Report
Geotechnical Engineering Services
Proposed Haggen Food and Pharmacy
Arlington, Washington

June 21, 1999

For
Briar Development Company
and Haggen, Inc.

GeoEngineers

File No. 1160-018-00-1130

GeoEngineers

Consulting Engineers
and Geoscientists
Offices in Washington,
Oregon, and Alaska

June 21, 1999

Briar Development Company
and Haggen, Inc.
c/o Pacific Land Design
9709 Third Avenue Northeast, Suite 203
Seattle, Washington 98115-2027

Attention: Michael Crowson

We are pleased to present four copies of our "Report, Geotechnical Engineering Services, for the Proposed Haggen Food and Pharmacy, Arlington, Washington."

Our services were completed in general accordance with the scope of services presented in our proposal dated April 6, 1999. Our services were authorized orally by you on April 9, 1999. Formal authorization was received from Joel Gordon of Buck & Gordon LLC on May 3, 1999.

Portions of the results of our study were discussed with you and Joel Gordon as our conclusions and recommendations were developed. We provided a general overview of our conclusions and recommendations in an e-mail to you on May 5, 1999 and a draft copy of our report dated May 5, 1999.

We appreciate the opportunity to be of service to you on this project. Please call us if you have any questions regarding the contents of this report or when we may be of further assistance.

Yours very truly,

GeoEngineers, Inc.

Bo McFadden, P.E.
Associate

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REPORT
GEOTECHNICAL ENGINEERING SERVICES
PROPOSED HAGGEN FOOD AND PHARMACY
ARLINGTON, WASHINGTON
FOR
BRIAR DEVELOPMENT COMPANY
AND HAGGEN, INC.

INTRODUCTION

This report presents the results of our geotechnical engineering services for development of the proposed Haggen Food and Pharmacy facility to be located southwest of the intersection of 204th Street Northeast and State Route 9 in Arlington, Washington. The site location is shown on the Vicinity Map, Figure 1.

We understand that the proposed development will consist of a retail store located in the south portion of the property and parking to the north. Three out-lots will be located along the north side of the site. The out-lots will occupy about a 180-foot deep strip extending east to west along 204th Street Northeast. Access will be 204th Street Northwest and 74th Avenue Northeast located along the west side of the site.

SCOPE

The purpose of our services is to develop design criteria for the geotechnical aspects of the proposed project. Our services will include the following tasks:

1. Review existing reports and maps in our files for the project area.
2. Explore shallow subsurface soil and ground water conditions by excavating 10 to 12 test pits using a rubber-tired backhoe. The test pits will likely extend to depths of about 8 to 12 feet.
3. Complete two infiltration tests in the area proposed or storm water infiltration. We will use the backhoe to setup the testing area at a suitable depth for infiltration.
4. Explore deep subsurface soil and ground water conditions to evaluate the potential impact of seismic ground shaking and liquefaction of the alluvial soils expected at the site by drilling three borings to depths of about 40 feet.
5. Evaluate pertinent physical and engineering characteristics of soils based on our findings during the exploration program and laboratory testing performed on soil samples obtained from the test pits and borings. We expect that laboratory testing will consist of moisture content and density determinations, and grain size analyses.
6. Develop recommendations for site preparation and earthwork, including evaluating the suitability of the on-site soils for use as structural fill and recommendations for placement and compaction of structural fill, and considerations for wet weather construction.
7. Provide recommendations for temporary cut slopes, and permanent cut and fill slopes, as appropriate.
8. Develop recommendations for shallow foundation support. This will include recommendations for reducing the risk of post-construction building and recommendations for lateral resistance.

9. Provide lateral earth pressure values for design of loading dock and below-grade building walls. This will include a coefficient of base friction to resist lateral forces.
10. Provide recommendations for support of on-grade floor slabs. This will include recommendations for special considerations where heavy rack storage or walks in coolers/freezers are planned.
11. Provide recommendations for temporary and permanent drainage improvements. This will include recommendations for a below-slab capillary break and moisture retarder, or drainage system if necessary, and foundation and wall drains.
12. Provide applicable Uniform Building Code site coefficient for seismic design. Based on our understanding of the site conditions liquefaction of the on-site soils will likely not be a design concern.
13. Provide recommendations for pavement subgrade preparation and asphalt pavement based on expected traffic information provided by the owner or on our experience on similar facilities.
14. Prepare a written report presenting our conclusions and recommendations together with supporting field and laboratory data.

SITE DESCRIPTION

SURFACE CONDITIONS

We reviewed information provided by Michael Crowson of Pacific Land Design that included a Concept Plan prepared by Pacific Land Design dated March 15, 1999, and a Boundary and Topographic Survey and the A.L.T.A./A.C.S.M Survey prepared by Penhallegon and Associates, Inc dated January 21, 1999.

The proposed project site is located at the southwest corner of the intersection of State Route 9 and 204th Street NE and lies approximately 1.5 miles south of the Stillaguamish River on a glacial outwash plain. The approximately 11-acre site is roughly rectangular in shape, measuring about 980 feet north to south and about 480 feet east to west and is presently undeveloped. The site is bordered by 204th Street Northeast to the north, State Route 9 to the east, undeveloped and residential property to the south and to the west by 74th Avenue NE. A tributary to Burry Creek extends east to west in a manmade channel located in the south portion of the site. An asphalt paved drive extends north to south on the east portion of the site. An overhead power line extends north to south about 20 to 30 feet west of the drive.

The ground surface generally slopes to the west-northwest across the site. The ground surface is at about Elevation 129 feet along much of the east side of the site and at about Elevation 131 in the southeast portion of the site. The ground surface along 74th Avenue Northeast that borders the west side of the site ranges from about Elevation 123 feet in the north to Elevation 128 in the south. Recent street improvements on the north and west sides of the site include a landscaping berm that extends about 2 feet above the site with small deciduous trees. Much of the remaining portions of the site are vegetated with short grass. The locations of surface features are shown on the Site Plan, Figure 2.

SUBSURFACE CONDITIONS

General

We explored subsurface soil and groundwater conditions at the site by drilling three borings to depths of about 20 to 40 feet below the ground surface (bgs) and excavating 14 test pits to depths of about 8 to 12 bgs. Gregory Drilling Inc. of Redmond, Washington completed the borings on April 13, 1999 using truck-mounted hollow-stem auger drilling equipment (CME 85). Custom Backhoe and Dumptruck Service, Inc. of Bellevue, Washington excavated the test pits on April 14, 1999 using a rubber-tired backhoe (Case 580K). Infiltration tests were completed in the west portion of the site to evaluate the suitability of utilizing an on-site system to infiltrate storm water. The locations of the explorations and infiltration tests are shown in Figure 2. The details of our field exploration program, laboratory testing and exploration logs are presented in Appendix A.

Soil Conditions

In general, the subsurface soil conditions are relatively uniform across the majority of the site. However the soils in the southeast portion of the site include several feet of moderately compressible silt and highly compressible organic silt.

In the explorations completed in the southeast portion of the site (test pits TP-2, TP-3, TP-4, TP-6, TP-7, and TP-13, and boring B-1) we observed about a 6-inch thick sod and rootmass layer overlying an approximately 1-to 2-foot thick topsoil layer consisting of medium stiff organic silt. Interbedded, compressible soft to medium stiff silt and organic silt was observed below the topsoil layer to depths ranging from about 4 to 8 feet bgs. We observed medium dense to dense glacial outwash sand and gravel with occasional cobbles below the compressible silt. The glacial outwash was observed to the bottom of the test pits at depths of about 9 to 12 feet bgs and to the bottom of boring B-1 at a depth of about 40 feet bgs. The glacial outwash observed in boring B-1 included medium dense to very dense silty fine to medium sand with interbedded layers of silt and occasional fine to coarse gravel. This soil unit was observed from about a depth of 23 feet to the bottom of the boring. This deeper interbedded silty sand and silt layer was encountered in boring B-1 only, located near the southeast corner of the site.

We observed a similar thickness of sod and rootmass overlying a somewhat thicker topsoil layer in most of the explorations located in the north and west portions of the site (boring B-2 and test pits TP-5, TP-8 through TP-12, and TP-14). We observed about a 6-inch thick sod and rootmass layer overlying an approximately 2- to 4-foot thick topsoil layer consisting of medium stiff organic silt. Beneath the topsoil layer the explorations encountered glacial outwash consisting of medium dense to dense sand and sand with silt, gravel and occasional cobbles. Occasional boulders up to 24-inches were also encountered during explorations in the sand and gravel unit.

Explorations completed along the central portion of the west side of the site (boring B-3 and test pit TP-1) encountered a sod, rootmass, topsoil and compressible silt thickness similar to what we observed in the southeast portion of the site. However, the compressible silt layer was not as thick and only moderately compressible. We observe the compressible silt layer to depths of about 5 to 6.5 feet. Medium dense glacial outwash was encountered below the compressible soil.

Ground Water Conditions

We observed shallow ground water seepage in the southeast portion of the site at depths of about 4, 5, and 8.5 feet in test pits TP-2, TP-3, and TP-7, respectively. No ground water seepage was observed in test pits TP-1, TP-4 through TP-6, and TP-8 through TP-13. We also observed shallow ground water seepage at a depth of about 2 feet in boring B-1 located in the southeast portion of the site. Shallow ground water seepage was not observed in borings B-2 and B-3, however we did observe deeper ground water seepage at depths of 17.5 and 13.5 feet bgs in the two borings, respectively.

Based on our explorations, ground water seepage appears to be present at shallower depths within the interbedded compressible soils observed in the southeast portion of the site. Ground water seepage within the outwash sand and gravel observed in the other portions of the site appears to be at a significantly greater depth. Ground water levels at the site should be expected to fluctuate as a function of seasonal precipitation, and other factors. We expect that the ground water seepage levels observed in the outwash sand and gravel present in the north and west portions of the site are likely near their highest levels. This expectation is based on the time of year our explorations were completed and the amount of precipitation received in the Puget Sound region this past winter. The shallow groundwater levels in the south portion of the site should also be expected to fluctuate with the rise and fall of the stream channel water levels.

Infiltration Tests

Two infiltration tests were completed on April 14, 1999 in the vicinity of the proposed storm water infiltration area using a procedure modified from the Environmental Protection Agency Falling Head Percolation Test methodology. The details of the infiltration test procedure are presented in Appendix A.

Infiltration tests IT-1 and IT-2 were performed at depths of about 9.5 and 9.0 feet below the ground surface, respectively. The soils encountered at these depths consist of medium dense sand and gravel with silt. These soils were encountered to a depth of 21.7 feet in boring B-3 completed in the proposed infiltration area. Ground water was encountered in the boring at a depth of about 13.5 feet during drilling.

The results of the infiltration tests indicate infiltration rates of 7 and 20 inches per hour for infiltration test IT-1 and IT-2, respectively.

CONCLUSIONS AND RECOMMENDATIONS

GENERAL

Based on the results of our explorations, laboratory testing and engineering analyses, we conclude that the site can be satisfactorily developed and the building supported on shallow foundations, as proposed. However, special consideration must be given to building foundation and floor slab support for the building area located in the southeast portion of the site where compressible soil is present.

Compressible silt and organic silt extending from about 4 to 8 feet or more below the exiting ground surface is present in the southeast portion of the site. The silts will initially compress rather significantly under foundation and floor slab loads in the building area and to a lesser degree below paved roadway and parking areas depending on final site grades. Long term secondary compression of the organic silt will occur over the life of the structure and are more difficult to predict. It may be possible to preloaded the building area to induce a significant portion of the initial settlement and reduce the rate and magnitude of secondary settlement. However, because the depth to the bottom of the compressible layer is not significant, we recommend that the compressible soil be removed from the southeast portion of the building area to reduce the risk of unacceptable magnitudes of post-construction settlement.

The surface soils below the sod layer include silt and organic silt (topsoil) that are very moisture sensitive and will be difficult to operate heavy equipment on in all but the driest weather. It will also be difficult to achieve adequate compaction with these soils to allow their use as structural fill. Therefore, we recommend that you plan to use clean imported granular borrow material for all building pad, roadway and parking area fill. It will be necessary to import fill for use in utility trench backfill to replace the unsuitable silt and organic silt when encountered within these areas.

The following sections of this report present our conclusions and recommendations for site development, foundation support and performance estimates of the proposed structure.

SITE PREPARATION AND EARTHWORK

Site Preparation

We recommend that pavement and building areas be stripped of all vegetation, sod and root systems. Based on our explorations, the depth of stripping required will generally be on the order of 6 inches. We also recommend that the underlying topsoil layer be stripped from the building area. This topsoil layer was observed to range from about 1 to 4 feet thick at the locations of our explorations. In our opinion, the topsoil layer may be left in place below pavement areas and walkways provided a suitable sand and gravel subbase thickness overlying a geotextile for soil separation is included for developing appropriate pavement support, as discussed below in the Pavement Design section of this report. It may be difficult for operation of heavy equipment on the site because of the topsoil that will be exposed at the surface after stripping. We recommend that wide track dozers be used to complete much of the site stripping to avoid significant disturbance of the underlying soil if it is to remain in place. If the stripping operations cause disturbance of the underlying soil, additional excavation may be necessary. Disturbance of the shallow subgrade soils should be expected if site preparation work is done during periods of wet weather or when the subgrade soils are still wet from seasonal rainfall. We therefore recommend site grading take place during the drier summer months (July through

September) to reduce grading costs. Material from the stripping operations should be sent off site for disposal or used for landscaping purposes.

We recommend that the compressible silt and organic silt encountered below the sod, rootmass and topsoil in the southeast portion of the site be removed from the building area and be replaced with structural fill to achieve design grade and provide suitable foundation support. We also recommend that the topsoil layer exposed at subgrade elevation in pavement areas be disced to aerate and dry the soil prior to compacting it to a firm unyielding condition.

The site should be graded to a slightly crowned surface once stripping has been completed. This grading should be done to enhance drainage from the site and proposed building areas, and to prevent ponding of water in areas to receive any additional fill.

The exposed subgrades in building, roadway and parking areas should be evaluated as the site grading is completed in each area. Proofrolling with heavy rubber-tired construction equipment should be used for this purpose, if practicable. The site should be proofrolled only after an extended period (at least two weeks) of dry weather. Probing should be used to evaluate the subgrade during periods of wet weather or when the subgrade soils are more than two or three percent wetter than their optimum moisture content. Any soft areas noted during proofrolling or probing should be excavated and replaced with compacted structural fill. We recommend that exposed subgrades in walkway areas be evaluated by probing, or by proofrolling if practical.

Once the subgrade in an area has been prepared all traffic except that required to place subsequent layers of material, should be kept off the area until paving is completed. We recommend that temporary roads and laydown areas be constructed to reduce the risk of disturbing the subgrade soils. Temporary roads should consist of 12 to 18 inches of quarry spalls or clean granular structural fill placed over geotextile fabric. The geotextile should be a woven fabric intended for soil separation and reinforcement within roadway embankments.

The recommended pavement sections presented in a subsequent section of this report for parking and light duty traffic (automobiles only) is not intended to support heavy construction traffic. If all or any part of these pavement sections is placed while building construction is still in progress, these areas should be barricaded and roped off to prevent vehicle access. This is to reduce the risk of softening of the subgrade, contamination of the subbase and base course materials soils, or pavement failure. The use of an asphalt treated base (ATB) pavement section for temporary roadways is discussed below under "Pavement Design."

Sedimentation and Erosion Control

In our opinion, the erosion potential of the on-site soils is low to moderate. Construction activities including stripping and grading will expose soils to the erosional effects of wind and water. The amount and potential impacts of erosion are partly related to the time of year that construction actually occurs. Wet weather construction will increase the amount and extent of erosion and potential sedimentation.

Erosion and sedimentation control measures may be implemented by using a combination of interceptor swales, straw bale barriers, silt fences and straw mulch for temporary erosion protection of exposed soils. All disturbed areas should be finish graded and seeded as soon as practical to reduce the risk of erosion. Erosion and sedimentation control measures should be installed and maintained in accordance with the requirements of the city of Arlington.

