GEOTECHNICAL ENGINEERING SERVICES
CAPITOL LAKE SEDIMENT CONTROL PROJECT
OLYMPIA, WASHINGTON

HWA Project No. 92055-2

July 1, 1994

Prepared for:

ENTRANCO

HWA
HONGWEST
& ASSOCIATES, INC.

HONG WEST
& ASSOCIATES, INC.

Geotechnical Engineering
Hydrogeology
Geoenvironmental Services
Testing & Inspection

July 1, 1994
HWA Project No. 92055-2

Mr. Ed Berschinski
ENTRANCO
10900 N.E. Eighth Street, Suite 300
Bellevue, Washington 98004

Subject: **Geotechnical Engineering Services**
Capitol Lake Sediment Control Project
Olympia, Washington

Dear Ed:

In accordance with your request, Hong West & Associates, Inc. (HWA) is pleased to present the results of our geotechnical engineering services related to the Capitol Lake Sediment Control Project, Olympia, Washington. The results of our study are presented in the accompanying report.

It has been a pleasure to work with you on this project. Should you have any questions or comments, or if we may be of further service, please do not hesitate to call.

Sincerely,

HONG WEST & ASSOCIATES, INC.

Robert C. Metcalfe
Geotechnical Engineer

Scott L. Hardman, P.E.
Senior Geotechnical Engineer

RCM:SLH (92055R-2.doc)

19730-64th Ave. W.
Lynnwood, WA 98036-5904
Tel. 206-774-0106
Fax. 206-775-7506

TABLE OF CONTENTS

LIST OF FIGURES (Following Text)

APPENDICES

GEOTECHNICAL ENGINEERING SERVICES
CAPITOL LAKE SEDIMENT CONTROL PROJECT
OLYMPIA, WASHINGTON

1.0 INTRODUCTION

Hong West & Associates, Inc. (HWA) has performed geotechnical engineering services related to the proposed Capitol Lake Sediment Control Project, Olympia, Washington. This report presents the results of our study regarding construction of a possible new dewatering basin for dredge spoil and characterization of soil materials within the existing dewatering facility, located at the southwest end of the middle basin of Capitol Lake (see Figure 1).

1.1 PROJECT DESCRIPTION

Our understanding of the project is based on discussions with the project team members, and review of pertinent documents. We have been provided with a copy of the preliminary draft report (including Figures 2 and 3) entitled "Ten Year Sediment Removal Plan for Capitol Lake, Olympia, Washington", prepared by Entranco, dated June 1994. Other reports which we have reviewed include CH2M/Hill (1976, exerpts), RZA (1982), and Brown & Caldwell (1984).

We understand the proposed sediment removal plan will include (1) possible construction of a new dewatering basin within the dewatering facility, located at the southwest end of the middle basin of Capitol Lake, (2) dredging sediment from the middle basin of Capitol Lake and pumping the material into the newly constructed dewatering basin, (3) dewatering the sediment within the basin, (4) excavating materials from the dewatering basin after a predetermined time period and disposing the materials at an off-site location, and (5) repeating the process, 1 through 4, on an annual basis. The vicinity map presented in Figure 1 shows the location of the dewatering facility relative to the middle basin of Capitol Lake.

We understand the formation of Capitol Lake in 1951 has resulted in accelerated accumulations of sediment within the lake basins. Estimates of sediment accumulation range from 20,000 to 57,000 cubic yards per year with an average sediment accumulation rate of approximately 35,000 cubic yards per year. We also understand that two previous dredging operations have occurred, the first between 1978 and 1982 when approximately 257,000 cubic yards of sediment were removed from the lake, and in 1986 when approximately 57,000 cubic yards of material were removed from the middle basin sediment trap. The proposed sediment control plan will involve removal of sediment from the middle basin of Capitol Lake at the rate of about 35,000 cubic yards per year. We

understand that the middle basin has been divided into nine sectors, as shown on the Vicinity Map on Figure 1, and the dredging plan will initiate in the middle basin sediment trap (Sector 1) and then progress northward. In addition to the dredging operation progressing northward during the sediment control project period, Sector 1 will be dredged every two years.

The location of the possible dewatering basin is shown on the Site Map (Figure 1). The new dewatering basin would be constructed between the dike and the former dewatering basins which are now considered wetland habitat (wetlands B and D). Feasibility of using the available area north of the former dewatering basin (Wetland B) as a dewatering basin for the proposed sediment control project is presently under evaluation. As such, the extent and configuration of the possible new dewatering facility is not known. For the purpose of this report, we assumed top of berm elevations at 20 feet, and the bottom of the new facility at Elevation 8 feet. We understand at least 4 feet of freeboard would need to be provided between the tops of containment berms and dredge spoils. A gravel access road would be constructed around the new facility.

1.2 Purpose and Scope of Work

The purpose of our geotechnical engineering services was to provide subsurface information and design recommendations regarding construction of the new dewatering basin. In particular, our study addressed:

- General subsurface soil conditions
- Depth to groundwater
- Characterization and evaluation of subsurface soils
- Potential beneficial uses of excavated materials
- Settlement and stability of containment berms
- Allowable dewatering basin side slopes
- Earthwork and materials
- General groundwater considerations

In addition, the study included:

- Laboratory testing of lakebed sediment samples collected by Entranco
- General geology of the remote disposal site located west of Marathon Park

A proposal for performing our geotechnical engineering services was submitted by HWA to Entranco on April 21, 1993 (revised February 23, 1994). Notice to Proceed was received in a facsimile signed by David Morency on February 2, 1994. During our field investigation the scope of work described in our proposal was changed such that no subsurface work would be performed at the remote disposal site. In addition, after our

initial field work was performed, the location of the new dewatering basin was subsequently changed to reflect wetland concerns, thus limiting the usefulness of information gathered from subsurface explorations performed within the area now classified as wetlands.

Our scope of work (reflecting changes made during our meeting on February 18, 1994, and subsequent deletion of work at the off-site disposal area) included the following:

1) Gather and review readily-available geotechnical and geologic data for the project area.

2) Plan and conduct on-site investigations to explore subsurface conditions at the existing dewatering facility. In addition we collected six soil samples at locations and depths specified by Entranco for the environmental assessment, and delivered the samples to a chemical laboratory designated by Entranco.

3) Conduct laboratory testing to determine geotechnical engineering properties of soils within the existing dewatering facility. The purpose of the laboratory testing was to characterize the general suitability of materials for beneficial uses such as compacted fill, topsoil, or others.

4) Perform engineering analysis and evaluation of data derived from the subsurface investigation and laboratory testing program, with respect to the proposed dredging plan and dewatering basin design.

5) Prepare a report containing the results of the geotechnical investigation, including geotechnical engineering recommendations related to the proposed dewatering basin excavation and containment berm design.

6) Provide geotechnical consultation relative to the dredging plan. This included laboratory gradation testing for 10 lakebed sediment samples collected by Entranco, and future geotechnical review of project plans.

7) Attend two project meetings and perform necessary project management and in-house review of the geotechnical work.

2.0 FIELD AND LABORATORY INVESTIGATIONS

2.1 FIELD EXPLORATION

Subsurface conditions were explored on February 23 and 24, 1994, under the full-time observation of HWA personnel. Subsurface explorations included excavating 12 test pits (TP-1 through TP-12) and 5 hand auger borings (HA-1 through HA-5) in the area of the possible new dewatering basin. The approximate locations of the test pits and hand auger borings are shown on the Site Plan (Figure 1). Test pits TP-1 through TP-8 and all hand auger borings were excavated prior to receiving notice that the existing dewatering basins are now considered wetlands. Test pits TP-9 through TP-12 were excavated to the north and east of Wetland B within a possible location for a new dewatering basin identified by Entranco.

The test pits were excavated using a Kubota KB28 trackhoe to depths ranging from about 7 to 12.5 feet below the ground surface. The depths of the test pits were either controlled by excessive caving of the pit sidewalls or by the reach of the trackhoe equipment. The hand auger borings were advanced to depths of 7 to 7.5 feet below the ground surface using a 3-inch diameter soil sampler. Explorations were located in the field by pacing distances from topographic features or fences, and plotted on the project base map.

All explorations were logged and disturbed soil samples were obtained at selected intervals for future evaluation and laboratory testing. Details of the field exploration program as well as summary logs of the test pits and hand auger borings are included in Appendix A, as are legends of the symbols and terms used on the logs.

2.2 LABORATORY TESTING

Laboratory tests were conducted on selected soil samples from the HWA explorations to characterize certain engineering properties. Laboratory tests conducted on soil samples included determination of moisture content, grain size distribution, plasticity, and compaction (maximum dry density and optimum moisture content). The tests were conducted in general accordance with appropriate American Society for Testing and Materials (ASTM) standards. The grain size distribution, plasticity and compaction results are presented in Appendix B, and the moisture content tests as well as the plasticity results are displayed on the logs in Appendix A.

