Earth Solutions NW LLC

Geotechnical Engineering
Geology
Environmental Scientists
Construction Monitoring

# GEOTECHNICAL ENGINEERING STUDY
# PROPOSED MIXED-USE BUILDING
# 18631 ALDERWOOD MALL PARKWAY
# LYNNWOOD, WASHINGTON

**ES-3836**

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**PREPARED FOR**

**COSMOS DEVELOPMENT COMPANY**

**July 6, 2015**


**Keven D. Hoffmann, E.I.T.**
**Project Engineer**

**Raymond A. Coglas, P.E.**
**Principal**


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# Important Information About Your

# Geotechnical Engineering Report

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

*The following information is provided to help you manage your risks.*

## Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

## Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

## A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

## Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

## Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

## A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

## A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

## Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

## Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

## Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of 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 equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

## Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

## Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

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Earth Solutions NW LLC

- Geotechnical Engineering
- Construction Monitoring
- Environmental Sciences

July 6, 2015
ES-3836

Cosmos Development Company
11747 Northeast 1st Street, Suite 300
Bellevue, Washington 98005

Attention: Mr. Oscar Del Moro

Dear Mr. Del Moro:

Earth Solutions NW, LLC (ESNW) is pleased to present this report titled "Geotechnical Engineering Study, Proposed Mixed-Use Building, 18631 Alderwood Mall Parkway, Lynnwood, Washington". Based on the conditions encountered during our June 2015 fieldwork, the site is underlain primarily by approximately two to three feet of fill and dense to very dense Vashon till. We understand the site will be redeveloped with a multi-story, mixed-use structure and related infrastructure improvements. Excavations on the order of 10 to 15 feet will likely be necessary to complete the underground garage-level construction for the proposed building. To support the proposed excavation, the use of open cuts, temporary shoring, or some combination of temporary slopes and shoring will be necessary.

Based on the results of our investigation, the proposed redevelopment is feasible from a geotechnical standpoint. Where competent, undisturbed Vashon till is exposed at subgrade elevations, proposed structures may be supported atop a conventional foundation system. Groundwater and water-bearing conditions were encountered at a depth of roughly 10 to 20 feet at the time of our June 2015 subsurface exploration. Temporary and permanent measures for subsurface drainage will need to be considered during final design. Recommendations for site excavations and related support, foundation design, drainage, and other pertinent geotechnical recommendations are provided in this study.

We appreciate the opportunity to be of service to you on this project. If you have questions regarding the content of this geotechnical engineering study, please call.

Sincerely,

**EARTH SOLUTIONS NW, LLC**

Keven D. Hoffmann, E.I.T.
Project Engineer

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**18631 ALDERWOOD MALL PARKWAY**
**LYNNWOOD, WASHINGTON**

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# INTRODUCTION

## General

This geotechnical engineering study was prepared for the proposed mixed-use building to be constructed at 18631 Alderwood Mall Parkway, east of the Alderwood Mall, in Lynnwood, Washington. The purpose of this study was to provide geotechnical recommendations for currently proposed redevelopment plans. Our scope of services for completing this geotechnical engineering study included the following:

- Completing subsurface borings for purposes of characterizing site soils;
- Completing laboratory testing of soil samples collected at the boring locations;
- Conducting engineering analyses, and;
- Preparation of this report.

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

- Conceptual Architectural Plan Set, prepared by Stricker Cato Murphy Architects, P.S., dated February 27, 2015;
- Online Web Soil Survey (WSS) resource, endorsed by the Natural Resources Conservation Service under the United States Department of Agriculture;
- Liquefaction Susceptibility Data for Snohomish County, October 2009, and;
- The Geologic Map of the Edmonds East and Part of the Edmonds West Quadrangles, Washington, by James P. Minard, 1983.

## Project Description

We understand proposed redevelopment plans include construction of a new multi-story, mixed-use building and related infrastructure improvements. The 13-story structure will be comprised of 11 stories of residential units, at-grade retail space, two levels of covered parking, and one level of below-grade parking. Surface parking will also be provided within the area south of the new structure. In total, 275 residential units, approximately 7,700 square feet of retail space, and approximately 153,000 square feet of parking (both covered and uncovered) are proposed for construction. The majority of structural loading will be concentrated within the northern portion of the site. Beech Road will be realigned to encompass the eastern and southern sides of the development prior to intersecting with both Alderwood Mall Parkway and the east entrance to the Alderwood Mall.

We anticipate grade cuts on the order of 10 to 15 feet will be necessary to construct proposed below-grade improvements. Competent Vashon till encountered below existing grades will facilitate temporary slope construction for the garage-level excavation. Where necessary, a conventional soldier pile or soil nail wall shoring system may also be incorporated into the plans. Column loading for the proposed structure is estimated to be on the order of 300 to 600 kips.

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

## SITE CONDITIONS

### Surface

The subject site is located approximately 400 feet north of the intersection between Beech Road and Alderwood Mall Parkway in Lynnwood, Washington. The approximate location of the property is illustrated on Plate 1 (Vicinity Map). The property is trapezoidal in shape and is comprised of one tax parcel (Snohomish County Parcel No. 003728-004-013-01) totaling approximately 1.88 acres.

The subject site is surrounded to the north by a Toys “R” Us retail store, to the east by Beech Road, to the south by a Sound Credit Union branch, and to the west by Alderwood Mall Parkway. The site is currently occupied by the Alderwood Medical Center and enveloping, paved parking areas. We understand existing structural improvements will be removed in lieu of the proposed redevelopment. Site topography is relatively level with little or no discernible elevation change. Vegetation is sparse and is comprised primarily of trees and shrubs around the site perimeter and in planters.

## Subsurface

An ESNW representative observed, logged, and sampled six soil borings, advanced at accessible locations within the property boundaries, on June 18, 2015 using a trailer-mounted drill rig and operators retained by our firm. Soil borings were completed for purposes of assessment and classification of site soils and characterization of groundwater conditions within areas proposed for new development. The approximate locations of the subsurface borings are depicted on Plate 2 (Boring Location Plan). Please refer to the boring logs provided in Appendix A for a more detailed description of subsurface conditions. Soil samples collected at the boring locations were analyzed in accordance with Unified Soil Classification System (USCS) methods and procedures.

### Fill

Underlying roughly two to three inches of asphalt, approximately two to three feet of fill was encountered at the boring locations. The fill was comprised primarily of medium dense, silty sand with gravel (USCS: SM). The fill was likely placed as a result of past legal grading activities associated with the existing level of development. Based on our field observations, in-situ fill can likely be reworked to the specifications of structural fill during construction, if desired.

### Native Soil

Underlying asphalt and fill, native soils encountered at the boring locations consisted primarily of dense to very dense, silty sand with gravel (USCS: SM), consistent with the typical makeup of Vashon till. Gravel beds and/or highly gravelly soils were encountered sporadically during our fieldwork, generally within the upper 5 to 10 feet of existing grades. Native soils were observed primarily in a moist condition; however, near the observed groundwater table elevation, 10 to 20 feet below the existing ground surface elevation (bgs), native soils were characterized as “wet” to “water bearing”. The maximum subsurface exploration depth was approximately 26 feet below existing grades.

### Geologic Setting

The referenced geologic map resource identifies Vashon till (Qvt) across the site and surrounding areas. As reported on the geologic map resource, Vashon till is typically comprised of a nonsorted mixture of clay, silt, sand, pebbles, cobbles, and boulders. The poorly sorted nature of the Vashon till is indicative of the materials overridden and incorporated into the ice. The great weight of the overriding ice resulted in massive compaction of the materials and is the primary reason Vashon till is referred to locally as “hardpan”. The referenced WSS resource identified the map unit “Urban land” across the site and surrounding areas. “Urban land” essentially refers to areas that have been previously subjected to movement or mixing by humans and related development activities. Based on our field observations, native soils on the subject site are primarily consistent with Vashon till deposits as outlined in this section.

## Groundwater

During our subsurface exploration completed on June 18, 2015, the groundwater table was encountered at boring locations B-1 and B-5 at a depth of approximately 20 feet bgs. At boring location B-6, the groundwater table was encountered at a depth of approximately 10 feet bgs. The identified groundwater zones corresponded with a relatively coarse sand and gravel deposit within the Vashon till. Based on our understanding of the proposed below-grade construction, groundwater should be anticipated within excavations for garage-level facilities and utilities at depth. Measures for temporary and permanent subsurface drainage should be considered during final design. 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 months.

# DISCUSSION AND RECOMMENDATIONS

## General

Based on the results of our study, construction of the proposed mixed-use redevelopment is feasible from a geotechnical standpoint. The primary geotechnical considerations associated with the proposed redevelopment include temporary excavations, shoring, and foundation support. Subsurface drainage and temporary and permanent control of groundwater are also important geotechnical considerations. Based on the results of our study, where competent, undisturbed Vashon till is exposed at subgrade elevations, the proposed structure may be supported atop a conventional foundation system.

