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GEOTECHNICAL ENGINEERING SERVICE Study
McCOLLUM PARK
128TH STREET SOUTHEAST
SNOHOMISH COUNTY, WASHINGTON

E-4428

Earth Consultants Inc.
Geotechnical Engineers, Geologists & Environmental Scientists

PREPARED FOR

BRUCE DEES AND ASSOCIATES

Mary L. Lynch
Staff Engineer

Glen Mann, P.E.
Vice-President

GEOTECHNICAL ENGINEERING SERVICES
McCOLLUM PARK
128TH STREET SOUTHEAST
SNOHOMISH COUNTY, WASHINGTON

E-4428

November 1, 1989

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Earth Consultants Inc.
Geotechnical Engineers, Geologists & Environmental Scientists

November 1, 1989 E-4428

Bruce Dees and Associates
222 East 26th, Room 202
Tacoma, Washington 98421

Attention: Mr. Bruce Dees

Gentlemen:

We are pleased to submit herewith our report titled "Geotechnical Engineering Study, McCollum Park, Snohomish County, Washington". This report presents the results of our field exploration, selective laboratory tests, and engineering analyses. The purpose and scope of our study was outlined in our April 25, 1989 proposal. This study did **not** include any environmental testing.

Our study indicates that the landfill is overlain by a one to four foot cap consisting of loose silty sand with gravel. The landfill thickness ranges from three to more than thirteen (13) feet. The landfill is underlain by medium dense sand with varying amounts of silt and/or organic silt.

Based on the encountered conditions, and the results of our analyses, we believe the site can be developed as planned. Additional cap material will be required, primarily in the southwestern portion of the landfill area. The upper foot of cap material should have a permeability of less than or equal to 10^{-6} centimeters per second.

These recommendations, along with other geotechnically related aspects of the project are discussed in more detail in the text of the attached report.

We appreciate this opportunity to have been of service to you during this initial phase of project development, and we look forward to working with you in the future phases as the project comes to fruition. In the meantime, should you or your consultants have any questions about the content of this report, or if we can be of further assistance, please call.

Very truly yours,

EARTH CONSULTANTS, INC.

Glen Mann, P. E.
Vice-President

GM/ML/sar

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GEOTECHNICAL ENGINEERING SERVICES
McCOLLUM PARK
128TH STREET SOUTHEAST
SNOHOMISH COUNTY, WASHINGTON

INTRODUCTION

Project Description

The subject site is located at 600 128th Street Southeast in Snohomish County, Washington approximately as indicated on the Vicinity Map, Plate 1. The purpose of this study is to explore the existing subsurface conditions at the site to help provide information regarding the depth and extent of the existing landfill and the thickness of the landfill cap, and on this basis, to develop geotechnical recommendations for the proposed development of the landfill portion of the site. At the time our study was performed, the site, existing building locations, and our exploratory locations were approximately as shown on the Test Pit Location Plan, Plate 2.

From our discussions, we understand you are developing a master plan for park development and use. This master plan will include recommendations for stream realignment, pathway construction, playfield development and other multi-use items. No building construction is anticipated in the near future.

If any of the above design criteria change, we should be consulted to review the recommendations contained in this report. In any case, we recommend that Earth Consultants, Inc. (ECI) be retained to perform a general review of the final design.

Scope of Services

We performed this study in general accordance with the scope of services outlined in our April 25, 1989 proposal. On this basis, our report addresses:

- information obtained from aerial photo review;
- geological and geotechnical information available in our library and files;
- excavation of a series of exploratory test pits within the general confines of the landfill occupying the northeastern part of the site;
- characterization of the landfill cap material and, where possible, the native soils underlying the landfill;
- the thickness and general composition of the landfill;
- recommendations for reconstruction of the landfill cap to create a suitable playfield surface; and

- recommendations for site drainage control.

No environmental sampling or testing was performed on this project on the basis of the qualified authorization received from the client excluding payment for such services.

This report has been prepared for specific application to this project only for the exclusive use of the Snohomish County Parks Department, Bruce Dees and associates, and their representatives. We recommend that this report, in its entirety, be included in the project contract documents for the information of the contractor.

SITE CONDITIONS

Surface

The subject site is located at 600 128th Street Southeast in Snohomish County, Washington (see Plate 1, Vicinity Map). The property is bounded by undeveloped property on the south and east, and by residential development to the west.

The site is generally level, with only a slight topographic slope down to the south. On a localized basis there are some steeper grade changes, particularly along the alignment of North Creek and in the wetland area to the northeast.

The northern part of the park is occupied by a dirt playfield in the northeast, by paved access and parking in the central part of the site, and by a swimming pool and picnic area in the northwest. Approximately in the center of the park is a multi-use building and behind this a Parks Department equipment yard. The southern portion of the park is occupied by a low-lying wetland area.

Subsurface

The landfill area of the site was explored by excavating ten test pits at the approximate locations shown on Plate 2. Please refer to the Test Pit Logs, Plates 6 through 12, for a more detailed description of the conditions encountered at each location explored. Descriptions of the field exploration methods and laboratory testing program are included as appendices to this report. The following is a generalized description of the subsurface conditions encountered.

Plate 2 shows our estimation of the approximate extent of the landfill in three cases: the originally estimated extent (as shown on the conceptual master plan); the extent of the landfill based on the results of our subsurface exploration; and the estimated extent beyond the perimeter defined by our study. Plate 4 presents several cross sectional views of the landfill. The approximate cap thickness, depth of landfill and bottom profile are included.

Our exploratory test pit excavations encountered a cap over the landfill which ranged between one foot (Pits 4 and 6) and four feet (Pits 3 and 8) in thickness. At Test Pit 7, we were unable to discern a fill cap beneath approximately four inches of topsoil and sod. At this location the soil matrix appeared to blend immediately into the landfill refuse content. The cap material consisted primarily of a loose silty sand with gravel.

The soil landfill cap is underlain by the raw landfill content, which ranged from three feet (Pit 9) to more than thirteen (13) feet (Pit 2) in thickness. The majority of the exposed landfill material comprised general household and building refuse including glass, plastic, metallic material, lumber pieces and other miscellaneous materials. In Test Pit 7 the refuse was intermixed with wood debris. The approximate thickness of the landfill content is contoured on Plate 3, attached. Test Pits 2, 3, 8 and 10 were all terminated within the refuse layer; they did not penetrate into the underlying soil.

The landfill is underlain by a variety of soils. At Test Pits 1 and 4, we encountered a medium dense silty sand with gravel. From the description, we estimate this material has a moderately low permeability which could allow seepage to occur over a relatively long period. At Test Pits 5 and 6, we found a soft organic clayey silt or silt. This material typically exhibits a relatively low degree of permeability and tends to retard seepage. At Test Pits 7 and 9, we found a medium dense medium to coarse grained sand with a small silt content. This material typically exhibits a relatively high rate of permeability, allowing seepage to occur over a short period.

In Test Pits TP-5 and TP-6, an oily\looking substance was observed seeping from the sides of our exploratory excavations. Several small buckets were encountered and may be the source of the observed seepage. In addition, heavy noxious fumes emanated from these pits. When this occurred, the test pits were immediately backfilled.

Groundwater

Light to moderate groundwater seepage was observed in only three of our excavations (Test Pits 3, 5 and 6). The depth of seepage ranged between about five and fourteen (14) feet below existing site grade. In Test Pits 3 and 6, it is likely this seepage occurs at the interface between the landfill content and the underlying, less-permeable native soils. At Test Pit 5 the seepage occurs in the midst of the landfill contents. In this case, it is possible that the seepage is contained within materials of variable permeability.