Grain size distribution analyses were also conducted on 10 lakebed sediment samples obtained by Entranco. Results of these laboratory tests are presented in Appendix C.

3.0 SITE CONDITIONS

The following section describes the general surface and subsurface conditions in the area of the possible new dewatering basin. In addition, the general geologic conditions at a potential off-site disposal area, located west of Marathon Park, are also described. Interpretations of site conditions are based on our site visit, subsurface exploration, and available geologic maps.

3.1 DEWATERING AREA

3.1.1 Surface Conditions

The present configuration (Figure 1) of the dewatering facility resulted from excavation of dredge spoils placed during the initial project in the late 1970's and filling and construction of berms as part of the second dredging operation in 1986. The Capitol Lake Interpretive Center located on the northwest end of the facility was also constructed as part of the second dredging and reconstruction project. The original dewatering basins within the dewatering facility have been recently classified as wetlands (wetlands B and D on Figure 1).

The dewatering facility is separated from the lake by a dike which supports an asphalt paved trail used for recreation purposes. The dike shows signs of past/current instability in the form of longitudinal cracking in the asphalt pavement as well as crescent shaped cracks along the lake side of the dike. These cracks were noted on the dike between the lake and Wetland D. Wetland D was partially covered by water at the time of our field investigation.

Wetlands B and D are separated by a timber slip spillway and boardwalk. The surface of Wetland B is at about Elevation 11 to 12 feet on the northwest side near the bridge and gradually grades upward to Elevation 16 to 17 feet on the eastern side. Wetland B was also partially cover by shallow surface water and wetland plant life on the west end at the time of our site visit. The water appeared to be between ½ and 1 foot deep in most areas. The eastern half of Wetland B was generally above the water level and supported grass, shrubs and deciduous trees.

The site of the possible new dewatering basin is east of Wetland B and southeast of Wetland D. This site occupies approximately 4 acres and is situated in the area with the highest land elevations within the dewatering facility. The north end of the possible new dewatering basin is at about Elevation 18 to 20 feet, while the south end is occupied by a knoll with a high point at about Elevation 27½ feet. Gravel access roads, trails and fences exist on the site. Vegetation on the site consists of grass, shrubs, and some small trees.

3.1.2 Subsurface Soils

Based on the soil conditions encountered in our exploratory test pits and hand auger borings as well as subsurface information obtained from RZA (1982), the site of the possible new dewatering basin appears to be underlain by a general sequence of loose to very loose fill materials, loose hydraulic fill (sandy), soft hydraulic fill and/or recent alluvium (fine grained), and a deeper dense sand and gravel unit. The explorations performed in the area occupied by Wetland B generally consisted of coarse grained hydraulic fill (sand) and fine grained hydraulic fill (silt). The fill materials extended to the full depth of our explorations. The soft recent alluvium and deeper sand and gravel was identified in previous explorations performed by RZA (1982). Generalized geologic cross sections through the possible new dewatering basin are shown on Figures 2, 3 and 4.

The soil units encountered in our exploratory test pits and hand auger borings, as well as those identified by RZA (1982) are described below:

Fill - Undocumented fill was encountered near the surface in test pits TP-9 through TP-12 on the east end of the site. In test pits TP-11 and TP-12, which are located the farthest east, the fill was about 5.5 and 7.5 feet thick, respectively. The fill in test pits TP-9 and TP-10 was between about 2.5 and 4 feet thick. Typically, the fill consisted of loose, poorly graded sand with silt and gravel. The fill contained a few cobbles and appeared to be part of the dike fill or original berm fills.

Hydraulic Fill (sand) - Hydraulic fill consisting of coarse grained material (sand and silty sand) was encountered across much of the site. The coarse grained hydraulic fill generally consisted of loose silty sand and/or poorly graded sand with a trace of gravel. This hydraulic fill material was encountered below the undocumented fill described above in test pits TP-11 and TP-12. Coarse grained hydraulic fill was encountered at the ground surface in test pits TP-1 through TP-7 and extended to the full depth of the test pits in TP-1 and TP-2 only. Fine grained hydraulic fill, described below, was encountered under the coarse grained fill in test pits TP-3 through TP-7. The coarse grained hydraulic fill was only about 1 foot thick near the top of test pit TP-4, and 2.5 to 3.5 feet thick in test pits TP-3, TP-5 and TP-6.

Although not encountered at the surface, hydraulic fill material consisting of silty sand was encountered in test pit TP-8 and hand auger borings HA-1 through HA-3. The silty sand was encountered approximately 4.5 to 6.5, 3.5 to 5, and 5 to 8 feet below the ground surface in HA-1 and HA-2, HA-3, and TP-8, respectively.

Hydraulic Fill and/or Recent Alluvium (silt) - Fine grained hydraulic fill and/or recent alluvium composed primarily of very soft to soft silt (ML) and elastic silt (MH) or organic silt (OH) was encountered underlying most of the coarse grained fill materials. The eastern part of the possible new dewatering basin was the only area where fine grained hydraulic fill or recent alluvium was not encountered in our explorations. No silt was encountered in test pits TP-1, TP-2, TP-11 and TP-12. The remainder of the site appears underlain by variable thicknesses of the soft silt. The contact between the fine grained hydraulic fill and recent alluvium is difficult to discern due to their similar compositions and consistencies.

Silt was encountered 2.5, 1 and 7 feet below the ground surface in test pits TP-3, TP-4 and TP-7, respectively. The silt was encountered between 2.5 and 4 feet below the ground surface in test pits TP-9 and TP-10, respectively. Based on previous borings performed by RZA (1982), the silt (recent alluvium) appears to extend down to about Elevation -19 feet and is underlain by medium dense to dense sand with gravel. The silt (fine grained hydraulic fill and/or recent alluvium) appears to be approximately 30 to 35 feet thick below the proposed north end of the possible new dewatering basin.

Deep Sand with Gravel - RZA (1982) encountered medium dense to dense sand with gravel at depth in a few of their borings. In the northern portion of the proposed new dewatering basin, two borings indicate the sand with gravel was encountered near Elevation -19 feet.

3.1.3 Groundwater

Groundwater encountered in the explorations was generally perched on the low permeability silt deposits. Groundwater was encountered 2 feet below the ground surface in test pit TP-3 located on the east end of Wetland B. Groundwater was encountered about 3 feet below the ground surface in test pit TP-6 on the west end. Perched groundwater encountered within the north portion of the possible new dewatering basin was about 1½ to 4 feet below the ground surface and appears to be influenced by the higher silt deposits in this area. Depths to groundwater within the south portion of the possible new dewatering basin ranged from about 1 to 3 feet below the ground surface on the west side (test pits TP-4 and TP-7), 2 to 2½ feet near the middle (test pits TP-1 and TP-2), to 9 feet on the east end (test pit TP-12).

The groundwater conditions reported above are for the date and location indicated, and therefore, may not necessarily be indicative of other times and/or locations. Furthermore,

it is anticipated that groundwater conditions will vary depending on the season, local subsurface conditions, water level changes in Capitol Lake and the adjacent wetlands, and other factors.

3.2 Potential Remote Disposal Site - General Geology

Based on our site reconnaissance and review of geologic literature (Noble, 1962), we anticipate three major geologic units underlying the potential remote disposal site west of Marathon Park (see Vicinity Map on Figure 1). These units: undocumented fill, alluvium, and glacial deposits, differ both geologically and in their engineering properties, as discussed below.

The major part of the site is relatively flat and underlain by recent alluvium deposited in an estuarine (tidal river) or alluvial (stream channel) environment. Undocumented fill also covers portions of the site. These deposits typically exhibit low shear strength and moderate to high compressibility, and may prove problematic for heavy structures or high embankments.

The steep hillsides ascending above the site appear underlain by soils of glacial and pre-glacial origin. Since these soils were compacted by the weight of overriding glacial ice, they typically exhibit high density and high shear strength. The soils include advance outwash gravel and sand overlying older silts and clayey silts. Soils exposed on the hillside include sands and silts. A prominent thin bed of silt was observed outcropping along the hillside at about Elevation 75 feet. Dense sand overlies the silt. We noted seeps at several places along the hillside, occurring in the base of the sand.

The Slope Stability Map of Thurston County, Washington (Artim, 1976) indicates the flat portion of the site as Class 1 soils, and the steep hillside as Class 3 soils. Class 1 soils are typically stable, but where marginal to class 3 soils, could be threatened by potential mass failure of steep slopes above. Class 3 soils are inferred to be potentially unstable because of unfavorable underlying geologic materials and steep slopes. These slopes include local areas of saturated sand on top of an impermeable soil layer (such as occurs at this site).

