard areas at or near the subject site. Along with site-specific field observations, ESNW reviewed the referenced critical areas map delineating areas potentially subject to geologic hazards. Geologic hazards within the City of Marysville include areas susceptible to landslides, seismic activity, and severe erosion.

Based on our review, the site and surrounding area do not contain geologic hazard areas as recognized by the MMC.

DISCUSSION AND RECOMMENDATIONS

General

In our opinion, construction of the proposed residential development is feasible from a geotechnical standpoint. Our field observations indicate the site is underlain primarily by medium dense to very dense silty sand with gravel glacial till deposits. Light to moderate groundwater seepage was observed at all exploration sites advanced during the April 2024 exploration.

The proposed residential structures may be supported on conventional continuous and spread footing foundations bearing on competent native soil, recompacted native soil, or new structural fill placed directly atop a competent subgrade surface. In general, competent native soil suitable for support of foundations will likely be encountered beginning at depths of roughly one to three feet below the existing ground surface.

Based on our observations of a relatively shallow depth to very dense, weakly cemented, unweathered glacial till deposits, full stormwater infiltration is not considered feasible for this site.

Site Preparation and Earthwork

Site preparation activities should consist of installing temporary erosion control measures and performing site stripping within the designated clearing limits. Subsequent earthwork activities will likely involve additional mass grading and infrastructure and utility installations.

Temporary Erosion Control

The following temporary erosion control measures should be considered:

- Temporary construction entrances and drive lanes, consisting of at least six inches of quarry spalls, should be considered to both minimize off-site soil tracking and provide stable surfaces at site entrances. Placing geotextile fabric underneath the quarry spalls will provide greater stability.

- Silt fencing should be placed around the appropriate portions of the site perimeter.

- When not in use, soil stockpiles should be covered or otherwise protected to reduce the potential for soil erosion, especially during periods of wet weather.

- Temporary measures for controlling surface water runoff, such as interceptor trenches, sumps, or interceptor swales, should be installed prior to beginning earthwork activities.

- Dry soils disturbed during construction should be wetted to minimize dust and airborne soil erosion.

- When appropriate, permanent planting or hydroseeding will help to stabilize site soils.

Additional Best Management Practices, as specified by the project civil engineer and indicated on the plans, should be incorporated into construction activities. Temporary erosion control measures may be modified during construction as site conditions require, as approved by the site erosion control lead.

Stripping

Topsoil was encountered within the upper 10 to 12 inches, and minor root intrusions generally extended below the topsoil into the upper weathered soil. The organic-rich topsoil should be stripped and segregated into a stockpile for later use on site or to haul off site. The material remaining immediately below the topsoil may have some root zones and will likely be variable in composition, density, and/or moisture content. The material exposed after initial topsoil stripping will likely not be suitable for direct structural support as is and will likely need to either be compacted in place or stripped and stockpiled for reuse as fill. Depending on the time of year stripping occurs, the soil exposed below the topsoil may be too wet to compact and will likely need to be aerated or treated. ESNW should observe initial stripping activities to provide recommendations regarding stripping depths and material suitability.

Excavations and Slopes

Based on the soil conditions observed at the subsurface exploration locations, excavation activities are likely to expose loose to medium dense native soils within the upper one to three feet of existing grades, becoming dense to very dense at depth. Groundwater seepage will likely be encountered within site excavations depending on the time of year. The following Federal Occupation Safety and Health Administration and Washington Industrial Safety and Health Act soil classifications and maximum allowable temporary slope inclinations may be used:

- Areas exposing groundwater seepage 1.5H:1V (Type C)
- Loose soil and fill 1.5H:1V (Type C)
- Medium dense soil 1H:1V (Type B)
- Dense to very dense native soil (hardpan) 0.75H:1V (Type A)

Permanent slopes should be planted with vegetation to both enhance stability and 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.

Structural Fill

Structural fill is defined as compacted soil placed in foundation, slab-on-grade, roadway, permanent slope, retaining wall, and utility trench backfill areas. Structural fill placed and compacted during site grading activities should meet the following specifications and guidelines:

- Structural fill material Granular soil
- Moisture content At or slightly above optimum
- Relative compaction (minimum) 95 percent (Modified Proctor)
- Loose lift thickness (maximum) 12 inches

The existing soil may not be suitable for use as structural fill unless the soil is at (or slightly above) the optimum moisture content at the time of placement and compaction. Soil shall not be placed dry of the optimum moisture content and should be evaluated by ESNW during construction.

With respect to underground utility installations and backfill, local jurisdictions may dictate the soil type(s) and compaction requirements. Unsuitable material or debris must be removed from structural areas if encountered.

In-situ and Imported Soil

The in-situ soils encountered at the subject site have a high sensitivity to moisture and were generally in a moist to wet condition at the time of exploration. Soils anticipated to be exposed on site will degrade if exposed to wet weather and construction traffic. Compaction of the soils to the levels necessary for use as structural fill may be difficult or impossible during wet weather conditions. Soils encountered during site excavations that are excessively over the optimum moisture content will likely 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.

Imported soil intended for use as structural fill should be evaluated by ESNW during construction. The imported soil must be workable to the optimum moisture content, as determined by the Modified Proctor Method (ASTM D1557), at the time of placement and compaction. During wet weather conditions, imported soil intended for use as structural fill should consist of a well-graded, granular soil with a fines content of 5 percent or less (where the fines content is defined as the percent passing the Number 200 sieve, based on the minus three-quarter-inch fraction).

Wet-Season Grading

If earthwork activities occur during wet weather, additional drainage measures, cement treatment of native soil (where allowed by the presiding jurisdiction), and/or the use of select fill material will likely be necessary. Additionally, measures to protect structural subgrades should be considered if exposed during wet weather. Site-specific recommendations can be provided at the time of construction and may include leaving cut areas several inches above design subgrade elevations, covering working surfaces with crushed rock, protecting structural fill soil from adverse moisture conditions, and additional TESC recommendations. ESNW can assist in obtaining a wet-season grading permit if required by the governing jurisdiction.