We anticipate the garage-level excavation will likely be completed using open cuts where sufficient space is available. Temporary shoring, or a combination of shoring and temporary sloping, will be necessary where the building will be sited in close proximity to the property limits. Where shoring is required, the use of a conventional cantilever or tieback soldier pile shoring system is feasible for support of excavations. Soil nailing should also be considered a feasible alternative for excavation shoring. For purposes of this study, preliminary recommendations for soil nailing, as well as recommendations for cantilever and tieback shoring, are provided.

Groundwater should be anticipated within the proposed excavations, which we understand are expected to depths on the order of 10 to 15 feet below existing grades. Depending on the volume of groundwater encountered, temporary and permanent measures for controlling groundwater may be necessary. In our opinion, a contingency for incorporating a permanent, sub-slab drainage system should be considered as part of the overall design. ESNW should further evaluate sub-slab conditions at the time of construction as the garage-level excavation is advanced to the subgrade elevation.

This study has been prepared specifically for the subject project and for the exclusive use of the Cosmos Development Company 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

The primary geotechnical considerations with respect to earthwork are related to the garage-level excavation, temporary slope construction, temporary excavation support, and foundation subgrade preparation. The soils encountered within building excavations should consist largely of surficial fill deposits and dense Vashon till. Site soils will likely be suitable for use as structural backfill behind retaining walls and as "closure" backfill around poured footing elements. The native soils can be characterized as having a generally moderate to high sensitivity to moisture. If the soils are exposed to excessive moisture, successful placement and compaction of the soil may prove difficult.

### Temporary Erosion Control

In general, control of off-site soil erosion for this project will likely be limited to construction entrances. Temporary construction entrances and drive lanes should consist of at least six inches of quarry spalls underlain by a non-woven filter fabric. Silt fencing should be installed along the site perimeter where appropriate. Soil stockpiles and exposed earth surfaces should be covered or otherwise protected to reduce soil erosion.

### Temporary Excavations and Slopes

As the below-grade excavation progresses, the relative soil density will likely increase from "medium dense" to "dense and very dense". Where competent, undisturbed Vashon till is exposed near existing surface grades, we anticipate native soils will exhibit good stability characteristics to support open-cut excavations. Provided appropriate methods of sloping and shoring for the excavation are incorporated into design and construction, overall stability of the excavation is anticipated to be excellent. Based on the soil conditions observed at the boring locations, the following temporary slope inclinations, as a function of horizontal to vertical (H:V) inclination, should be considered allowable:

- Loose or medium dense fill 1.5H:1V
- Weathered Vashon till 1H:1V
- Unweathered Vashon till 0.75H:1V

Steeper temporary slope inclinations within very dense, undisturbed Vashon till, such as 0.5H:1V or 0.25H:1V, may be feasible based on the actual site conditions observed during construction and must be approved by ESNW when appropriate. ESNW should observe the excavation and assess allowable temporary slope inclinations based on the soil and groundwater conditions exposed within the excavation. Supplementary recommendations for excavation sloping may be made by ESNW based on the conditions observed during earthwork activities. Please refer to the *Shoring* section of this study for specific recommendations regarding temporary shoring.

### In-situ Soils

From a geotechnical standpoint, native soils encountered at the boring locations will generally be suitable for use as structural fill. Based on relatively appreciable fines contents, native soils have a moisture sensitivity that should be considered moderate to high. Successful use of native soils as structural fill will largely be dictated by the moisture content at the time of placement and compaction. If the on-site soils cannot be successfully compacted, the use of an imported soil may be necessary.

In our opinion, if grading activities take place during months of heavy rainfall activity, a contingency should be provided in the project budget for expenses related to both the export of unsuitable soil and the import of granular structural fill that is not moisture sensitive. Soils with fines contents greater than 5 percent typically degrade rapidly when exposed to periods of rainfall.

### Imported Soils

Imported soil intended for use as structural fill should consist of a well-graded granular soil with a moisture content that is at or slightly above the optimum level. 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 defined as the percent passing the Number 200 sieve, based on the minus three-quarter-inch fraction.

### Structural Fill

Due to the anticipated magnitude of foundation loading, footings should be placed atop competent, undisturbed Vashon till rather than structural fill. With respect to the subject project, structural fill is defined as compacted soil placed in foundation, slab-on-grade, and roadway areas. Fill placed to construct permanent slopes and throughout retaining wall and utility trench backfill areas should also be considered structural fill. Soils placed in structural areas should be placed in loose lifts of 12 inches or less and compacted to a relative compaction of 90 percent, based on the laboratory maximum dry density as determined by the Modified Proctor Method (ASTM D1557). More stringent compaction specifications may be required for utility trench backfill zones depending on the responsible utility district or jurisdiction.

## Shoring

We anticipate cuts on the order of 10 to 15 feet will be necessary for below-grade improvements in accordance with project redevelopment plans. Where sufficient space is available and where competent soil conditions are encountered, below-grade excavations will likely be completed using open cuts. Temporary shoring, or a combination of shoring and temporary sloping, will be necessary where buildings will be sited in close proximity to the property limits and where loose to medium dense soils are exposed within the excavation.

In our opinion, where shoring is required, the use of a conventional cantilever or tieback soldier pile shoring system is feasible for support of excavations. Soil nailing should also be considered a feasible alternative for excavation shoring. For purposes of this study, preliminary recommendations for soil nailing, as well as recommendations for cantilever and tieback shoring, are provided. Where tiebacks or soil nails are necessary with respect to the shoring design, easements will likely be required from adjacent property owners to accommodate the tendons.

### Preliminary Soil Nail Design

Based on the conditions encountered at the boring locations, the dense to very dense Vashon till is favorable for construction of soil nail walls. For preliminary design purposes, the following design parameters may be considered for temporary soil nail walls:

- Internal angle of friction — 32 degrees (upper fills)<br>38 degrees (Vashon till)
- Cohesion — 50 psf (upper fills)<br>200 psf (Vashon till)
- Ultimate pullout capacity — 3,000 lb per foot (upper fills)<br>6,000 lb per foot (Vashon till)
- Soil moist unit weight — 125 pcf
- Nail spacing (maximum) — 6 feet (horizontal and vertical)
- Vertical elements — W6x25 (where necessary)

The design parameters provided in this section are intended for preliminary analysis of a soil nail wall design. Based on the results of preliminary analyses, modification of these values by ESNW may be appropriate. With respect to soil nail shotcrete facing, temporary or permanent facings may be considered as part of the overall top-down construction. As appropriate, the soil nail wall designer will need to consider shotcrete thickness and reinforcement requirements, such as bending and punching shear, for temporary or permanent facings. Surcharge loading from adjacent buildings and right-of-ways should also be considered in the design.

### Cantilever and Single-Tieback Soldier Piles

Depending upon the proposed excavation depth, the shoring system should be designed to resist lateral soil pressure based on an active or at-rest earth pressure condition. Surcharge loading from adjacent roadways, buildings, and slopes should be included in the shoring design where applicable. The following parameters may be used for shoring design:

- Active earth pressure (level backfill; Vashon till) — 30 pcf (equivalent fluid)
- At-rest earth pressure (level backfill; Vashon till) — 50 pcf
- Traffic surcharge (where applicable) — 100 psf (rectangular distribution)
- Preliminary building surcharge* — 150 psf (rectangular distribution)
- Passive earth pressure (Vashon till) — 400 pcf**

* *Where applicable; building surcharge values should be reevaluated based on further assessment of adjacent building foundation levels, proximity, and loading*

** *Passive earth pressure value may be applied over two pile diameters*

A factor-of-safety of 1.5 has been applied to the passive earth pressure value provided in this section. A typical earth pressure distribution for an active earth pressure condition is provided on Plate 3 (Cantilever and Single Tieback Wall). Allowable soldier pile deflections for walls subjected to active earth pressures should be limited to one inch.

At-rest pressures should be used where the shoring system will support adjacent foundation loads and where deflection of the shoring wall and adjacent ground subsidence must be minimized. Where some defection is determined to be acceptable, an earth pressure based on a value that is between the at-rest and active values may also be considered. Recommendations for allowable soldier pile deflections can be provided once the alignment and proximity of shoring walls to adjacent structures has been established. ESNW should review the shoring wall design in order to provide supplemental earth pressure and building surcharge recommendations as necessary. Where at-rest earth pressures are applied, a triangular distribution of pressure similar to the distribution illustrated on Plate 3 should be used.

**Soldier Piles**

Soldier pile installation should be observed by a representative of ESNW to verify pile depths and soil conditions. Appropriate pile lengths and embedment depths shall be determined by the project structural engineer or respective shoring system designer. If sloughing of the soldier pile excavation occurs, the contractor should be prepared to case soldier pile excavations as necessary. Where groundwater seepage is encountered in excavations, localized sloughing should be expected. As indicated in the *Tieback Anchors* section of this report, soldier piles embedded at least 10 feet into dense, native Vashon till may be designed with an end bearing capacity of 15,000 psf.

### Timber Lagging

Lagging should be installed in four-foot maximum lifts as the excavation is advanced. Maximum lifts of up to six feet may be acceptable for short periods of time provided the lagging is installed immediately thereafter. A representative of ESNW should observe the shoring excavation to assess the stability of the cut. The lagging should be backfilled as the excavation is advanced to minimize voids between the lagging and cut face and to reduce the potential for ground subsidence behind the shoring wall. Where sloughing of the excavation results in the development of a void behind the lagging, injection of lean mix into the voided area should be considered.