It should be noted that the mapping and slope stability classifications shown by Artim (1976) are on a gross scale, and are not intended for site-specific evaluations. The intent of the mapping is to indicate general areas which exhibit generally similar slope stability characteristics, for use in planning. Evaluation of site-specific slope stability was not included in our scope of services. Any site improvements planned on or adjacent to the steep slope areas should be evaluated with respect to potential slope stability impacts.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the field exploration, laboratory testing, and engineering analyses performed, it is our opinion that the excavation and berms required for construction of the new dewatering basin are feasible from a geotechnical perspective, provided the recommendations presented in this report are incorporated in project design and construction. Recommendations are provided below for potential beneficial uses of excavated materials, design and construction of the containment berms, allowable basin side slopes, earthwork and materials, groundwater considerations and general excavation characteristics.

4.1 Potential Beneficial Uses of Excavated Materials

Some materials excavated from the new dewatering basin may be beneficially used elsewhere if desired. Depending on the materials excavated, potential beneficial uses may include on-site berm fill, off-site structural fill, general landscaping fill, topsoil, or liner/cover materials for landfills.

Existing soils within the possible new dewatering basin site can be divided into two general soil types - coarse and fine grained materials. Future dredging operations may also produce materials of varying grain size distribution. Sediments dredged from the sediment trap located at the south end of the middle basin of Capitol Lake (Sector 1) may be significantly coarser grained than the sediments dredged from other sectors. These coarser sediments could be isolated (separated from the fine grained soils) and potentially used in beneficial applications off-site. All existing sediment as well as future sediment within the new dewatering basin should be tested prior to use on or off site.

Potential beneficial uses of the coarse and fine grained soils may include:

Coarse Grained Soils: Existing coarse grained soils (less than about 20 percent fines) which occupy much of the site can be used as on-site berm fill or possibly off-site structural fill. These soils have relatively low percentages of fines, are less sensitive to moisture, can be compacted in less than ideal weather conditions, and may potentially be used on nearby construction projects. Other uses may include trench backfill and general fill. In addition, the coarse grained soils dredged from Sector 1 may also be used in similar situations, depending on the particle size distribution. Coarse grained soils with fines contents between about 20 and 40 percent may not be suitable as structural or embankment fill, but may be used as general fill or trench backfill in certain situations.

Fine Grained Soils: Fine grained soils (greater than 50 percent fines) are typically highly moisture sensitive and are difficult to compact when over optimum moisture

content. Existing on-site fine grained soils, as well as future accumulations of fine grained sediments, are anticipated to have water contents significantly over their optimum moisture content and would require drying out and placement and compaction in dry weather conditions. These materials are not suitable as structural or embankment fill, however, soils with about 20 to 40 percent fines may potentially be used as general fill not underlying structures.

Fine grained soils within the area of the new dewatering basin and future dredged soils with high fines contents (greater than about 50 percent) may be suitable as topsoil provided that necessary admixtures are used, if required. Topsoil suitability tests were conducted on four fine grained samples collected from within the former dewatering basin (Wetland B). The test results and recommended admixtures are presented in Appendix B.

Other uses for the fine grained soils may include liner or cover materials for landfills. Fine grained soils used in this application would need to have relatively high plasticity index and relatively low permeability (if required). If not used as a low permeability layer, then the fine grained materials could potentially be used as the topsoil cover material over a landfill. Other potential uses may include liners for containment ponds or other applications where low permeability materials are desirable.

The above evaluations of potential beneficial uses are general in nature based on the limited data available. As such, the above recommendations should be used for preliminary planning purposes only. Any parties considering using on-site materials, for whatever purpose, should perform additional investigation and/or testing to verify that the properties of the soils are adequate for the intended purpose. Project-specific recommendations should be developed for use of those soils on other sites.

4.2 Stability of Existing Dike

The existing dike was constructed in a relatively loose state as indicated by previous borings by RZA (1982). Numerous failures have occurred along the dike and there are indications that present failures may be occurring as evidenced by longitudinal cracking along the dike. The trail on top of the dike also exhibits an undulating surface which indicates the dike is experiencing or has experienced differential settlements. We expect that most of the settlements have occurred by this time. Additional settlement may occur if the dike elevation is raised or if lake levels are lowered. Future slope failures along the dike may occur, especially during heavy rainfall events, high water conditions, or during an earthquake.

Construction of the new dewatering basin would require significant excavating along the west side of the dike and berms up to 5 to 6 feet high may be constructed along the east and north ends of the dewatering basin. We anticipate the induced settlements along the dike in this area will be minimal due to the location of the berms. In addition, the higher (5 to 6-foot) berm fills will be required near the southeast end of the basin which is underlain primarily by coarse grained soils.

The excavation required for the dewatering basin is not anticipated to affect the stability of the dike if the interior slopes of the basin are no steeper than 3H:1V. This assumes the berm configurations illustrated in the cross sections (Figures 2, 3 and 4) are accurate.

4.3 Proposed Containment Berms

Design of the possible new dewatering basin includes construction of low height containment berms around the perimeter. The top of the containment berms may have a design elevation of 20 feet, 12 feet above the bottom elevation (Elevation 8 feet) of the dewatering basin. The maximum height of the berms is on the order of 5 to 6 feet. The berms may be constructed using on-site coarse grained soils, as discussed in Section 4.1 and 4.4. A perimeter unpaved gravel access road is planned around the dewatering basin and will be constructed on the berms in most areas.

4.3.1 Settlement

Consolidation of the soft silt deposits will result in settlements of the proposed berm fill due to increased vertical loading. Generally, we anticipate the maximum settlements will be on the order of 4 to 6 inches where the berm is about 5 to 6 feet high and the silt deposits are relatively close to the bottom of the berm fill. Maximum settlements may occur on the west sides of both the north and south basins where berm heights are expected to be highest and the silt deposits are relatively close to the ground surface. We anticipate settlements in most other areas will be less than approximately 3 inches.

4.3.2 Stability and Allowable Side Slopes

We recommend that berm side slopes be constructed at inclinations no steeper than 3H:1V, if properly compacted as discussed in Section 4.4. A minimum factor of safety of 1.5 is expected if this slope configuration is used in design and construction.

The interior slopes of the new dewatering basin will be excavated in the underlying loose sand and soft silt deposits. We anticipate the lower 7 to 8 feet of the northern interior slopes will be excavated in the soft silts. Most of the southern portion of the new basin would likely be excavated in the loose sand deposits, except on the west side. Due to the loose nature of the sand and the soft consistency of the silts, the interior slopes of the

dewatering basin should be excavated at inclinations no steeper than 3H:1V in order to provide a sufficient factor of safety against slope instability.

4.4 Earthwork and Materials

4.4.1 Site Preparation and Remedial Grading

Prior to grading operations, we recommend that Wetlands B and D be protected from sedimentation during construction of the dewatering basin. A sedimentation/erosion control plan should be developed and implemented in accordance with applicable state or federal requirements.

Site preparation should begin with the removal of all deleterious matter, asphalt, concrete, and vegetation with the exception of trees to be incorporated into the final landscaping plan. We recommend that surficial materials such as the topsoil be completely removed from all areas supporting the berms or gravel access road and hauled off-site.

We anticipate that all of the on-site surficial soils can be excavated with light to moderate effort using heavy duty construction equipment. It is anticipated that groundwater will be encountered near the ground surface.

4.4.2 Subgrade Preparation

Exposed subgrade prepared for placement of berm fill should demonstrate at least 85 percent of the maximum dry density, using ASTM D 1557 (Modified Proctor). Existing sandy soils or disturbed surfaces that do not meet this requirement should be additionally worked by scarifying to a depth of 6 inches, moisture conditioned as necessary, and compacted. Minimal excavating should be performed in areas where berms will be placed to avoid overexcavating down to the soft silt deposits.

Soft subgrade conditions may be encountered, particularly if construction is performed during the wet season, soft silts are encountered during grading, or shallow groundwater conditions render the soil unworkable. A working surface may be constructed if the subgrade becomes unstable and will not support construction traffic. In this event, the unstable subgrade should be overexcavated 12 inches and covered with a layer of geotextile construction fabric. The geotextile used should consist of Mirafi 160N or equal as approved by the geotechnical consultant, placed with sheets overlapping a minimum of 2 feet. A working surface should be placed on top of the geotextile fabric, consisting of a minimum 18-inch layer of sand and gravel. Placement of the geotextile and construction of the working surface should be observed by the geotechnical consultant.

Subgrades for proposed access roads should be properly compacted prior to placement of gravel base materials. If the required subgrade density (Section 4.4.4) can not be attained by scarifying and recompacting, then the subgrade should be overexcavated 18 inches and recompacted. The proposed gravel access road should be properly designed based on the subgrade conditions and anticipated heavy vehicles.

4.4.3 Materials

The on-site coarse grained soils have a relatively low percentage of fines; portions of these materials should serve as adequate berm fill material. On-site soils used as berm fill should contain less than 20 percent fines. Soils with a higher silt content may be suitable if the earthwork is performed during relatively dry weather, the soil is properly conditioned, and the contractor's methods are conducive to proper compaction of the soil. If wet conditions exist and the density requirements can not be attained then the use of on-site soils with less than about 10 percent fines, or import granular fill may be required. The underlying silt deposits are not suitable for use as berm fill on the project due to their slow drainage characteristics and low strength properties. The suitability of earth materials should be verified by the geotechnical consultant prior to use on the project.