You should appreciate, however, that groundwater and seepage levels are not static. One should expect fluctuations in the levels depending on the season, amount of rainfall, surface water runoff, and other factors. Generally, the groundwater or seepage levels will be higher in the wetter winter months, typically October through May. If you intend to perform any earthwork operations around the lower lying perimeter of the existing landfill, you should be prepared to deal with varying seepage levels.

DISCUSSION AND RECOMMENDATIONS

General

Based on the results of our study, it is our opinion that the site can be developed generally as planned, provided the recommendations contained in this report are incorporated into the final site development plans.

The McCollum Park landfill currently is not required to conform to state and local regulations regarding the landfill closure. However, we spoke with Ms. Karen Nakhjiri, with Snohomish County Solid Waste Division, who offered the following general guidelines for capping the landfill:

- The landfill cap should consist of at least two feet of "till" like soil material.
- The upper foot of the cap material should have a permeability of less than or equal to 10^{-6} centimeters per second in order to prevent the infiltration of surface water into the landfill below. Alternately an impermeable poly liner can be used for this purpose.
- A drainage layer and topsoil should be placed above the impermeable cap material.

Based on our subsurface exploration, additional cap material (between six to twenty-four inches) will be required in the southwestern portion of the landfill area. The permeability of existing cap can be reduced to the recommended amount by intermixing bentonite powder in the upper twelve inches of the cap material.

The performance of the impermeable bentonite/soil layer will depend primarily on how it is constructed. Care should be taken to adequately mix the bentonite into the soil and water should be applied to allow the bentonite to swell and seal.

These, and other geotechnically-related aspects of the project, are discussed in more detail in the following sections of this report.

Methane

Based on the Parks Department's experience to date, it is evident that the landfill generates varying amounts of Methane gas. It was reported to us that the Parks Department workers required gas masks to work in the excavation for the swimming pool during construction because of the apparently high gas concentrations. The generation of this gas is a common experience with virtually all landfills. Over the past years, several Methane flares have been

installed around the perimeter of the landfill. These flares are periodically lit to burn off any excess gas.

Although we attempted to monitor Methane gas emissions during the excavation of our exploratory test pits, the results were so irregular as to be of no use. Nevertheless, we believe Methane gas is emitted from the landfill when the surficial cap is penetrated.

Methane gas typically poses a problem when buildings are constructed over land from which the gas is emitted. Since it is an odorless and colorless gas, it is difficult to determine its presence without use of a mechanical alarm system. Its major threat is to people within poorly ventilated enclosed spaces, such as buildings. The only means of eliminating the gas is to remove and dispose the complete landfill contents. In our opinion, this is neither practical or economical.

To avoid the build-up of Methane in any structure that might be built over or within close proximity to the landfill in the foreseeable future, we recommend the installation of a ventilation barrier beneath the building. This barrier should consist of between twelve (12) and twenty-four (24) inches of free draining, fines-free gravel. Perforated or slotted pipe should be placed within the gravel layer, with the perforations or slots facing downwards, to provide a means of collecting free gas. These pipes should be connected to a manifold which, in turn, is extended up the side of the building to vent well above the roof level. If the building is to be totally enclosed and subject to a high degree of use by park staff or the public, we also recommend you install an interior Methane alarm. This alarm should be attached to an exhaust fan of sufficient capacity to be capable of removing the building's interior gas volume rapidly. By this means it is possible to essentially eliminate the concern that Methane gas will have a negative impact on building users.

In our experience, it has typically been the case that where Methane is emitted from an excavation or through a relatively large area, such as a landfill cap, there is little threat to use of the area providing adequate ventilation occurs. The emission of Methane can be controlled to some degree during construction by preventing your earthwork contractor from penetrating through the landfill cap. You should also **demand** in the project specifications that your contractor only work on the cap area if he has on-site one or more large brush fans and masks for use by his workers. We also recommend that either the contractor or ECI monitor all excavation work to check on the emission and magnitude of emission of any Methane gas. This monitoring will help determine the need for use of brush fans to ventilate the area or the need for masks.

Over the long term (post-construction), the installation of a new and essentially impermeable cap should prevent the emission of Methane that would pose a threat to park users. However, we recommend that you install several additional flares around the landfill perimeter that, along with the existing flares, can be periodically lit to burn off excess Methane.

Site Preparation and General Earthwork

The playfield areas and areas requiring additional cap material should be stripped and cleared of all slabs, trees, existing utilities, surface vegetation, organic matter and any other deleterious material. We anticipate an average stripping depth of four inches will be required. Stripped materials should be removed from the site and disposed, or "lost" in landscaping berms, as desired. The stripped material should not be mixed with any materials to be used as structural fill.

Given the variable surficial topography of the landfill area, it is possible that you could "reconstruct" the landfill in two or three different levels to reduce the potential amount of fill placement and compaction necessary for park development. Regardless, you will need to perform some site grading to generate relatively level surfaces on which to work. Your earthwork contractor should exercise considerable care in this phase of his work to reduce the possibility that his equipment will penetrate through the relatively thin existing landfill cap. **Any penetration** through the existing landfill cap **must be monitored for methane gas emissions.** The area of penetration should be carefully but thoroughly rolled to help densify the exposed materials, then overlain with a relatively impermeable fill layer.

Once the landfill surface has been rough-graded, the exposed surface and any areas of the site where structural fill, foundations, floor slabs or pavement areas are to be built should be proofrolled. This procedure, which should be performed under our representative's full-time observation, can be accomplished with an appropriately sized steel wheel roller. Its purpose is to densify the exposed surface and the materials to shallow depth beneath the surface and to determine the presence and approximate areal extent of any soft or unstable areas. Any such areas should be appropriately moisture conditioned and recompacted.

If any of these areas are outside the landfill perimeter and cannot be satisfactorily recompacted, they should be overexcavated and the unsuitable materials removed and disposed. The resulting excavation should then be backfilled with either compacted structural fill or a crushed rock. Typically, an overexcavation depth of between two and three feet is adequate for this purpose.

If any such areas lie within the perimeter of the landfill, they should be left in the recompacted condition and **not** be overexcavated. Based on the information currently available to us regarding the proposed use of the landfill area, the concerns about potentially unstable subgrade soils are of significantly less impact than those in an area of building or pavement construction. Furthermore, the landfill should be covered with a minimum thickness of two feet of material to create an "impermeable" cap. The cap material is discussed later in this section of the report.

Structural fill is defined as any fill placed under buildings, roadways, slabs, pavements, or any other load bearing areas. Ideally, but particularly during wet weather, structural fill should comprise a free-draining, granular organic-free material with a maximum size of three

inches. It should contain less than 5 percent fines (silt and clay-size particles passing the No. 200 mesh sieve). During dry weather, any **compactible** non-organic soil meeting the above maximum size criterion may be used as structural fill.

Fill under pavements and walks should be placed in similar thin horizontal lifts and, with the exception of the upper twelve (12) inches, be compacted to at least 90 percent of maximum dry density. The top twelve (12) inches should be compacted to at least 95 percent of maximum dry density.

The on-site soils at the time of our exploration were near the optimum moisture content and, if desired, may be used as structural fill provided the grading operations are conducted during dry weather. However, the on-site soils contain a significant amount of fines. Thus, compaction and grading will be difficult if the soil moisture increases above the optimum moisture content. If necessary, the moisture content can be reduced by aeration in dry weather, or by intermixing lime or cement powder to absorb excess moisture.