Foundations

The proposed residential structures may be supported on conventional continuous and spread footing foundations bearing on competent native soil, recompacted native soil, or new structural fill placed directly atop a competent subgrade surface. In general, competent native soil suitable for support of foundations will likely be encountered beginning at depths of roughly one to three feet bgs. Where loose or unsuitable soil conditions are exposed at foundation subgrade elevations, compaction of the soil to the specifications of structural fill or overexcavation and replacement with suitable structural fill will likely be necessary. An ESNW representative should confirm suitability of foundation subgrades at the time of construction.

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

- Allowable soil bearing capacity 2,500 psf
- Passive earth pressure 300 pcf
- 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. The passive earth pressure and coefficient of friction values include a safety factor of 1.5. 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 settlement should occur during construction as dead loads are applied.

Site Retaining Walls

Site retaining walls must be designed to resist earth pressures and applicable surcharge loads. The following parameters may 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 8H psf*

* *Where H equals the retained height (in feet).*

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.

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. The upper 12 inches of the wall backfill may consist of a less permeable soil, if desired.

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. A perforated drainpipe 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.

Slab-on-Grade Floors

Slab-on-grade floors should be supported on a firm and unyielding subgrade consisting of competent native soil or at least 12 inches of new structural fill. Unstable or yielding areas of the subgrade should be recompacted or overexcavated and replaced with suitable structural fill prior to slab construction.

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 defined as the percent passing the number 200 sieve, based on the minus three-quarters-inch fraction. In areas where slab moisture is undesirable, installation of a vapor barrier below the slab should be considered. If used, the vapor barrier should consist of a material specifically designed to function as a vapor barrier and should be installed in accordance with the manufacturer's specifications.

Utility Support and Trench Backfill

The soils observed at the subsurface exploration locations are generally suitable for support of utilities. Use of the native soil as structural backfill in the utility trench excavations will depend on the in-situ moisture content at the time of placement and compaction. If native soil is placed below the optimum moisture content, settlement will likely occur once wet weather impacts the trenches. As such, backfill soils should be properly moisture conditioned, as necessary, to ensure acceptability of the soil moisture content at the time of placement and compaction. Native soil will be difficult or impossible to use as utility trench backfill during extended wet weather conditions. In this respect, moisture conditioning or treatment of the soils may be necessary at some locations prior to use as structural fill. Utility trench backfill should be placed and compacted to the specifications of structural fill provided in this report or to the applicable requirements of the presiding jurisdiction.

Preliminary 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 proof rolling with a loaded dump truck. Structural fill in pavement areas should be compacted to the specifications previously detailed in this report. Soft, wet, or otherwise unsuitable or yielding subgrade conditions will require remedial measures, such as overexcavation and/or placement of thick crushed rock or structural fill sections, prior to pavement.

We anticipate new pavement sections will be subjected primarily to passenger vehicle traffic. For lightly loaded pavement areas subjected primarily to passenger vehicles, the following preliminary pavement sections may be considered:

- A minimum of two inches of hot-mix asphalt (HMA) placed over four inches of crushed rock base (CRB).

- A minimum of two inches of HMA placed over three inches of asphalt-treated base (ATB).

Heavier traffic areas generally require thicker pavement sections depending on site usage, pavement life expectancy, and site traffic. For preliminary design purposes, the following pavement sections for occasional truck traffic and access roadways may be considered:

- Three inches of HMA placed over six inches of CRB.

- Three inches of HMA placed over four and one-half inches of ATB.

An ESNW representative should be requested to observe subgrade conditions prior to placement of CRB or ATB. As necessary, supplemental recommendations for achieving subgrade stability and drainage can be provided. If on-site roads will be constructed with an inverted crown, additional drainage measures will be recommended to assist in maintaining road subgrade and pavement stability.

Final pavement design recommendations, including recommendations for heavy traffic areas, access roads, and frontage improvement areas, can be provided once final traffic loading has been determined. Road standards utilized by the governing jurisdiction may supersede the recommendations provided in this report. The HMA, ATB, and CRB materials should conform to WSDOT specifications. All soil base material should be compacted to a relative compaction of 95 percent, based on the laboratory maximum dry density as determined by ASTM D1557.

Drainage

Groundwater seepage will likely be encountered within 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, interceptor swales, and sumps. An interceptor drain installed along the upslope portions of the site may help to reduce groundwater seepage at lower elevations of the site. ESNW should be consulted during preliminary grading to identify areas of seepage and provide recommendations to reduce the potential for seepage-related instability.

Surface grades must be designed to direct water away from buildings. 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 four feet or more as setbacks allow. In our opinion, perimeter footing drains should be installed at or below the invert of the building footings. A typical footing drain detail is provided on Plate 4 of this report.

If buildings will incorporate crawl spaces rather than on-grade slabs, in our opinion, a crawl space drain system will provide adequate drainage in lieu of perimeter footing drains. The crawl space drain must provide positive drainage to an appropriate outlet.

Infiltration Evaluation

In general, the relatively dense, weakly cemented, and unweathered glacial till soils (hardpan) observed at depths beginning at about one to three feet bgs generally exhibit very poor soil infiltration characteristics, which is exhibited by the shallow zones of perched groundwater seepage and iron oxide staining. In our opinion, the unweathered glacial till soils should be considered impermeable for design purposes, and full infiltration should be considered infeasible from a geotechnical standpoint.

Detention Pond Wall Design

Based on the referenced site plans, a stormwater detention pond with cast-in-place concrete walls will be constructed in the southwest corner of the project site. Pond wall foundations should be supported on undisturbed, dense native soil or crushed rock placed on dense native soil. Based on subsurface conditions observed during the fieldwork, dense to dense glacial till deposits are anticipated to be exposed beginning at depths of roughly one and three to feet bgs within the pond footprint.