Import material used as berm fill should consist of granular soils. Such fill materials should be less than 2½ inches in maximum dimension, with less than 7 percent passing the U.S. Standard No. 200 sieve (WSDOT 9-03.14). The fine-grained portion of structural fill soils should consist of non-plastic material. Maximum particle size greater than 2½ inches may be acceptable, but should be approved by the project engineer prior to use.

Gravel import used as surfacing for the proposed access roads should consist of crushed surfacing base course (WSDOT 9-03.9(3)) or other as specified by the designer of the access road.

4.4.4 Relative Compaction Criteria

Berm and fill soils should be moisture conditioned to within 3 percent of optimum moisture content, placed in loose, horizontal lifts less than 8 inches in thickness, and compacted to at least 90 percent of the maximum dry density, determined using ASTM D 1557. Subgrades prepared for the proposed gravel access roads should be compacted to 95 percent of maximum dry density in the upper 1 foot. Gravel import used as road surfacing should be compacted to a minimum of 90 percent.

The procedure to achieve proper density of a compacted fill depends on the size and type of compacting equipment, the number of passes, thickness of the layer being compacted, and certain soil properties. Where the excavation size restricts the use of heavy machinery,

smaller equipment can be used, but the soil must be placed in lifts thin enough to achieve the required compaction.

Generally, loosely compacted soils are a result of poor construction technique or improper moisture content. Soils with a high percentage of silt or clay are particularly susceptible to becoming too wet, and coarse grained materials easily become too dry, for proper compaction. Silty or clayey soils with a moisture content too high for adequate compaction should be dried as necessary, or moisture conditioned by mixing with drier materials, or other methods. Sprinkling is sometimes required to wet a coarse-grained soil to near optimum moisture content before compaction.

If possible, preparation of areas to receive fill, fill placement, and paving operations should be performed during dry weather conditions. Compaction should take place immediately after subgrade preparation, and the newly prepared areas should be protected against saturation from precipitation.

4.5 Dredge Spoils

If possible, we recommend the coarse grained dredge spoils be separated during the dredging process prior to pumping in fine grained sediments. This may only be possible when dredging operations are performed in Sector 1. If the coarse grained sediments are separated it may be possible to dewater these materials at a faster rate; excavation could potentially occur relatively soon after placement.

We anticipate underwater slopes created within the dewatering basins during the dredging process will be on the order of 10H:1V or flatter. When the sediments within the basins are dewatered then steeper side slopes will be possible, especially when excavation operations are performed.

4.6 Excavation Characteristics

We anticipate that soils underlying the possible new dewatering site can be excavated with light to moderate effort using heavy duty excavating equipment. The presence of the soft silts at shallow depths below the site may necessitate the use of low ground contact pressure equipment -- rubber tired equipment should be avoided. If fine and coarse grained materials are separated for different uses then care should be taken during the excavating process to prevent mixing of the materials. Materials excavated for use as berm fill around the dewatering basin should be observed, tested and approved by the project geotechnical engineer prior to use.

Due to high groundwater conditions and the presence of soft silts, a dragline or large trackhoe may be required for excavation. Conventional equipment can not be directly

supported by the soft silt materials. Dewatering of the site during initial construction of the dewatering basin may improve excavation operations, but may not be necessary. It may be possible to excavate the materials from the new basin without dewatering using a dragline or track mounted excavators with long reach capabilities. The bucket on the trackhoe should be provided with weep holes to allow water to escape prior to loading hauling equipment.

4.7 Groundwater Considerations

Perched groundwater was encountered at relatively shallow depths, 2.5 to 4 feet below the ground surface (about Elevation 16 feet) in the northern portion of the new dewatering basin. Groundwater varied in the southern portion of the new dewatering basin, ranging from 1 to 3 feet below the ground surface (between Elevation 12 and 14.5 feet) on the west side, 2 to 2.5 feet below the ground surface in the middle (between Elevation 14.5 and 15 feet), and 7 to 9 feet below the ground surface on the east side (between Elevation 7 and 11 feet).

The bottom elevation of the new dewatering basin may be at 8 feet, therefore, significant volumes of groundwater may be encountered during the excavation operation. However, if excavated during the drier summer months, substantially different groundwater conditions may be encountered. Since most of the water appears to be perched over the silt materials, as observed during a wet period of the year (February), we anticipate smaller volumes of water will be encountered during the drier months.

We anticipate that groundwater within the excavation can be controlled using sump pumps, if needed. Since the excavation will be filled with dredge spoils in the future, dewatering may not be necessary unless it will facilitate construction operations. Appropriate measures should be taken to properly treat water pumped from the excavation prior to being dispensed back into the lake or other areas due to possible high turbidity or other environmental concerns.

4.8 Seismicity and Soil Liquefaction Potential

The site lies within a Seismic Zone 3, as defined in the current *Uniform Building Code*. This seismic zone includes the Puget Sound region, and represents an area susceptible to moderately high seismic activity. During a strong seismic event, the site would be subjected to significant ground motion, and may be impacted by secondary seismic effects such as soil liquefaction and/or lateral spreading. The potential for strong ground motion at this site is considered no greater than for the Olympia area in general. Consequently, moderate levels of earthquake shaking should be anticipated during the design life of the proposed dewatering basin.

When shaken by an earthquake, certain soils temporarily lose strength and behave as a liquid, a phenomenon known as soil liquefaction. The seismically induced loss of soil strength can result in failure of the ground surface that is most typically expressed as landslides or lateral spreads, surface cracks and settlement, and/or sand boils. Seismically induced liquefaction typically occurs in loose, saturated, sandy materials commonly associated with recent river, lake, and beach sedimentation. In addition, seismically induced liquefaction can occur in areas of loose, saturated hydraulic fill.

A 1965 earthquake (Body Wave Magnitude, M_b = 6.5), with an epicenter about 13 miles southeast of downtown Seattle, caused significant damage to some areas of the dike around Capitol Lake. Seismic induced shaking resulted in liquefaction and lateral spreading related damage to the dike and overlying roadway. The largest recorded earthquake (Richter Magnitude, M_L = 7.1) in the State of Washington occurred in 1949, with an epicenter 10 miles east of Olympia.

Conditions susceptible to soil liquefaction might be anticipated in the saturated hydraulic fill deposits underlying the proposed dewatering basins. Loose sand and very soft silt deposits were encountered underlying the site and groundwater was encountered at shallow depths. Some differential movement should be anticipated during a strong earthquake event, due to seismically-induced settlement and lateral spreading of the saturated and partially saturated soils beneath the proposed berms.

5.0 UNCERTAINTY AND LIMITATIONS

The conclusions, recommendations and opinions presented herein are (1) based upon our evaluation and interpretation of the findings of our field and laboratory programs, (2) based upon an interpolation of subsurface conditions between the exploratory hand auger borings and test pit excavations, (3) based upon our understanding of the project plans, and (4) based on the assumption that sufficient observation and testing will be performed by the geotechnical consultant during construction.

Experience has shown that subsurface soil and groundwater conditions can vary radically over small distances. Inconsistent conditions can occur between explorations and not be detected by a geotechnical study.

This report is issued with the understanding that it is the responsibility of the owner, or of his representative, to ensure that the information and recommendations contained herein are brought to the attention of the appropriate design team personnel and incorporated in the project plans and specifications, and the necessary steps are taken to see that the contractor and subcontractors carry out such recommendations in the field.

Within the constraints of schedule and budget, we attempted to prepare the findings and recommendations of this report in accordance with generally accepted professional principles and practices in the fields of geotechnical engineering and engineering geology. No warranty, expressed or implied, is made.

This firm does not practice or consult in the field of safety engineering. We do not direct the contractor's operations, and we cannot be responsible for the safety of personnel other than our own on the site; the safety of others is the responsibility of the contractor. The contractor should notify the owner if he considers any of the recommended actions presented herein unsafe.

6.0 REFERENCES

Artim, E. R., 1976, *Slope Stability Map of Thurston County, Washington*, Washington Division of Geology & Earth Resources, Geol. Map GM-15.

Brown and Caldwell, 1984. *Operation and Maintenance Manual for Capitol Lake Dredge Spoils Treatment Site.*

CH2M Hill, 1977. *Capitol Lake Restoration and Recreation Plan, Final Environmental Impact Statement and Supporting Documents*, prepared for the State of Washington Department of General Administration.