Landfill Capping Layer

As indicated earlier in this report, the Snohomish County Solid Waste Division offered some general guidelines regarding an appropriate capping material. They suggested that the landfill cap comprise a **minimum** of two feet of "Till-like" material (glacial till soil of relatively low permeability). The upper one foot of this material should have a permeability of less than or equal to 10^{-6} centimeters per second to prevent infiltration of surface water into the landfill below. (As an alternative they also suggested the use of a poly liner.) Lastly, they recommend the installation of a drainage layer above the impermeable cap material.

In an attempt to produce a material of the recommended degree of permeability, we performed a limited laboratory study involving the intermixing of the in-place capping soils with varying amounts of Bentonite clay powder. While the in-place soils are not necessarily "till-like", they are generally relatively fine-grained. For laboratory testing purposes, primarily because of the limited size of the test equipment, we only used that fraction of the soil passing the Number 4 mesh sieve; the gravel content was eliminated from the test procedure. The soil/bentonite mixture was placed in a falling head permeameter under a three foot head of water for a twenty-four (24) hour period.

Based on the results of our tests, we determined that the most suitable mixture was that which used 5 percent by dry weight of bentonite. This mixture produced a permeability of approximately $2x10^{-8}$ centimeters per second, well below the levels suggested by the Solid Waste Division. However, as mentioned above, this test was performed on the finer soil and excluded the gravel. When the gravel is remixed, the permeability is likely to increase but is expected to stay below the suggested level of 10^{-6} centimeters per second.

In order to provide a well intermixed cap material, your earthwork contractor will need to exercise considerable care in his operations. Once the bentonite has been spread over the

surface of the landfill being treated, the intermixing must be accomplished quickly to prevent loss of bentonite by wind activity. We recommend this intermixing be performed with a disc harrow or rototiller since, in our experience, this has provided a thorough degree of intermixing. When the bentonite has been intermixed, the treatment area should be moisture conditioned. On the basis of our laboratory testing program, we estimate that the field moisture content should be on the order of about 12 percent. However, because this is **critical** to thorough intermixing, the actual moisture content **must** be closely monitored in the field. It is important that the soil/bentonite mixture becomes slightly plastic during this process. It will also help if the material pumps slightly during the intermixing and compaction process, since this will tend to help the soil matrix fill the voids between the gravel and the soil. In-place dry densities of about one hundred twenty-five (125) to one hundred thirty (130) pounds per cubic foot should be achievable in the field. Providing the above procedure is closely followed, and that it is closely monitored throughout, the cap material should prove to be essentially impermeable and to have a permeability rating of at least 10^{-6} centimeters per second.

Excavations and Slopes

While no major excavations or slope construction efforts are anticipated in construction, some slope construction may be required along portions of the landfill perimeter. You should be aware that in no case should excavation slopes, including utility trenches, be greater than the limits specified in local, state and national government safety regulations.

Temporary cuts greater than four feet in depth should be sloped at an inclination no steeper than 1H:1V. If slopes of this inclination, or flatter, cannot be constructed, or if excavations greater than four feet in depth are required, temporary shoring may be necessary. This shoring will help protect against slope or excavation collapse, and will provide protection to workmen in the excavation. If temporary shoring is required, we will be available to provide geotechnical shoring design criteria, if requested.

All permanent cut and fill slopes should be inclined no steeper than 2H:1V. These recommendations are applicable to slopes with a maximum height of ten feet. If higher slopes are anticipated, we should be contacted for the appropriate design and construction criteria.

We also recommend that all excavated slopes be examined at the time of construction by ECI's representative to verify that conditions are as anticipated. Supplementary recommendations can then be developed, if needed, to enhance stability. Such measures can include, but not necessarily be limited to, flattening of slopes or installation of surface or subsurface drains. In any case, water should not be allowed to flow uncontrolled over the top of any slopes. All buildings should be set back a distance at least equal to the height of the slope to avoid imposing any structural load on the face of the slope.

All permanently exposed slopes should be seeded with an appropriate species of deep-rooted, rapid-growth vegetation to reduce erosion potential and improve stability of the surficial layer of soil.

Site Drainage

A drainage layer will be necessary between the playfield surface and the impermeable cap layer below. We understand that the actual design of this drainage layer is the responsibility of the landscape architect. However, we anticipate the drainage layer will comprise no less than six inches of free draining sand and/or gravel mixture in which several small diameter (four inch) PVC pipes will be laid in a grid with a gradient sufficient to initiate gravity flow to a suitable discharge.

We do not expect the site groundwater levels will present any major construction-related problems. However, the site should be graded such that surface water is directed off the site. Water should not be allowed to stand in any area where buildings, slabs, pavements or playfield areas are to be constructed. During construction, loose surfaces should be roller-sealed at night to reduce the potential for moisture infiltration into the soils. Final site grades should allow for drainage away from the building foundations or from the center of the new playfield. We suggest that the ground be sloped at a gradient of 3 percent for a distance of at least ten feet away from the buildings except in areas that are to be paved.

If seepage is encountered in excavations during future construction, we recommend your contractor slope the bottom of the excavation to one or more shallow sump pits. The collected water can then be pumped from these pits to a positive and permanent discharge, such as a nearby storm drain. Depending on the magnitude of such seepage, it may also be necessary to interconnect the sump pits by a system of shallow connector trenches.

We recommend the appropriate locations of subsurface drains, if needed, be established during grading operations by ECI's representative at which time the seepage areas, if present, may be more clearly defined.

Landfill Seepage

As can be seen on Plate 3, the deeper portion of the landfill appears to be along the northeastern edge of the site. None of the three test pits dug in this area penetrated through the refuse. Given the bottom-of-landfill contours shown on Plate 4, it appears to us that water seeping down through the landfill contents could drain down into this lower-lying area. Since we are currently unaware of the nature of the underlying native soil, it is essentially impossible to determine if such collected water would seep down into the underlying sol or would remain in-place over an impermeable material. Further, more-detailed site exploration will be necessary to determine the existing in-place conditions. Such additional study would include the drilling of at least one boring to sufficient depth to determine the depth and nature of the underlying material.

The soils encountered in several exploratory excavations are also relatively coarse-grained and are likely to be relatively free-draining. As a result, it is a reasonable assumption that water seeping down to the bottom of the landfill can, and probably does, seep down into the underlying native soil.

The concern generated by such seepage is related to the nature of the seepage (the potential contamination, given the source) and the direction (does it seep to North Creek or the wetlands?). These concerns, too, can only be answered through more extensive site exploration and testing. We recommend you pursue a more detailed site study and are prepared to provide you a scope-of-services and cost estimate to perform the study when requested.

CLOSURE

Limitations

Our recommendations and conclusions are based on the site materials observed, selected laboratory testing, engineering analyses, the design information you provided us, and our experience and engineering judgement. The conclusions and recommendations are professional opinions derived in a manner consistent with that level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area. No warranty is expressed or implied.

The recommendations submitted in this report are based upon the data obtained from the test pits. The test pits were randomly located in the landfill area only. We did not examine the subsurface conditions elsewhere on the site. **Soil and groundwater conditions between test pits may vary from those encountered.** The nature and extent of variations between our exploratory locations may not become evident until construction. If variations then appear, ECI should be requested to reevaluate the recommendations of this report and to modify or verify them in writing prior to proceeding with the construction.

We did **not** perform any environmental sampling, testing or analysis of any of the materials encountered, since this was expressly excluded from our contract.

Additional Services

We recommend that ECI be retained to perform a general review of the final design and specifications. This will allow us to verify that the earthwork and foundation recommendations have been properly interpreted and implemented in the design plans and in the construction specifications.