Structural Fill

All new fills in building and pavement areas should be placed and compacted as structural fill. The suitability of soil for use as structural fill will depend on its gradation and moisture content. In our opinion, the near surface silty soils (topsoil) should not be considered for use as structural fill. However the glacial outwash sand and gravel encountered below the topsoil in our explorations should be suitable for use as structural will where compaction to 95 percent of maximum dry density (MDD) (per ASTM D-1557) is required and warm, dry weather prevails before and during the placement and compaction of these soils. We recommend, therefore, that the project be planned to include importing sand and gravel to replace the upper topsoil layer in all utility trench excavations and for replacing the compressible silt and organic silt removed from the building area.

We recommend that all imported sand and gravel contain less than 5 percent fines (material passing U.S. Standard No. 200 sieve) by weight relative to the fraction of the material passing the ¾-inch sieve. This material should be free of debris, organic contaminants and rock fragments larger than 6 inches.

All structural fill placed to support foundations and floor slabs should be compacted to at least 95 percent of MDD (per ASTM D-1557). Pavement area fill, including utility trench backfill, should be compacted to at least 90 percent of MDD, except for the upper 2 feet below finished subgrade surface, which should be compacted to at least 95 percent of MDD. Structural fill to support walkways should be placed after the subgrade is evaluated as recommended above and be compacted to at least 90 percent of MDD.

Structural fill should be placed in loose lifts not exceeding 8 to 10 inches in thickness. Each lift should be conditioned to the proper moisture content and compacted to the specified density before placing subsequent lifts. We recommend that a representative from our firm be present during proofrolling and/or probing of the exposed subgrade soils in pavement areas and placement of structural fill. Our representative will evaluate the adequacy of the subgrade soils and identify areas needing further work, perform in-place moisture-density tests in the fill to determine if the compaction specifications are being met, and advise on any modifications to procedure which might be appropriate for the prevailing conditions.

Open Cut Excavations

The stability of open cut slopes is a function of soil type, ground water level, slope inclination, slope height and nearby surface loads. The use of inadequately designed open cuts could impact the stability of adjacent work areas, existing utilities, and endanger personnel. In our opinion, the contractor will be in the best position to observe subsurface conditions continuously throughout the construction process and to respond to variable soil and ground water conditions. Therefore, the contractor should have the primary responsibility for deciding whether or not to use open cut slopes rather than some form of temporary excavation support, and for establishing the safe inclination of the cut slope. All open cut slopes and temporary excavation support should be constructed or installed, and maintained in accordance with the requirements of the appropriate governmental agency.

For planning purposes only, we recommend that temporary cut slopes be no steeper than 1-½H:1V (horizontal to vertical) in the existing fill. Stable cut slopes in the compressible silt and organic silt layers will be partially dependent time of year construction occurs and on how effectively the ground water level is lowered. Depending on the ground water conditions during construction stable slopes in these soils could vary from about 1-½H:1V to 3H:1V. Acceptable slope inclinations should be determined during construction and should be in accordance with OSHA and WISHA guidelines.

The above guidelines assume that surface loads such as equipment loads and storage loads will be kept a sufficient distance away from the top of the cut so that the stability of the excavation is not affected. We recommend that this distance be not less than half the height of the cut.

It should be expected that excavation faces would experience some sloughing and raveling. Berms, swales, or drainage ditches should be installed around the perimeter of each excavation to intercept surface runoff and reduce the potential for flow over the top of slopes.

Some ground water seepage may be encountered in the excavations depending on the time of year. We expect that ditching and sump pumping during construction will be sufficient to keep water from ponding in relatively shallow excavation.

Permanent Cut and Fill Slopes

We recommend that any permanent slopes be constructed at 3H:1V, or flatter. Flatter slopes might be considered for ease of maintenance.

Unprotected slopes will be subject to erosion until a protective vegetative cover is well established. Therefore, we recommend that any slope surfaces be planted as soon as practical to minimize the potential for erosion. A temporary covering, such as jute mesh, should be installed on the slopes as necessary until the vegetative cover has taken effect.

Appropriate drainage measures, as described below in the "Drainage Considerations" section of this report, should be implemented to collect and control surface runoff and ground water seepage.

FOUNDATION SUPPORT

Based on our analyses, we recommend that the building be supported on shallow foundations bearing on either the medium dense to dense glacial outwash encountered in our explorations or on structural fill extending down to the glacial outwash. The zone of structural fill should extend laterally beyond the edges of the footings a minimum distance equal to the thickness of the zone of fill placed.

We recommend that exterior footings be founded at least 18 inches below lowest adjacent finished grade. Interior footings should be founded a minimum of 12 inches below bottom of slab. The recommended allowable bearing pressure for footings supported as recommended is 3,000 pounds per square foot (psf). The allowable soil bearing pressure applies to the total of dead plus long-term live loads and may be increased by up to one-third for short-term live loads such as wind or seismic forces.

We estimate that the post-construction settlement of footings founded on the medium dense to dense glacial outwash or structural fill extending to the glacial outwash soil, as recommended above, will be less than ½ inch. Differential settlement between equally loaded column footing or along a 25-foot section of continuous wall footing should be less than ½ inch. We expect most of the footing settlements will occur as loads are applied. Loose or disturbed soils not removed from the footing excavation prior to placing concrete will result in additional settlement.

We recommend that all footing excavations be evaluated by a representative of our firm immediately before any structural fill, mud mat, steel or concrete is placed, to evaluate if the work is being completed in accordance with our recommendations and that subsurface conditions are as expected.

LATERAL RESISTANCE

Lateral loads can be resisted by passive resistance on the sides of the footings and by friction on the base of the footings. Passive resistance should be evaluated using an equivalent fluid density of 250 pounds per cubic foot (pcf) where footings are surrounded by structural fill compacted to at least 95 percent of MDD, as recommended. Resistance to passive pressure should be calculated from the bottom of adjacent floor slabs and paving or below a depth of 1 foot where the adjacent area is unpaved, as appropriate. Frictional resistance can be evaluated using 0.4 for the coefficient of base friction against footings. The above values incorporate a factor of safety of about 1.5.

FLOOR SLAB SUPPORT

We recommend that floor slabs be supported on grade provided the upper topsoil layer and the compressible silt and organic silt has been removed from the building area. We recommend that floor slabs be supported on 4 inches of well-graded sand and gravel containing less than 3 percent fines (material passing U.S. Standard No. 200 sieve) to provide a capillary break. If prevention of moisture migration through the slab is essential in the building, (i.e., in portions of the building areas where an adhesive will be used to attach tile or carpeting, for storage areas, and for enclosed areas), a vapor retarder such as plastic sheeting should be installed between the slab and the gravel base course. It may also be prudent to apply a sealer to the slab to further retard the migration of moisture through the floor. A 2-inch thick layer of fine to medium sand containing less than 3 percent fines may be placed over the vapor retarder to protect it during slab construction and to aid in uniform curing of the concrete.

RETAINING AND LOADING DOCK WALLS

Retaining walls that are typically not constrained from rotating outward should be designed for a lateral pressure based on an equivalent fluid density of 35 pounds per cubic foot (pcf). Loading dock walls, which are typically constrained from rotating outward, should be designed for a lateral pressure based on an equivalent fluid density of 55 pcf. Heavy compaction equipment should not be operated adjacent to the walls within a distance equal to the height of the walls. The fill within this zone should be compacted with relatively light, hand-operated mechanical equipment.

Positive drainage should be provided behind retaining walls by placing a zone of free draining sand and gravel containing less than 3 percent fines against the wall. This drainage zone should be at least 12 inches wide (measured horizontally) and extend along the entire height of the wall. Perforated pipe must be installed at the base of this drainage layer and be connected to tightlines that direct the flow to the storm drain or other suitable disposal point. It is generally not necessary to provide drainage behind loading dock walls.

Passive and frictional resistance acting on portions of the walls and footings should be evaluated as discussed above in the Lateral Resistance section of this report.

PAVEMENT DESIGN

The exposed subgrade in pavement areas should be proofrolled or otherwise examined as discussed above in the "Site Preparation' section of this report to detect areas of soft subgrade or unsuitable soils. This is especially important where the existing topsoil layer remains in place below the pavement areas. Soft or disturbed areas which develop in the subgrade should be removed and replaced with granular fill compacted as recommended to provide adequate pavement support. The thickness of additional sand and gravel fill required will depend upon the firmness of the subgrade at specific locations and should be evaluated during construction.

We recommend that the pavement section in automobile parking areas consist of at least 3 inches of Class B asphalt concrete, 4 inches of clean crushed rock base, and 12 inches of subbase overlying a geotextile for soil separation and additional subgrade strength. In roadway and truck loading areas, the minimum thickness should be 4 inches of asphalt concrete, 6 inches of crushed rock base and 12 inches subbase over a geotextile. The subbase material should meet the requirements previously specified for gradation of structural fill. These pavement sections require that the subgrade is prepared as recommended and that pavement construction is done during a period of extended dry weather.

The crushed rock base course and subbase should each be compacted to at least 95 percent of the maximum dry density determined in accordance with ASTM D-1557. It is important to pavement performance that backfill in utility trenches located in areas to be paved also be compacted as specified for structural fill.

The geotextile should be a woven fabric intended for soil separation and reinforcement in roadway embankments. Mirafi 500X and Amoco 2002 are two such suitable geotextiles for this application. Similar geotextiles are available from other manufacturers.

It may be desirable to place asphalt treated base (ATB) in place of the base course layers if permanent roadway alignments will be used for access during construction. This will be particularly important if building construction continues into the winter season and roadway and parking areas have not yet been paved. The ATB will, in conjunction with the subbase, provide a section less susceptible to damage than the base course and subbase layers only.

The required thickness of subbase material can be reduced with an ATB section. We recommend that this alternative pavement section in automobile parking areas consist of at least 2 inches of Class B asphalt concrete, 4 inches of ATB and 12 inches of subbase overlying a geotextile. In roadway and truck loading areas, the minimum thickness' should be 3 inches of asphalt concrete, 5 inches of ATB and 12 inches of subbase overlying a geotextile. It is important to realize that some damage will likely occur to the ATB and subgrade during construction and repair may be necessary prior to final paving. Areas accessible to heavy construction traffic should be limited to prevent excessive damage to the ATB and subgrade.

We recommend that the ATB be evaluated by proofrolling prior to placing final pavement. Soft areas observed during proof rolling should be removed and the subgrade repaired as recommended above under "Site Preparation."

SEISMICITY

General

The Puget Sound area is a seismically active region and has experienced thousands of earthquakes in historical time. Seismicity in this region is attributed primarily to the interaction between the Pacific, Juan de Fuca and North American plates. The Juan de Fuca plate is subducting beneath the North American Plate. Each year 1,000 to 2,000 earthquakes occur in Oregon and Washington. However, only five to 20 of these are typically felt because the majority of recorded earthquakes are smaller than Richter magnitude 3.

In recent years two large earthquakes occurred which resulted in some liquefaction in loose alluvial deposits and significant damage to some structures. The first earthquake, which was centered in the Olympia area, occurred in 1949 with a Richter magnitude of 7.1. The second earthquake, which occurred in 1965, was centered between Seattle and Tacoma and had a Richter magnitude of 6.5.

Uniform Building Code (UBC) Site Coefficient

The Puget Sound region is designated as a Seismic Zone 3 in the 1997 edition of the Uniform Building Code (UBC). For Zone 3 locations, a Seismic Zone Factor (Z) of 0.30 is applicable based on UBC Table 16-I. In our opinion, the soil profile at the site is best characterized as Type Sc, based on UBC Table 16-J.

Design Earthquake Levels

The key seismic design parameters are the peak acceleration and the Richter magnitude of the earthquake. In general, a design earthquake is chosen based on the probability that the design earthquake will not be exceeded over a given time period. The level of seismicity recommended in the 1997 edition of the UBC for human occupancy buildings is an earthquake with a 10 percent probability of being exceeded in a 50-year period. The design earthquake event that corresponds to this probability is an earthquake with a Richter magnitude of 7.5 and a peak horizontal ground acceleration of approximately 0.3g.

Liquefaction Potential

Liquefaction is a condition where soils experience a rapid loss of internal strength as a consequence of strong ground shaking. Ground settlement, lateral spreading and/or sand boils may result from soil liquefaction. Structures supported on liquefied soils can suffer foundation settlement or lateral movement that may be severely damaging to the structures.

Conditions favorable to liquefaction occur in loose to medium dense, clean to moderately silty sand that is below the ground water table. This condition is not present at this site.

DRAINAGE CONSIDERATIONS

We expect that shallow perched groundwater may be encountered during grading, and foundation and utility excavation. We anticipate that this water can be temporarily handled during construction by ditching and pumping from sumps, as necessary. All collected water should be safely routed to suitable discharge points.

We recommend that perimeter footing drains be installed for all buildings. The perimeter drains should be installed at the base of the exterior footings. The perimeter drains should be provided with cleanouts and should consist of at least 4-inch-diameter perforated, smooth-walled PVC pipe placed on a bed of, and surrounded by 6 inches of drainage material enclosed in a non-woven geotextile to prevent fine soil from migrating into the drain material. The drainage zone should consist of free-draining gravel containing less than 3 percent fines. The perimeter drains should be sloped to drain by gravity, if practicable, to a suitable discharge point, preferably a storm drain.

Roof runoff should be collected in a tightline system and routed to suitable discharge points. All paved and landscaped areas should be graded so that surface drainage is directed away from the buildings to appropriate catch basins.

LIMITATIONS

We have prepared this report for use by Briar Development Company, Haggen, Inc., Pacific Land Design and other members of the design team for use in the design of a portion of this project. The conclusions and recommendations in this report should be applied in their entirety. The data and report should be provided to prospective contractors for bidding or estimating purposes; but our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

The project was in the preliminary design stage at the time this report was prepared. We expect that additional consultation will be necessary during design development. If there are any changes in the grades, location, configuration or type of construction planned, the conclusions and recommendations presented in this report might not be fully applicable. If such changes are made, we should be engaged to review our conclusions and recommendations and to provide written modification or verification, as appropriate. When the design is finalized, we recommend that we be engaged to review those portions of the specifications and drawings that relate to geotechnical considerations to see that our recommendations have been interpreted and implemented as intended.

There are possible variations in subsurface conditions between the locations of explorations. Variations may also occur with time. Some contingency for unanticipated conditions should be included in the project budget and schedule. We strongly recommend that sufficient monitoring, testing and consultation be provided by our firm during construction to (1) determine if the conditions encountered are consistent with those indicated by the explorations, (2) provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and (3) evaluate whether or not earthwork and foundation installation activities comply with the contract plans and specifications.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in this area at the time the report was prepared. No warranty or other conditions, express or implied, should be understood.

◆

We trust this provides the information you require at this time. We appreciate the opportunity to be of service to you on this project. Please contact us should you have any questions concerning our findings or recommendations, or should you require additional information.

JEROME J. McFADDEN, JR.
STATE OF WASHINGTON
26693
REGISTERED PROFESSIONAL ENGINEER
6/21/99
EXPIRES 3/4/01

Respectfully submitted,

GeoEngineers, Inc.