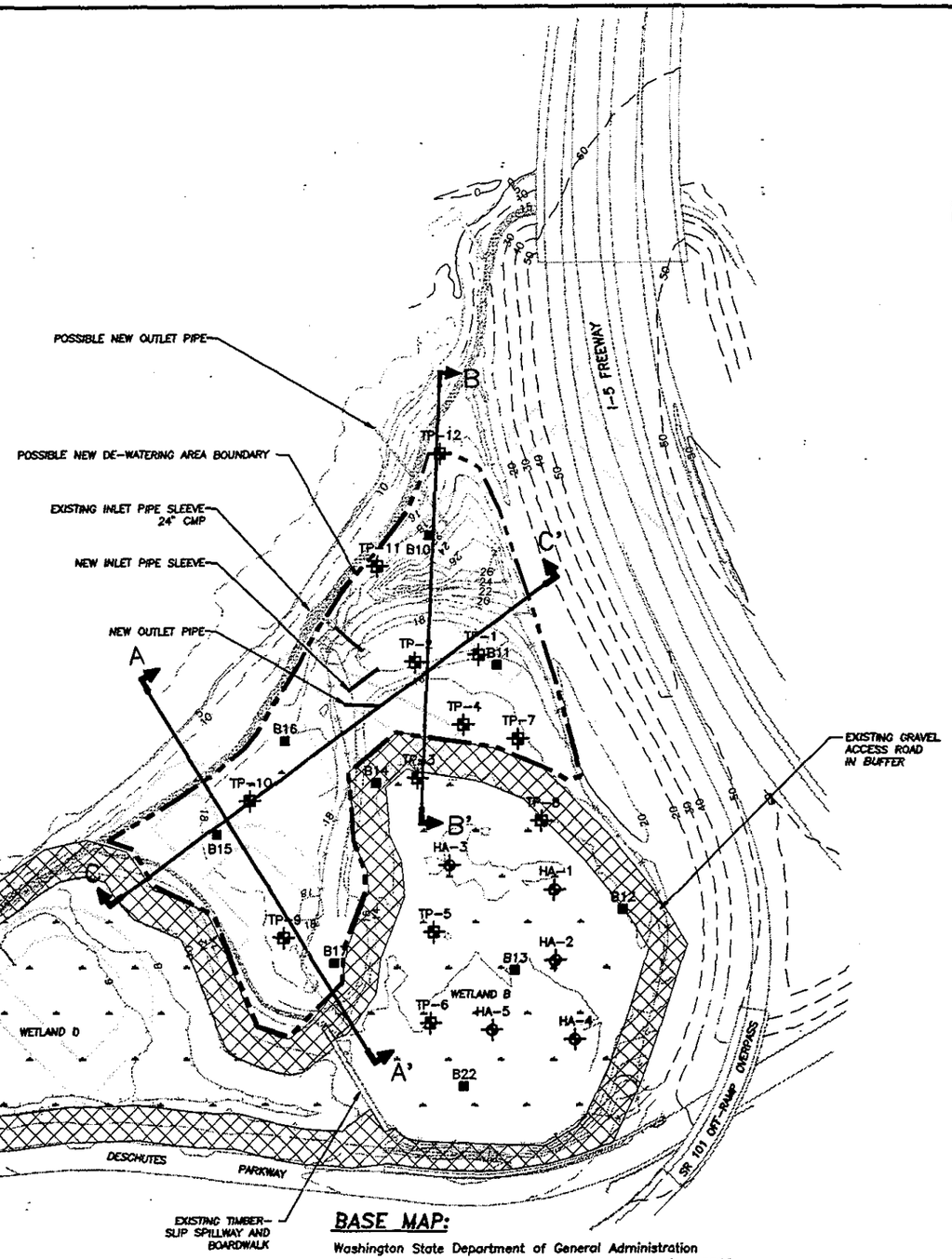
Noble, J. B., 1962, *Geologic Map of Thurston County, Washington*, Washington Division of Geology and Earth Resources Unnumbered Map.

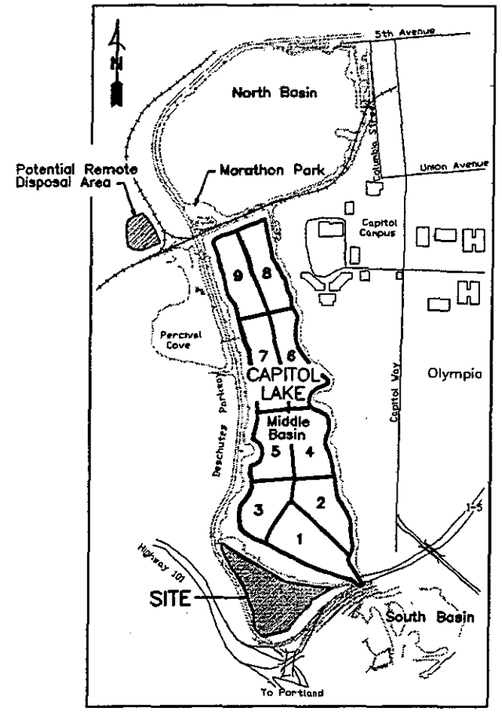
Rittenhouse-Zeman & Associates (RZA), 1982. *Soils and Foundation Exploration, Capitol Lake Restoration Project*, prepared for Jongejan Gerrard McNeal, Inc. and the State of Washington Department of General Administration.

Uniform Building Code, 1988, International Conference of Building Officials, 926 p.

Washington State Department of Transportation/American Public Works Association, 1994, *Standard Specifications for Road, Bridges, and Municipal Construction.*

CAPITOL LAKE





VICINITY MAP

LEGEND

- TP-5 — Approximate Test Pit Location
- HA-2 — Approximate Hand Auger Location
- B13 — Approximate Boring Location (RZA, 1982)
- A — A' — Generalized Geologic Cross Section Location
- Existing Gravel Road to be Abandoned
- Existing Fence
- Sediment De-Watering Area Boundary
- Existing Interpretive Center Trail
- Wetland
- Wetland Buffer

BASE MAP:

Washington State Department of General Administration
Capitol Lake 10-year Sediment Removal Plan : 1995-2005.
Figure 3: De-watering Area Detail, Sheet 2 of 2, Provided by ENTRANCO.

DATUM
CITY OF OLYMPIA

200 100 0 200 400
Scale: 1"=200'

NOTES

1. Wetland Boundaries Shown are Approximate.
2. Contours Shown in Sediment De-Watering Area at 2 Foot Intervals. Upland Contours Shown at 10 Foot Intervals.

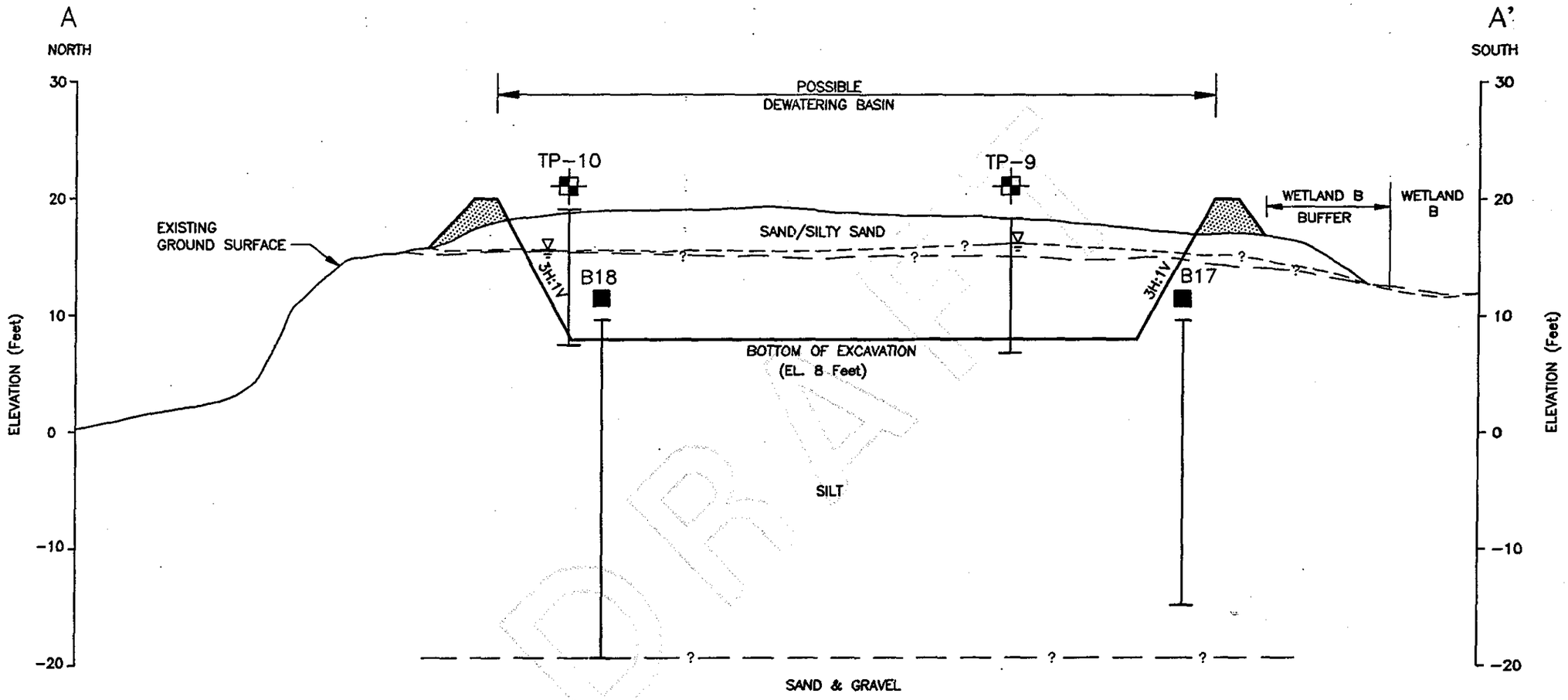
HWA HONGWEST & ASSOCIATES, INC.