As indicated earlier in the text, we recommend additional site exploration and testing be performed to better determine the vertical extent of the landfill, particularly in the northeastern part of the site, the drainage characteristics of the underlying site soils, and the potential direction of groundwater flow. We are prepared to provide you a scope-of-services and cost estimate for these services at your request.

As indicated earlier, we encountered some noxious materials within the landfill's content. In our opinion, based on the odors emitted and the visual condition of the materials, additional sampling, testing and analysis should be conducted on these materials to better determine their make-up and the potential problems associated with their presence. We are available to provide you a scope-of-services and cost estimate for this additional work when requested.

We also recommend that ECI be retained to provide geotechnical services during construction. This is to provide a measure of continuity, to observe compliance with the design concepts, specifications or recommendations and to allow design changes in the event subsurface conditions differ from those anticipated prior to the start of construction. Because of the settlement-sensitive nature of this project, and the need to construct an impermeable landfill cap which involves close control of the earthwork contractor, we do not accept any responsibility for the performance of the foundation or earthwork unless we are retained to provide these services.

APPENDIX A
FIELD EXPLORATION
E-4428

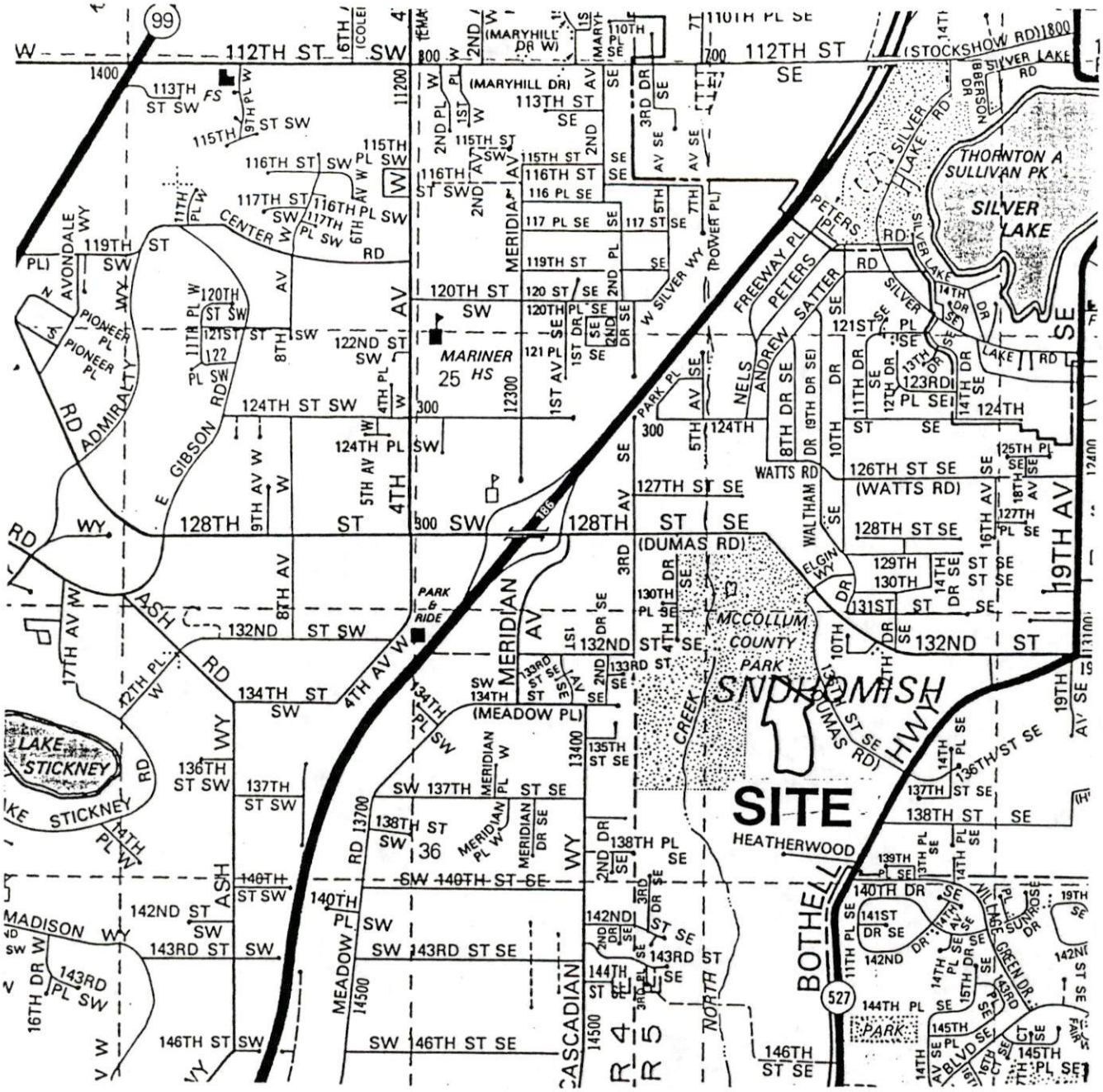
Our field exploration was performed on August 17, 1989. Subsurface conditions at the site were explored by excavating ten test pits to a maximum depth of fifteen (15) feet below existing grade.

Approximate test pit locations were determined by taping from existing property features. Approximate test pit elevations were determined by interpolating from contour lines on a topographic map provided by Snohomish County Parks Department. The locations and elevations of the test pits should be considered accurate only to the degree implied by the method used. These approximate locations are shown on the Test Pit Location Plan, Plate 2.

The field exploration was continuously monitored by a geotechnical engineer from our firm who classified the soils encountered and maintained a log of each test pit, obtained representative samples, measured groundwater levels, and observed pertinent site features. All samples were visually classified in general accordance with the Unified Soil Classification System which is presented on Plate 5, Legend. The Test Pit Logs are presented on Plates 6 through 12. The final logs represent our interpretations of the field logs and the results of the laboratory examination and selective tests of field samples. The stratification lines on the logs represent the approximate boundaries between soil types. In actuality, the transitions may be more gradual.

The density or consistency of the soil was estimated based on the effort required to excavate the soil, the stability of the trench walls, and other factors.

Representative soil samples were placed in closed containers and returned to our laboratory for further examination and testing.