Bo McFadden, P.E.
Associate

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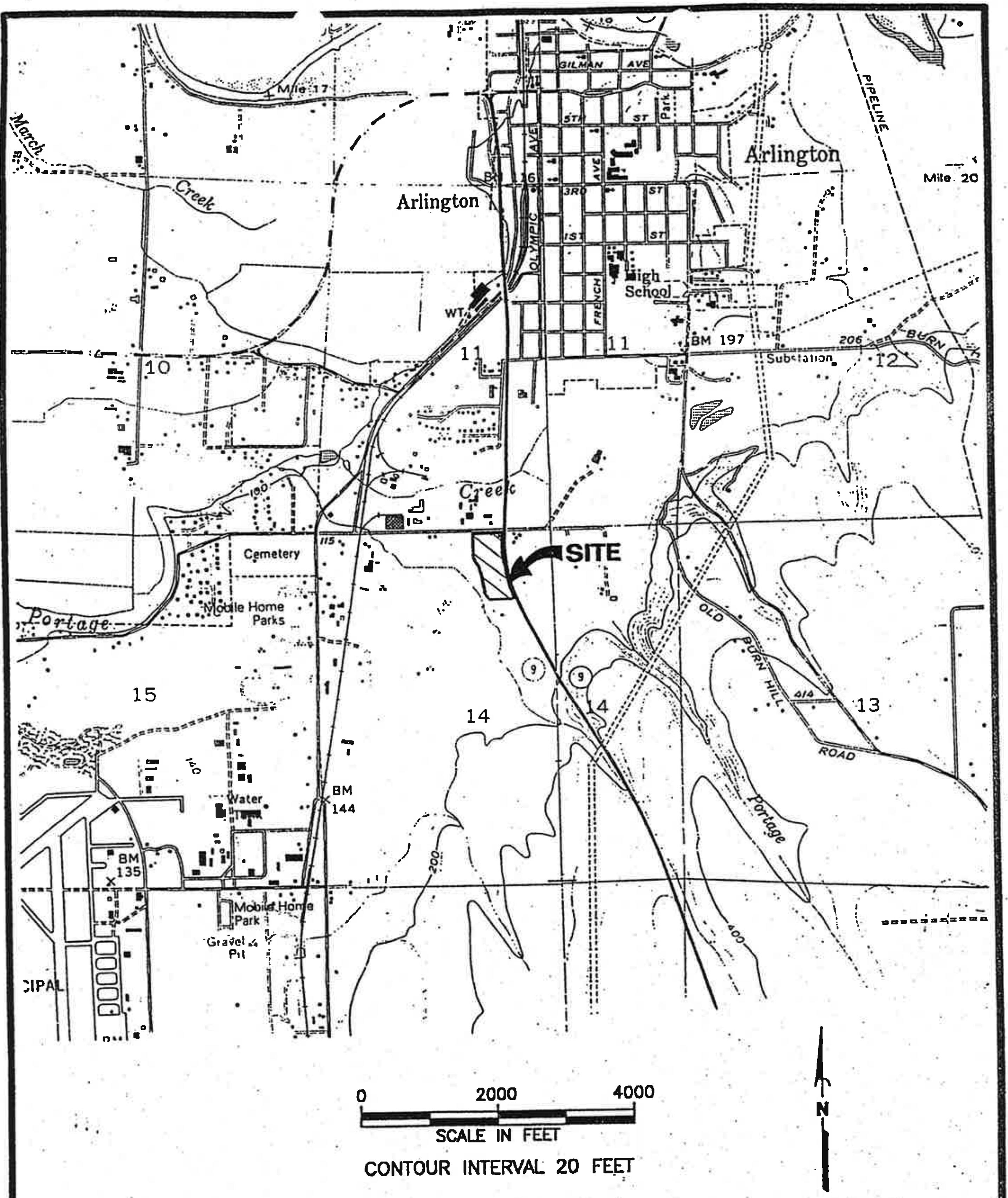

Reference: USGS 7.5' topographic quadrangle map "Arlington East, Wash." photorevised 1968 and "Arlington West, Wash." photorevised 1981.

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VICINITY MAP

FIGURE 1

04/29/99

1160-018-01

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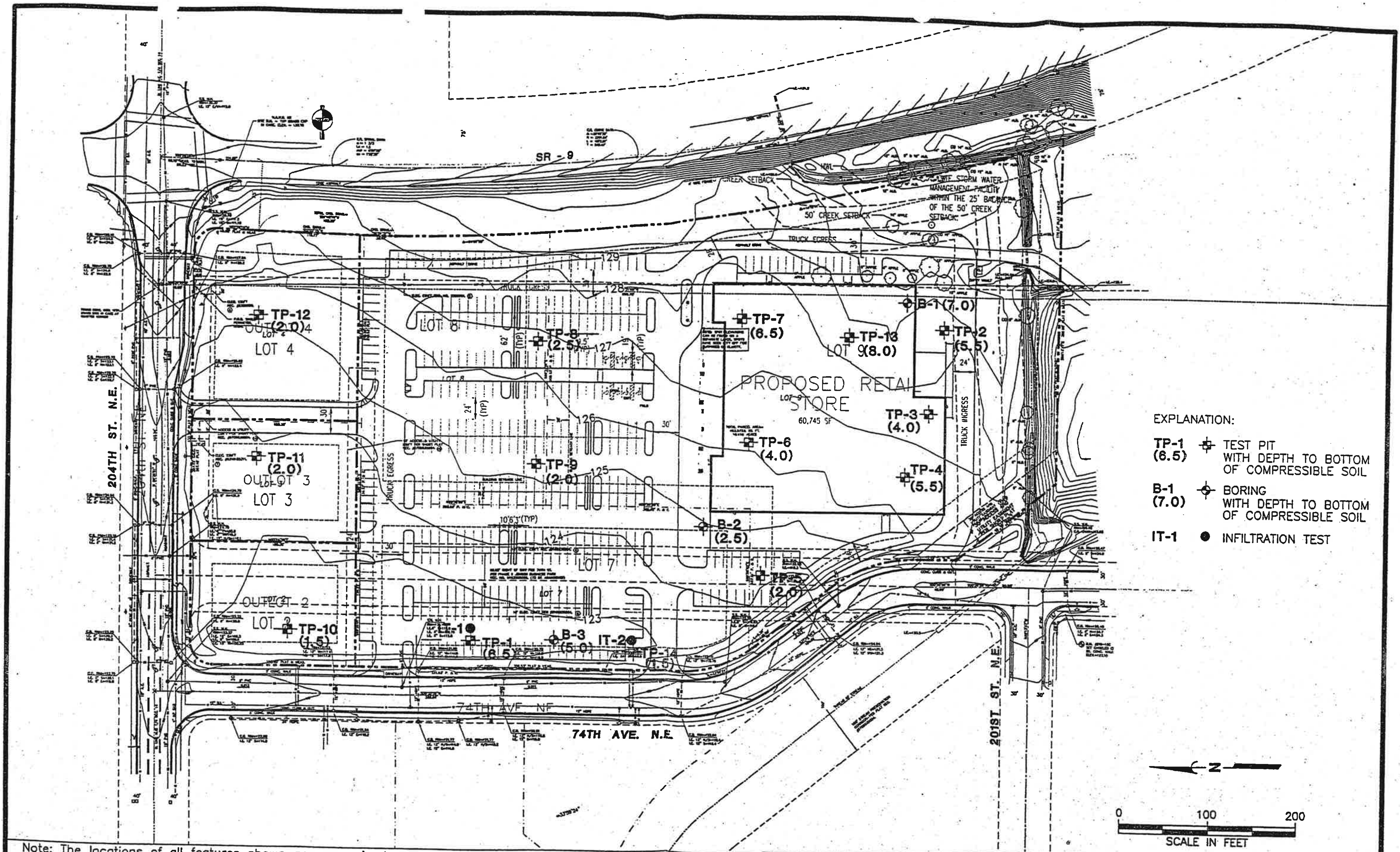

Note: The locations of all features shown are approximate.

Reference: Drawing entitled "Arlington Retail Site, Lots 2,3,4,7,8 & 9, Short Plat, Jensen Business Park – Phase III" by Penhallegon Assoc. Consulting Engineers, Inc. dated 01/21/99 and drawing entitled "Concept Plan, Proposed Retail, Arlington, Wash." by Pacific Land Design dated 03/15/99.

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SITE PLAN

FIGURE 2

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APPENDIX A

FIELD EXPLORATIONS AND LABORATORY TESTING

APPENDIX A

FIELD EXPLORATIONS AND LABORATORY TESTING

FIELD EXPLORATIONS

We explored subsurface soil and groundwater conditions at the site by drilling three borings (B-1 through B-3) to depths of 20.0 to 40.0 feet below the existing ground surface. Gregory Drilling Inc. of Redmond, Washington completed the borings on April 13, 1999 using a CME 85 truck-mounted hollow-stem auger drill rig. In addition, 14 test pits (TP-1 through TP-14) were excavated to depths of about 8.0 to 12.0 feet below the existing ground surface. Custom Backhoe and Dumptruck Service, Inc. of Bellevue, Washington excavated the test pits on April 14, 1999 using a Case 580K rubber-tired backhoe.

Two in-field infiltration tests (IT-1 and IT-2) were performed on April 14, 1999 using a test procedure modified from the Environmental Protection Agency (EPA) falling head percolation test (EPA Design Manual Onsite Wastewater Treatment and Disposal Systems dated 1982). Infiltration tests IT-1 and IT-2 were completed at depths of 9.5 and 9.0 feet below the ground surface, respectively, in the west portion of the site where infiltration of storm water is proposed. A solid wall, 6-inch-diameter polyvinyl chloride (PVC) pipe was placed in the bottom of the excavation and secured in-place by lightly tamping and backfilling around the pipe. Following the initial 4-hour pre-soak period 6-inches of water was placed in the pipe. Water level measurements were recorded at specified intervals, each time adjusting the water level back to the reference level of 6-inches above the bottom of the hole. Water level measurements were continued until consistent infiltration rates were observed. The PVC pipe was removed and the excavation backfilled at the end of each test.

Locations of the explorations and percolation tests were determined in the field by pacing distances from existing site features and/or matching the contours on the site Boundary and Topographic Survey prepared by Penhallegon Associates Consulting Engineers, Inc. dated January 21, 1999. Ground surface elevations shown on the exploration logs are based on the same topographic map. The locations of the explorations infiltration tests are shown on the Site Plan, Figure 2.

The explorations were continuously monitored by a geologist from our firm who visually examined and classified the soils encountered, obtained representative soil samples, observed ground water conditions, and prepared a detailed log of each exploration. A 3-inch outside-diameter, heavy-duty split-barrel sampler with brass liner rings was used to obtain relatively undisturbed samples from the borings. A 300-pound automatic hammer was used to drive the sampler. The blow counts resulting from driving the sampler with a 300-pound hammer falling 30 inches area roughly equivalent to those from the Standard Penetration Test. The number of blows required to drive the sampler the least 12 inches, or other indicated distance, is recorded on the boring logs. Corrections are necessary to adjust for the efficiency of the automatic hammer (generally 90 to 93 percent efficient) when using the blow count data for analyses. Disturbed grab samples were obtained from the test pits with occasional undisturbed (thin-wall) samples obtained in the soft compressible soils. Soils encountered were visually classified in general accordance with the classification system described in Figure A-1. A key to the boring log symbols is presented in Figure A-2. The boring logs are presented in Figures A-3 through A-5. The test pit logs are presented in Figures A-6 through A-11. The logs are based on our interpretation of the field and laboratory data and indicate the various types of soils encountered. They also indicate the depths at which the soils or their characteristics change, although the change might actually be gradual. The densities noted on the boring logs are based on the blow counts. The densities noted on the test pit logs are based on the difficulty of excavating, probing with a ½-inch-diameter hand probe, and our experience and judgment of the conditions encountered. The borings were backfilled in general accordance with local regulatory requirements. The test pits were backfilled with the excavated material and compacted to the extent possible using the backhoe bucket.

LABORATORY TESTING

Selected soil samples obtained from the borings and test pits were returned to our lab and visually examined to confirm or modify field classifications. Selected soil samples were tested to determine their natural moisture content and dry density. The results of the moisture content and density determinations for samples obtained from the borings are presented on the boring logs. The results of moisture content determinations for samples obtained from the test pits are presented in Figure A-12. In addition, sieve analyses were completed on selected samples to determine their grain size distribution (ASTM D422 and D1140). The sieve analyses results for a composite sample of the sand and gravel with silt that we observed in the test pits is presented in Figure A-13. The composite sample consists of the following samples:

Exploration Number	Sample Depth (Feet)
TP-6	5.0
TP-9	6.7
TP-10	3.0
TP-12	5.0

One consolidation test was completed on a representative sample of the compressible organic soil (peat) encountered in the test pits. The results of this test are presented in Figure A-14.

SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE GRAINED SOILS More Than 50% Retained on No. 200 Sieve	GRAVEL More Than 50% of Coarse Fraction Retained on No. 4 Sieve	CLEAN GRAVEL	GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND More Than 50% of Coarse Fraction Passes No. 4 Sieve	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY-GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE GRAINED SOILS More Than 50% Passes No. 200 Sieve	SILT AND CLAY Liquid Limit Less Than 50	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILT AND CLAY Liquid Limit 50 or More	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC CLAY, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT
SOIL PREDOMINANTLY COMPOSED OF COAL FRAGMENTS (SEE NOTE BELOW)			CF	COAL FRAGMENTS

NOTES:

1. Field classification is based on visual examination of soil in general accordance with ASTM D2488-90.
2. Soil classification using laboratory tests is in general accordance with ASTM D2487-90.
3. Descriptions of soil density or consistency are based on interpretation of blow count data, visual appearance of soils, and/or test data.
4. Fill beneath much of the site consists of coal fragments. The coal originated from mining operations conducted on nearby properties. The texture of this material varies, but consists predominantly of silt- and sand-size coal fragments with occasional gravel-size fragments.

SOIL MOSTURE MODIFIERS:

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

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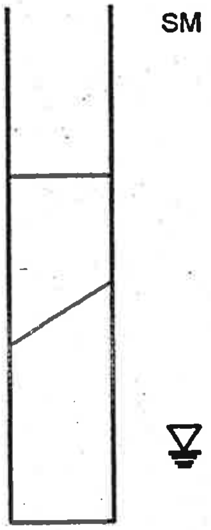
SOIL CLASSIFICATION SYSTEM

FIGURE A-1

LABORATORY TESTS

AL	Atterberg Limits
CP	Compaction
CS	Consolidation
DS	Direct shear
GS	Grain size
%F	Percent fines
HA	Hydrometer Analysis
SK	Permeability
SM	Moisture Content
MD	Moisture and density
SP	Swelling pressure
TX	Triaxial compression
UC	Unconfined compression
CA	Chemical analysis

SOIL GRAPH:



SM Soil Group Symbol (See Note 2)

Distinct Contact Between Soil Strata

Gradual or Approximate Location of Change Between Soil Strata

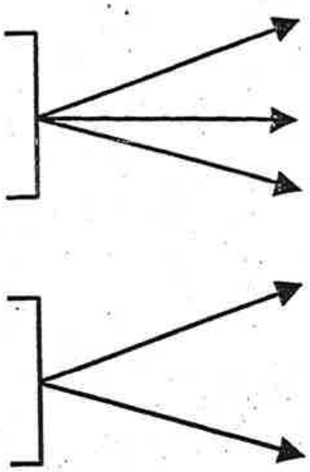
Water Level

Bottom of Boring

BLOW COUNT/SAMPLE DATA:

Blows required to drive a 2.4-inch I.D. split-barrel sampler 12 inches or other indicated distances using a 300-pound hammer falling 30 inches.

Blows required to drive a 1.5-inch I.D. (SPT) split-barrel sampler 12 inches or other indicated distances using a 140-pound hammer falling 30 inches.



22 ■ Location of relatively undisturbed sample

12 ☒ Location of disturbed sample

17 ☐ Location of sampling attempt with no recovery

10 ▐ Location of sample obtained in general accordance with Standard Penetration Test (ASTM D-1586) procedures

26 ◫ Location of SPT sampling attempt with no recovery

☰ Location of grab sample

"P" indicates sampler pushed with weight of hammer or against weight of drill rig.

NOTES:
1. The reader must refer to the discussion in the report text, the Key to Boring Log Symbols and the exploration logs for a proper understanding of subsurface conditions.
2. Soil classification system is summarized in Figure A-1.