CAPITOL LAKE
SEDIMENT CONTROL PROJECT

SITE PLAN

PROJECT NO.: 92055-2 FIGURE: 1

C:\PROJECTS\92055-2\D-002.DWG



LEGEND

TP-10 ⊕	Approximate Test Pit Location
B18 ■	Approximate Boring Location (RZA, 1982)
—?— ▽	*Observed Water Level at Time of Excavation*
—?—	Geologic Contact Extrapolated between Explorations
▱	Berm Fill
———	*Approximate Excavation Limits*

NOTE:

This generalized soil profile was compiled from available subsurface information in the vicinity. It is interpretive. Actual soil conditions between explorations may vary from those shown.

Scale: Horizontal 1" = 50'
Vertical 1" = 10'

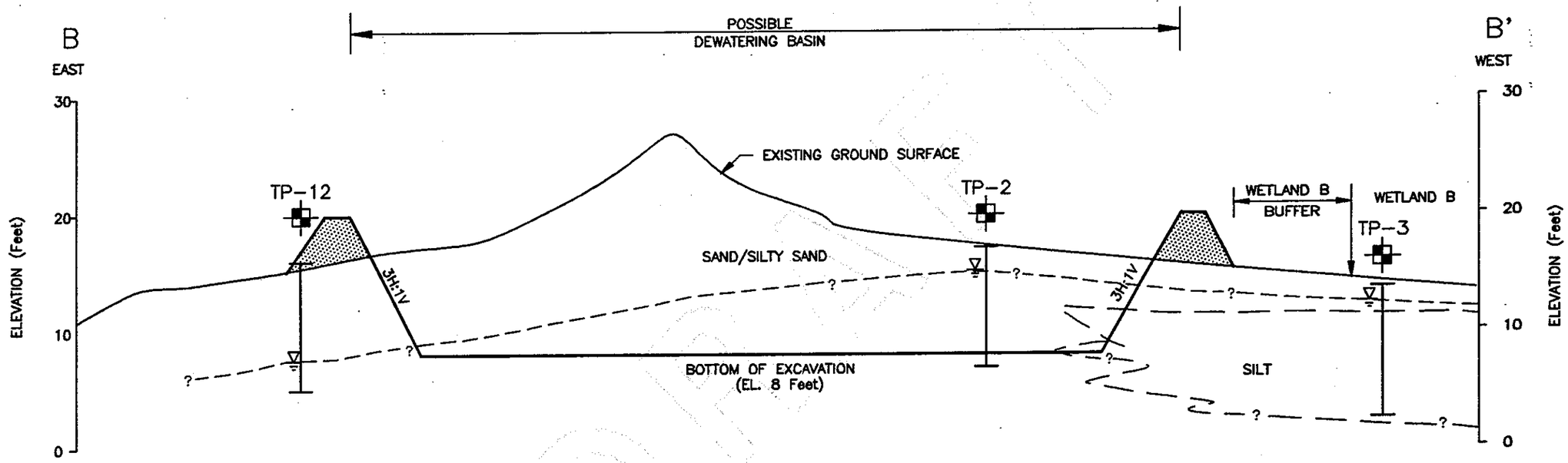
HWA HONGWEST & ASSOCIATES, INC.

CAPITOL LAKE
SEDIMENT CONTROL PROJECT

GENERALIZED GEOLOGIC
CROSS SECTION A-A'

PROJECT NO.: 92055-2 FIGURE: 2

C:\PROJECTS\92055-2\A-002.DWG



LEGEND

TP-10	Approximate Test Pit Location
B18	Approximate Boring Location (RZA, 1982)
—?—	Observed Water Level at Time of Excavation
—?—	Geologic Contact Extrapolated between Explorations
	Berm Fill
	Approximate Excavation Limits

NOTE:

This generalized soil profile was compiled from available subsurface information in the vicinity. It is interpretive. Actual soil conditions between explorations may vary from those shown.

Scale: Horizontal 1" = 50'
Vertical 1" = 10'

HWA HONGWEST & ASSOCIATES, INC.

CAPITOL LAKE
SEDIMENT CONTROL PROJECT

GENERALIZED GEOLOGIC
CROSS SECTION B-B'

PROJECT NO.: 92055-2 FIGURE: 3

C:\PROJECTS\92055-2\A-003.DWG

C

WEST

POSSIBLE
DEWATERING BASIN

C'

EAST

ELEVATION (Feet)

30
20
10
0
-10
-20

TP-10
TP-2
TP-1
B18
B16
B14
B11

EXISTING GROUND SURFACE

WETLAND D
BUFFER

3H:1V

SAND/SILTY SAND

BOTTOM OF EXCAVATION
(EL. 8 Feet)

SILT

SILTY SAND

SILT

SILTY SAND

SILT

SILTY SAND

SAND & GRAVEL

LEGEND

TP-10	Approximate Test Pit Location
B18	Approximate Boring Location (RZA, 1982)
—?—	Observed Water Level at Time of Excavation
—?—	Geologic Contact Extrapolated between Explorations
	Berm Fill
	Approximate Excavation Limits

NOTE:

This generalized soil profile was compiled from available subsurface information in the vicinity. It is interpretive. Actual soil conditions between explorations may vary from those shown.

Scale: Horizontal 1" = 50'
Vertical 1" = 10'

HWA
HONGWEST & ASSOCIATES, INC.

CAPITOL LAKE
SEDIMENT CONTROL PROJECT

GENERALIZED GEOLOGIC
CROSS SECTION C-C'

PROJECT NO.: 92055-2 FIGURE: 4

APPENDIX A

FIELD INVESTIGATION

APPENDIX A

FIELD INVESTIGATION

The field exploration program consisted of excavating and sampling 12 test pits (TP-1 through TP-12) and five hand auger borings (HA-1 through HA-5) at selected locations, on February 23 and 24, 1994. The approximate test pit and hand auger locations are shown on the Site Plan (Figure 1). Hong West & Associates personnel advanced the hand auger borings to depths of 7 to 7½ feet below the ground surface. Samples of subsurface soils were obtained using a 3-inch outside diameter hand auger.

The test pits were excavated under the full-time observation of HWA personnel by Neuharth Brothers of Monroe, Washington. The excavation equipment consisted of a Hokkaido KH28-L trackhoe. The trackhoe was used because of its low ground contact pressure and potential for less disturbance to on-site vegetation. The test pits were excavated to depths ranging from about 7 to 12½ feet below the ground surface.

Hand auger borings and test pits were located in the field by pacing distances from nearby references, such as fences, gravel roads and topographic features as indicated on the Site Plan (Figure 1).

Disturbed soil samples were obtained from the test pit and hand auger excavations, sealed in plastic bags, and returned to our Lynnwood, Washington, laboratory for further examination and testing. In addition, as directed by Entranco personnel, samples were obtained at 1, 3 and 6.5 feet below the ground surface in test pit TP-4 and hand auger boring HA-5, and placed in jars. The samples were delivered to a chemical laboratory specified by Entranco.

Field personnel recorded pertinent information for each exploration, including soil sample depths, stratigraphy, soil engineering characteristics, and groundwater occurrence. Soils were classified in general accordance with ASTM D 2487 and/or D 2488. Summary test pit and hand auger boring logs are included in this appendix, as are legends of the symbols and terms used on the logs. The stratigraphic contacts shown on the individual logs represent the approximate boundaries between soil types. The actual transitions may be more gradual or abrupt. The soil and groundwater conditions depicted are only for the specific dates and locations reported, and are therefore not necessarily representative of other locations and times.

LEGEND OF TERMS USED ON EXPLORATION SOIL LOGS

Soil classifications presented on the exploration soil logs are based on visual field and laboratory observations, using ASTM D 2488. Soil descriptions are presented in the following general order: Density/consistency, color, modifier, MAJOR CONSTITUENT, minor constituent(s), moisture content, soil structure(s), additional remarks.

DENSITY/CONSISTENCY

Density/consistency of soils encountered in exploratory borings is usually based on the Standard Penetration Test (SPT) N-value or "blowcount", ASTM D 1586. Using this method, the sampler is driven 18 inches with a 140-pound hammer falling 30 inches. The SPT N-value is the number of blows for the last 12 inches of sampler drive.