Perimeter drains should be installed around the pond walls and conveyed to an approved discharge point. The presence of perched groundwater seepage should be anticipated during excavation activities for the detention pond.

The following parameters can be used for detention pond wall design:

• Allowable soil bearing capacity (dense native soil)	5,000 psf
• Active earth pressure (unrestrained)	35 pcf
• Active earth pressure (unrestrained, hydrostatic)	80 pcf
• At-rest earth pressure (restrained)	55 pcf
• At-rest earth pressure (restrained, hydrostatic)	100 pcf
• Traffic surcharge (passenger vehicles)	70 psf (rectangular distribution)
• Slope and block wall surcharge (N and E sides)	140 psf (rectangular distribution)**
• Coefficient of friction	0.40
• Passive earth pressure	300 pcf
• Seismic surcharge	8H psf*

** Where H equals the retained height (in feet).*
*** Represents an effective 4-foot soil surcharge.*

The passive earth pressure and coefficient of friction values include a safety factor of 1.5. The pond walls should be backfilled with free-draining material or, if a sheet drain material is used, suitable common earth is acceptable. The upper one foot of the wall backfill can consist of a less permeable soil, if desired. A perforated drainpipe should be placed along the base of the wall and connected to an approved discharge location. If the elevation of the pond bottom is such that gravity flow to an outlet is not possible, the portion of the wall below the drain should be designed to include hydrostatic pressure. Design values accounting for hydrostatic pressure are included above.

ESNW should observe grading operations for the detention pond wall and the subgrade conditions prior to concrete forming and pouring to confirm conditions are as anticipated and to provide supplemental recommendations, as necessary. Additionally, ESNW should be contacted to review final detention pond designs to confirm that appropriate geotechnical parameters have been incorporated.

We anticipate native soil will be used as detention pond wall backfill. The native soil is moisture sensitive and will settle once impacted by wet weather if placed below the optimum moisture content. ESNW recommends placing the native soil at or slightly above the optimum moisture content. Native soil placed substantially above the optimum moisture content will require additional time or remediation prior to supporting a structure.

Seismic Design

The 2018 International Building Code (2018 IBC) recognizes the most recent edition of the Minimum Design Loads for Buildings and Other Structures manual (ASCE 7-16) for seismic design, specifically with respect to earthquake loads. Based on the soil conditions encountered at the test pit locations, the parameters and values provided below are recommended for seismic design per the 2018 IBC.

Parameter	Value
Site Class	C*
Mapped short period spectral response acceleration, S_S (g)	1.108
Mapped 1-second period spectral response acceleration, S_1 (g)	0.393
Short period site coefficient, F_a	1.2
Long period site coefficient, F_v	1.5
Adjusted short period spectral response acceleration, S_{MS} (g)	1.329
Adjusted 1-second period spectral response acceleration, S_{M1} (g)	0.59
Design short period spectral response acceleration, S_{DS} (g)	0.886
Design 1-second period spectral response acceleration, S_{D1} (g)	0.393

* *Assumes very dense native soil conditions, encountered to a maximum depth of nine-and-one-half feet bgs during the April 2024 field exploration, remain dense to at least 100 feet bgs. Based on our experience with the project geologic setting (glacial till) across the Puget Sound region, soil conditions are likely consistent with this assumption.*

Liquefaction Susceptibility

Liquefaction is a phenomenon that can occur within a soil profile as a result of an intense ground shaking or loading condition. Most commonly, liquefaction is caused by ground shaking during an earthquake. Sand or silt soil profiles that are loose, cohesionless, and present below the groundwater table are most susceptible to liquefaction. During the ground shaking, the soil contracts, and porewater pressure increases. The increased porewater pressure occurs quickly and without sufficient time to dissipate, resulting in water flowing upward to the ground surface and a liquefied soil condition. Soil in a liquefied condition possesses very little shear strength in comparison to the drained condition, which can result in a loss of foundation support for structures.

In our opinion, and consistent with the depiction on the referenced liquefaction susceptibility map, site susceptibility to liquefaction may be considered very low or negligible. The absence of a shallow groundwater table and the relatively dense, weakly cemented characteristics of the native soil were the primary bases for this opinion.

LIMITATIONS

This study has been prepared for the exclusive use of Keystone Land, LLC, and its representatives. The recommendations and conclusions provided in this 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 neither expressed nor implied. Variations in the soil and groundwater conditions observed at the exploration locations may exist and may not become evident until construction. ESNW should reevaluate the conclusions provided in this study if variations are encountered.

Additional Services

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

REFERENCES

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

- Road and Storm Drainage Plan, prepared by Solid Ground Engineering, Job No. 23-0012, dated January 15, 2024

- Existing Conditions Map, prepared by Solid Ground Engineering, Job No. 23-0012, dated March 12, 2024

- Geologic Map of the Lake Stevens Quadrangle, Snohomish County, Washington, by Minard, J.P., 1985

- WSS, maintained by the Natural Resources Conservation Service under the USDA

- Soil Survey of Snohomish County Area, Washington, by Debose and Klungland, USDA Soil Conservation Service, issued July 1983

- Liquefaction Susceptibility Map of Snohomish County, Washington, prepared by Palmer, S.P. et al., endorsed by the Washington State Department of Natural Resources, dated September 2004

- City of Marysville – Geologic Hazards Map, dated February 2024

- MMC Chapter 22E.010 – Article IV

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.