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KEY TO BORING LOG SYMBOLS

FIGURE A-2

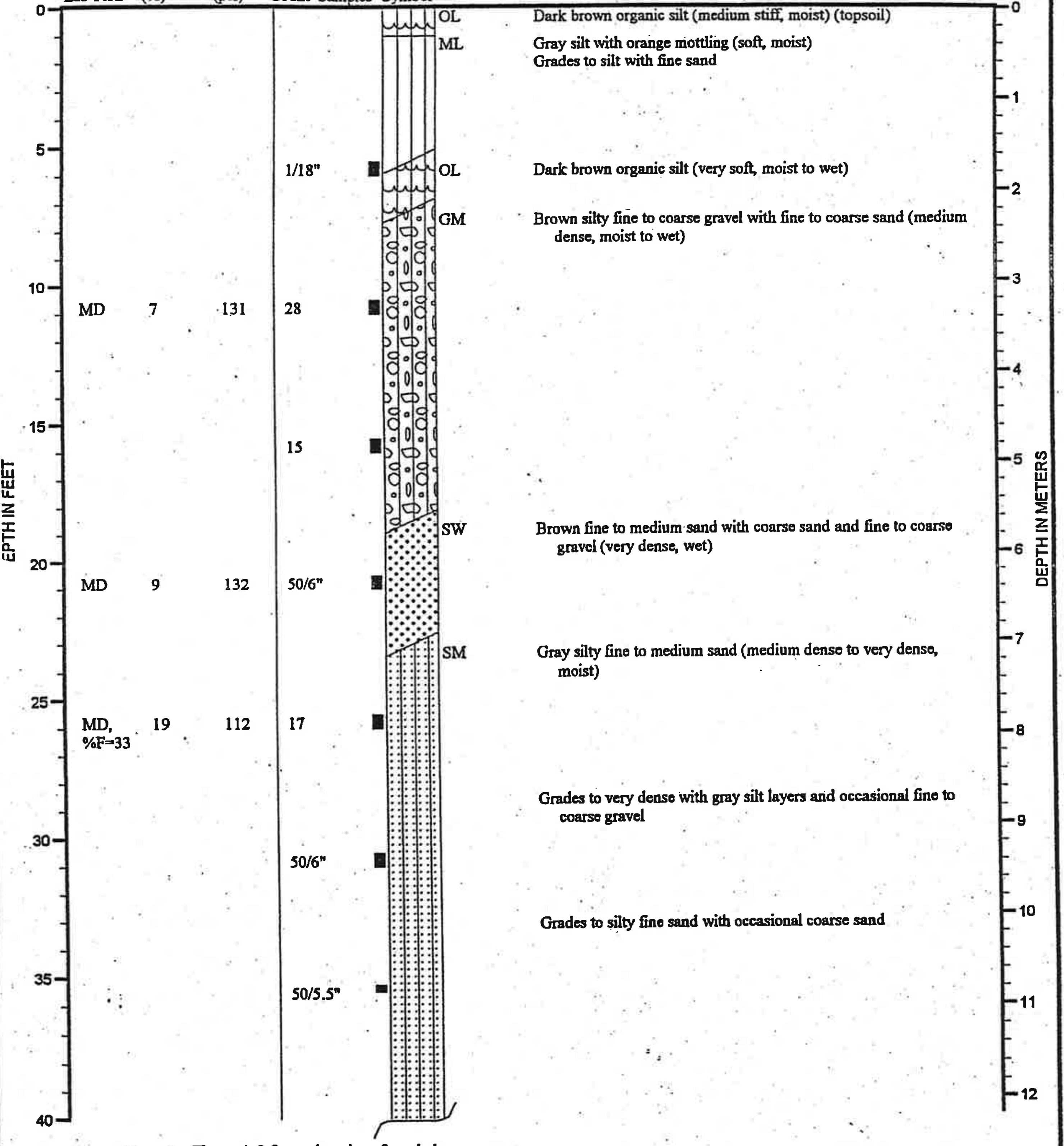
0000-000-00-0000 XXX:XXXxxx 00/00/00 (a-2ns.ppt)

BORING B-1

TEST DATA

DESCRIPTION

Surface Elevation (ft.): 129



Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	Description
					OL	Dark brown organic silt (medium stiff, moist) (topsoil)
					ML	Gray silt with orange mottling (soft, moist) Grades to silt with fine sand
			1/18"	■	OL	Dark brown organic silt (very soft, moist to wet)
					GM	Brown silty fine to coarse gravel with fine to coarse sand (medium dense, moist to wet)
MD	7	131	28	■		
			15	■		
					SW	Brown fine to medium sand with coarse sand and fine to coarse gravel (very dense, wet)
MD	9	132	50/6"	■		
					SM	Gray silty fine to medium sand (medium dense to very dense, moist)
MD, %F=33	19	112	17	■		
						Grades to very dense with gray silt layers and occasional fine to coarse gravel
			50/6"	■		
						Grades to silty fine sand with occasional coarse sand
			50/5.5"	■		

Note: See Figure A-2 for explanation of symbols

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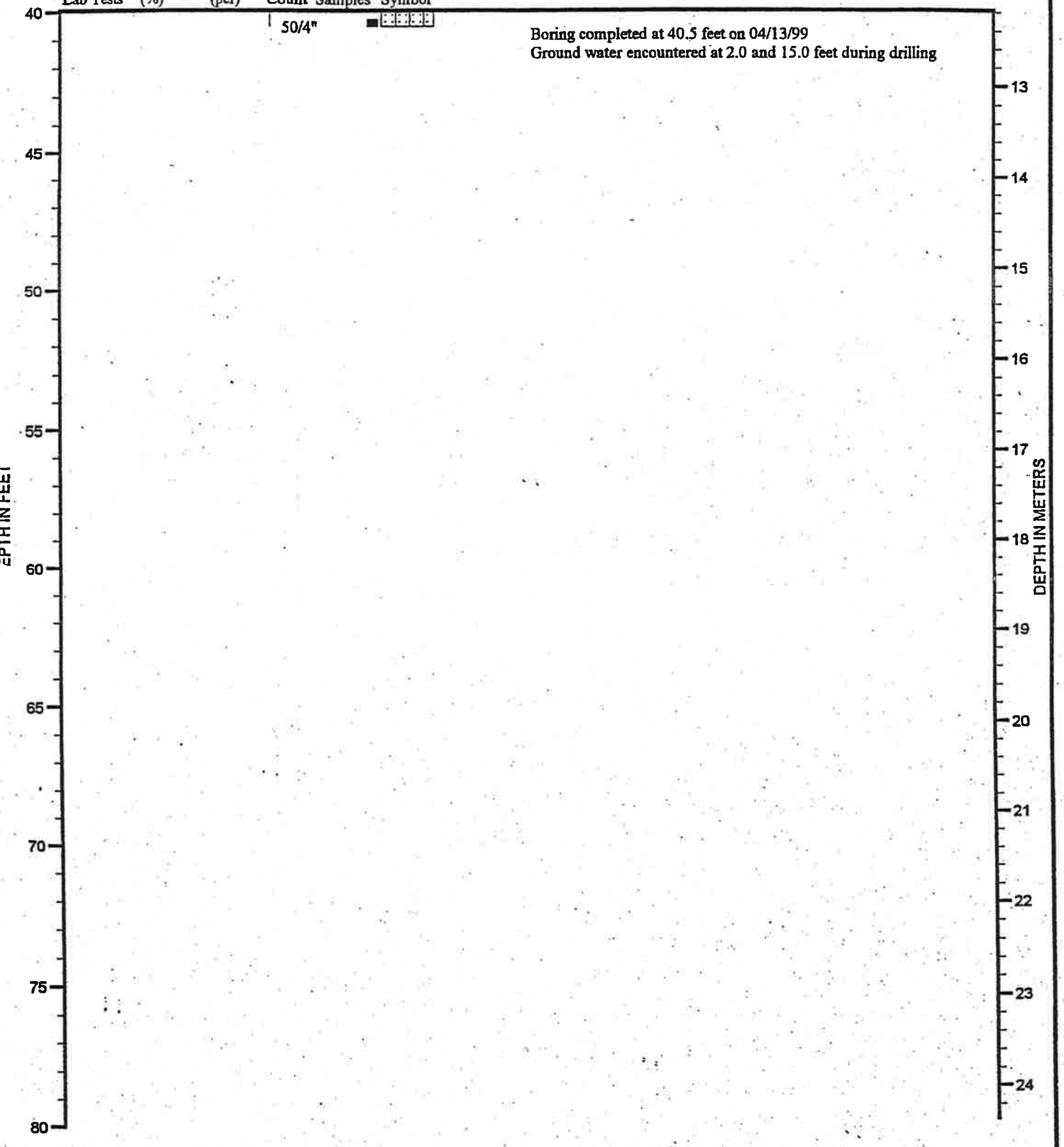
LOG OF BORING

FIGURE A-3

TEST DATA

BORING B-1
(Continued)

Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	DESCRIPTION
			50/4"	■	⁙	Boring completed at 40.5 feet on 04/13/99 Ground water encountered at 2.0 and 15.0 feet during drilling



Note: See Figure A-2 for explanation of symbols

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LOG OF BORING

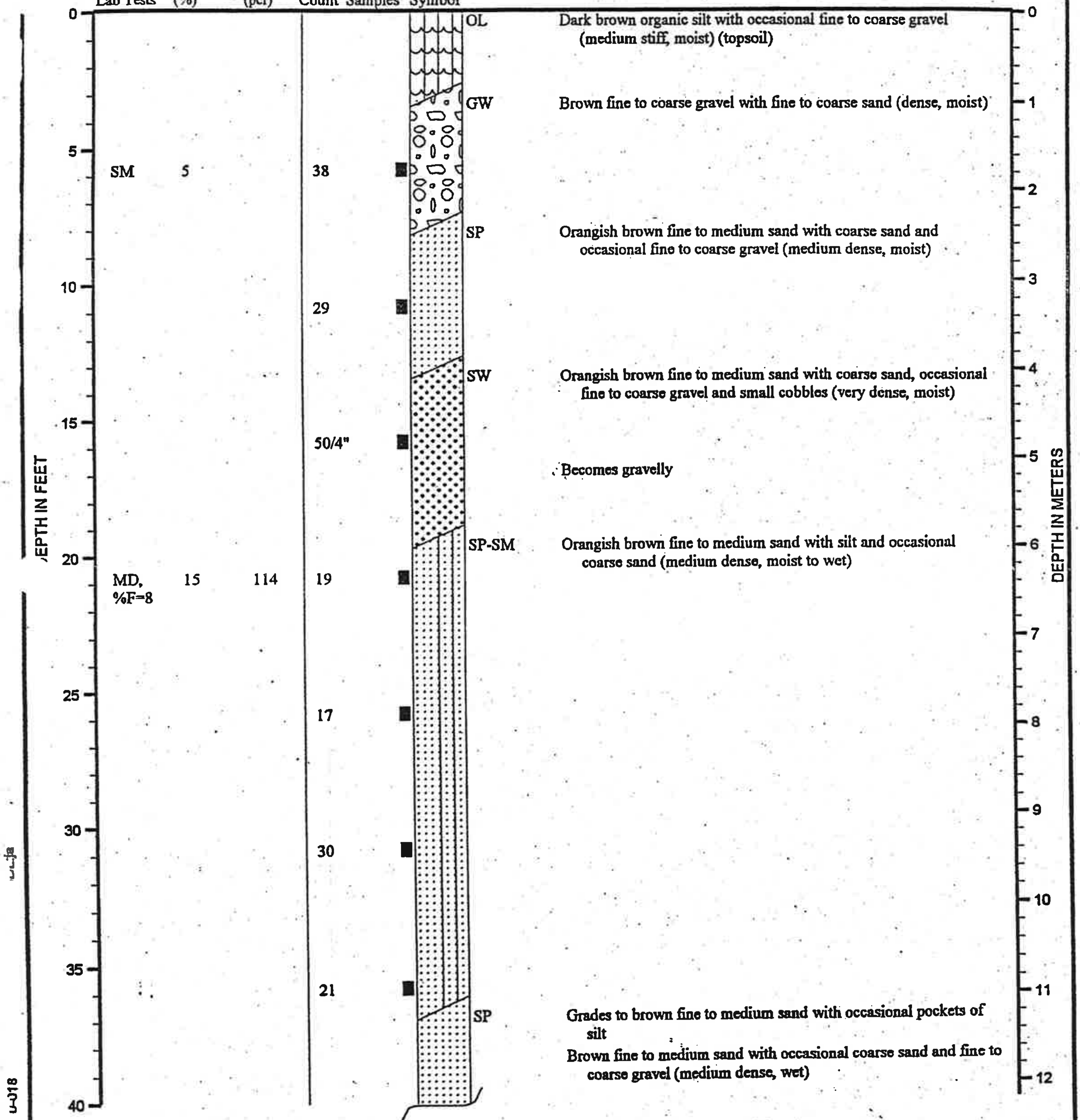
FIGURE A-3

TEST DATA

BORING B-2

DESCRIPTION

Surface Elevation (ft.): 125



Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	Description
					OL	Dark brown organic silt with occasional fine to coarse gravel (medium stiff, moist) (topsoil)
					GW	Brown fine to coarse gravel with fine to coarse sand (dense, moist)
SM	5		38	■		
					SP	Orangish brown fine to medium sand with coarse sand and occasional fine to coarse gravel (medium dense, moist)
			29	■		
					SW	Orangish brown fine to medium sand with coarse sand, occasional fine to coarse gravel and small cobbles (very dense, moist)
			50/4"	■		
						Becomes gravelly
					SP-SM	Orangish brown fine to medium sand with silt and occasional coarse sand (medium dense, moist to wet)
MD, %F=8	15	114	19	■		
			17	■		
			30	■		
			21	■		
					SP	Grades to brown fine to medium sand with occasional pockets of silt
						Brown fine to medium sand with occasional coarse sand and fine to coarse gravel (medium dense, wet)

Note: See Figure A-2 for explanation of symbols

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LOG OF BORING

FIGURE A-4

TEST DATA

BORING B-2
(Continued)

Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	DESCRIPTION
MD	24	103	18	■	▨	Boring completed at 41.5 feet on 04/13/99 Ground water encountered at 17.5 feet during drilling

EPTH IN FEET

40
45
50
55
60
65
70
75
80

DEPTH IN METERS

13
14
15
16
17
18
19
20
21
22
23
24

Note: See Figure A-2 for explanation of symbols

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LOG OF BORING

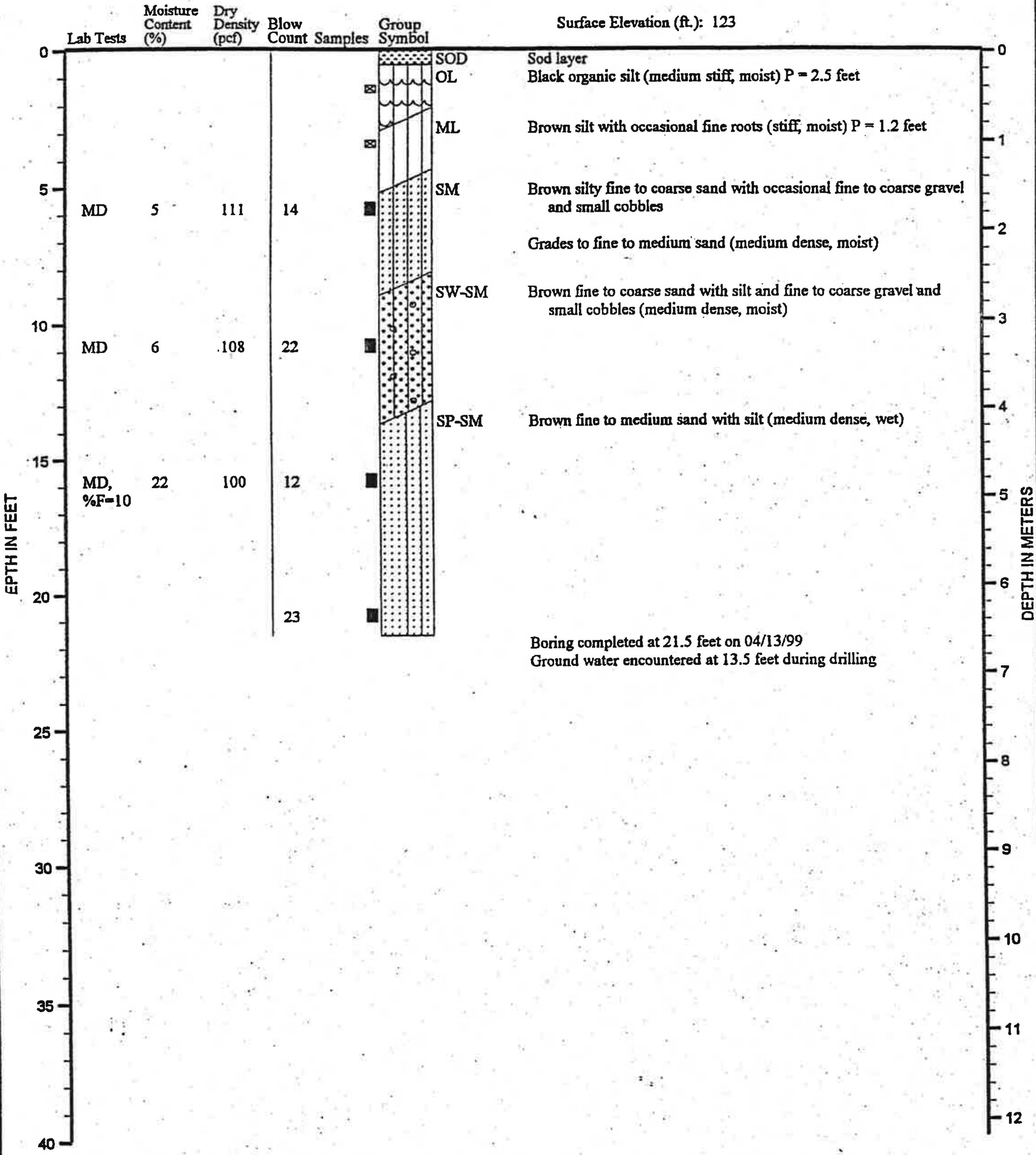
FIGURE A-4

TEST DATA

BORING B-3

DESCRIPTION

Surface Elevation (ft.): 123



Lab Tests	Moisture Content (%)	Dry Density (pcf)	Blow Count	Samples	Group Symbol	Description
					SOD	Sod layer
				⊠	OL	Black organic silt (medium stiff, moist) P = 2.5 feet
				⊠	ML	Brown silt with occasional fine roots (stiff, moist) P = 1.2 feet
					SM	Brown silty fine to coarse sand with occasional fine to coarse gravel and small cobbles
MD	5	111	14	■		
						Grades to fine to medium sand (medium dense, moist)
					SW-SM	Brown fine to coarse sand with silt and fine to coarse gravel and small cobbles (medium dense, moist)
MD	6	108	22	■		
					SP-SM	Brown fine to medium sand with silt (medium dense, wet)
MD, %F=10	22	100	12	■		
			23	■		