If the shoring wall is designed as a temporary system, a 50 percent reduction in lateral earth pressure may be assumed. Permanent lagging should be designed with pressure equal to 100 percent of the design lateral earth pressure.

### Tieback Anchors

Tiebacks should be located as high on the wall as possible and should be designed based on the following preliminary parameters:

- Allowable anchor friction (Vashon till) 2,000 psf
- Declination angle (from horizontal) 15 to 20 degrees
- Soldier pile end bearing capacity 15,000 psf
- No load zone See Plate 4

The allowable anchor friction value provided above applies to tieback anchors that will be post-grouted after installation. Tieback anchors should be verification tested and proof tested in general accordance with Section 8.3 of the Recommendations for Prestressed Rock and Soil Anchors (Post-Tensioning Institute, 4$^{th}$ Edition, 2004). A minimum of two verification tests, completed to 200 percent of the design load, should be performed. Verification test anchors may be used as production anchors provided anchor testing is acceptable. Production anchors should be proof tested to approximately 130 percent of the design load. A representative of ESNW should observe the anchor testing and provide documentation of the test results. Tieback anchors should be locked off to an appropriate percentage (typically between 80 to 100 percent) of the design load.

### Shoring Wall Drainage

Shoring walls should be provided with adequate drainage to reduce the potential for excess buildup of hydrostatic pressure. During construction, drainage occurring between the timber lagging is usually sufficient to prevent the development of excessive hydrostatic pressures. Where permanent building walls will be constructed alongside temporary shoring walls, a sheet drain material should be installed along the face of the shoring wall. A typical detail illustrating a sheet drain and permanent wall drainage system is provided on Plate 5 (Shoring Wall Drainage). As appropriate, waterproofing should be specified by the project architect.

### Shoring Monitoring

Due to the proximity of adjacent buildings and public rights-of-way, the shoring monitoring program should consist of optical surveying during soldier pile wall installation. A video survey should be performed prior to beginning the excavations to document the current conditions of the surrounding features. Initial survey points should be placed at strategic locations along adjacent foundations and right-of-way alignments that will allow for periodic measurement during and after the shoring installation, which will allow for efficient monitoring of the site to identify and remediate excessive deflections or excavation-related movements, if they occur. Prior to the start of construction, ESNW, the project owner, and the construction contractor should review relevant project plans and develop a monitoring program for the site.

Following installation of the soldier piles, monitoring points are typically established on the tops of the piles prior to proceeding with the excavation. Initial baseline readings of the survey points should be acquired prior to proceeding with the excavation. Readings should be acquired twice weekly during the excavation phase of the construction and may be reduced to once weekly after excavations have been completed. ESNW should review the optical survey data as it becomes available during the course of construction. The monitoring program should be supplemented with periodic observations by ESNW representatives during the excavation phase of construction. If soil nailing is utilized, a similar or equivalent monitoring program should be implemented.

## <u>Foundations</u>

Where competent, undisturbed Vashon till is exposed at foundation subgrade elevations, the proposed structure may be supported atop a conventional foundation system. Based on the results of our fieldwork, dense Vashon till will likely be encountered at excavation subgrade elevations and should be suitable for foundation support. Where necessary, loose or unsuitable soil conditions exposed at foundation subgrade elevations should be overexcavated and replaced with lean mix concrete. Provided the foundation will be supported as recommended, the following parameters may be used for design:

- Allowable soil bearing capacity — 8,000 psf
- Passive earth pressure — 350 pcf (equivalent fluid)
- Coefficient of friction — 0.40

A one-third increase in the allowable soil bearing capacity may be assumed for short-term wind and seismic loading conditions. The above passive pressure and friction values include a factor-of-safety of 1.5. With structural loading as expected and foundation support as described above, total settlement in the range of one inch, as well as differential settlement of about one-half inch, or less, over the span of a typical column spacing, is anticipated. The majority of settlement should occur during construction as dead loads are applied.

## Seismic Design

The 2012 International Building Code recognizes the American Society of Civil Engineers (ASCE) for seismic site class definitions. In accordance with Table 20.3-1 of the ASCE Minimum Design Loads for Buildings and Other Structures manual, Site Class C should be used for design.

The referenced liquefaction susceptibility map indicates the site and surrounding areas maintain very low liquefaction susceptibility. Liquefaction is a phenomenon where saturated or loose 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 should be considered negligible. Notwithstanding the groundwater table encountered between approximately 10 to 20 feet below existing grades, native soils were consistently characterized as “very dense” during our fieldwork. In general, dense Vashon till is not susceptible to liquefaction during a seismic event.

## Slab-on-Grade Floors

If the basement garage level is constructed as slab-on-grade, it should be supported on a well-compacted firm and unyielding subgrade. Where feasible, native Vashon till likely to be exposed at the slab-on-grade subgrade level should be considered suitable for support. The slab subgrade should be mechanically compacted and exhibit a firm and unyielding condition. 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.

**Sub-Slab Drainage**

Based on our field observations, the groundwater table may be encountered within site excavations. In general, the groundwater table was encountered at approximately 20 feet bgs during our subsurface exploration; however, at boring location B-6, the groundwater table was encountered at 10 feet bgs. In our opinion, a contingency for incorporating a permanent, sub-slab drainage system should be considered as part of the overall design. ESNW should further evaluate sub-slab conditions at the time of construction as the garage-level excavation is advanced to the subgrade elevation. The following preliminary recommendations may be considered for a sub-slab drainage system:

- Drain pipe (4-inch diameter) — Perforated, rigid Sch. 40
- Pipe spacing (maximum) — 25 feet on center
- Pipe invert (minimum) — 16 inches below slab bottom
- Filter fabric wrap — Mirafi 140N (or equivalent)
- Drainage fill — 1-inch-diameter drain rock
- Trench width (minimum) — 16 inches

Drainage fill should extend upward to the capillary break. In general, the sub-slab drainage system design should be reevaluated by ESNW at the time of construction based on the actual groundwater conditions observed. As necessary, modifications to the drainage system should be incorporated into the design and construction to achieve the objectives of the sub-slab drainage system.

**<u>Retaining Walls</u>**

Retaining walls must be designed to resist earth pressures and applicable surcharge loads. For design of the garage-level foundation walls, the earth pressure values provided for cantilever shoring walls (see the *Cantilever and Single-Tieback Soldier Piles* section of this study) should be used for yielding and restrained wall conditions. With respect to site retaining walls constructed independently of building foundation walls, the following values should be used for design:

- Active earth pressure (yielding condition) — 35 pcf (equivalent fluid)
- At-rest earth pressure (restrained condition) — 50 pcf
- Traffic surcharge* (passenger vehicles) — 100 psf (rectangular distribution)
- Passive earth pressure — 350 pcf (equivalent fluid)
- Coefficient of friction — 0.40
- Seismic surcharge — 6H** psf

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

The above design parameters are based on a level backfill condition and level grade at the wall toe. Revised design values will be necessary if sloping grades are to be used above or below retaining walls. Additional surcharge loading from adjacent foundations, sloped backfill, or other loads should be included in the retaining wall design.

**Retaining Wall Drainage**

Where foundation walls are formed against the shoring wall, the shoring wall drainage system illustrated on Plate 5 may be utilized. Where retaining walls are backfilled, the backfill material should consist of a 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. Based on the observed subsurface and groundwater conditions at the time of construction, use of an approved sheet drain material may also be considered in lieu of free-draining backfill. ESNW should review conditions at the time of construction in order to provide supplementary recommendations for sheet drainage as appropriate. A perforated drain pipe should be placed along the base of the wall and connected to an appropriate discharge location. A typical retaining wall drainage detail is provided on Plate 6 (Retaining Wall Drainage Detail).

## Drainage

During our subsurface exploration completed on June 18, 2015, the groundwater table was encountered at the boring locations between depths of approximately 10 to 20 feet bgs. Localized zones of seepage should be anticipated during garage-level excavation activities. The need for dewatering during construction should be reevaluated once final building elevations have been established. Temporary measures to control groundwater seepage and surface water runoff during construction would likely involve interceptor trenches and sumps. As indicated in the *Sub-Slab Drainage* section of this report, it is our opinion a contingency for incorporating a permanent, sub-slab drainage system should be considered as part of the overall design. ESNW should further evaluate sub-slab conditions at the time of construction as the garage-level excavation is advanced to the subgrade elevation.

Finish grades around the proposed building site should be sloped away from the building exteriors at a gradient of 2 percent. Where pavement areas are present at the building exteriors, the slope may be reduced to 1 percent. Surface water must not be allowed to pond adjacent to structures or slopes.

## 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 previously detailed in this report. It is possible that soft, wet, or otherwise unsuitable subgrade areas may still exist after base grading activities. Areas containing unsuitable or yielding subgrade conditions will require remedial measures, such as overexcavation and replacement with thicker crushed rock or structural fill sections, prior to pavement. In general, based on our observations of competent Vashon till underlying existing pavement areas, we anticipate minimal grading and/or remedial earthwork activities will be necessary to support new pavement areas.