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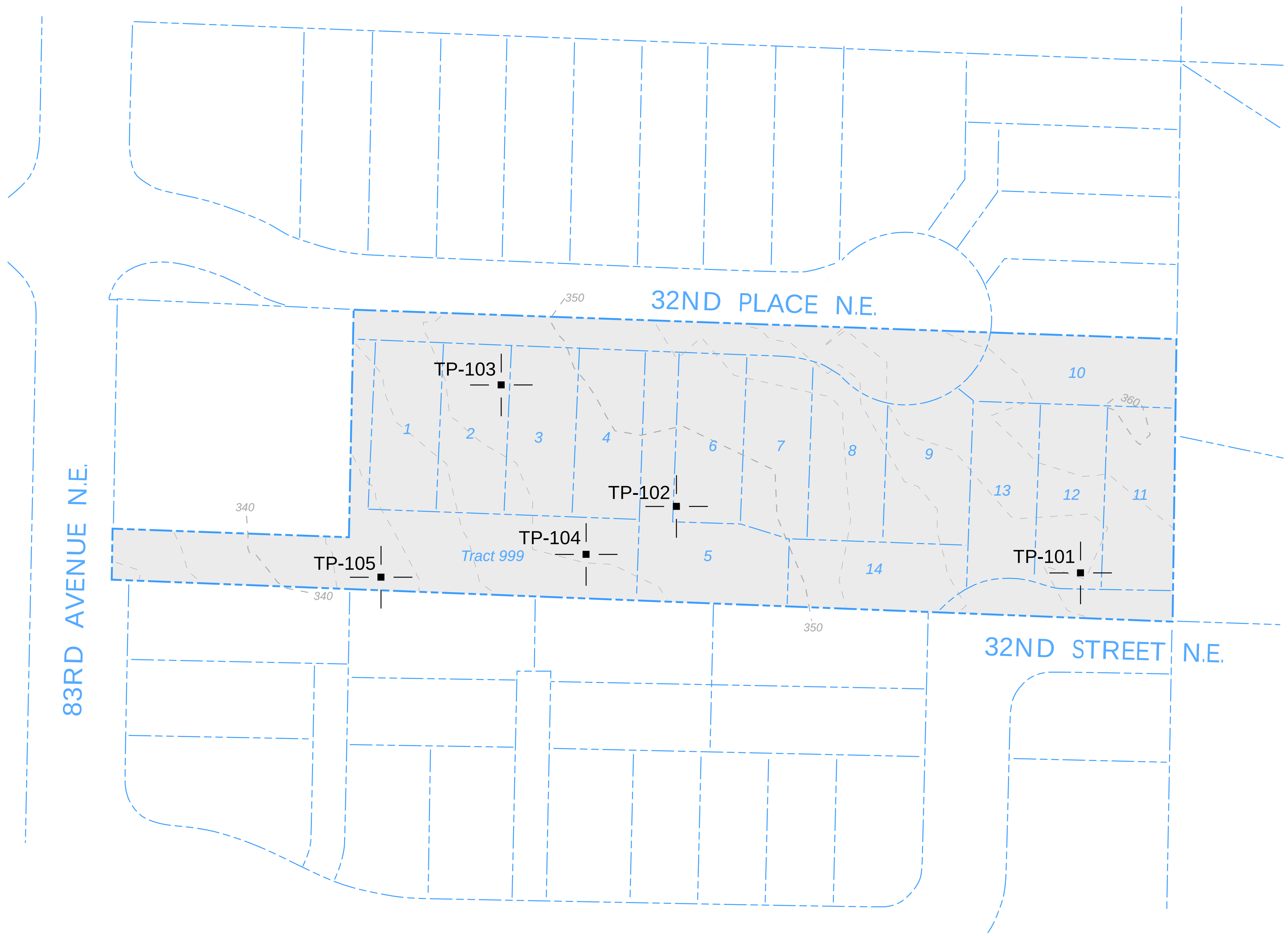
Vicinity Map
Serenity Trails
Marysville, Washington

Drawn MRS	Date 04/15/2024	Proj. No. 8702.01
Checked BCS	Date April 2024	Plate 1



LEGEND

TP-101 — Approximate Location of ESNW Test Pit, Proj. No. ES-8702.01, April 2024

Subject Site

10 — Proposed Lot Number

NORTH

1"=80'

0 40 80 160

Scale in Feet

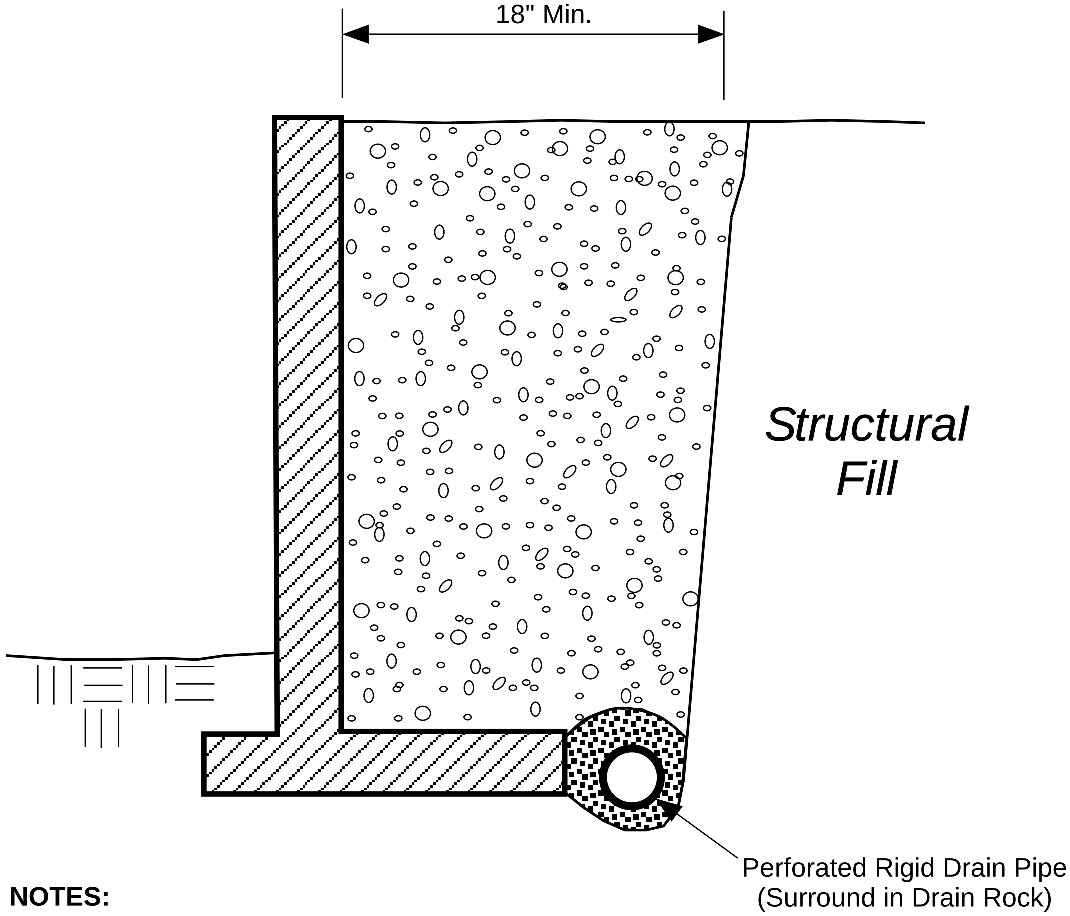
NOTE: The graphics shown on this plate are not intended for design purposes or precise scale measurements, but only to illustrate the approximate test locations relative to the approximate locations of existing and / or proposed site features. The information illustrated is largely based on data provided 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.