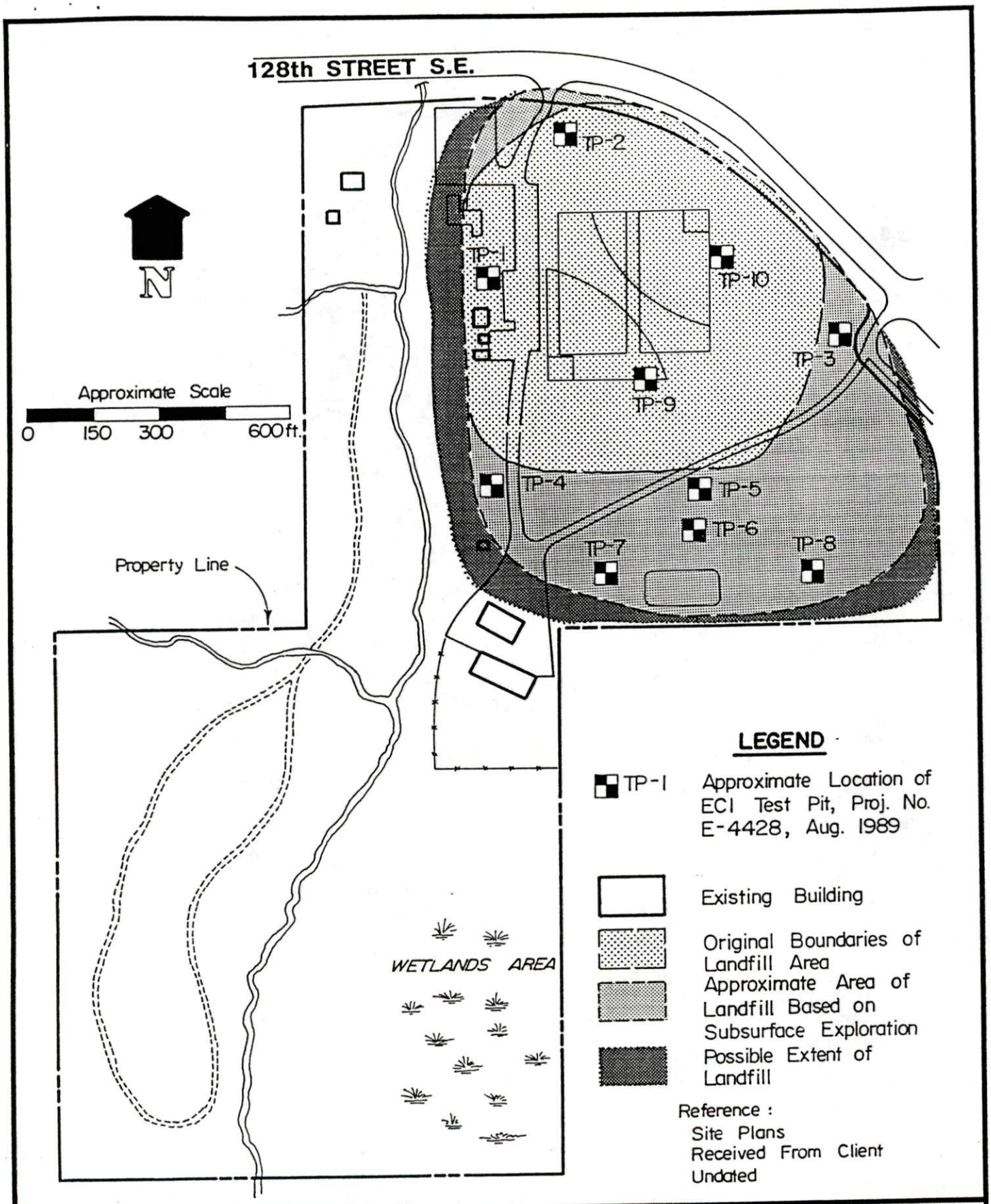


Reference :
Snohomish County / Map 48
By Thomas Brothers Maps
Dated 1988

Earth Consultants Inc.
Geotechnical Engineers, Geologists & Environmental Scientists

Vicinity Map
McCollum Park
Snohomish County, Washington

Proj. No. 4428	Drwn. GLS	Date Aug. '89	Checked ML	Date 8/23/89	Plate 1



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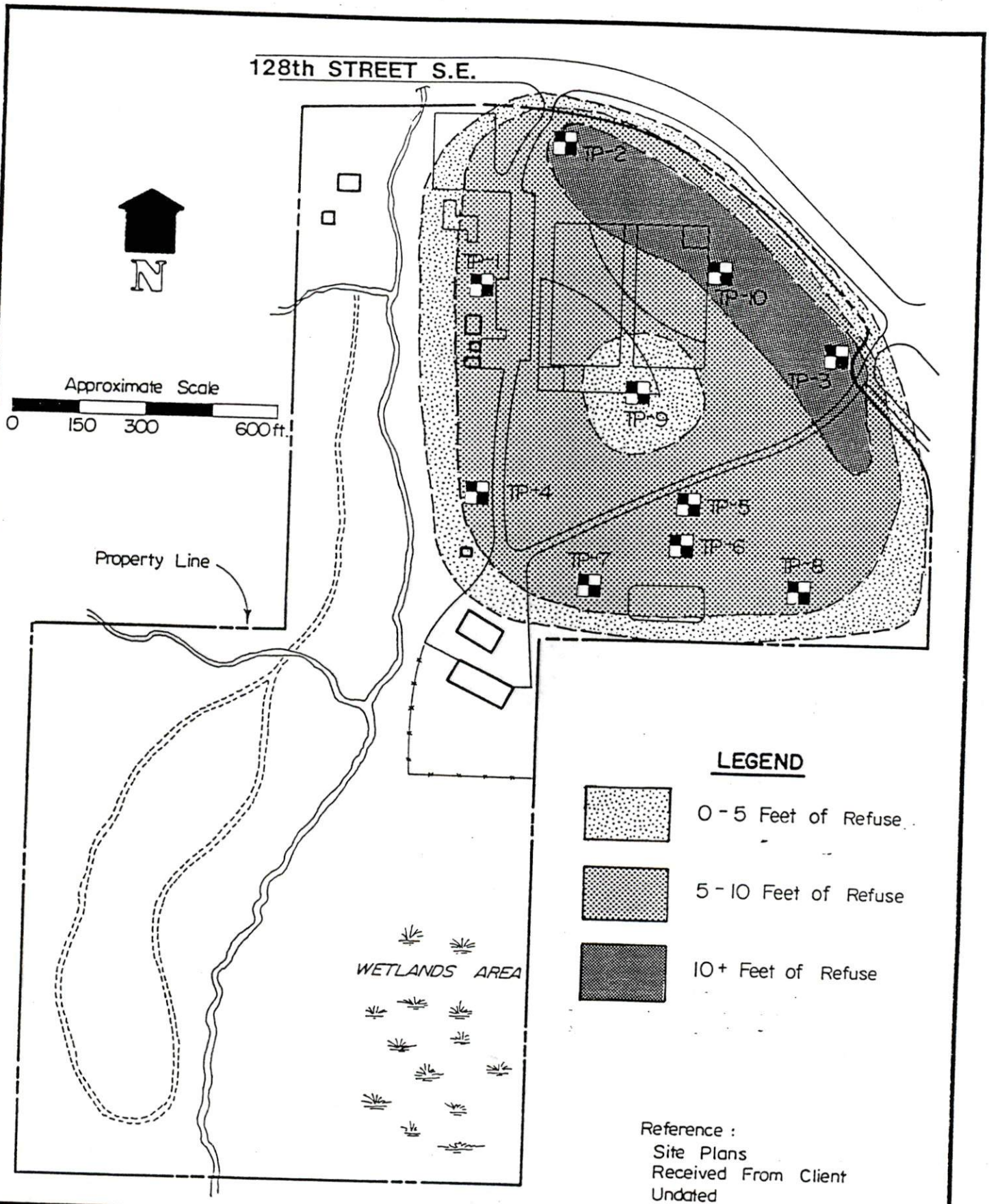
Geotechnical Engineers, Geologists & Environmental Scientists