We expect new pavement sections to 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), or;
- A minimum of two inches of HMA placed over three inches of asphalt treated base (ATB).

For relatively high volume, heavily loaded pavements subjected to more frequent truck traffic, the following preliminary pavement sections may be considered:

- A minimum of three inches of HMA placed over six inches of CRB, or;
- A minimum of three inches of HMA placed over four inches of ATB.

The HMA, ATB and CRB materials should conform to WSDOT specifications. All soil base material should be compacted to at least 95 percent of the maximum dry density. Final pavement design recommendations may be provided once final traffic loading has been determined. City of Lynnwood road standards may supersede the recommendations provided in this report.

## Utility Support and Trench Backfill

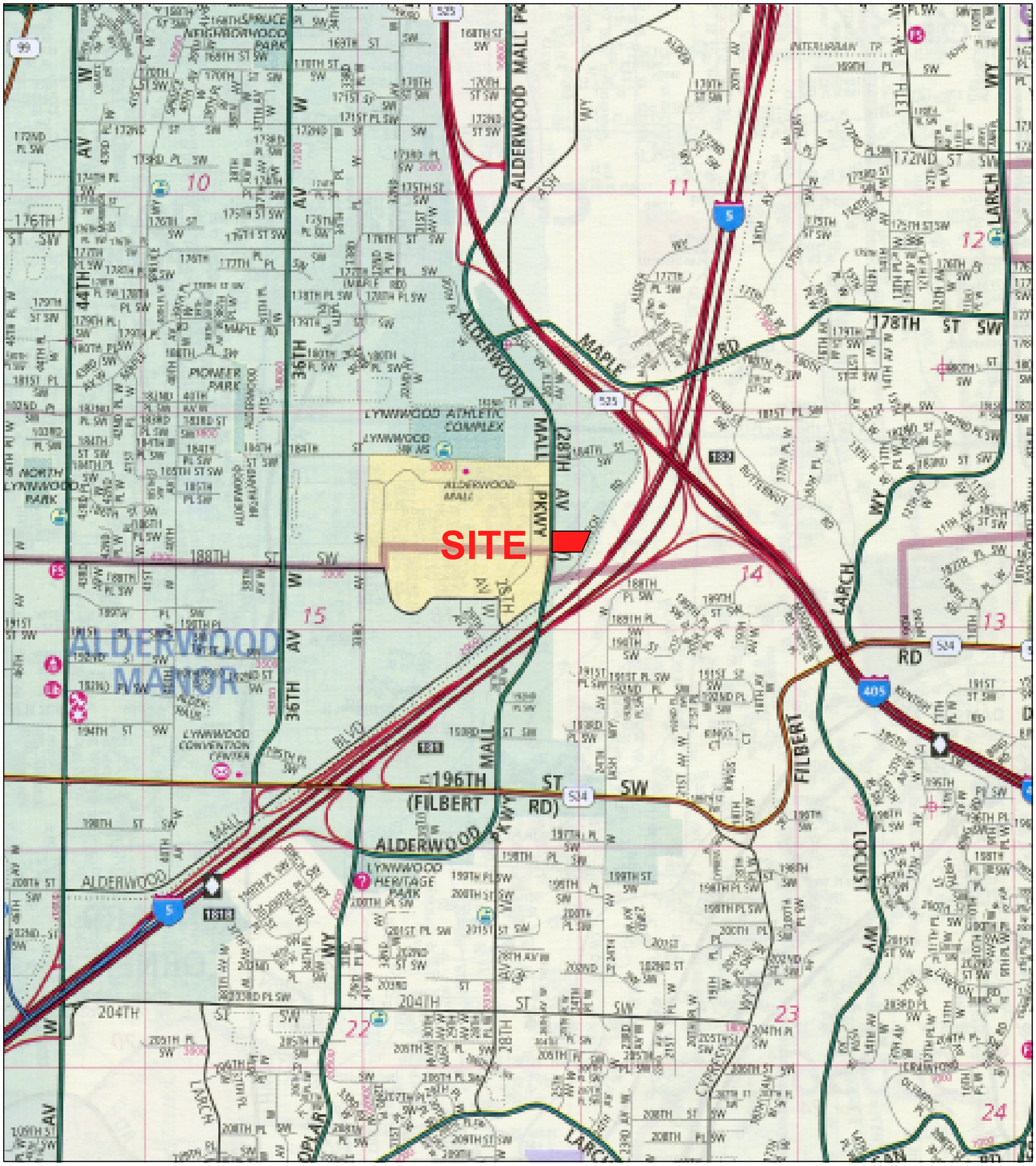
In our opinion, soils observed at the boring locations will generally be suitable for support of utilities. Excessively loose or unstable soils encountered within trench excavations should not be used for supporting utilities. In general, the observed on-site soils should be suitable for use as structural backfill in the utility trench excavations, provided the soils are at or near optimum moisture contents at the time of placement and compaction. Moisture conditioning 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 specifications of the City of Lynnwood, as appropriate.

## 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 boring 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 final project plans 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
Map 455
By The Thomas Guide
Rand McNally
32nd Edition

NORTH

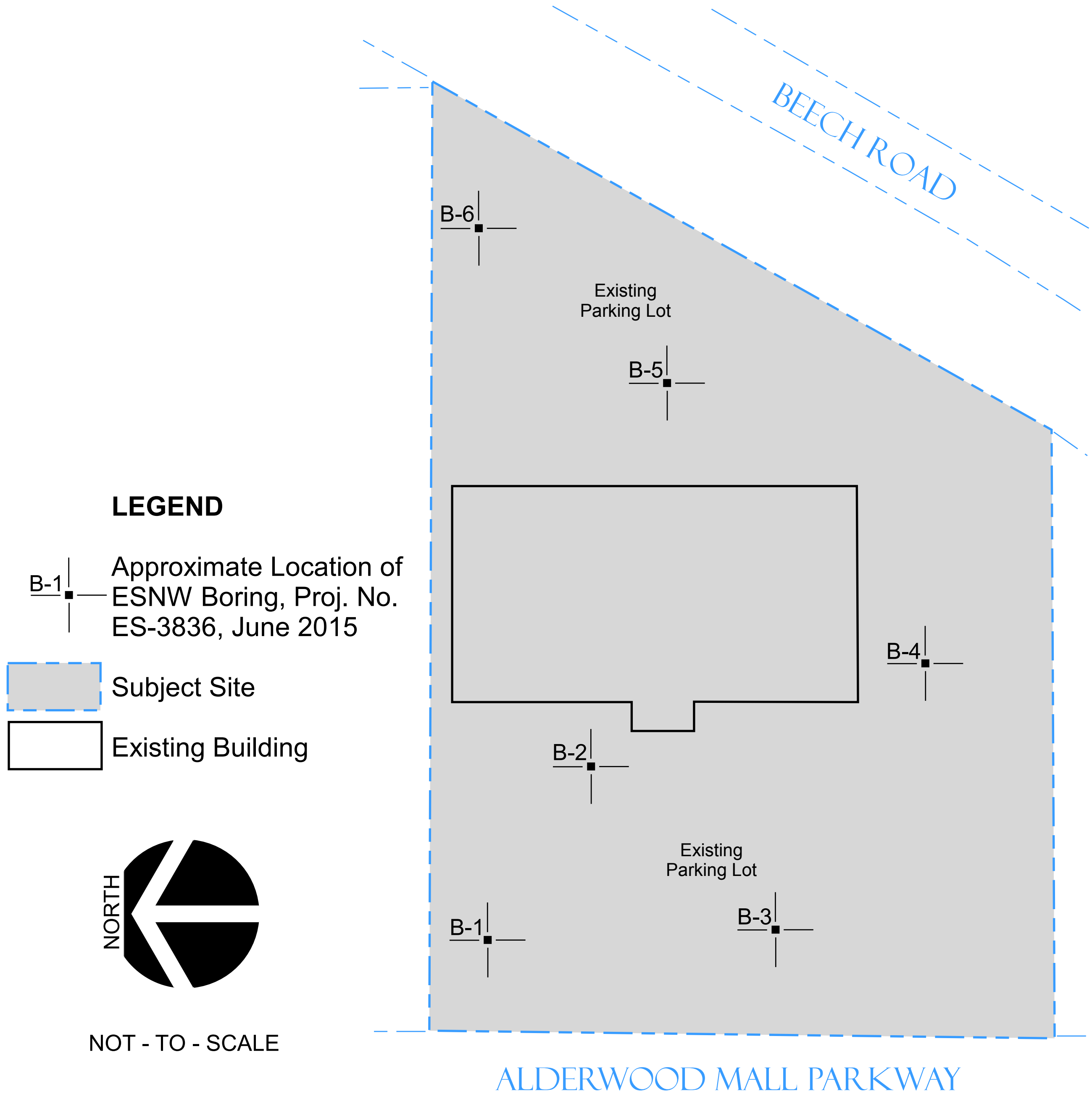
NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

**Earth Solutions NW LLC**

Earth Solutions NW LLC
Geotechnical Engineering, Construction Monitoring and Environmental Sciences

Vicinity Map
Alderwood Mixed-Use Building
Lynnwood, Washington

| | | |
|---|---|---|
| Drwn. MRS | Date 06/26/2015 | Proj. No. 3836 |
| Checked KDH | Date June 2015 | Plate 1 |




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.