Granular Soil Density	SPT N-value	Cohesive Soil Consistency	SPT N-value	Unconfined Compressive Strength (tsf)
Very loose	0 - 4	Very soft	0 - 2	< 0.25
Loose	4 - 10	Soft	2 - 4	0.25 - 0.5
Medium dense	10 - 30	Medium stiff	4 - 8	0.5 - 1.0
Dense	30 - 50	Stiff	8 - 15	1.0 - 2.0
Very dense	> 50	Very stiff	15 - 30	2.0 - 4.0
		Hard	> 30	> 4.0

MOISTURE CONTENT

Dry	Little perceptible moisture
Damp	Some perceptible moisture, probably below optimum
Moist	Probably near optimum moisture content
Wet	Much perceptible moisture, probably above optimum

MINOR CONSTITUENTS

	Estimated Percentage
Trace	0 - 5
Some	5 - 12
Modifier (sandy, silty, etc.)	12 - 30
Very (plus modifier)	30 - 50

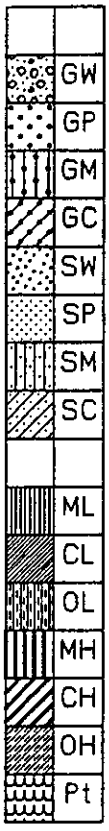
TERMS DESCRIBING SOIL STRUCTURES

Bedded	Composed of layers thicker than 1 cm, of varying color and/or texture.
Calcareous	Containing a significant amount of calcium carbonate.
Cemented	Rock or soil hardened by the precipitation of a mineral cement among the grains of the sediment.
Fissured	Containing shrinkage cracks, frequently filled with fine sand or silt, usually more or less vertical.
Indurated	A rock or soil hardened or consolidated by pressure, cementation, or heat.
Interbedded	Composed of alternating beds of different soil types.
Laminated	Composed of thin (< 1 cm) layers of varying color and/or texture.
Poorly graded	Predominantly a single grain size, or having some intermediate sizes missing ("gap" graded).
Slickensided	Having previously-sheared planes of weakness that are slick and glossy in appearance.
Well graded	Having a wide range of grain sizes, with substantial amounts of intermediate particle sizes.

HONG WEST & ASSOCIATES, INC.

LEGEND OF SYMBOLS USED ON EXPLORATION SOIL LOGS

GRAPHIC SYMBOLS FOR SOIL TYPES



NON-COHESIVE SOILS (<50% passing No. 200 sieve)

- GW — well graded gravel and gravel/sand mix
- GP — poorly graded gravel, gravel/sand mix
- GM — silty gravel, gravel/sand/silt mix
- GC — clayey gravel, gravel/sand/clay mix
- SW — well graded sand, gravelly sand
- SP — poorly graded sand, little or no fines
- SM — silty sand, sand/silt mix
- SC — clayey sand, sand/clay mix

COHESIVE SOILS (>50% passing No. 200 sieve)

- ML — inorganic silt and very fine sand
- CL — inorganic, low plasticity clay
- OL — organic, low plasticity clay, silt/clay mix
- MH — inorganic, elastic silt, silt/sand mix
- CH — inorganic, high plasticity clay
- OH — organic, medium to high plasticity clay
- Pt — peat and other highly organic soil

SAMPLE TYPE SYMBOLS

BOREHOLE SAMPLES

- 2.0" OD Split Spoon (SPT)
- Shelby Tube
- 3.0" OD Split Spoon with Brass Rings
- Grab Sample (cuttings)
- Core Run

TEST PIT SAMPLES

- Bag (bulk sample)
- Grab (small volume)
- Shelby Tube

HAND BORING SAMPLES

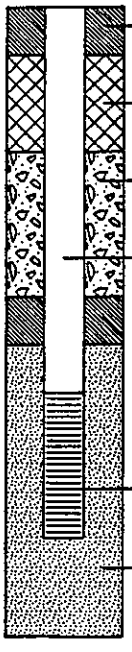
- Non-standard penetration (40 lb. hammer with 12 inch drop)
- Grab Sample (post hole)
- Shelby Tube

ROTARY BOREHOLE SAMPLES

- Continuous Core Sample

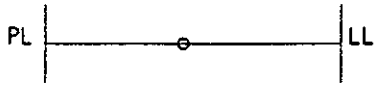
Note: The graphic symbols used for the various soil types are based on symbols recommended in the Unified Soil Classification System. Graphic logs are based on subjective field identification of soils, and laboratory data where available.

GROUNDWATER MONITORING WELL SYMBOLS



- Bentonite Seal
- Grout Backfill
- Cuttings Backfill or Caved Hole
- Piezometer Casing
- Groundwater Level (noted during drilling)
- Groundwater Level (measured in piezometer after water level stabilized)
- Slotted Piezometer Casing
- Sand Backfill

ATTERBERG LIMITS



o – Natural Moisture Content

PL – Plastic Limit

LL – Liquid Limit

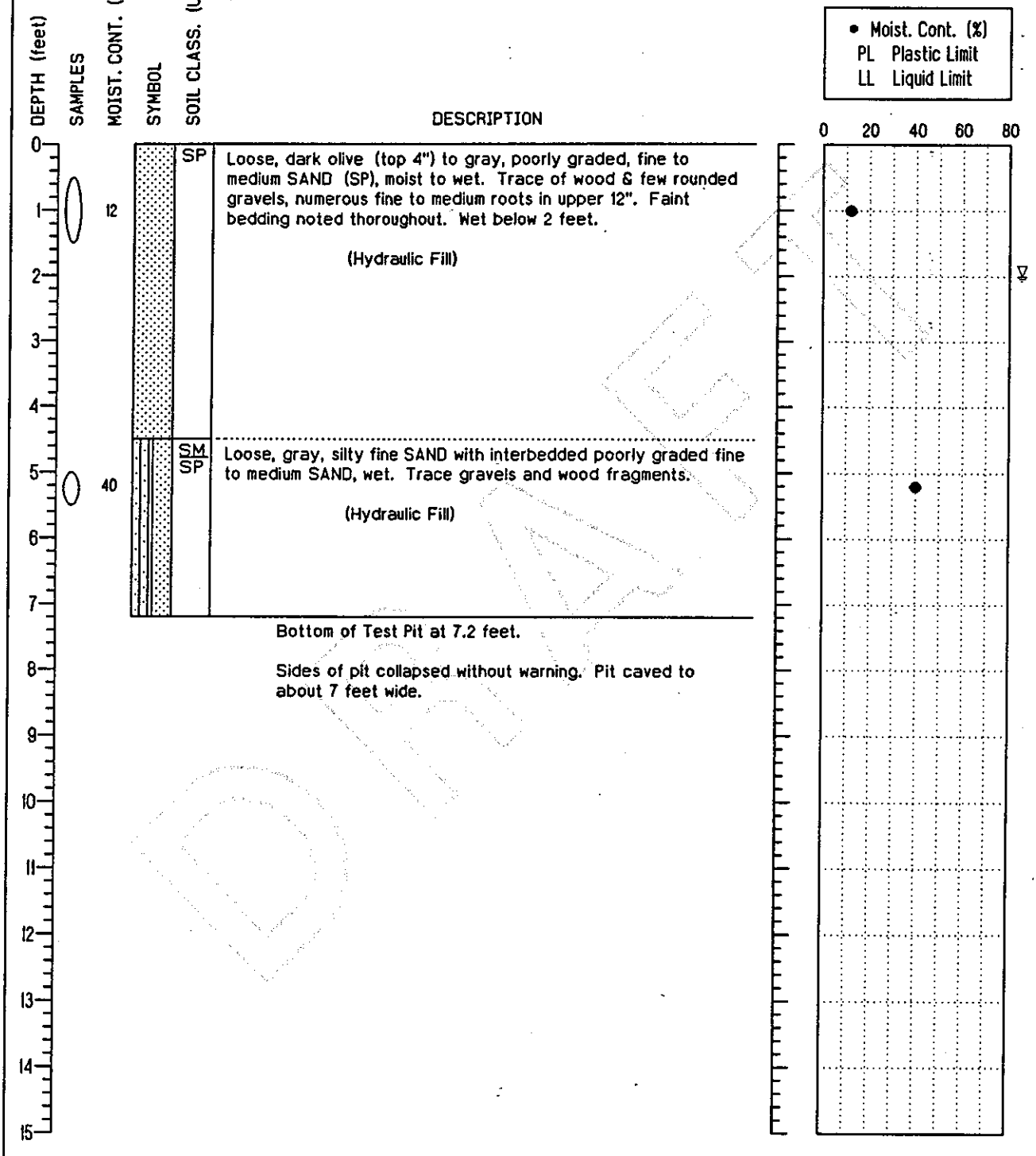
HONGWEST & ASSOCIATES, INC.

HONG WEST & ASSOCIATES, INC.