Test Pit Location Plan
McCollum Park
Snohomish County, Washington

Proj. No. 4428	Drwn. GLS	Date Aug. '89	Checked ML	Date 8/23/89	Plate 2



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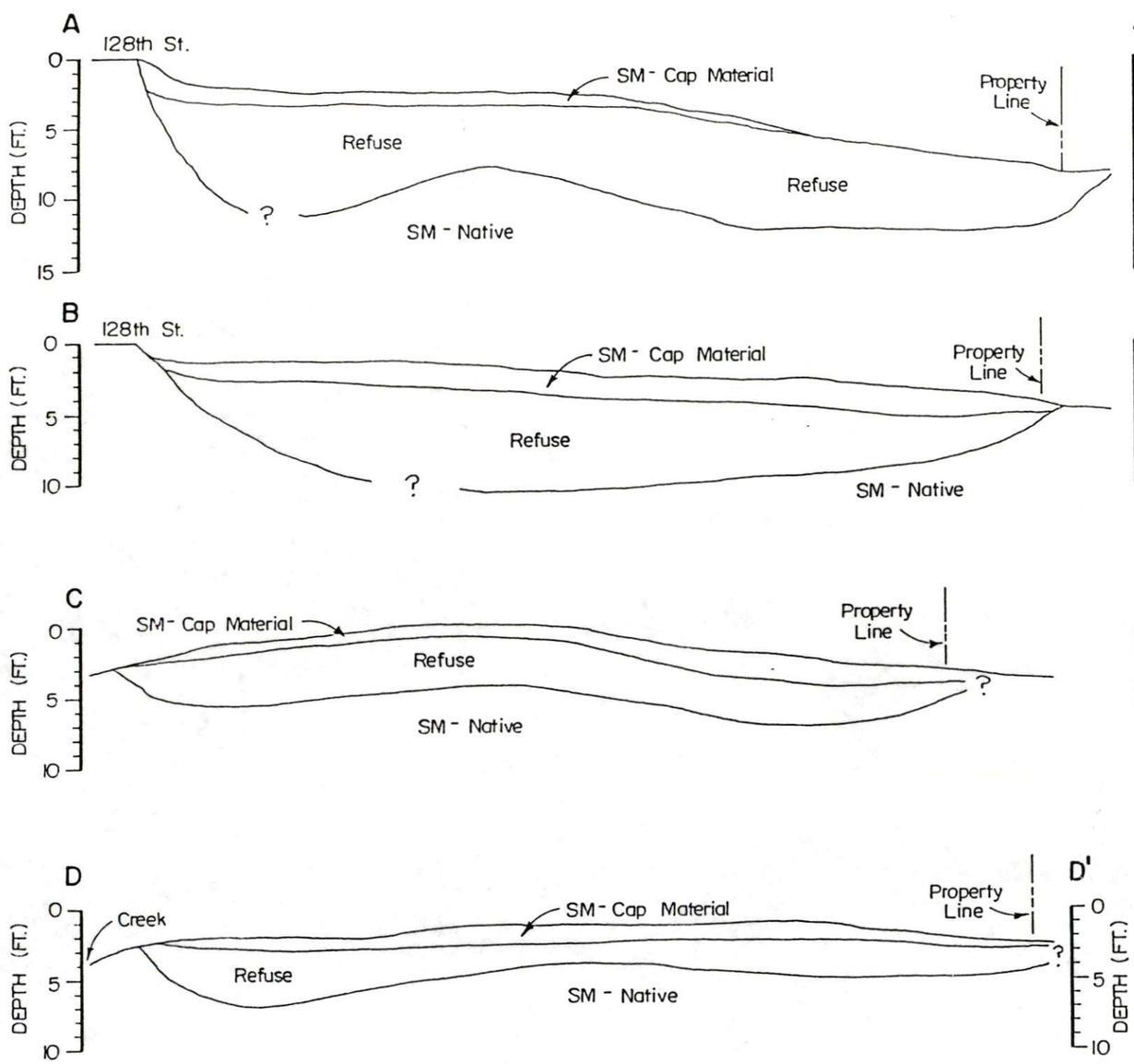
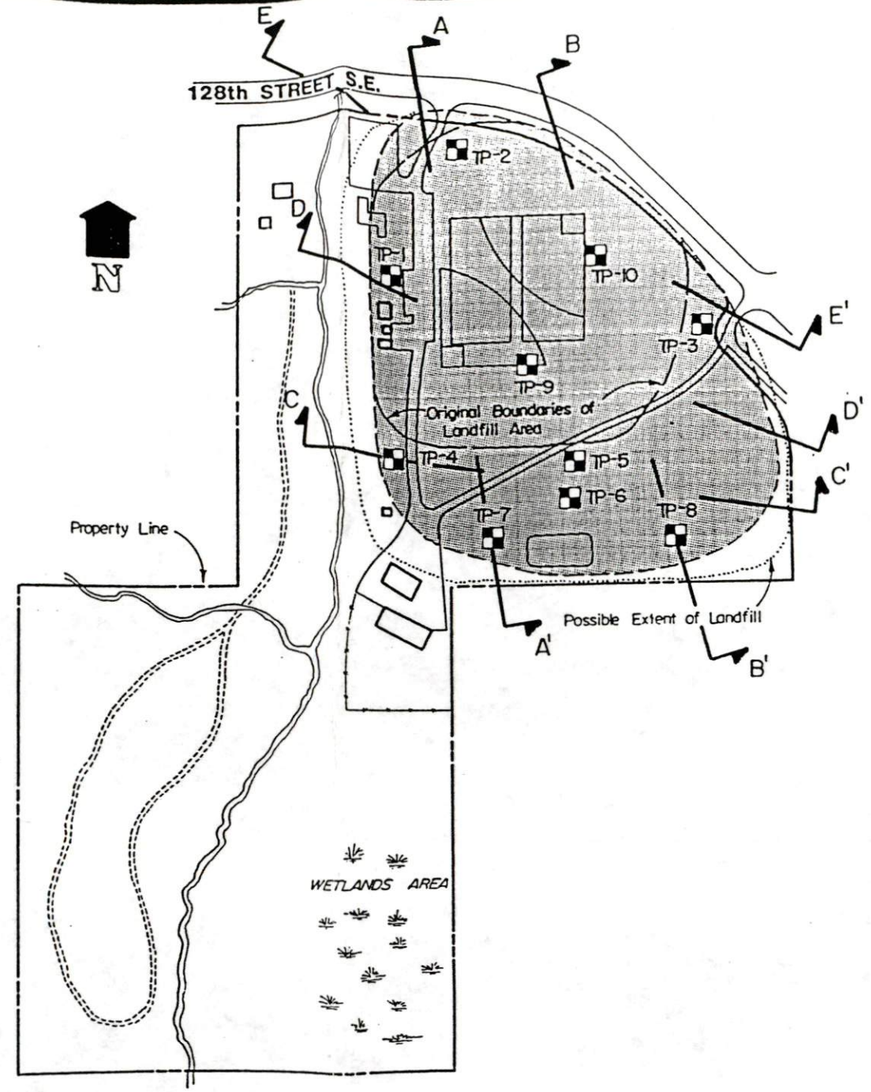
Contours of Depth of Refuse
McCollum Park
Snohomish County, Washington

Proj. No. 4428	Drwn. GLS	Date Aug. '89	Checked ML	Date 8/23/89	Plate 3





Cross Section Scales:

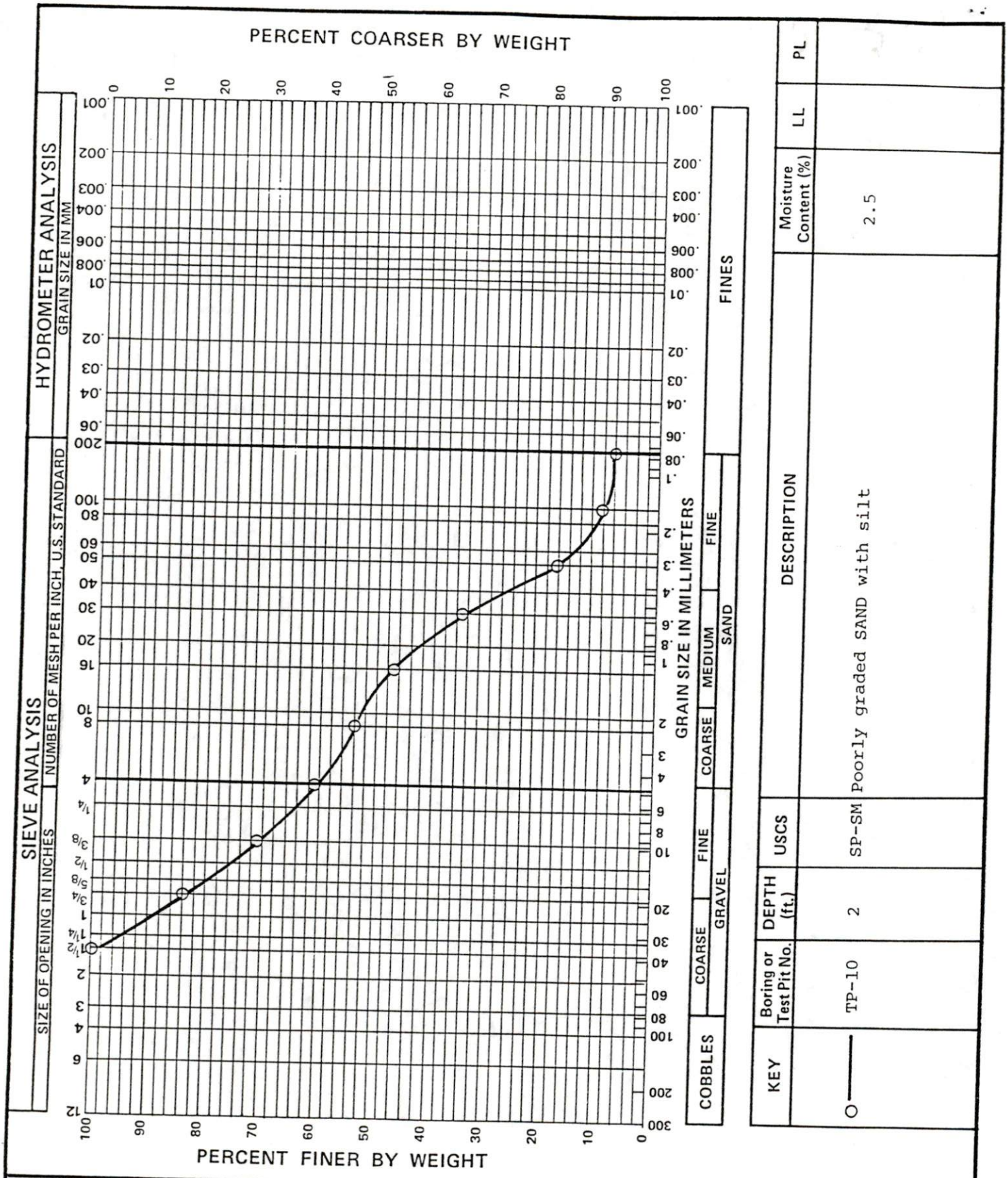
Horizontal Scale
0 100 200 400ft.

Vertical Scale
0 10 20 40ft.

Earth Consultants Inc.
Geotechnical Engineers, Geologists & Environmental Scientists

Generalized Cross Sections
McCollum Park
Snohomish County, Washington

Proj No. 4428	Drwn. GLS	Date Oct. '89	Checked ML	Date 10/4/89	Plate 4



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Geotechnical Engineering and Geology

GRAIN SIZE ANALYSES

MCCOLLUM PARK
SNOHOMISH COUNTY, WASHINGTON

Proj. No. 4428 | Date Aug'89 | Plate 13

DISTRIBUTION

E-4428

4 Copies

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APPENDIX B
LABORATORY TESTING
E-4428

General

We conducted laboratory tests on several representative soil samples to verify or modify the field soil classification of the units encountered and to evaluate the material's general physical properties and engineering characteristics. A brief description of each of the tests performed for this study is provided below. The results of laboratory tests performed on specific samples are provided either at the appropriate sample depth on the individual test pit log or on a separate data sheet contained in this Appendix. However, it is important to note that **these test results may not accurately represent the overall in-situ soil conditions.** All of our recommendations are based on our interpretation of these test results and their use in guiding our engineering judgement. ECI cannot be responsible for the interpretation of these data by others.

In accordance with our Standard Fee Schedule and General Conditions, the soil samples for this project will be discarded after a period of thirty (30) days following completion of this report unless we are otherwise directed in writing.

Soil Classification

As mentioned earlier, all soil samples are visually examined in the field by our representative at the time they are obtained. They are subsequently packaged and returned to our Bellevue office, where they are independently reexamined by one of our engineers. The original description is verified or modified, as necessary. With the help of information obtained from classification tests, the samples are described in general accordance with the Unified Soil Classification System, ASTM Test Method D-2487-83. The resulting descriptions are provided at the appropriate sample location on the individual test pit log and are qualitative only. The attached Legend, Plate 5, provides pictorial symbols that match the written descriptions.

Moisture

Moisture content tests were performed on all samples obtained from the test pits. The purpose of these tests is to approximately ascertain the in-place moisture content of the soil sample tested. The moisture content is determined in general accordance with ASTM Test Method D-2216-80. The information obtained assists us by providing qualitative information regarding soil strength and compressibility. The result of this test is presented at the appropriate sample depth on the test pit logs.

Particle Size Analysis

A detailed grain size analyses was conducted on one of the shallow soil samples to determine the size distribution of the sampled soil. The information gained from this analysis allows us to provide a detailed description and classification of the in-place materials. In turn, this helps us to understand how the in-place materials will react when moved and reworked during earthwork operations. The results are presented on Plate 13, and classification symbols are provided as part of the appropriate individual sample descriptions on the test pit logs.

TEST PIT NO. 10

Logged By ML

Date 8-17-89

Elev. 400±

Depth (ft.)	USCS	Soil Description	W (%)
0	SP-SM	(4" topsoil and sod) "Fill" Light brown SAND with silt and gravel, damp, loose, -gray below 1½'	3
5		Garbage - general household refuse -with gray silty SAND below 7½	
10			
15		Test pit terminated at 15 feet below existing grade. No groundwater seepage encountered during excavation.	
20			

Subsurface conditions depicted represent our observations at the time and location of this exploratory hole, modified by engineering tests, analysis, and judgement. They are not necessarily representative of other times and locations. We cannot accept responsibility for the use or interpretation by others of information presented on this log.

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TEST PIT LOGS
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TEST PIT NO. 8

Logged By ML

Date 8-17-89

Elev. 392±

Depth (ft.)	USCS	Soil Description	W (%)
0	sm	(4" topsoil and sod) "Fill" Brown silty SAND with gravel, dry, loose -light reddish brown below 2'	4
5		Garbage - general household refuse -with blackish brown silty SAND below 7½'	
10		Test pit terminated at 12 feet below existing grade due to obstruction. No groundwater seepage encountered during excavation.	
15			

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TEST PIT NO. 9

Logged By ML

Date 8-17-89

Elev. 400±

Depth (ft.)	USCS	Soil Description	W (%)
0	sm	(4" topsoil and sod) "Fill" Light brown silty SAND with gravel, dry, loose	
		Garbage - general household refuse	
5	sp-sm	Gray medium to coarse grained SAND with silt, moist, medium dense	5
10		Test pit terminated at 11 feet below existing grade. No groundwater seepage encountered during excavation.	
15			

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TEST PIT NO. 6

Logged By ML

Date 8-17-89

Elev. 395±

Depth (ft.)	USCS	Soil Description	W (%)
0	sm	"Fill" Light brown silty SAND with gravel, dry, loose	
		Garbage - barrel, glass, oil, tar present	
5			◁
	ml	Dark brown organic SILT or topsoil	
		Test pit terminated at 8 feet below existing grade. Moderate groundwater seepage encountered at 6½ feet during excavation Hole terminated due to intense fumes.	
10			
15			

Subsurface conditions depicted represent our observations at the time and location of this exploratory hole, modified by engineering tests, analysis, and judgement. They are not necessarily representative of other times and locations. We cannot accept responsibility for the use or interpretation by others of information presented on this log.