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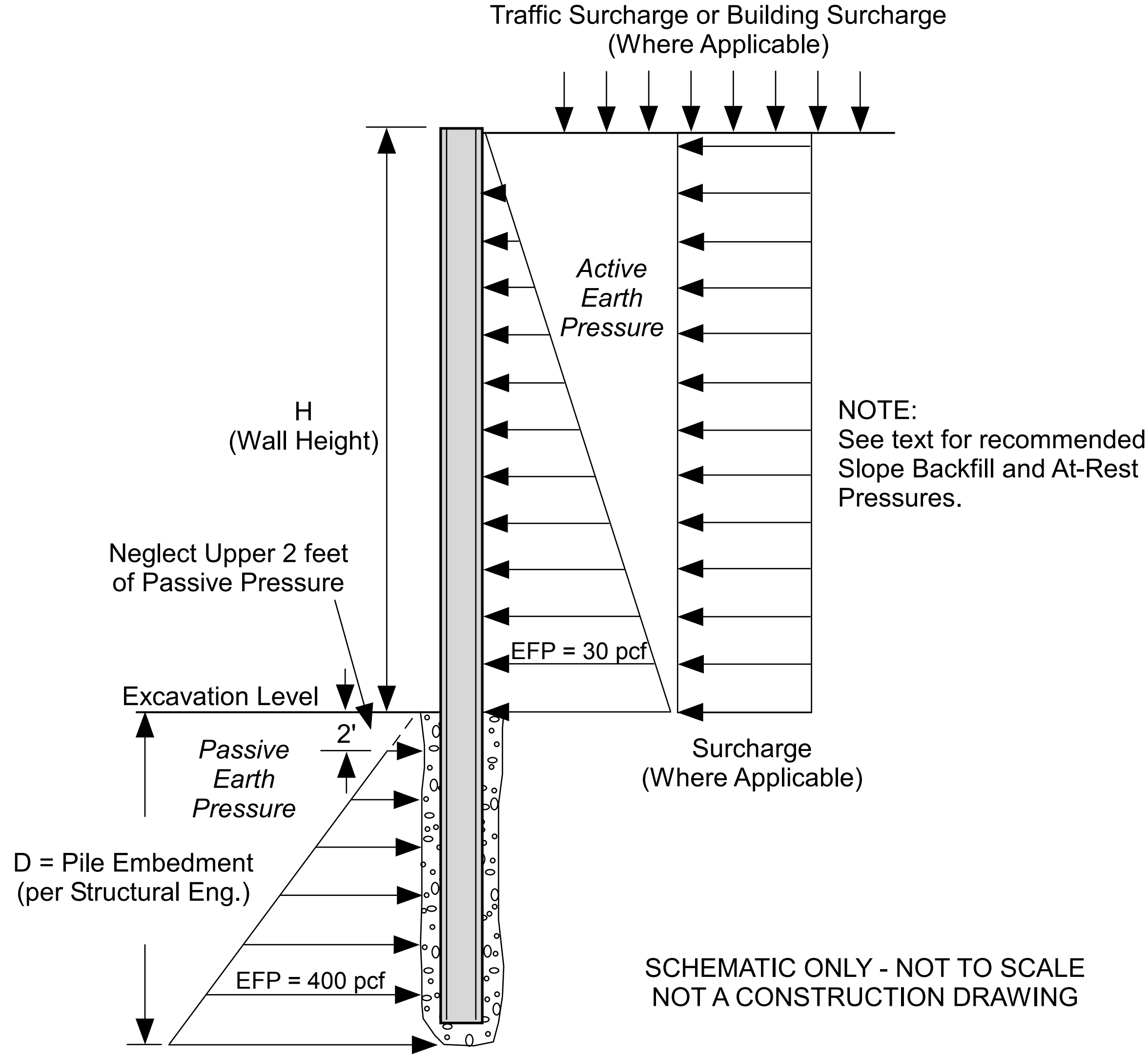
Boring Location Plan
Alderwood Mixed-Use Building
Lynnwood, Washington

| | | |
|---|---|---|
| Drwn. MRS | Date 06/26/2015 | Proj. No. 3836 |
| Checked KDH | Date June 2015 | Plate 2 |




SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

**NOTES:**

1. This Plate is intended for illustration of pressure distribution and is not a design drawing.
2. The Passive Pressure value includes a factor-of-safety of 1.5.
3. See text for adjacent building or traffic surcharges.

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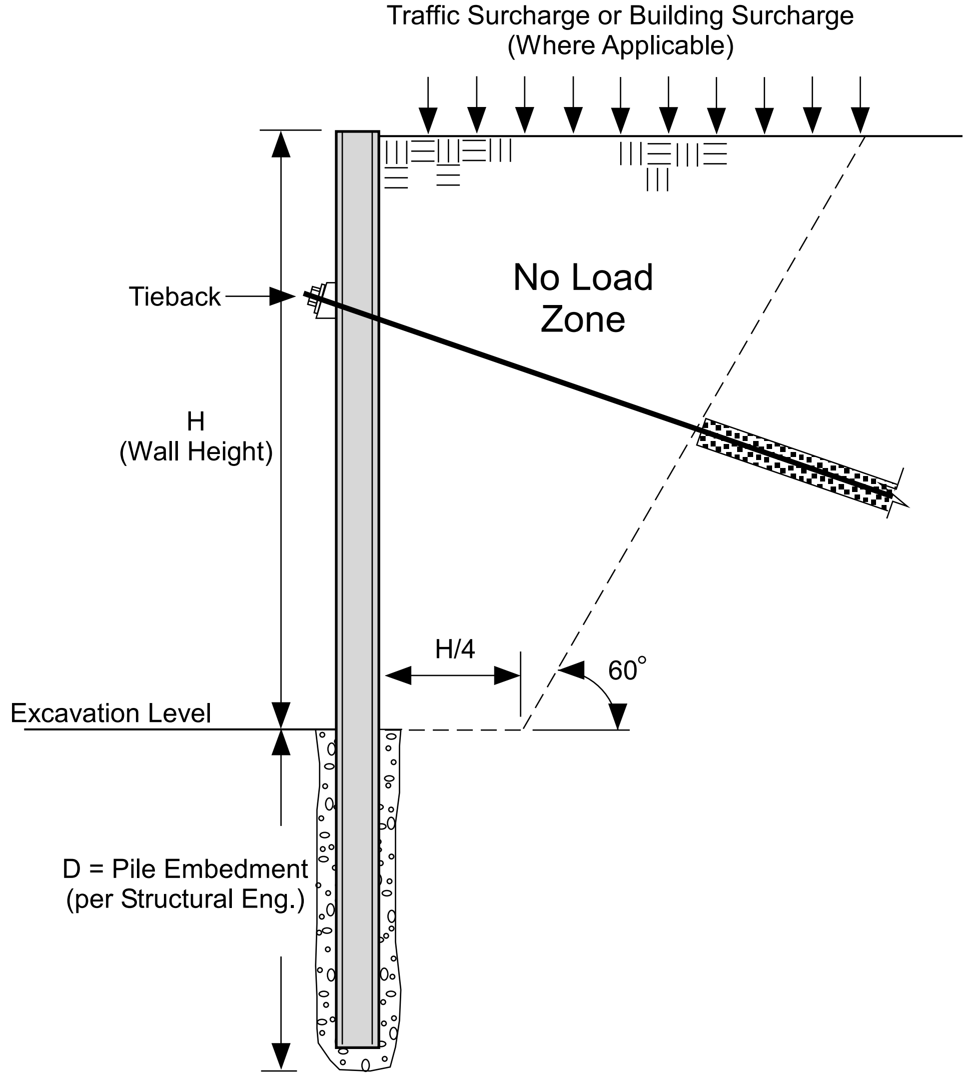
CANTILEVER & SINGLE TIEBACK WALL
Alderwood Mixed-Used Building
Lynnwood, Washington

| | | |
|---|---|---|
| Drwn. MRS | Date 06/26/2015 | Proj. No. 3836 |
| Checked KDH | Date June 2015 | Plate 3 |