Test Pit Location Plan
Serenity Trails
Marysville, Washington

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

Drawn	MRS
Checked	BCS
Date	04/16/2024
Proj. No.	8702.01
Plate	2

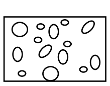


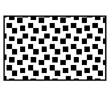
NOTES:

- 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

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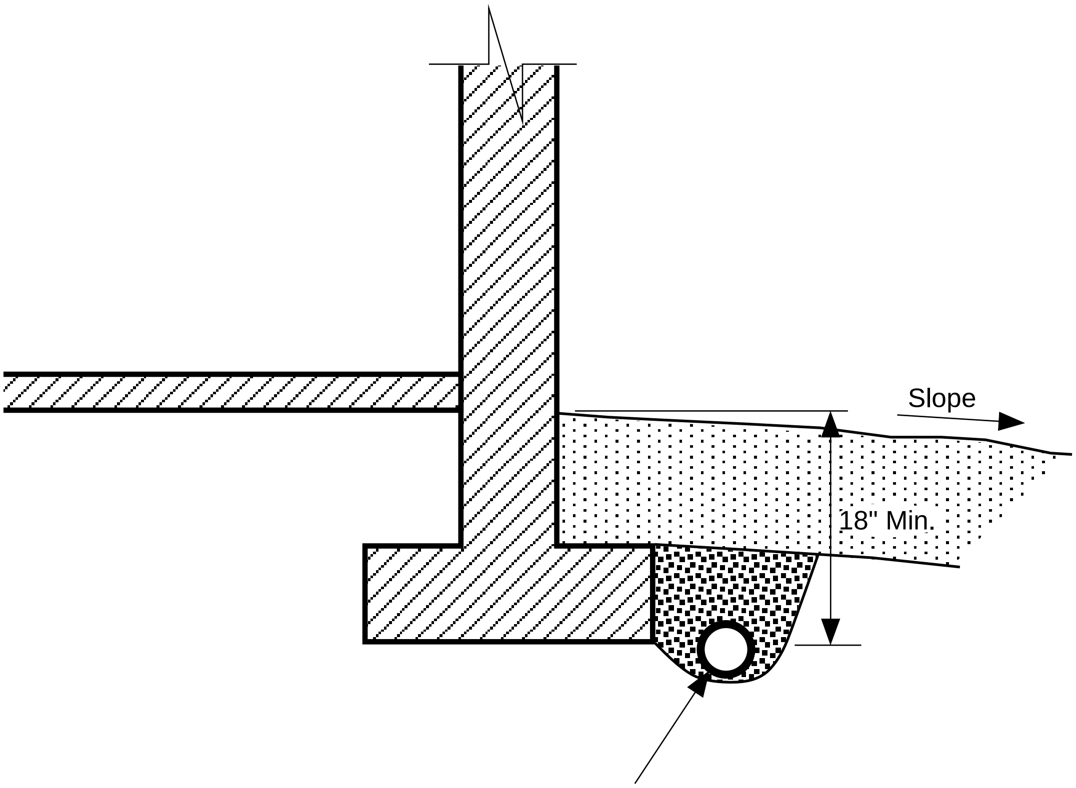
Retaining Wall Drainage Detail
Serenity Trails
Marysville, Washington

Drawn MRS	Date 04/15/2024	Proj. No. 8702.01
Checked BCS	Date April 2024	Plate 3

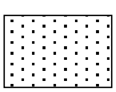


NOTES:

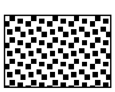
- Do NOT tie roof downspouts to Footing Drain.
- Surface Seal to consist of 12" of less permeable, suitable soil. Slope away from building.

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

LEGEND:



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



1-inch Drain Rock

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

Footing Drain Detail
Serenity Trails
Marysville, Washington

Drawn MRS	Date 04/15/2024	Proj. No. 8702.01
Checked BCS	Date April 2024	Plate 4

Appendix A

Subsurface Exploration Logs

ES-8702.01

Subsurface conditions on site were explored on April 2, 2024, by excavating five test pits using a machine and operator provided by the client. The approximate locations of the test pits are illustrated on Plate 2 of this study. The subsurface exploration logs are provided in this Appendix. The test pits were advanced to a maximum depth of about nine-and-one-half feet bgs.