Boring completed at 21.5 feet on 04/13/99
Ground water encountered at 13.5 feet during drilling

Note: See Figure A-2 for explanation of symbols

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LOG OF BORING

FIGURE A-5

LOG OF TEST PIT

DEPTH BELOW GROUND SURFACE (FEET)	SOIL GROUP CLASSIFICATION SYMBOL	DESCRIPTION
		TEST PIT 1
		Approximate ground surface elevation: 123 feet
0.0 - .20	SOD	2-inch sod layer
.20 - 4.5	OL	Black organic silt (medium stiff, moist) (topsoil)
4.5 - 6.5	ML	Light brown silt with occasional fine to coarse sand and fine to coarse gravel (medium stiff, moist)
6.5 - 9.5	SM	Brown silty fine to medium sand with coarse sand and occasional fine to coarse gravel (medium dense, moist)
		Test pit completed at 9.5 feet on 04/14/99
		No ground water seepage observed
		No caving observed
		TEST PIT 2
		Approximate ground surface elevation: 128.5 feet
0.0 - 0.5	SOD	Sod layer
0.5 - 1.5	OL	Black organic silt (medium stiff, moist) (topsoil)
1.5 - 5.5	ML	Gray silt (stiff, moist) Grades to orange mottling at 2.5 feet Grades too soft at 4.0 feet
5.5 - 9.0	SM	Dark brown and gray silty fine to coarse sand with fine to coarse gravel with thin layers of organic silt
		Test pit completed at 9.0 feet on 04/14/99
		Moderate ground water seepage observed at 4.0 feet
		Severe caving observed at 5.0 feet
		Disturbed soil samples obtained at 2.5 feet

THE DEPTHS OF THE TEST PIT LOGS, ALTHOUGH SHOWN TO 0.1 FOOT, ARE BASED ON AN AVERAGE OF MEASUREMENTS ACROSS THE TEST PIT AND SHOULD BE CONSIDERED ACCURATE TO 0.5 FOOT

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LOG OF TEST PIT

FIGURE A-6

1160-018-00 JDL:ja 041999 (testpits.xls)

LOG OF TEST PIT

DEPTH BELOW GROUND SURFACE (FEET)	SOIL GROUP CLASSIFICATION SYMBOL	DESCRIPTION
		TEST PIT 3
		Approximate ground surface elevation: 127.5 feet
0.0 - 0.5	SOD	Sod layer
0.5 - 1.5	OL	Black organic silt with occasional fine to coarse sand (medium stiff, moist) (topsoil)
1.5 - 2.5	ML	Brown silt with orange mottling (medium stiff, moist)
2.5 - 2.75	OL	Black organic silt (medium stiff, moist)
2.75 - 3.25	SM	Brown silty fine sand (medium dense, moist)
3.25 - 3.75	OL	Black organic silt (medium stiff, moist)
3.75 - 8.25	SM	Brownish gray mottled silty fine sand (medium dense, moist to wet)
8.25 - 11.75	SP	Brown fine to medium sand with coarse sand and occasional fine to coarse gravel (dense, wet) Grades to gravelly sand with cobbles at 9.75 feet
		Test pit completed at 11.5 feet on 04/14/99 Moderate ground water seepage observed at 5.4 feet Minor caving observed at 5.0 feet Disturbed soil samples obtained at 2.5 and 8.5 feet
		TEST PIT 4
		Approximate ground surface elevation: 126.5 feet
0.0 - 0.5	SOD	Sod layer
0.5 - 3.0	OL	Black organic silt (medium stiff, moist) (topsoil)
3.0 - 5.3	ML	Brown silt (stiff, moist)
5.3 - 11.6	SP	Brown fine to medium sand with coarse sand, occasional fine to coarse gravel and cobbles (dense, wet)
		Test pit completed at 11.6 feet on 04/14/99 No ground water seepage observed Minor caving observed at 5.0 feet Disturbed soil samples obtained at 6.0 feet
		TEST PIT 5
		Approximate ground surface elevation: 124 feet
0.0 - 0.5	SOD	Sod layer
0.5 - 2.0	OL	Black organic silt (medium stiff, moist) (topsoil)
2.0 - 4.0	SP	Brown fine to medium sand with coarse sand, occasional fine to coarse gravel and cobbles (medium dense, moist)
4.0 - 10.5	GW	Brown fine to coarse gravel with fine to coarse sand (dense, moist)
		Test pit completed at 10.5 feet on 04/14/99 No ground water seepage observed No caving observed

THE DEPTHS OF THE TEST PIT LOGS, ALTHOUGH SHOWN TO 0.1 FOOT, ARE BASED ON AN AVERAGE OF MEASUREMENTS ACROSS THE TEST PIT AND SHOULD BE CONSIDERED ACCURATE TO 0.5 FOOT

1160-018-00 JDL:ja 041999 (testpits.xls)

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LOG OF TEST PIT

FIGURE A-7

LOG OF TEST PIT

DEPTH BELOW GROUND SURFACE (FEET)	SOIL GROUP CLASSIFICATION SYMBOL	DESCRIPTION
		TEST PIT 6
		Approximate ground surface elevation: 126 feet
0.0 - 0.5	SOD	Sod layer
0.5 - 2.3	OL	Black organic silt (medium stiff, moist) (topsoil)
2.3 - 4.1	ML	Brown silt with fine sand (medium stiff, moist)
4.1 - 11.9	SW	Brown fine to coarse gravel with fine to coarse sand and small to large cobbles (dense, moist). Grades between sand with gravel and gravel with sand.
		Test pit completed at 11.9 feet on 04/14/99 No ground water seepage observed No caving observed Disturbed soil sample obtained at 5.0 feet
		TEST PIT 7
		Approximate ground surface elevation: 127.5 feet
0.0 - 0.5	SOD	Sod layer
0.5 - 2.5	OL	Black organic silt (medium stiff, moist) (topsoil)
2.5 - 3.0	SM	Brownish gray organic silt (medium stiff, moist)
3.0 - 3.2	OL	Black organic silt (soft, moist)
3.2 - 3.6	SM	Gray silty fine sand (medium dense, moist)
3.6 - 4.5	OL	Brownish gray organic silt (medium stiff, moist)
4.5 - 6.5	ML	Brownish gray silt with orange mottling (medium stiff, moist)
6.5 - 11.3	GW	Brown silty fine to coarse gravel with fine to coarse sand and cobbles (dense, wet)
		Test pit completed at 11.3 feet on 04/14/99 Moderate ground water seepage observed at 8.6 feet Moderate caving observed at 7.0 feet Disturbed soil samples obtained at 3.0 and 4.5 feet Undisturbed thin wall sample obtained at 3.0 feet

THE DEPTHS OF THE TEST PIT LOGS, ALTHOUGH SHOWN TO 0.1 FOOT, ARE BASED ON AN AVERAGE OF MEASUREMENTS ACROSS THE TEST PIT AND SHOULD BE CONSIDERED ACCURATE TO 0.5 FOOT

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LOG OF TEST PIT

FIGURE A-8

LOG OF TEST PIT

DEPTH BELOW GROUND SURFACE (FEET)	SOIL GROUP CLASSIFICATION SYMBOL	DESCRIPTION
		TEST PIT 8
		Approximate ground surface elevation: 126.5 feet
0.0 - 0.5	SOD	Sod layer
0.5 - 2.5	OL	Black organic silt (medium stiff, moist) (topsoil)
2.5 - 4.0	SP	Brown fine to medium sand with coarse sand and occasional fine to coarse gravel (medium dense, moist)
4.0 - 8.0	GW	Brown fine to coarse gravel with fine to coarse sand and cobbles (dense, moist)
8.0 - 10.5	SP	Brown fine to medium sand with coarse sand, occasional fine to coarse gravel and cobbles (medium dense, moist)
		Test pit completed at 10.5 feet on 04/14/99 No ground water seepage observed No caving observed
		TEST PIT 9
		Approximate ground surface elevation: 125 feet
0.0 - 0.5	SOD	Sod layer
0.5 - 2.2	OL	Black organic silt (medium stiff, moist) (topsoil)
2.2 - 5.0	SP/SW	Brown fine to coarse sand with fine to coarse gravel and cobbles interbedded with lenses of fine to coarse gravel with fine to coarse sand and cobbles (medium dense, moist)
5.0 - 6.0	SP	Brown fine to medium sand with occasional fine to coarse gravel (medium dense, moist)
6.0 - 12.2	GW	Fine to coarse gravel with fine to coarse sand and cobbles (dense, moist)
		Test pit completed at 12.2 feet on 04/14/99 No ground water seepage observed No caving observed Disturbed soil samples obtained at 6.7 feet
		TEST PIT 10
		Approximate ground surface elevation: 123 feet
0.0 - 1.5	OL	Black organic silt (medium stiff, moist) (topsoil)
1.5 - 10.5	SW	Brown fine to coarse sand with occasional fine to coarse gravel (dense, moist) Grades to fine to coarse sand with fine to coarse gravel and cobbles at 4 feet
		Test pit completed at 10.5 feet on 04/14/99 No ground water seepage observed No caving observed Disturbed soil samples obtained at 1.0 and 3.0 feet

THE DEPTHS OF THE TEST PIT LOGS, ALTHOUGH SHOWN TO 0.1 FOOT, ARE BASED ON AN AVERAGE OF MEASUREMENTS ACROSS THE TEST PIT AND SHOULD BE CONSIDERED ACCURATE TO 0.5 FOOT

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LOG OF TEST PIT

FIGURE A-9

1160-018-00 JDL:ja 041999 (testpits.xls)

LOG OF TEST PIT

DEPTH BELOW GROUND SURFACE (FEET)	SOIL GROUP CLASSIFICATION SYMBOL	DESCRIPTION
		TEST PIT 11
		Approximate ground surface elevation: 124 feet
0.0 - 0.2	SOD	Sod layer
0.2 - 2.2	OL	Black organic silt (medium stiff, moist) (topsoil)
2.2 - 4.0	GW	Brown fine to coarse gravel with fine to coarse sand and cobbles (medium dense, moist)
4.0 - 11.5	SP	Brown fine to medium sand with occasional fine to coarse gravel, cobbles and boulders (dense to very dense, moist) 12 inch boulders encountered at 8.0 feet
		Test pit completed at 11.5 feet on 04/14/99 No ground water seepage observed No caving observed Disturbed soil samples obtained at 6.2 and 11.5 feet
		TEST PIT 12
		Approximate ground surface elevation: 125.5 feet
0.0 - 0.5	SOD	Sod layer
0.5 - 1.4	OL	Black organic silt (medium stiff, moist) (topsoil)
1.4 - 2.1	ML	Light brown silt with organic matter (medium stiff, moist)
2.1 - 11.5	SW	Brown fine to coarse sand with fine to coarse gravel and cobbles (dense, moist) Grades between fine to coarse sand with fine to coarse gravel and fine to coarse gravel with fine to coarse sand
		Test pit completed at 11.5 feet on 04/14/99 No ground water seepage observed No caving observed Disturbed soil samples obtained at 5.0 feet
		TEST PIT 13
		Approximate ground surface elevation: 128.5 feet
0.0 - 0.5	SOD	Sod layer
0.5 - 1.5	OL	Organic silt (medium stiff, moist) (topsoil)
1.5 - 3.1	ML	Light brown silt with fine sand (medium stiff, moist)
3.1 - 4.0	OL	Light brown organic silt (medium stiff, moist)
4.0 - 5.5	OL	Dark brown to black organic silt (soft, moist to wet)
5.5 - 8.0	OL	Gray organic silt (soft, moist)
8.0 - 12.1	GW	Grades between fine to coarse sand with fine to coarse gravel and fine to coarse gravel with fine to coarse sand
		Test pit completed at 12.1 feet on 04/14/99 No ground water seepage observed No caving observed Disturbed soil samples obtained at 2.5, 4.0, 4.5 and 7.0 feet Two undisturbed thin wall samples obtained at 4.0 foot depth

THE DEPTHS OF THE TEST PIT LOGS, ALTHOUGH SHOWN TO 0.1 FOOT, ARE BASED ON AN AVERAGE OF MEASUREMENTS ACROSS THE TEST PIT AND SHOULD BE CONSIDERED ACCURATE TO 0.5 FOOT

GeoEngineers

LOG OF TEST PIT

FIGURE A-10

LOG OF TEST PIT

DEPTH BELOW GROUND SURFACE (FEET)	SOIL GROUP CLASSIFICATION SYMBOL	DESCRIPTION
		TEST PIT 14 Approximate ground surface elevation: 123 feet
0.0 - 0.5	SOD	Sod layer
0.5 - 1.5	OL	Black organic silt (medium stiff, moist) (topsoil)
1.5 - 10.0	SW	Brown fine to coarse sand with fine to coarse gravel and cobbles encountered occasional boulders up to 24 inches (medium dense, moist)
		Test pit completed at 10.0 feet on 04/14/99 No ground water seepage observed Minor caving observed at 5.0 feet

THE DEPTHS OF THE TEST PIT LOGS, ALTHOUGH SHOWN TO 0.1 FOOT, ARE BASED ON AN AVERAGE OF MEASUREMENTS ACROSS THE TEST PIT AND SHOULD BE CONSIDERED ACCURATE TO 0.5 FOOT