SCHEMATIC ONLY - NOT TO SCALE
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Earth Solutions NWLLC
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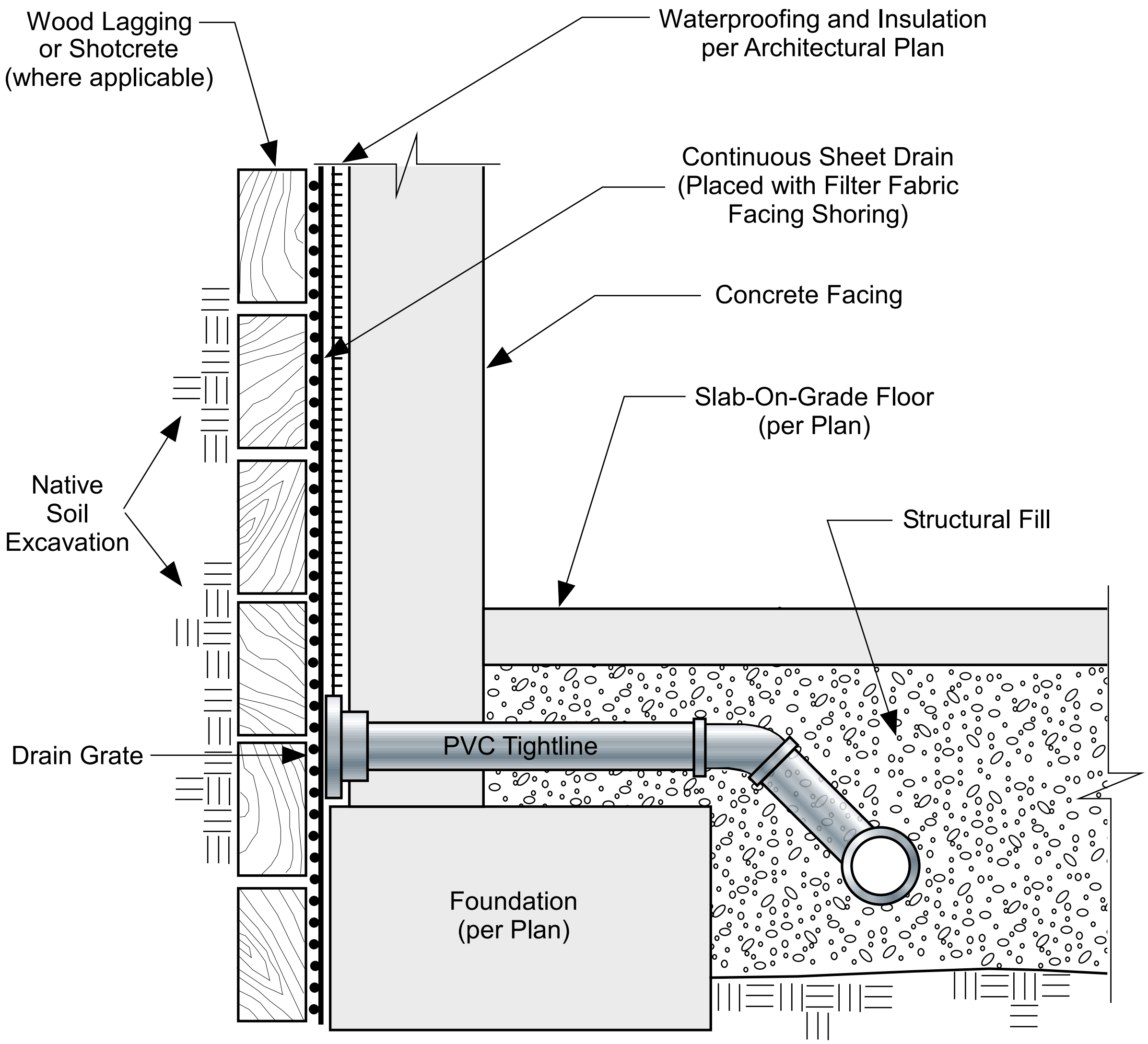
NO LOAD ZONE
Alderwood Mixed-Use Building
Lynnwood, Washington

| | | |
|---|---|---|
| Drwn. MRS | Date 06/26/2015 | Proj. No. 3836 |
| Checked KDH | Date June 2015 | Plate 4 |




NOTE: Drain through wall should be installed at middle of lagging.

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

**Earth Solutions NW LLC**
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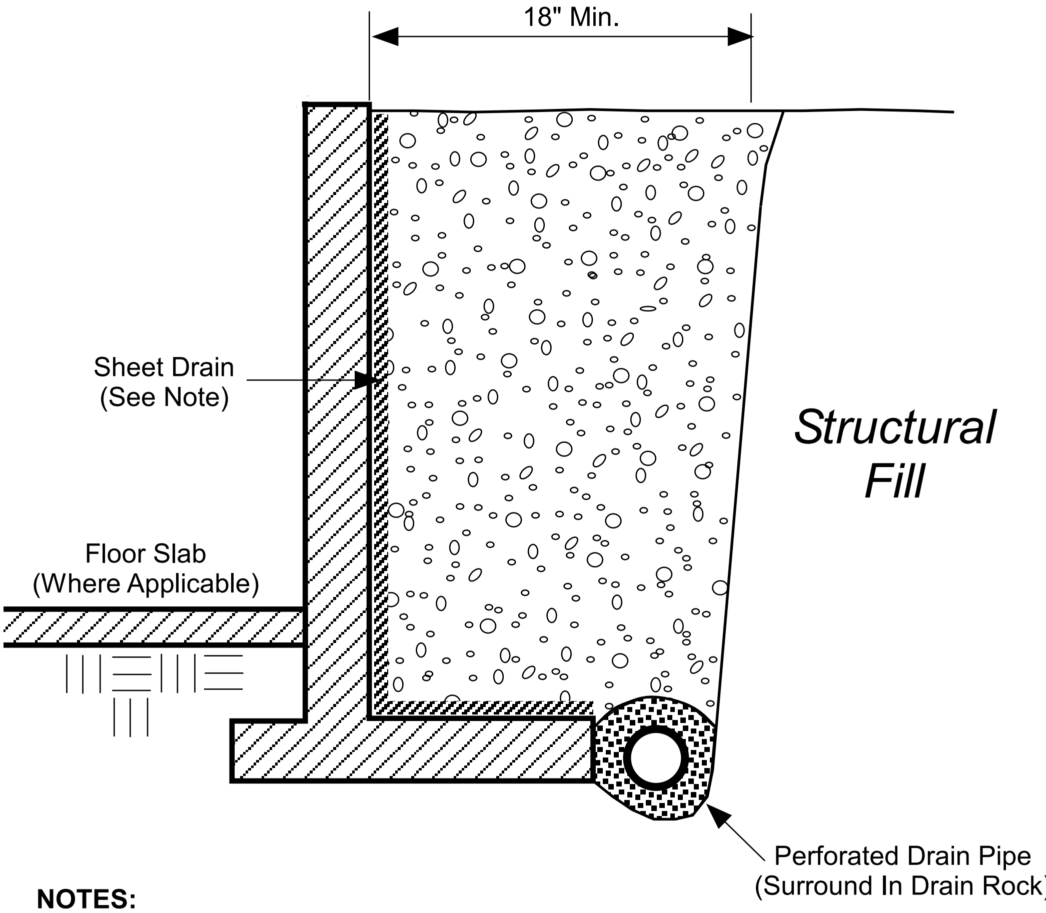
SHORING WALL DRAINAGE
Alderwood Mixed-Use Building
Lynnwood, Washington

| | | |
|---|---|---|
| Drwn. MRS | Date 06/26/2015 | Proj. No. 3836 |
| Checked KDH | Date June 2015 | Plate 5 |




**NOTES:**

- Free Draining Backfill should consist of soil having less than 5 percent fines. Percent passing #4 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" Drain Rock.

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**LEGEND:**

Free-Draining Structural Backfill

1-inch Drain Rock

Earth Solutions NW LLC
Geotechnical Engineering, Construction Monitoring and Environmental Sciences

RETAINING WALL DRAINAGE DETAIL
Alderwood Mixed-Use Building
Lynnwood, Washington

| | | |
|---|---|---|
| Drwn. MRS | Date 06/26/2015 | Proj. No. 3836 |
| Checked KDH | Date June 2015 | Plate 6 |

## Appendix A

## Subsurface Exploration
## Boring Logs

## ES-3836

Subsurface conditions at the subject site were explored on June 18, 2015 by advancing six borings using a trailer-mounted drill rig and operators retained by our firm. The approximate locations of the subsurface exploration borings are illustrated on Plate 2 of this study. The subsurface boring logs are provided in this Appendix. The borings were advanced to a maximum depth of approximately 26 feet below existing grades.