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.

Major Divisions			Symbol	Description
Coarse-Grained Soils - More Than 50% Retained on No. 200 Sieve	Gravels - More Than 50% of Coarse Fraction Retained on No. 4 Sieve	< 5% Fines	GW	Well-graded gravel with or without sand, little to no fines
			GP	Poorly graded gravel with or without sand, little to no fines
		> 12% Fines	GM	Silty gravel with or without sand
			GC	Clayey gravel with or without sand
	Sands - 50% or More of Coarse Fraction Passes No. 4 Sieve	< 5% Fines	SW	Well-graded sand with or without gravel, little to no fines
			SP	Poorly graded sand with or without gravel, little to no fines
		> 12% Fines	SM	Silty sand with or without gravel
			SC	Clayey sand with or without gravel
Fine-Grained Soils - 50% or More Passes No. 200 Sieve	Silts and Clays Liquid Limit Less Than 50		ML	Silt with or without sand or gravel; sandy or gravelly silt
			CL	Clay of low to medium plasticity; lean clay with or without sand or gravel; sandy or gravelly lean clay
			OL	Organic clay or silt of low plasticity
	Silts and Clays Liquid Limit 50 or More		MH	Elastic silt with or without sand or gravel; sandy or gravelly elastic silt
			CH	Clay of high plasticity; fat clay with or without sand or gravel; sandy or gravelly fat clay
			OH	Organic clay or silt of medium to high plasticity
Highly Organic Soils			PT	Peat, muck, and other highly organic soils
Fill			FILL	Made Ground

Moisture Content

Dry - Absence of moisture, dusty, dry to the touch

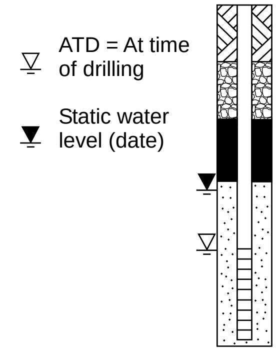
Damp - Perceptible moisture, likely below optimum MC

Moist - Damp but no visible water, likely at/near optimum MC

Wet - Water visible but not free draining, likely above optimum MC

Saturated/Water Bearing - Visible free water, typically below groundwater table

Symbols



Terms Describing Relative Density and Consistency

Coarse-Grained Soils:

Density	SPT blows/foot
Very Loose	< 4
Loose	4 to 9
Medium Dense	10 to 29
Dense	30 to 49
Very Dense	≥ 50

Fine-Grained Soils:

Consistency	SPT blows/foot
Very Soft	< 2
Soft	2 to 3
Medium Stiff	4 to 7
Stiff	8 to 14
Very Stiff	15 to 29
Hard	≥ 30

Test Symbols & Units

Fines = Fines Content (%)

MC = Moisture Content (%)

DD = Dry Density (pcf)

Str = Shear Strength (tsf)

PID = Photoionization Detector (ppm)

OC = Organic Content (%)

CEC = Cation Exchange Capacity (meq/100 g)

LL = Liquid Limit (%)

PL = Plastic Limit (%)

PI = Plasticity Index (%)

Component Definitions

Descriptive Term	Size Range and Sieve Number
Boulders	Larger than 12"
Cobbles	3" to 12"
Gravel	3" to No. 4 (4.75 mm)
Coarse Gravel	3" to 3/4"
Fine Gravel	3/4" to No. 4 (4.75 mm)
Sand	No. 4 (4.75 mm) to No. 200 (0.075 mm)
Coarse Sand	No. 4 (4.75 mm) to No. 10 (2.00 mm)
Medium Sand	No. 10 (2.00 mm) to No. 40 (0.425 mm)
Fine Sand	No. 40 (0.425 mm) to No. 200 (0.075 mm)
Silt and Clay	Smaller than No. 200 (0.075 mm)

Modifier Definitions

Percentage by Weight (Approx.)	Modifier
< 5	Trace (sand, silt, clay, gravel)
5 to 14	Slightly (sandy, silty, clayey, gravelly)
15 to 29	Sandy, silty, clayey, gravelly
≥ 30	Very (sandy, silty, clayey, gravelly)

Classifications of soils in this geotechnical report and as shown on the exploration logs are based on visual field and/or laboratory observations, which include density/consistency, moisture condition, grain size, and plasticity estimates, and should not be construed to imply field or laboratory testing unless presented herein. Visual-manual and/or laboratory classification methods of ASTM D2487 and D2488 were used as an identification guide for the Unified Soil Classification System.

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

EXPLORATION LOG KEY

Earth Solutions NW LLC
15365 NE 90th Street, Suite 100
Redmond, WA 98052
Office (425) 449-4704 | esnw.com
Branch Office: Pasco, WA

TEST PIT NUMBER TP-101

PROJECT NUMBER ES-8702.01
PROJECT NAME Serenity Trails
DATE STARTED 4/2/24 **COMPLETED** 4/2/24
GROUND ELEVATION
EXCAVATION CONTRACTOR Client Provided
LATITUDE 48.02529 **LONGITUDE** -122.11679
LOGGED BY BCS **CHECKED BY** HTW
GROUND WATER LEVEL:
NOTES
AT TIME OF EXCAVATION
SURFACE CONDITIONS Brush
AFTER EXCAVATION

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			TPSL	1.0	Dark brown TOPSOIL -moderate root intrusions
2.5	GB	MC = 14.2 Fines = 37.3	SM		Gray silty SAND with gravel, dense to very dense, moist -moderate groundwater seepage at 1' -probed 6" [USDA Classification: gravelly fine sandy LOAM] -moderate iron oxide staining 1' to 2' -weakly cemented -becomes very dense
5.0	GB	MC = 14.8		7.0	

Test pit terminated at 7.0 feet below existing grade. Groundwater seepage encountered at 2.0 feet during excavation. No caving observed.