GeoEngineers

LOG OF TEST PIT

FIGURE A-11

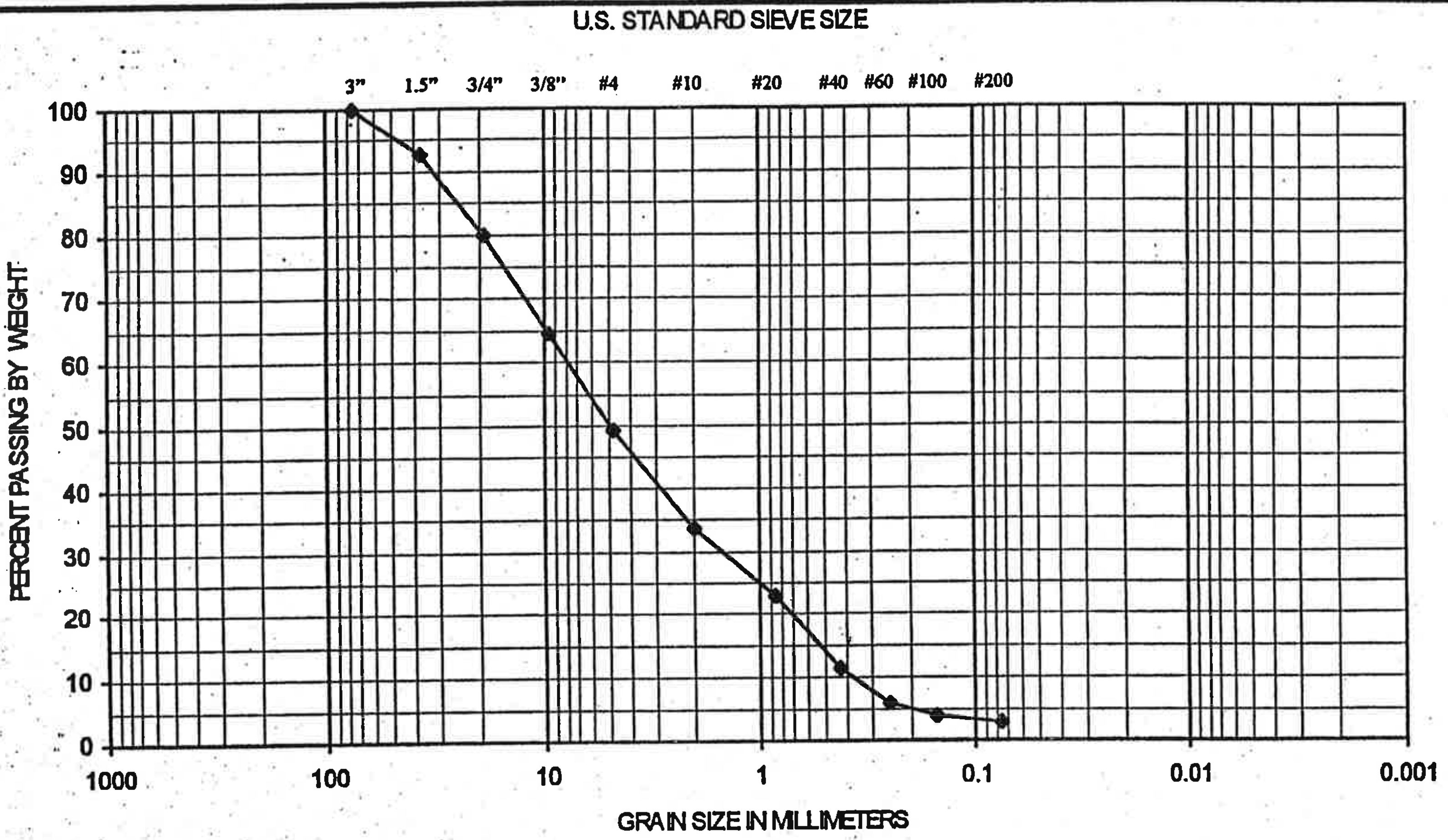
1160-018-00 JDL:ja 041999 (testpits.xls)

MOISTURE CONTENT

EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	SOIL CLASSIFICATION *	MOISTURE CONTENT (PERCENT)
TP-2	2.5	ML	33
TP-3	2.5	ML	21
TP-4	6.0	GW	12
TP-6	5.0	GW	6
TP-7	4.5	ML	34
TP-10	1.0	OH	36
TP-10	3.0	GW-GM	4
TP-11	6.0	GW	7
TP-12	5.0	GW	5
TP-13	7.0	ML	32

* Refer to test pit logs for complete soil description

1160-018-00 JJM:MBB:mbb 4/26/99 (Sieves.ppt)



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	EXPLORATION NUMBER	SAMPLE DEPTH	SOIL CLASSIFICATION
◆	Composite of TP 6, 9, 10, & 12	5.0', 6.7', 3.0', & 5.0', respectively	Brown fine to coarse gravel with medium to coarse sand (GW)

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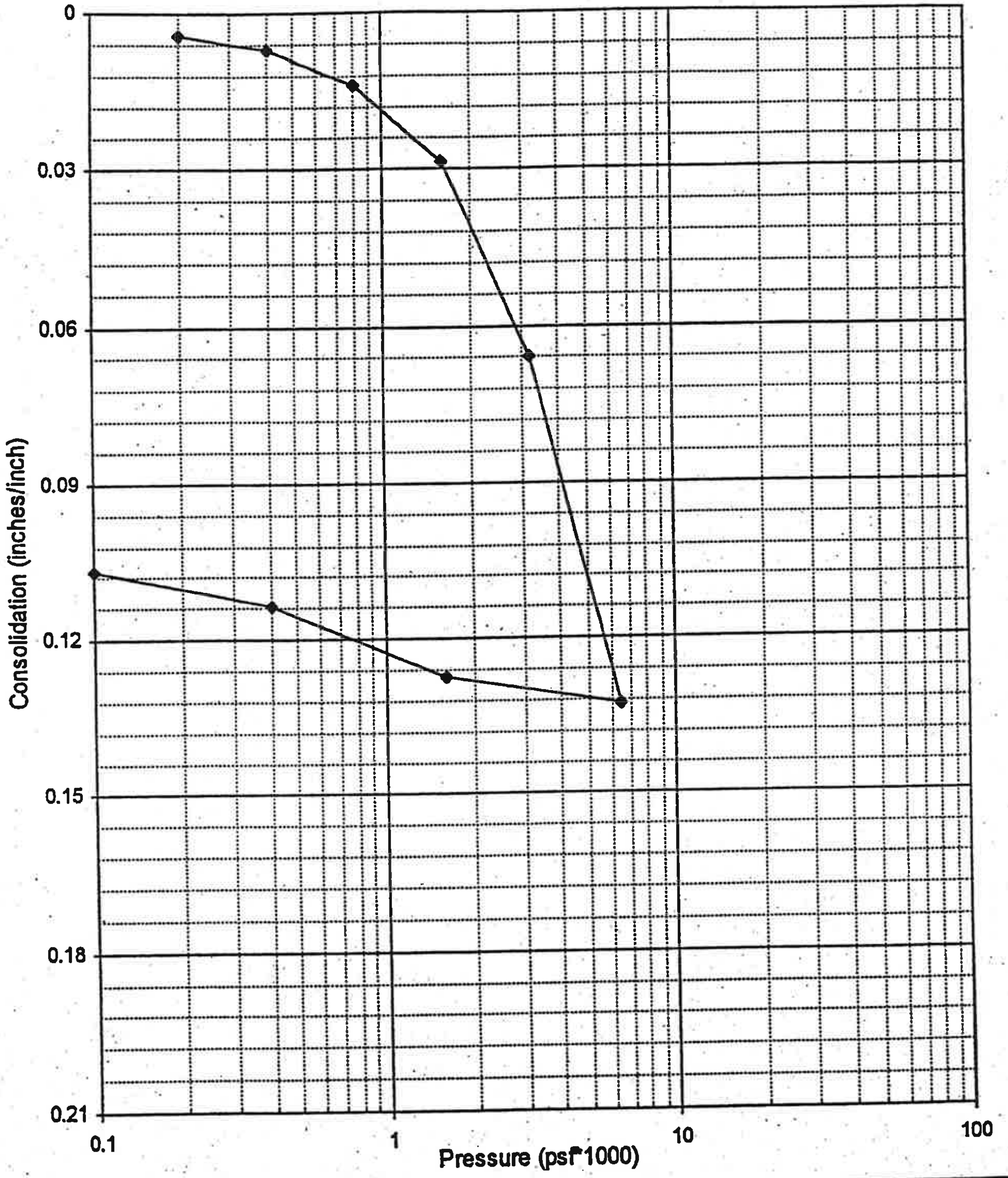
SIEVE ANALYSIS RESULTS

FIGURE A-13



BORING NUMBER	SAMPLE DEPTH (FEET)	SOIL CLASSIFICATION	INITIAL MOISTURE CONTENT	INITIAL DRY DENSITY (LBS/FT³)
TP-3	3	Dark brown organic silt (OL)	85	49

1160-018-00 JJM:pdr 04/30/99 (consol.ppt)

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CONSOLIDATION TEST RESULTS

FIGURE A-14

TERRA ASSOCIATES, Inc.

Consultants in Geotechnical Engineering, Geology
and
Environmental Earth Sciences

April 2, 2003
Project No. T-5358

Mr. Stuart Monson
PS Arlington, LLC
10515 – 20th Street SE, Suite 100
Everett, Washington 98205

Subject: Geotechnical Consultation
Haggen Food and Pharmacy
State Route 9 and 204th Street NE
Arlington, Washington

Reference: Geotechnical Engineering Services, Proposed Haggen Food and Pharmacy, prepared by Geo Engineers, Inc., dated June 21, 1999

Dear Mr. Monson:

As requested, we evaluated soil and groundwater conditions at the subject site. The primary purpose of our work was to determine if, in our opinion, the new grocery store building could obtain foundation support on existing soil conditions beneath the organic topsoil layer. We also have provided geotechnical engineering recommendations for pavement subgrade and groundwater drainage controls for the southern perimeter of the site.

SITE AND PROJECT DESCRIPTION

The proposed project is a new 63,516 square foot Haggen Food and Pharmacy retail store on an approximate 10.4-acre site. In association with the Haggen store, proposed site development plans will include three out lot building pads along the north section of the property. Access to the complex will be provided from the north off 204th Street NE, and from the west off 74th Avenue NE. Detailed plans for the proposed development will generally match the existing topography with only minor cuts and fills to achieve subgrade elevations. Utility hookups will be provided from 204th Street NE and 74th Avenue NE, and site development stormwater treatment and discharge will be through a bio-swale/infiltration facility.

We expect that the buildings will generally consist of perimeter concrete tilt-up wall panels or block walls, with interior isolated columns supporting a roof framing system. Structural loads will be about 4 to 6 kips per foot for perimeter bearing walls, and 50 to 100 kips for interior columns. We expect product loading on the floors will range from 200 to 300 pounds per square foot (psf).

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Phone (425) 821-7777 • Fax (425) 821-4334 • terra@terra-associates.com

Soil Conditions

Soil conditions observed in the test pits excavated varied throughout the site. In general, we observed 12 to 32 inches of a black organic rich topsoil/sod covering the ground surface. Beneath this surface cover, to depths of 2.5 to 4.5 feet, we observed loose and wet, dark brown to reddish-brown silty sand to sandy silt. We then observed wet, interbedded sandy silt, silty sand, and clayey silt to depths of four to nine feet. In a few of the test pits, thin layers of organic silt were observed. These soils were usually encountered in the south to southeast section of the site. Beneath these interbedded soils, we observed light brown to brown silty sand with some gravel to sandy gravel to the termination depths of our test pits.

The *Geologic Map of the Arlington West 7.5 Minute Quadrangle, Snohomish County, Washington,* by James P. Minard (U.S.G.S., 1985), shows the soils on the project site as Marysville Sand Member, Recessional Outwash Deposits (Qvrm). Observations made during our explorations are generally consistent with this classification.

The preceding discussion is intended to be a brief review of the soil conditions encountered. For more detailed descriptions, please refer to the Test Pit Logs, Figure 2 through 8.

Groundwater

We observed slight to moderate groundwater seepage in Test Pits TP-1, TP-2, TP-3, TP-5, TP-11, and TP-12. The seepage levels we observed generally ranged from 3.0 to 7.5 feet below existing surface grades. The test pits were not allowed to remain open for an extended period of time, which would allow for a more detailed evaluation of the groundwater observed. Fluctuations in the groundwater seepage should be expected on a seasonal and annual basis. Typically, the seepage reaches maximum levels during and shortly following the wet winter months, and diminishes or is completely absent during the dry summer months. In our opinion, based on the time of year we conducted our study, seepage levels observed were near maximum levels.

DISCUSSION AND RECOMMENDATIONS

General

Based on the results of our study, in our opinion, soil and groundwater conditions observed at the site would not preclude development as planned. However, the site is mantled by a relatively thick layer of organic topsoil that will not be suitable for support of new construction. This organic surface layer will need to be stripped and removed from below all new construction. The thickness of the layer varied from about 12 to 32 inches, with an average thickness of about 18 inches. Also, the native soils immediately underlying the organic surface layer consist of interbedded layers of silty sand, sandy silt, and silt along with thin seams of organic silt. In our opinion, these native soils will not be suitable for immediate support of building foundations. To gain suitable support, we recommend excavating and removing the native soils for a minimum depth of two feet below the building perimeter and interior footings, and restoring the foundation subgrade with granular structural fill. The overexcavation and replacement with granular structural fill should extend a minimum lateral distance of 12 inches beyond the outside edge of the individual footing elements.

Relatively shallow groundwater was observed at test pits excavated along the south and eastern sides of the site. Proposed building grades are relatively close to the observed groundwater level and, in the case of the southern loading dock, construction grades are below the observed groundwater level. It will be necessary to intercept this groundwater flow on a permanent basis and direct it to an approved point of discharge in order to prevent building and pavement impacts. This will require installation of an interceptor trench along the eastern and southern margins of the site.

The near-surface inorganic native soils encountered at the site contain a significant amount of fines and will be difficult to compact as structural fill when too wet. The ability to use native soil from site excavations as structural fill will depend on its moisture content and the prevailing weather conditions at the time of construction. If grading activities will take place during winter, the owner should be prepared to import clean granular material for use as structural fill and backfill. The clean sandy gravels encountered in the central to northern sections of the site would meet this specification.

The following sections provide detailed recommendations regarding these issues and other geotechnical design considerations. These recommendations should be incorporated into the final design drawings and construction specifications.

Site Preparation and Grading

To prepare the site for construction, all vegetation, organic surface soils, and other deleterious materials should be stripped and removed from the site. Surface stripping depths of about 12 to 32 inches should be expected in order to remove the majority of the organic topsoil/sod.

When site stripping is complete, cuts and fills can be made to establish desired finish grades. To establish support for building foundations, we recommend overexcavating the native soils a minimum of two feet below the bottom of the footing elements and restoring the foundation subgrade with compacted granular structural fill. The overexcavation and replacement should extend a minimum lateral distance of 12 inches from the sides of the footings.

Elsewhere on the site, prior to placing fill, we recommend proofrolling all exposed surfaces to determine if any isolated soft and yielding areas are present. Cut areas that will provide direct support for new construction should also be proofrolled. If excessively yielding areas are observed and cannot be stabilized in place by compaction, the affected soils should be removed to firm bearing and grade restored with structural fill. If the depth of excavation to remove unstable native soils is excessive, the use of geotextile fabric, such as Mirafi 500X or equivalent, in conjunction with clean granular structural fill, can be considered to limit the depth of removal. In general, experience has shown that a minimum of 18 inches of clean granular structural fill over the geotextile fabric should establish a stable bearing surface. A representative of Terra Associates, Inc. should observe all proofrolling operations. We also recommend field evaluations at the time of construction to verify stable subgrades.

Existing organic topsoil will not be suitable for use as structural fill. Our study also indicates that the near surface native soils contain a significant amount of fines (silt and clay size particles). These soils will be difficult to compact as structural fill when too wet or too dry. Accordingly, the ability to use native soils from site excavations as structural fill will depend on their moisture content and the prevailing weather conditions at the time site grading activities take place. The deeper sandy gravels should be suitable to reuse as structural fill in most weather conditions. Existing asphalt pavement that will be removed can also be recycled and used in structural fill areas. However, the pavement must be pulverized to produce a maximum size of six inches.