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 NWLLC

## SOIL CLASSIFICATION CHART

| MAJOR DIVISIONS | | | SYMBOLS GRAPH | SYMBOLS LETTER | TYPICAL DESCRIPTIONS |
|---|---|---|---|---|---|
| COARSE GRAINED SOILS | GRAVEL AND GRAVELLY SOILS | CLEAN GRAVELS | | GW | WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES |
| | | (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 | | GM | SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES |
| | | (APPRECIABLE AMOUNT OF FINES) | | 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 | | SW | WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES |
| | | (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 | | SM | SILTY SANDS, SAND - SILT MIXTURES |
| | | (APPRECIABLE AMOUNT OF FINES) | | 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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# BORING NUMBER B-1



**CLIENT** Cosmos Development Company
**PROJECT NAME** Alderwood Mixed-Use Building
**PROJECT NUMBER** 3836
**PROJECT LOCATION** Lynnwood, Washington
**DATE STARTED** 6/18/15 **COMPLETED** 6/18/15
**GROUND ELEVATION** 410 ft **HOLE SIZE**
**DRILLING CONTRACTOR** Boretec1, Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** HSA
▽ **AT TIME OF DRILLING** 20.0 ft / Elev 390.0 ft
**LOGGED BY** KDH **CHECKED BY** KDH
**AT END OF DRILLING** ---
**NOTES** Surface Conditions: 2" Asphalt
**AFTER DRILLING** ---

| DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % | BLOW COUNTS (N VALUE) | TESTS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 0 | | | | | SM | | Brownish gray silty SAND with gravel, dense, damp (Fill) |
| | SS | 100 | 37-50/3" | MC = 5.60% | | | |
| 3.0 | | | | | | | 407.0 |
| | | | | | SM | | Gray silty SAND with gravel, very dense, moist (Glacial Till) |
| 5 | SS | 100 | 31-50/5" | MC = 9.80%<br>Fines = 24.00% | | | |
| | | | | | | | -significant gravel content, hard drilling at 8' |
| 10 | SS | 100 | 50/4" | MC = 10.30% | | | |
| 15 | SS | 100 | 50/5" | MC = 5.70% | | | |
| 20.0 ▽ | | | | | | | 390.0 |

*(Continued Next Page)*

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# BORING NUMBER B-1



**CLIENT** Cosmos Development Company
**PROJECT NAME** Alderwood Mixed-Use Building
**PROJECT NUMBER** 3836
**PROJECT LOCATION** Lynnwood, Washington

| DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % | BLOW COUNTS (N VALUE) | TESTS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 20 | SS | | 50/0" | MC = 7.00% | SM | | Gray silty SAND with gravel, very dense, water bearing (Glacial Till)<br>-groundwater table at 20' |
| 25 | SS | 100 | 50/3" | MC = 7.30% | | | 25.3 — 384.8 |
| | | | | | | | Boring terminated at 25.25 feet below existing grade. Groundwater table encountered at 20.0 feet during drilling. Boring backfilled with bentonite chips.<br>Bottom of hole at 25.3 feet. |

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# BORING NUMBER B-2



**CLIENT** Cosmos Development Company
**PROJECT NAME** Alderwood Mixed-Use Building
**PROJECT NUMBER** 3836
**PROJECT LOCATION** Lynnwood, Washington
**DATE STARTED** 6/18/15 **COMPLETED** 6/18/15
**GROUND ELEVATION** 410 ft **HOLE SIZE**
**DRILLING CONTRACTOR** Boretec1, Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** HSA
**AT TIME OF DRILLING** ---
**LOGGED BY** KDH **CHECKED BY** KDH
**AT END OF DRILLING** ---
**NOTES** Surface Conditions: 2" Asphalt
**AFTER DRILLING** ---

| DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % | BLOW COUNTS (N VALUE) | TESTS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 0 | | | | | SM | | Brownish gray silty SAND with gravel, medium dense, moist (Fill) |
| 2.0 | | | | | | | 408.0 |
| | | | | | SM | | Gray silty SAND with gravel, very dense, moist (Glacial Till) |
| 5 | SS | 100 | 50/6" | MC = 6.40% | | | |
| | | | | | | | -becomes grayish brown |
| 10 | SS | 100 | 50/6" | MC = 10.60%<br>Fines = 37.20% | | | -increased moisture content |
| 15 | SS | 100 | 50/1" | MC = 8.90% | | | |
| 20 (20.0) | | | | | | | 390.0 |

*(Continued Next Page)*

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# BORING NUMBER B-2



**CLIENT** Cosmos Development Company

**PROJECT NAME** Alderwood Mixed-Use Building

**PROJECT NUMBER** 3836

**PROJECT LOCATION** Lynnwood, Washington

| DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % | BLOW COUNTS (N VALUE) | TESTS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| | SS | | 50/0" | | | | -no recovery |
| | | | | | | | Boring terminated at 20.0 feet below existing grade. No groundwater encounterd during drilling. |
| | | | | | | | Bottom of hole at 20.0 feet. |

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# BORING NUMBER B-3



**CLIENT** Cosmos Development Company
**PROJECT NAME** Alderwood Mixed-Use Building
**PROJECT NUMBER** 3836
**PROJECT LOCATION** Lynnwood, Washington
**DATE STARTED** 6/18/15 **COMPLETED** 6/18/15
**GROUND ELEVATION** 410 ft **HOLE SIZE**
**DRILLING CONTRACTOR** Boretec1, Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** HSA
**AT TIME OF DRILLING** ---
**LOGGED BY** KDH **CHECKED BY** KDH
**AT END OF DRILLING** ---
**NOTES** Surface Conditions: 2" Asphalt
**AFTER DRILLING** ---

| DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % | BLOW COUNTS (N VALUE) | TESTS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 0 | | | | | SM | | Brownish gray silty SAND with gravel, medium dense, damp (Fill) |
| | SS | 100 | 50/5" | MC = 5.70% | | | |
| 3.0 | | | | | SM | | 407.0 |
| | | | | | | | Tan silty SAND with gravel, very dense, moist (Glacial Till) |
| 5 | SS | 100 | 31-50/6" | MC = 5.30% | | | |
| | | | | | | | -significant gravel content to 8', hard drilling |
| 10 | SS | 100 | 26-50/6" | MC = 6.00% | | | -brown and olive green oxide staining |
| 11.0 | | | | | | | 399.0 |

Boring terminated at 11.0 feet below existing grade. No groundwater encountered during drilling. Boring backfilled with bentonite chips.
Bottom of hole at 11.0 feet.

GENERAL BH / TP / WELL 3836.GPJ GINT US.GDT 7/1/15

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Fax: 425-449-4711

# BORING NUMBER B-4



**CLIENT** Cosmos Development Company
**PROJECT NAME** Alderwood Mixed-Use Building
**PROJECT NUMBER** 3836
**PROJECT LOCATION** Lynnwood, Washington
**DATE STARTED** 6/18/15 **COMPLETED** 6/18/15
**GROUND ELEVATION** 409 ft **HOLE SIZE**
**DRILLING CONTRACTOR** Boretec1, Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** HSA
**AT TIME OF DRILLING** ---
**LOGGED BY** KDH **CHECKED BY** KDH
**AT END OF DRILLING** ---
**NOTES** Surface Conditions: 2" Asphalt
**AFTER DRILLING** ---

| DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % | BLOW COUNTS (N VALUE) | TESTS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION | |
|---|---|---|---|---|---|---|---|---|
| 0 | | | | | SM | | Brownish gray silty SAND with gravel, medium dense, moist (Fill) | |
| 2.0 | | | | | | | | 407.0 |
| | | | | | SM | | Gray silty SAND with gravel, very dense, moist (Glacial Till) | |
| 5 | SS | 100 | 29-50/5" | MC = 4.00% | | | | |
| | | | | | | | -significant gravel content at 9', hard drilling | |
| 10 | SS | 100 | 50/5" | MC = 8.00% | | | | |
| 10.4 | | | | | | | | 398.6 |
| | | | | | | | Boring terminated at 10.42 feet below existing grade. No groundwater encountered during drilling. Boring backfilled with bentonite chips. Bottom of hole at 10.4 feet. | |

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# BORING NUMBER B-5



**CLIENT** Cosmos Development Company
**PROJECT NAME** Alderwood Mixed-Use Building
**PROJECT NUMBER** 3836
**PROJECT LOCATION** Lynnwood, Washington
**DATE STARTED** 6/18/15 **COMPLETED** 6/18/15
**GROUND ELEVATION** 410 ft **HOLE SIZE**
**DRILLING CONTRACTOR** Boretec1, Inc.
**GROUND WATER LEVELS:**
**DRILLING METHOD** HSA
**AT TIME OF DRILLING** 20.0 ft / Elev 390.0 ft
**LOGGED BY** KDH **CHECKED BY** KDH
**AT END OF DRILLING** —
**NOTES** Surface Conditions: 3" Asphalt
**AFTER DRILLING** —

| DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % | BLOW COUNTS (N VALUE) | TESTS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 0 | | | | | SM | | Brownish gray silty SAND with gravel, medium dense, damp (Fill) |
| | SS | 100 | 50/3" | MC = 1.70% | | | |
| 3.0 | | | | | | | 407.0 |
| | | | | | SM | | Gray silty SAND with gravel, very dense, moist (Glacial Till) |
| | | | | | | | -becomes dense |
| 5 | SS | 100 | 15-27-21 (48) | MC = 9.50% Fines = 40.80% | | | |
| | SS | 100 | 35-50/3" | MC = 9.10% | | | -becomes very dense |
| 10 | SS | 100 | 26-35-50/5" | MC = 9.20% | | | |
| 15 | SS | 100 | 50/6" | MC = 8.10% | | | |
| | | | | | | | -groundwater table at 20' |
| 20 | | | | | | | ▽ -no recovery at 20' |

(Continued Next Page)

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# BORING NUMBER B-5



**CLIENT** Cosmos Development Company

**PROJECT NAME** Alderwood Mixed-Use Building

**PROJECT NUMBER** 3836

**PROJECT LOCATION** Lynnwood, Washington

| DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % | BLOW COUNTS (N VALUE) | TESTS | U.S.C.S. | GRAPHIC LOG | | MATERIAL DESCRIPTION | |
|---|---|---|---|---|---|---|---|---|---|
| 20 | | | | | | | | | |
| | SS | 100 | 50/6" | | SM | | 20.5 | Gray silty SAND with gravel, very dense, moist (Glacial Till) *(continued)* | 389.5 |
| | | | | | | | | Boring terminated at 20.5 feet below existing grade. Groundwater table encountered at 20.0 feet during drilling. Boring backfilled with bentonite chips. Bottom of hole at 20.5 feet. | |