LIMITATIONS: Ground elevation (if listed) is approximate; the test location was not surveyed. Coordinates are approximate and based on the WGS84 datum. Do not rely on this test log as a standalone document. Refer to the text of the geotechnical report for a complete understanding of subsurface conditions.

Earth Solutions NW LLC
15365 NE 90th Street, Suite 100
Redmond, WA 98052
Office (425) 449-4704 | esnw.com
Branch Office: Pasco, WA

TEST PIT NUMBER TP-102

PROJECT NUMBER ES-8702.01
PROJECT NAME Serenity Trails
DATE STARTED 4/2/24 **COMPLETED** 4/2/24
GROUND ELEVATION
EXCAVATION CONTRACTOR Client Provided
LATITUDE 48.02538 **LONGITUDE** -122.11780
LOGGED BY BCS **CHECKED BY** HTW
GROUND WATER LEVEL:
NOTES
AT TIME OF EXCAVATION
SURFACE CONDITIONS Field grass
AFTER EXCAVATION

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			TPSL	1.0	Dark brown TOPSOIL
			SM		Brown silty SAND with gravel, loose to medium dense, wet
2.5					-becomes gray, dense to very dense, moist -moderate groundwater seepage at 2.5' -probed 3" -light iron oxide staining to ~4'
	GB	MC = 14.2			
					-weakly cemented
5.0					
7.5	GB	MC = 13.4		7.5	

Test pit terminated at 7.5 feet below existing grade. Groundwater seepage encountered at 2.5 feet during excavation. No caving observed.

LIMITATIONS: Ground elevation (if listed) is approximate; the test location was not surveyed. Coordinates are approximate and based on the WGS84 datum. Do not rely on this test log as a standalone document. Refer to the text of the geotechnical report for a complete understanding of subsurface conditions.

TEST PIT NUMBER TP-103

Earth Solutions NW LLC
15365 NE 90th Street, Suite 100
Redmond, WA 98052
Office (425) 449-4704 | esnw.com
Branch Office: Pasco, WA

PROJECT NUMBER ES-8702.01
PROJECT NAME Serenity Trails
DATE STARTED 4/2/24 **COMPLETED** 4/2/24
GROUND ELEVATION
EXCAVATION CONTRACTOR Client Provided
LATITUDE 48.02554 **LONGITUDE** -122.11831
LOGGED BY BCS **CHECKED BY** HTW
GROUND WATER LEVEL:
NOTES
AT TIME OF EXCAVATION
SURFACE CONDITIONS Field grass
AFTER EXCAVATION

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			SM	1.0	Gray silty SAND, loose, wet (Fill)
			TPSL	2.0	Dark brown sandy TOPSOIL (Fill) -minor root intrusions
2.5			GP	3.0	Brownish gray poorly graded GRAVEL, loose, wet (Fill) -PVC pipe, drain rock
5.0	GB	MC = 21.2	SM		Gray silty SAND with gravel, medium dense to dense, wet -light iron oxide staining from 3' to 5' -light groundwater seepage between 4' and 5' -becomes very dense, weakly cemented -decreasing moisture content
	GB	MC = 16.8		7.0	

Test pit terminated at 7.0 feet below existing grade. Groundwater seepage encountered at 4.5 feet during excavation. No caving observed.

LIMITATIONS: Ground elevation (if listed) is approximate; the test location was not surveyed. Coordinates are approximate and based on the WGS84 datum. Do not rely on this test log as a standalone document. Refer to the text of the geotechnical report for a complete understanding of subsurface conditions.

Earth Solutions NW LLC
15365 NE 90th Street, Suite 100
Redmond, WA 98052
Office (425) 449-4704 | esnw.com
Branch Office: Pasco, WA

TEST PIT NUMBER TP-104

PROJECT NUMBER ES-8702.01
PROJECT NAME Serenity Trails
DATE STARTED 4/2/24 **COMPLETED** 4/2/24
GROUND ELEVATION
EXCAVATION CONTRACTOR Client Provided
LATITUDE 48.02534 **LONGITUDE** -122.11805
LOGGED BY BCS **CHECKED BY** HTW
GROUND WATER LEVEL:
NOTES
AT TIME OF EXCAVATION
SURFACE CONDITIONS Field grass
AFTER EXCAVATION

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			TPSL		Dark brown TOPSOIL with 5/8" crushed rock (Fill)
1.0			SM		Brown silty SAND with gravel, medium dense, wet
2.5					-becomes gray, dense to very dense -probed 3" -weakly cemented -moderate to heavy iron oxide staining to 5'
	GB	MC = 18.6			-light groundwater seepage
5.0					-becomes very dense -decreasing moisture content
7.5					
9.0	GB	MC = 12.4 Fines = 36.7			[USDA Classification: gravelly fine sandy LOAM]

Test pit terminated at 9.0 feet below existing grade. Groundwater seepage encountered at 3.5 feet during excavation. No caving observed.

LIMITATIONS: Ground elevation (if listed) is approximate; the test location was not surveyed. Coordinates are approximate and based on the WGS84 datum. Do not rely on this test log as a standalone document. Refer to the text of the geotechnical report for a complete understanding of subsurface conditions.