Structural fill placed during dry weather may consist of any non-organic, compactable granular soil having a maximum aggregate size of six inches. If the moisture content of the fill soil cannot be adequately maintained, or if structural fill will be placed during wet weather, we recommend using a structural fill material that meets the following grading requirements:

Maximum Aggregate Size	6 inches
Minimum Retained on the No. 4 Sieve	25 percent
Maximum Passing the No. 200 Sieve (Based on the Minus 3/4-inch Fraction)	5 percent

Structural fill materials should be placed in uniform loose layers not exceeding 12 inches and compacted to a minimum of 95 percent of the soils' maximum density, as determined by American Society for Testing and Materials (ASTM) Test Designation D-698 (Standard Proctor). The moisture content of the soil at the time of compaction should be within about two percent of its optimum, as determined by this same ASTM method.

Foundations

With foundation subgrade prepared as recommended in the preceding section, suitable support for standard spread footing foundations will be provided. For frost protection, foundations exposed to the weather should obtain support at a minimum depth of 18 inches below the final exterior grade. Interior foundations should obtain support at a minimum depth of 12 inches below the bottom of the slab-on-grade floor.

Foundations obtaining support on compacted granular structural fill or on the competent native granular soils observed below the upper interbedded deposits can be designed for an allowable bearing capacity of 3,000 psf. A one-third increase in this capacity can be used when considering short-term transitory loading, such and wind and seismic. With expected structural loading and this bearing stress applied, estimated total foundation settlement is about one inch, with differential settlement of about one-half inch.

For designing foundations to resist lateral loads, a base friction coefficient of 0.35 can be used. Passive earth pressures acting on the side of the footing can also be considered. We recommend calculating this lateral resistance using an equivalent fluid weight of 300 pounds per cubic foot (pcf). We recommend not including the upper 12 inches of soil in this computation because they can be affected by weather or disturbed by future grading activity. This value assumes the foundation will be constructed neat against structural fill placed and compacted as described in the Site Preparation and Grading section of this report. The values recommended include a safety factor of 1.5.

Slab-on-Grade Construction

Slabs-on-grade may be supported on the subgrade prepared as recommended in the Site Preparation and Grading section of this report. Immediately below the floor slab, we recommend placing a four-inch thick capillary break layer composed of clean, free-draining coarse sand or fine gravel that has less than three percent passing the No. 200 sieve. This material will reduce the potential for upward capillary movement of water through the underlying soil and subsequent wetting of the floor slab. Where moisture by vapor transmission is undesirable, a durable plastic membrane should be placed on the capillary break layer. The membrane should be covered with two inches of clean, moist coarse sand to guard against damage during construction and to aid in curing of the concrete.

For the anticipated non-uniform floor slab loading, we estimate post-construction floor settlements will be about one-half inch. If this amount of settlement is not acceptable, or non-uniform floor slab loading in excess of 300 psf is expected, then we recommend implementing a surcharge program to pre-consolidate the upper compressible soils. Specific details of the surcharge program can be provided if desire. In general, it would consist of placing two to four feet of fill material above the elevation of the finished floor grade and allowing expected settlement under this loading to occur prior to construction. We estimate that the time for this settlement to occur under the fill surcharge loading would be in the range of two to four weeks.

For thickness design of the slab subjected to point loading from storage racks and fork lift vehicle traffic, we recommend using a subgrade modulus (k_s) of 200 pounds per square inch per inch (pci) of deflection.

Subsurface Drainage

As noted earlier, relatively shallow groundwater was observed at test pits excavated along the south and eastern sides of the site. Proposed building grades are relatively close to the observed groundwater level and, in the case of the southern loading dock, construction grades are below the observed groundwater level. It will be necessary to intercept this groundwater flow on permanent basis and direct it to an approved point of discharge in order to prevent building and pavement impacts.

We recommend installing a subsurface intercepting drain along the outside edge of pavement on the eastern and southern perimeters of the building site. The beginning point of the interceptor drain should be inline with the northeast building corner. The drain invert at this location should be at a maximum elevation of Elev. 123. The drain should continue south from this point and turn westward along the southern length of the building. The drain invert adjacent the loading dock area should be at a maximum elevation of Elev. 120. From this point the drain can be installed with a minimum flow gradient of one-half percent and taken to discharge to the infiltration facility or other approved location. The drain should consist of a six-inch diameter perforated PVC pipe that is bedded and backfilled with 3/4-inch minus washed drainage aggregate to within 12 inches of the final pavement subgrade elevation. Structural fill should be used to backfill the final 12 inches of trench for immediate support of the pavement structure. A layer of filter fabric, such as Mirafi 140N or equivalent, should be placed over the drainage aggregate prior to backfilling with the upper 12 inches of structural fill. The groundwater flow that would be intercepted by this installation is estimated to be in the range of 0.2 to 0.3 cubic feet per day per foot of interceptor trench.

Pavement

Pavement subgrade should be prepared as described in the Site Preparation and Grading section of this report. Regardless of the degree of relative compaction achieved, the subgrade must be firm and relatively unyielding before paving. The subgrade should be proofrolled with heavy construction equipment to verify this condition.

The pavement design section is dependent upon the supporting capability of the subgrade soils and the traffic conditions to which it will be subjected. For traffic consisting mainly of light passenger and commercial vehicles with only occasional heavy traffic, we recommend the following pavement sections:

- Two inches of asphalt concrete (AC) over four inches of crushed rock base (CRB)
- Two inches of AC over three inches of asphalt-treated base (ATB)

For heavy traffic areas such truck lanes and the loading dock area we recommend the following pavement sections:

- Three inches of AC over six inches of CRB
- Three inches of AC over four inches of ATB

The paving materials used should conform to the Washington State Department of Transportation (WSDOT) specifications for Class B asphalt concrete, ATB, and CRB.

As an alternative means to prepare a stable subgrade and pavement base, we recommend considering using a soil cement application. The soil cement can be constructed using the inorganic native soils or existing structural fill. The subgrade should be initially prepared as recommended in the Site Preparation and Grading section of this report. Following grading, we recommend scarifying the top 12 inches of the subgrade and then blending in Type 1 Portland cement at a rate ranging from of 65 to 80 pounds per square yard of surface area. The actual rate required should be determined when the subgrade is rough graded. The cement should be blended uniformly with the soils, with the mixture also moisture conditioned as necessary. The soil cement moisture should be within –1 to +3 percent of optimum, as determined by ATSM Test Designation D-698 (Standard Proctor) prior to compaction. Once blended and conditioned, the soil cement should be compacted to a minimum of 95 percent of its maximum dry density, as determined by this ASTM standard. The soil cement should achieve a minimum 3-day compressive strength of 150 psi.

Initial compaction of the soil cement should be accomplished with a sheep's foot compactor. Once compacted, rough grading can be completed with final compaction achieved using a steel-drum roller. Compaction and rough grading should be completed within a three-hour time period following application and blending of the cement with the soil.

Long-term pavement performance will depend on surface drainage. A poorly-drained pavement section will be subject to premature failure as a result of surface water infiltrating into the subgrade soils and reducing their supporting capability. For optimum pavement performance, we recommend surface drainage gradients of at least two percent. Some degree of longitudinal and transverse cracking of the pavement surface should be expected over time. Regular maintenance should be planned to seal cracks when they occur.

After grading and compaction, traffic on the soil cement should be kept to a minimum for a period of three days. The soil cement should also be kept moist as required for a minimum of seven days, or until pavement construction by application of water using a fog sprayer or water truck with a pressurized spray bar. Water should be applied to only keep the surface moist. Excessive application causing ponding or erosion should be avoided. If the soil cement base will not be paved over following initial curing and traffic will traverse the base, we recommend placing a two-inch thick layer of crushed rock over the soil cement to reduce surface degradation.

Quality control during construction of the soil cement base should include verification of the following:

- Cement application rate
- Moisture and compaction
- Compressive strength

A minimum of three test specimens from the same soil cement sample should be prepared for compressive strength testing for each day's construction.

We recommend that the pavement section constructed over the 12 inches of soil cement base consist of 3 inches of AC.

LIMITATIONS

We prepared this report in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made. This report is the copyrighted property of Terra Associates, Inc., and is intended for specific application to the Haggen Food and Pharmacy project. This report is for the exclusive use of PS Arlington, LLC and their authorized representatives.

The analyses and recommendations presented in this report are based on data obtained from the test pits excavated on-site. Variations in soil conditions can occur, the nature and extent of which may not become evident until construction. If variations appear evident, Terra Associates, Inc. should be requested to reevaluate the recommendations in this report prior to proceeding with construction.

We trust the information presented is sufficient for your current needs. If you have any questions or require additional information, please call.

Sincerely yours,
TERRA ASSOCIATES, INC.

David P. Laush/ae

David P. Laush, L.E.G.
Engineering Geologist

THEODORE J. SCHEPPER
28742

4/2/03

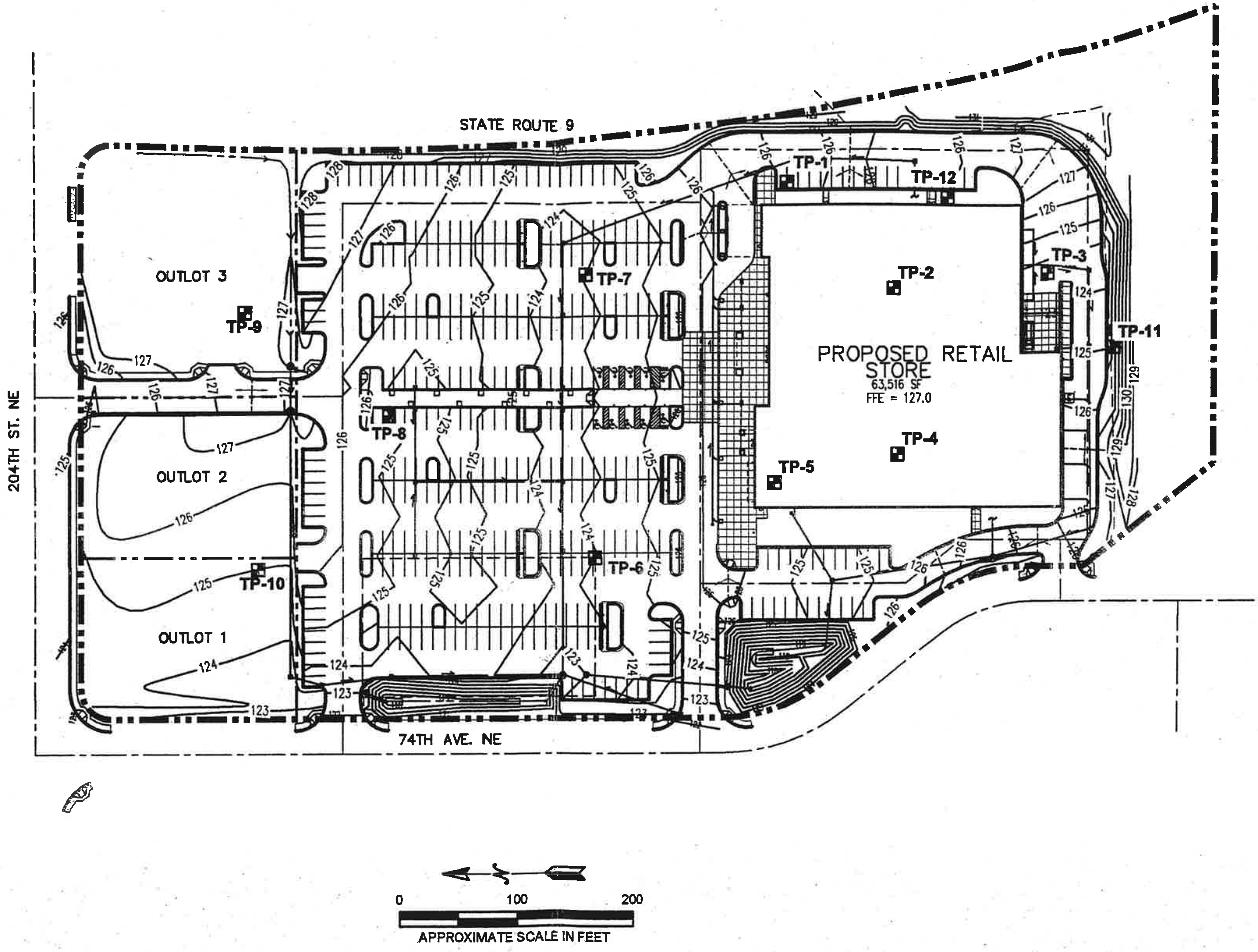
Theodore J. Schepper, P.E.
Principal Engineer

DPL/TJS:ae

EXPIRES 6/18/03

Encl:
- Figure 1 – Exploration Location Plan
- Figure 2 – Unified Soil Classification System
- Figures 3 through 8 – Test Pit Logs
- Figures 9 and 10 – Grain Size Analyses

cc: Mr. Michael Crowson, PacLand



NOTE:
THIS SITE PLAN IS SCHEMATIC. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE. IT IS INTENDED FOR REFERENCE ONLY AND SHOULD NOT BE USED FOR DESIGN OR CONSTRUCTION PURPOSES.

REFERENCE:
SITE PLAN PROVIDED BY PACLAND

LEGEND:
▪ TP-1 APPROXIMATE LOCATION OF TEST PIT

Terra Associates, Inc.
Consultants in Geotechnical Engineering
Geology and
Environmental Earth Sciences

EXPLORATION LOCATION PLAN
HAGGEN FOOD AND PHARMACY
ARLINGTON, WASHINGTON

Proj. No. T-5358 | Date APR 2003 | Figure 1

MAJOR DIVISIONS			LETTER SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS More than 50% material larger than No. 200 sieve size	GRAVELS More than 50% of coarse fraction is larger than No. 4 sieve	Clean Gravels (less than 5% fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
			GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines.
		Gravels with fines	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines.
			GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines.
	SANDS More than 50% of coarse fraction is smaller than No. 4 sieve	Clean Sands (less than 5% fines)	SW	Well-graded sands, gravelly sands, little or no fines.
			SP	Poorly-graded sands or gravelly sands, little or no fines.
		Sands with fines	SM	Silty sands, sand-silt mixtures, non-plastic fines.
			SC	Clayey sands, sand-clay mixtures, plastic fines.
FINE GRAINED SOILS More than 50% material smaller than No. 200 sieve size	SILTS AND CLAYS Liquid limit is less than 50%		ML	Inorganic silts, rock flour, clayey silts with slight plasticity.
			CL	Inorganic clays of low to medium plasticity, (lean clay).
			OL	Organic silts and organic clays of low plasticity.
	SILTS AND CLAYS Liquid limit is greater than 50%		MH	Inorganic silts, elastic.
			CH	Inorganic clays of high plasticity, fat clays.
			OH	Organic clays of high plasticity.
HIGHLY ORGANIC SOILS			PT	Peat.