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# BORING NUMBER B-6



CLIENT Cosmos Development Company
PROJECT NAME Alderwood Mixed-Use Building
PROJECT NUMBER 3836
PROJECT LOCATION Lynnwood, Washington
DATE STARTED 6/18/15 COMPLETED 6/18/15
GROUND ELEVATION 410 ft HOLE SIZE
DRILLING CONTRACTOR Boretec1, Inc.
GROUND WATER LEVELS:
DRILLING METHOD HSA
AT TIME OF DRILLING —
LOGGED BY KDH CHECKED BY KDH
AT END OF DRILLING —
NOTES Surface Conditions: 2" Asphalt
AFTER DRILLING —

| DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % | BLOW COUNTS (N VALUE) | TESTS | U.S.C.S. | GRAPHIC LOG | MATERIAL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 0 | | | | | SM | | Brownish gray silty SAND with gravel, medium dense, moist (Fill) |
| 2.0 | | | | | | | 408.0 |
| | | | | | SM | | Grayish brown silty SAND with gravel, dense, moist (Glacial Till) |
| 5 | SS | 100 | 35-27-16 (43) | MC = 10.60% | | | |
| | | | | | | | -becomes brown, increased sand content |
| 10 | SS | 100 | 21-18-20 (38) | MC = 18.30% | | | -groundwater table at 10', becomes water bearing |
| 15 | SS | 100 | 15-26-45 (71) | MC = 15.40%<br>Fines = 13.10% | | | -becomes brown silty SAND, very dense, water bearing |
| 20 | | | | | | | 20.0 — 390.0 |

*(Continued Next Page)*

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# BORING NUMBER B-6



**CLIENT** Cosmos Development Company

**PROJECT NAME** Alderwood Mixed-Use Building

**PROJECT NUMBER** 3836

**PROJECT LOCATION** Lynnwood, Washington

| DEPTH (ft) | SAMPLE TYPE NUMBER | RECOVERY % | BLOW COUNTS (N VALUE) | TESTS | U.S.C.S. | GRAPHIC LOG | | MATERIAL DESCRIPTION | |
|---|---|---|---|---|---|---|---|---|---|
| 20 | SS | 100 | 40-50/3" | MC = 9.00% | SM | | | Brown silty SAND with gravel, very dense, water bearing | |
| 25 | SS | 100 | 29-50/5" | MC = 12.50% | | | 25.9 | -silt interbeds | 384.1 |
| | | | | | | | | Boring terminated at 25.92 feet below existing grade. Groundwater table encountered at 10.0 feet during drilling. Boring backfilled with bentonite chips. | |
| | | | | | | | | Bottom of hole at 25.9 feet. | |

# Appendix B

## Laboratory Test Results

## ES-3836

Earth Solutions NW LLC
Earth Solutions NW
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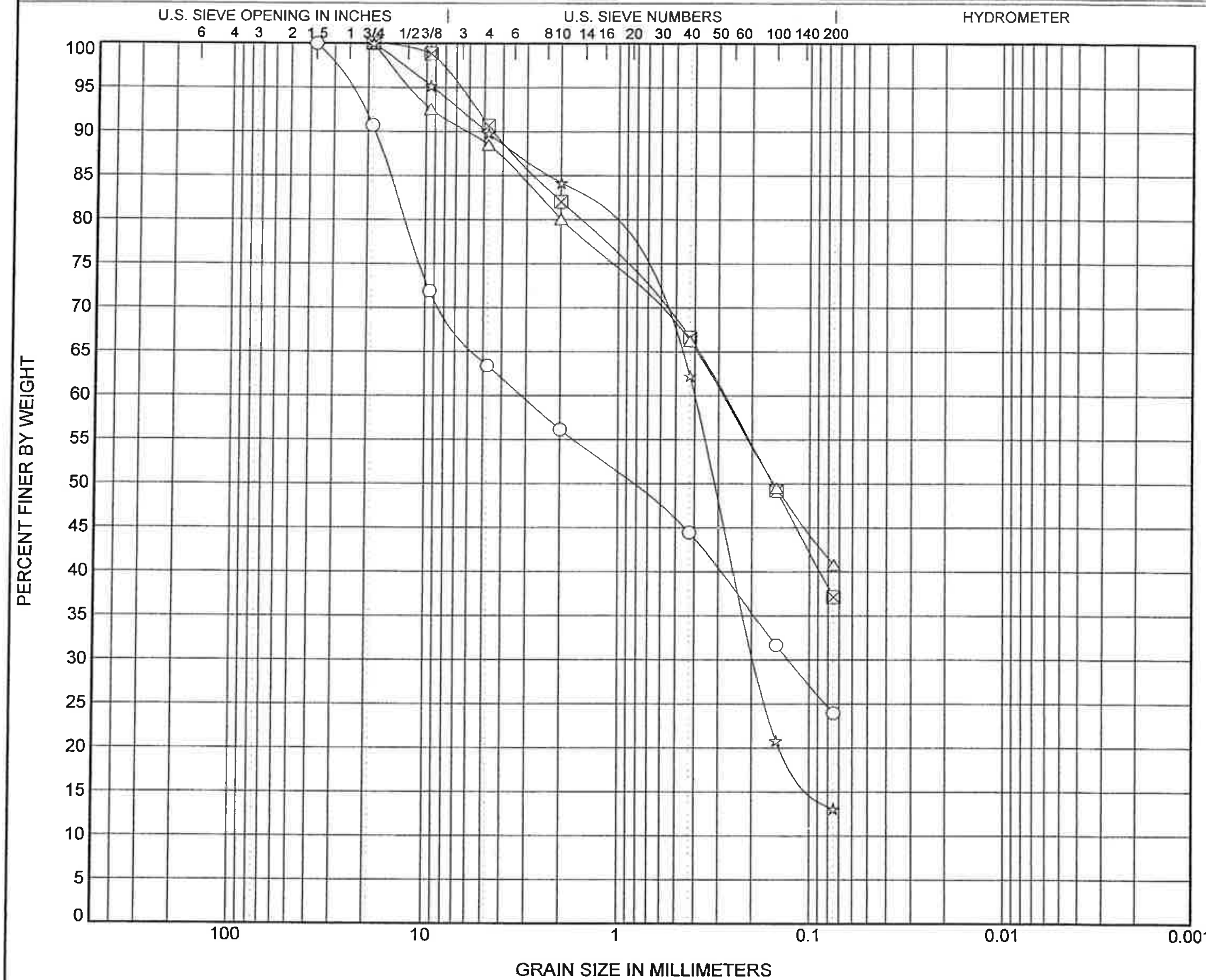
Bellevue, WA 98005
Telephone: 425-284-3300

# GRAIN SIZE DISTRIBUTION

**CLIENT** Cosmos Development Company
**PROJECT NAME** Alderwood Mixed-Use Building
**PROJECT NUMBER** ES-3836
**PROJECT LOCATION** Lynnwood




| COBBLES | GRAVEL | | SAND | | | SILT OR CLAY |
|---|---|---|---|---|---|---|
| | coarse | fine | coarse | medium | fine | |

| | Specimen Identification | | Classification | LL | PL | PI | Cc | Cu |
|---|---|---|---|---|---|---|---|---|
| ○ | B-1 | 5.0ft. | **Gray Silty SAND with Gravel, SM** | | | | | |
| ⊠ | B-2 | 10.0ft. | **Grayish Brown Silty SAND, SM** | | | | | |
| △ | B-5 | 5.0ft. | **Gray Silty SAND, SM** | | | | | |
| ☆ | B-6 | 15.0ft. | **Brown Silty SAND, SM** | | | | | |
| | | | | | | | | |

| | Specimen Identification | | D100 | D60 | D30 | D10 | %Gravel | %Sand | %Silt | %Clay |
|---|---|---|---|---|---|---|---|---|---|---|
| ○ | B-1 | 5.0ft. | 37.5 | 3.163 | 0.129 | | 36.6 | 39.4 | 24.0 | |
| ⊠ | B-2 | 10.0ft. | 19 | 0.286 | | | 9.3 | 53.5 | 37.2 | |
| △ | B-5 | 5.0ft. | 19 | 0.288 | | | 11.5 | 47.7 | 40.8 | |
| ☆ | B-6 | 15.0ft. | 19 | 0.402 | 0.189 | | 10.2 | 76.7 | 13.1 | |
| | | | | | | | | | | |

GRAIN SIZE ES-3836.GPJ GINT US LAB.GDT 6/23/15

**Report Distribution**

**ES-3836**

| | |
|---|---|
| **EMAIL ONLY** | **Cosmos Development Company**<br>**11747 Northeast 1st Street, Suite 300**<br>**Bellevue, Washington 98005**<br><br>**Attention: Mr. Oscar Del Moro** |