Earth Solutions NW LLC
15365 NE 90th Street, Suite 100
Redmond, WA 98052
Office (425) 449-4704 | esnw.com
Branch Office: Pasco, WA

TEST PIT NUMBER TP-105

PROJECT NUMBER ES-8702.01 **PROJECT NAME** Serenity Trails
DATE STARTED 4/2/24 **COMPLETED** 4/2/24 **GROUND ELEVATION**
EXCAVATION CONTRACTOR Client Provided **LATITUDE** 48.02529 **LONGITUDE** -122.11852
LOGGED BY BCS **CHECKED BY** HTW **GROUND WATER LEVEL:**
NOTES ∇ **AT TIME OF EXCAVATION**
SURFACE CONDITIONS Field grass **AFTER EXCAVATION**

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			TPSL		Dark brown TOPSOIL
1.0			SM		Brown silty SAND, medium dense, wet -becomes gray, dense to very dense -moderate iron oxide staining to ~5' to 6' -probed 2" [USDA Classification: gravelly LOAM]
2.5					
	GB	MC = 19.9 Fines = 42.5			
5.0					-light to moderate groundwater seepage from 5' to 7' -becomes very dense, weakly cemented
7.5					
9.5	GB	MC = 13.6			

Test pit terminated at 9.5 feet below existing grade. Groundwater seepage encountered at 5.0-7.0 feet during excavation. No caving observed.

LIMITATIONS: Ground elevation (if listed) is approximate; the test location was not surveyed. Coordinates are approximate and based on the WGS84 datum. Do not rely on this test log as a standalone document. Refer to the text of the geotechnical report for a complete understanding of subsurface conditions.

Appendix B

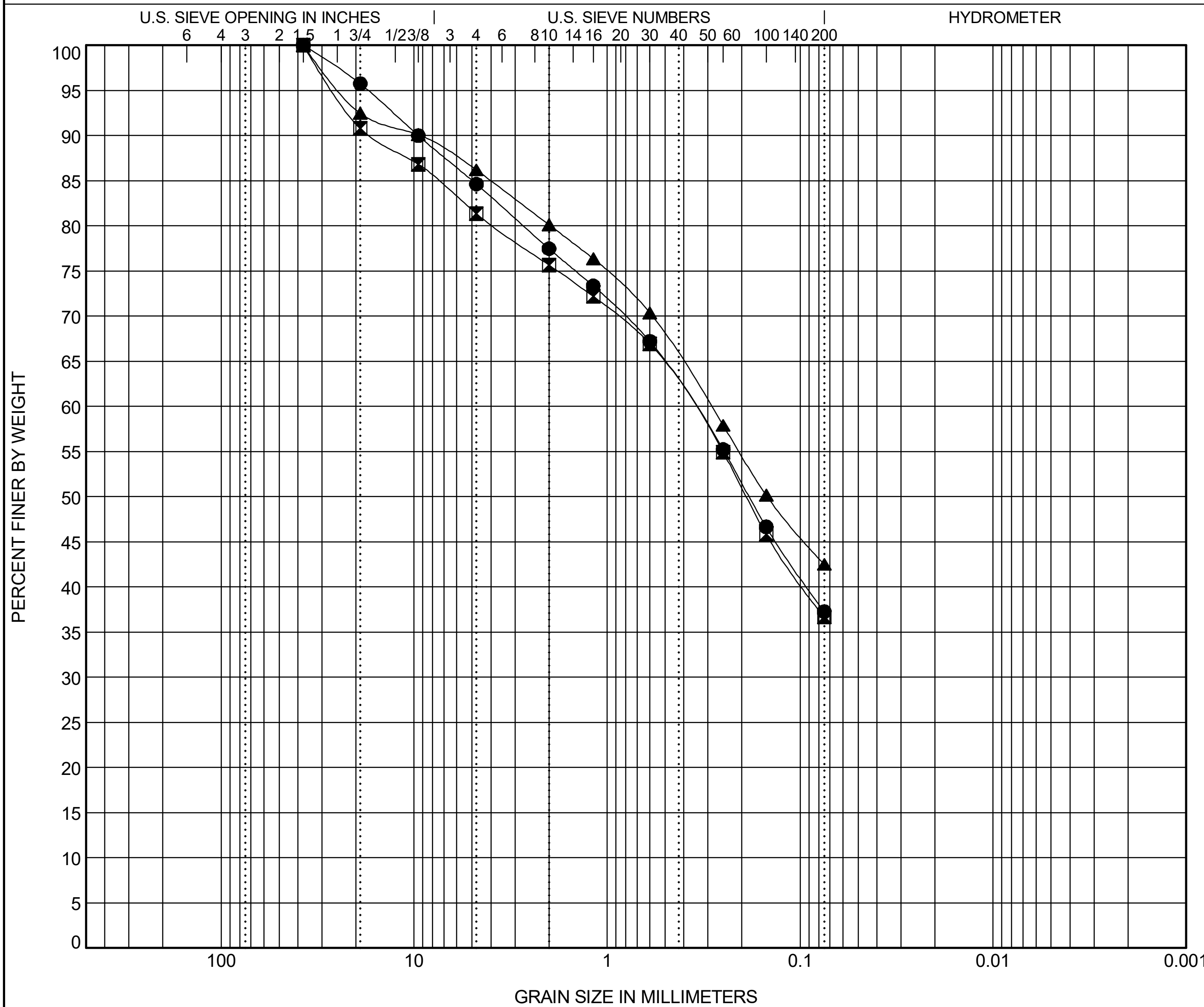
Laboratory Test Results

ES-8702.01

Earth Solutions NW LLC
15365 NE 90th Street, Suite 100
Redmond, WA 98052
Office (425) 449-4704 | esnw.com
Branch Office: Pasco, WA

GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-8702.01 **PROJECT NAME** Serenity Trails



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	Cc	Cu
●	TP-101	2.00ft.	USDA: Gray Gravelly Fine Sandy Loam. USCS: SM with Gravel.		
⊠	TP-104	9.00ft.	USDA: Gray Gravelly Fine Sandy Loam. USCS: SM with Gravel.		
▲	TP-105	3.00ft.	USDA: Gray Gravelly Loam. USCS: SM.		

	Specimen Identification		D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
●	TP-101	2.0ft.	37.5	0.354						37.3	
⊠	TP-104	9.0ft.	37.5	0.361						36.7	
▲	TP-105	3.0ft.	37.5	0.29						42.5	