DEFINITION OF TERMS AND SYMBOLS

	Density	Standard Penetration Resistance in Blows/Foot
COHESIONLESS	Very loose	0-4
	Loose	4-10
	Medium dense	10-30
	Dense	30-50
	Very dense	>50

	Consistency	Standard Penetration Resistance in Blows/Foot
COHESIVE	Very soft	0-2
	Soft	2-4
	Medium stiff	4-8
	Stiff	8-16
	Very stiff	16-32
	Hard	>32

I	2" OUTSIDE DIAMETER SPLIT SPOON SAMPLER
Ⅱ	2.4" INSIDE DIAMETER RING SAMPLER OR SHELBY TUBE SAMPLER
▼	WATER LEVEL (DATE)
Tr	TORVANE READINGS, tsf
Pp	PENETROMETER READING, tsf
DD	DRY DENSITY, pounds per cubic foot
LL	LIQUID LIMIT, percent
PI	PLASTIC INDEX
N	STANDARD PENETRATION, blows per foot

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Environmental Earth Sciences

UNIFIED SOIL CLASSIFICATION SYSTEM
HAGGEN FOOD AND PHARMACY
ARLINGTON, WASHINGTON

Proj. No. T-5358	Date APR 2003	Figure 2

Test Pit No. TP-1

Logged by: DPL

Approximate Elev. 128'

Date: 3/20/03

Depth (ft.)	Soil Description	Moisture Content (%)	
0	32 inches black organic TOPSOIL/SOD.		
	Light brown sandy SILT, trace mottling, stiff, wet. (ML)	26	▼
	Dark brown organic sandy SILT, soft, wet. (OL)	22	
5	Light brown sandy SILT to silty SAND, trace mottling, very fine grained, medium dense, wet. (SM)	21 32 10	
	Brown silty SAND with gravel, fine grained, medium dense, wet. (SM)		
10	Test pit terminated at 9 feet. Slight to moderate groundwater seepage encountered at 4 feet.		
15			

Test Pit No. TP-2

Logged by: DPL

Approximate Elev. 128'

Date: 3/20/03

Depth (ft.)	Soil Description	Moisture Content (%)	
0	20 inches black organic TOPSOIL/SOD.		
	Dark brown to reddish-brown silty SAND, fine grained, some mottling at 4 feet, medium dense, wet. (SM)	21	
	Dark brown organic sandy SILT, stiff, moist. (OL)	28	
5	Reddish-brown sandy SILT to silty SAND, thin interbedded layer of gray fine sand, medium dense, moist to wet. (SM)	28	
	Reddish-brown clayey SILT, mottled, stiff, wet. (ML)	33	
	Light brown SAND to brown sandy GRAVEL, fine to coarse grained, medium dense, wet. (SP/GP)	9	▼
10	Test pit terminated at 9 feet. Slight groundwater seepage encountered at 8.5 feet.		
15			

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Environmental Earth Sciences

UNIFIED SOIL CLASSIFICATION SYSTEM
HAGGEN FOOD AND PHARMACY
ARLINGTON, WASHINGTON

Proj. No. T-5358	Date APR 2003	Figure 3

Test Pit No. TP-3

Logged by: DPL

Approximate Elev. 128'

Date: 3/20/03

Depth (ft.)	Soil Description	Moisture Content (%)	
0	12 inches black organic TOPSOIL/SOD.		
	Mottled grayish-brown sandy SILT, soft to stiff, wet. (ML)	7	
	Mottled dark brown to dark gray organic silty SAND, fine grained, medium dense, moist. (SM)	19	
	Grayish-brown silty SAND with some gravel, fine to medium grained, medium dense, wet. (SM)	13	▼
5	Dark brown organic clayey SILT, iron stained, stiff, wet. (OL)		
	Bluish-gray clayey SILT, stiff, wet. (ML/CL)	43	
	Brown silty gravelly SAND, fine to coarse grained, dense, wet. (SP)	10	
	Test pit terminated at 8 feet. Very slight groundwater seepage encountered at 5 feet.		
10			
15			

Test Pit No. TP-4

Logged by: DPL

Approximate Elev. 126.5'

Date: 3/20/03

Depth (ft.)	Soil Description	Moisture Content (%)	
0	26 inches black organic TOPSOIL/SOD.		
	Brown sandy SILT to silty SAND to silty SAND with gravel, fine grained, medium dense, moist to wet. (SM)	10	
5	Brown sandy GRAVEL, fine to coarse grained, medium dense to dense, wet to moist. (GP)	8	
	Test pit terminated at 9 feet. No groundwater seepage encountered.		
10			
15			

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UNIFIED SOIL CLASSIFICATION SYSTEM
HAGGEN FOOD AND PHARMACY
ARLINGTON, WASHINGTON

Proj. No. T-5358 | Date APR 2003 | Figure 4

Test Pit No. TP-5

Logged by: DPL

Approximate Elev. 126'

Date: 3/20/03

Depth (ft.)	Soil Description	Moisture Content (%)	
0	24 inches black organic TOPSOIL/SOD.		
	Dark brown silty SAND to sandy SILT with gravel, fine grained, medium dense, moist to wet. (SM)	25	
5	Reddish-brown sandy GRAVEL, fine to coarse grained, medium dense to dense, wet. (GP)	6	▼
	Brown SAND, trace gravel, fine to medium grained, medium dense, wet. (SP)	11	
10	Test pit terminated at 9 feet. Slight groundwater seepage encountered at 6 feet.		
15			

Test Pit No. TP-6

Logged by: DPL

Approximate Elev. 124'

Date: 3/20/03

Depth (ft.)	Soil Description	Moisture Content (%)	
0	18 inches black organic TOPSOIL/SOD.		
	Brown silty SAND, fine grained, loose, moist. (SM)	10	
5	Brown silty sandy GRAVEL to sandy GRAVEL, fine to coarse grained, medium dense, moist. (GP)	3	
10	Test pit terminated at 6 feet. No groundwater seepage encountered.		
15			

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Test Pit No. TP-7

Logged by: DPL

Approximate Elev. 127'

Date: 3/20/03

Depth (ft.)	Soil Description	Moisture Content (%)
0	14 inches black organic TOPSOIL/SOD.	
	Brown sandy GRAVEL, fine to coarse grained, rootlets, medium dense, moist. (GP)	
	Brown silty SAND, fine grained, loose to medium dense, moist. (SM)	25
5	Brown sandy GRAVEL, trace cobbles, fine to coarse grained, medium dense, moist. (GP)	3 5
10	Test pit terminated at 8 feet. No groundwater seepage encountered.	
15		

Test Pit No. TP-8

Logged by: DPL

Approximate Elev. 125'

Date: 3/20/03

Depth (ft.)	Soil Description	Moisture Content (%)
0	18 inches black organic TOPSOIL/SOD.	
	Brown silty SAND, fine grained, loose to medium dense, moist. (SM)	15
5	Brown sandy GRAVEL, trace cobbles, fine to coarse grained, medium dense, moist. (GP)	2 5
10	Test pit terminated at 7 feet. No groundwater seepage encountered.	
15		

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Test Pit No. TP-9

Logged by: DPL

Approximate Elev. 125'

Date: 3/20/03

Depth (ft.)	Soil Description	Moisture Content (%)	
0	18 inches black organic TOPSOIL/SOD.		
	Brown silty SAND, fine grained, loose to medium dense, moist. (SM)	21	
5	Brown sandy GRAVEL, fine to coarse grained, medium dense, moist. (GP)	5	
	Test pit terminated at 6 feet. No groundwater seepage encountered.		
10			
15			

Test Pit No. TP-10

Logged by: DPL

Approximate Elev. 123'

Date: 3/20/03

Depth (ft.)	Soil Description	Moisture Content (%)	
0	18 inches black organic TOPSOIL/SOD.		
	(2 to 6 inches brown silty SAND)		
	Brown sandy GRAVEL, fine to coarse grained, medium dense, moist. (GP)	4	
5		3	
	Test pit terminated at 6.5 feet. No groundwater seepage encountered.		
10			
15			

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Test Pit No. TP-11

Logged by: DPL

Approximate Elev. 128'

Date: 3/20/03

Depth (ft.)	Soil Description	Moisture Content (%)	
0	18 inches black organic TOPSOIL/SOD.		
	Mottled brown sandy SILT, trace organic seam, soft to stiff, wet. (ML)	20	▼
	Gray SAND, fine to medium grained, loose to medium dense, wet. (SM)	17	
	Dark brown organic sandy SILT, soft to stiff, wet. (OL)	37	
5	Mottled grayish-brown to reddish-brown silty SAND, fine grained, loose to medium dense, wet. (SM)	25 56	
	Reddish-brown clayey SILT, stiff, wet. (ML/CL)		
	Bluish-green sandy SILT to silty SAND, fine grained, medium dense, wet. (ML/SM)	24	
	Gray sandy GRAVEL to gravelly SAND, medium dense, wet. (GP)	25	
10	Test pit terminated at 9.5 feet. Slight groundwater seepage encountered at 3 feet.		
15			

Test Pit No. TP-12

Logged by: DPL

Approximate Elev. 129'

Date: 3/20/03

Depth (ft.)	Soil Description	Moisture Content (%)	
0	12 inches black organic TOPSOIL/SOD.		
	Reddish-brown silty SAND, fine to medium grained, loose to medium dense, wet. (SM)	5 25	
	Mottled gray silty SAND, fine grained, loose to medium dense, wet. (SM)	15	
5	Grayish-brown silty SAND, trace organic seams, fine grained, some mottling, medium dense, wet. (SM)		
	Reddish-gray sandy clayey SILT, iron stained seams, stiff, wet. (ML)	25 39	▼
	Reddish-gray silty SAND, iron stained, fine grained, medium dense, wet. (SM)	27	
10	Test pit terminated at 9 feet. Slight groundwater seepage encountered at 7.5 feet.		
15			

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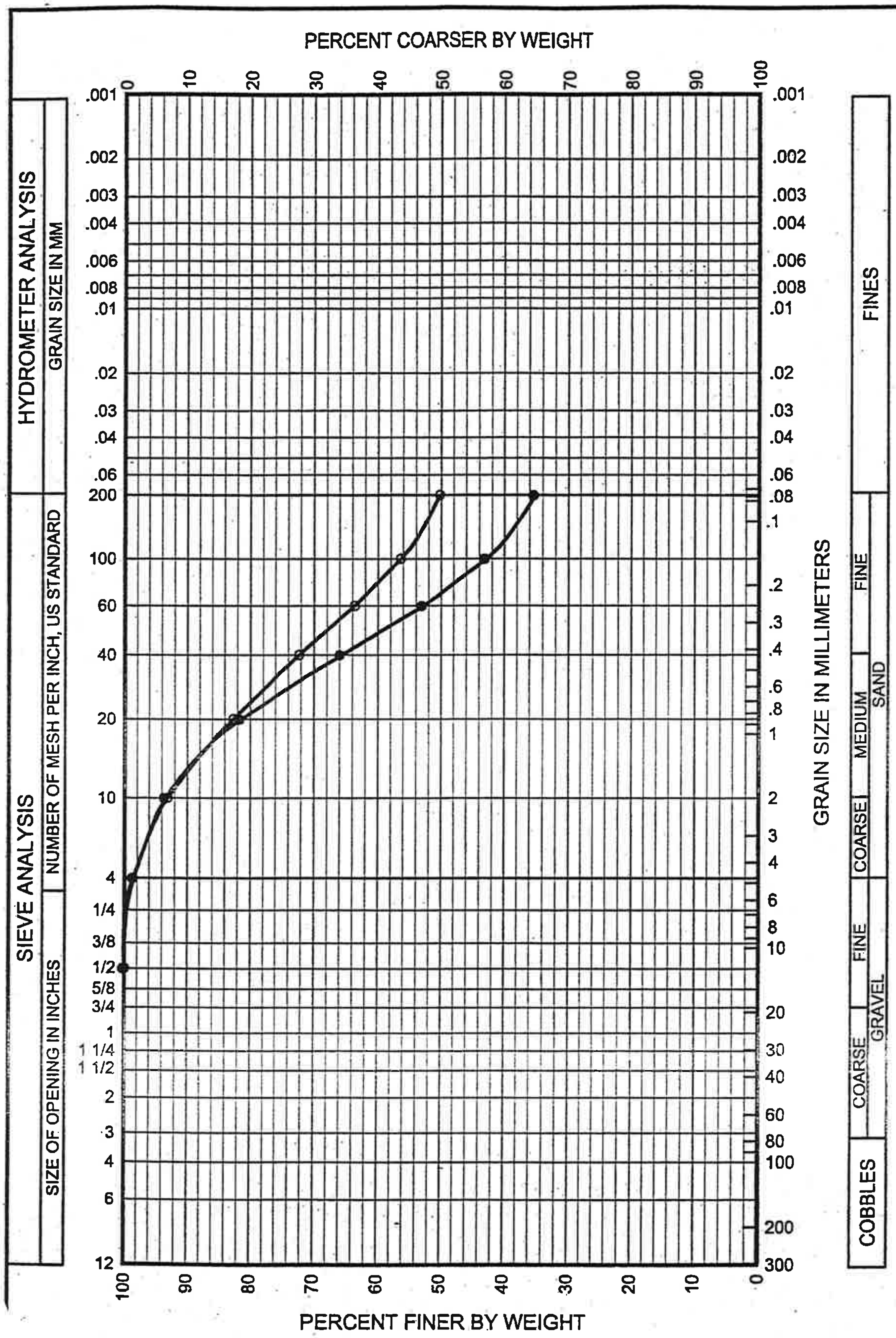

Key	Exploration Number	Depth (ft.)	USCS	Description	Moisture Content (%)	LL	PL
●	TP-1	4.5	SM	silty SAND	22		
○	TP-2	3.5-4.0	ML	sandy SILT	28		

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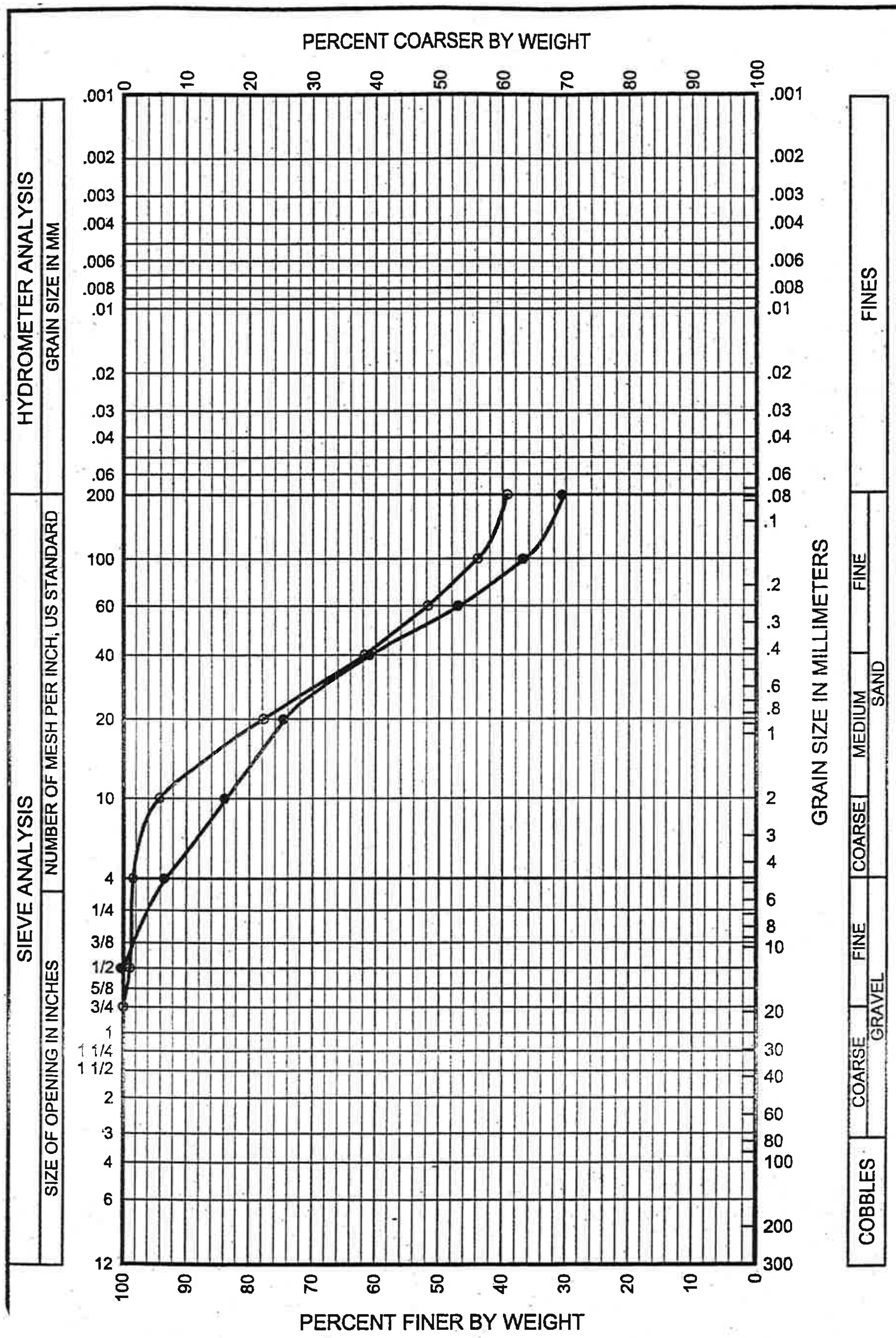

Key	Exploration Number	Depth (ft.)	USCS	Description	Moisture Content (%)	LL	PL
●	TP-3	3.0	SM	silty SAND	19		
○	TP-5	2.5	SM	silty SAND	25		

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