TEST PIT NO. 7

Logged By ML

Date 8-17-89

Elev. 388±

0		(4" topsoil and sod) "Fill" Brown silty SAND with gravel soil matrix with 50% - 75% garbage and wood debris	
5		-black and burned below 4'	
10	sp-sm	Gray medium grained SAND with silt, wet, medium dense	11
		Test pit terminated at 12 feet below existing grade. No groundwater seepage encountered during excavation.	
15			

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TEST PIT NO. 4

Logged By ML

Date 8-17-89 Elev. 390±

Depth (ft.)	USCS	Soil Description	W (%)
0	sm	(4" topsoil and sod) Light brown silty SAND with gravel and garbage, dry, loose	
		Garbage - general household refuse	
5			
10	sm	Gray silty SAND with gravel, moist, medium dense	8
15		Test pit terminated at 11 feet below existing grade. No groundwater seepage encountered during excavation.	

Subsurface conditions depicted represent our observations at the time and location of this exploratory hole, modified by engineering tests, analysis, and judgement. They are not necessarily representative of other times and locations. We cannot accept responsibility for the use or interpretation by others of information presented on this log.

TEST PIT NO. 5

Logged By ML

Date 8-17-89 Elev. 395±

	USCS		W (%)
0	sm	"Fill" (4" topsoil and sod) Light brown silty SAND with gravel, dry, loose	3
		Garbage - general household refuse	
5		-tar, oil(?), buckets encountered at 7' -oil(?) oozing from side at 7'	◁
10	ml	Black organic clayey SILT, plastic, wet, soft	
15		Test pit terminated at 12 feet below existing grade. Moderate groundwater seepage encountered at 5 feet during excavation. Hole terminated due to intense fumes.	

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TEST PIT NO. 3

Logged By ML

Date 8-17-89

Elev. 394±

Depth (ft.)	USCS	Soil Description	W (%)
0	sm	"Fill" Light brown silty SAND with gravel, dry, medium dense	5
		-with organics and roots below 2½'	
5		Garbage - general household refuse	
10		-with blackish brown silty SAND below 11'	
15		(Possibly through fill at 15')	◁
		Test pit terminated at 15 feet below existing grade. Very light groundwater seepage encountered at 14 feet during excavation.	
20			

TEST PIT NO. 2

Logged By ML

Date 8-17-89

Elev. 396±

Depth (ft.)	USCS	Soil Description	W (%)
0	sm	"Fill"(4" topsoil and sod) Light brown silty SAND with gravel, dry, loose -gray below 1½'	6
5		Garbage - cans, bottles (glass and plastic), wood, metal, paper - general household refuse	
10		-with gray silty SAND with gravel below 11'	
15		Test pit terminated at 15 feet below existing grade. No groundwater seepage encountered during excavation.	
20			

Subsurface conditions depicted represent our observations at the time and location of this exploratory hole, modified by engineering tests, analysis, and judgement. They are not necessarily representative of other times and locations. We cannot accept responsibility for the use or interpretation by others of information presented on this log.

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TEST PIT NO. 2

Logged By ML

Date 8-17-89

Elev. 396±

Depth (ft.)	USCS	Soil Description	W (%)
0	sm	"Fill"(4" topsoil and sod) Light brown silty SAND with gravel, dry, loose -gray below 1½'	6
		Garbage - cans, bottles (glass and plastic), wood, metal, paper - general household refuse	
5			
10		-with gray silty SAND with gravel below 11'	
15		Test pit terminated at 15 feet below existing grade. No groundwater seepage encountered during excavation.	
20			

Subsurface conditions depicted represent our observations at the time and location of this exploratory hole, modified by engineering tests, analysis, and judgement. They are not necessarily representative of other times and locations. We cannot accept responsibility for the use or interpretation by others of information presented on this log.

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TEST PIT NO. 1

Logged By ML

Date 8-17-89

Elev. 395±*

Depth (ft.)	USCS	Soil Description	W (%)
0	sm	"Fill" (4" topsoil and sod) Brown silty SAND with gravel, moist, loose to medium dense -gray below 1½'	12
5		Garbage - cans, paper, bottles, household refuse	
10	sm	Gray silty SAND with gravel, moist, medium dense	10
15		Test pit terminated at 12 feet below existing grade. No groundwater seepage encountered during excavation. *Elevation reference - topographic survey provided by Snohomish Co. Parks Dept.	
20			

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MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTION
Coarse Grained Soils	Gravel And Gravelly Soils	Clean Gravels (little or no fines)		GW gw	Well-Graded Gravels, Gravel-Sand Mixtures, Little Or No Fines
				GP gp	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little Or No Fines
	More Than 50% Coarse Fraction Retained On No. 4 Sieve	Gravels With Fines (appreciable amount of fines)		GM gm	Silty Gravels, Gravel-Sand-Silt Mixtures
				GC gc	Clayey Gravels, Gravel-Sand-Clay Mixtures
	Sand And Sandy Soils	Clean Sand (little or no fines)		SW sw	Well-Graded Sands, Gravelly Sands, Little Or No Fines
				SP sp	Poorly-Graded Sands, Gravelly Sands, Little Or No Fines
More Than 50% Material Larger Than No. 200 Sieve Size	More Than 50% Coarse Fraction Passing No. 4 Sieve	Sands With Fines (appreciable amount of fines)		SM sm	Silty Sands, Sand-Silt Mixtures
				SC sc	Clayey Sands, Sand-Clay Mixtures
Fine Grained Soils	Silts And Clays	Liquid Limit Less Than 50		ML ml	Inorganic Silts & Very Fine Sands, Rock Flour, Silty-Clayey Fine Sands; Clayey Silts w/ Slight Plasticity
				CL cl	Inorganic Clays Of Low To Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean
				OL ol	Organic Silts And Organic Silty Clays Of Low Plasticity
More Than 50% Material Smaller Than No. 200 Sieve Size	Silts And Clays	Liquid Limit Greater Than 50		MH mh	Inorganic Silts, Micaceous Or Diatomaceous Fine Sand Or Silty Soils
				CH ch	Inorganic Clays Of High Plasticity, Fat Clays
				OH oh	Organic Clays Of Medium To High Plasticity, Organic Silts
Highly Organic Soils				PT pt	Peat, Humus, Swamp Soils With High Organic Contents

Topsoil		Humus And Duff Layer
Fill		Highly Variable Constituents

The Discussion In The Text Of This Report Is Necessary For A Proper Understanding Of The Nature Of The Material Presented In The Attached Logs

Notes :

Dual symbols are used to indicate borderline soil classification. Upper case letter symbols designate sample classifications based upon laboratory testing; lower case letter symbols designate classifications not verified by laboratory testing.

- 2"O.D. SPLIT SPOON SAMPLER
- 2.4"I.D. RING SAMPLER OR SHELBY TUBE SAMPLER
- P SAMPLER PUSHED
- SAMPLE NOT RECOVERED
- WATER LEVEL (DATE)
- WATER OBSERVATION WELL

- C TORVANE READING, tsf
- qu PENETROMETER READING, tsf
- W MOISTURE, percent of dry weight
- pcf DRY DENSITY, pounds per cubic ft.
- LL LIQUID LIMIT, percent
- PI PLASTIC INDEX

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LEGEND

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