TEST PIT LOG

EXCAVATION COMPANY: Neuharth Bros.
EXCAVATION METHOD: Kubota KB28 Trackhoe
SAMPLING METHOD: Grab

TOTAL DEPTH: 7.2 Feet
SURFACE ELEVATION: ±17 Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: CAPITOL LAKE

TEST PIT: TP-1

LOCATION: Olympia, Washington
DATE COMPLETED: 2/23/94
LOGGED BY: Rod Faubion

PROJECT NUMBER: 92055-2

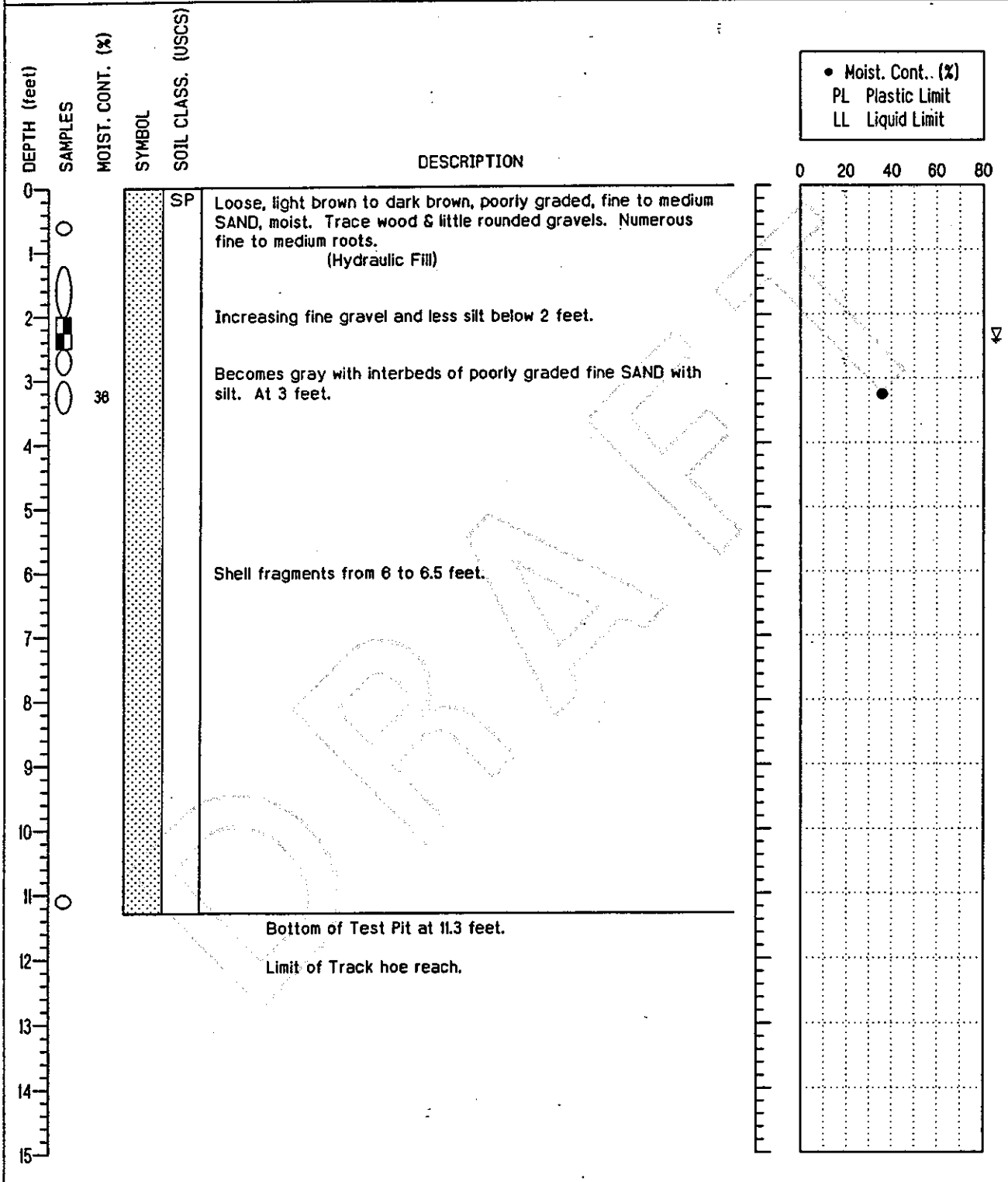
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

TEST PIT LOG

EXCAVATION COMPANY: Neuharth Bros.
EXCAVATION METHOD: Kubota KB28 Trackhoe
SAMPLING METHOD: Grab

TOTAL DEPTH: 11.3 Feet
SURFACE ELEVATION: ±17 Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: CAPITOL LAKE

TEST PIT: TP-2

LOCATION: Olympia, Washington
DATE COMPLETED: 2/23/94
LOGGED BY: Rod Faubion

PROJECT NUMBER: 92055-2

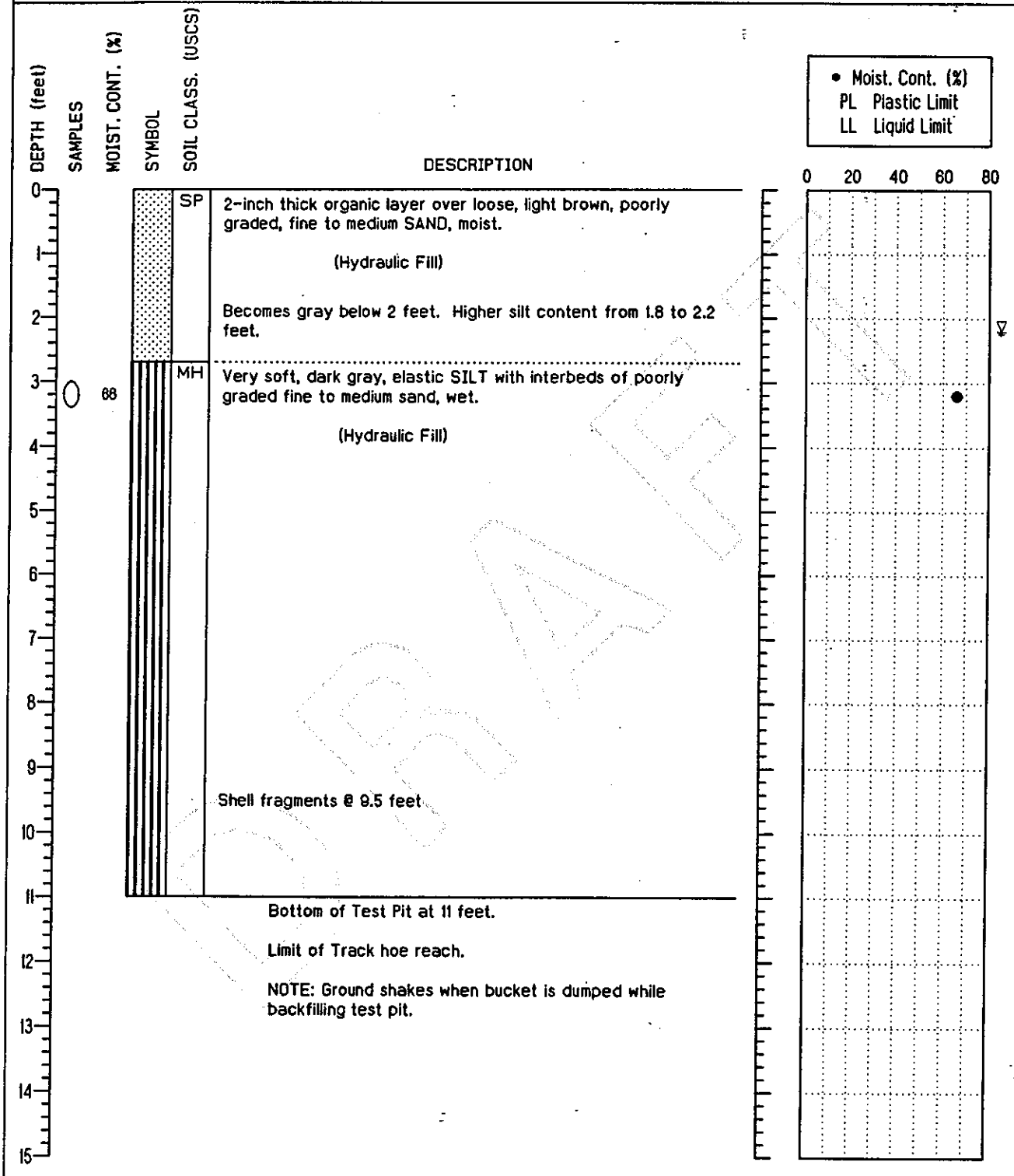
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

TEST PIT LOG

EXCAVATION COMPANY: Neuharth Bros.
EXCAVATION METHOD: Kubota KB28 Trackhoe
SAMPLING METHOD: Grab

TOTAL DEPTH: 11 Feet
SURFACE ELEVATION: ±14 Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: CAPITOL LAKE

TEST PIT: TP-3

LOCATION: Olympia, Washington
DATE COMPLETED: 2/23/94
LOGGED BY: Rod Faubion

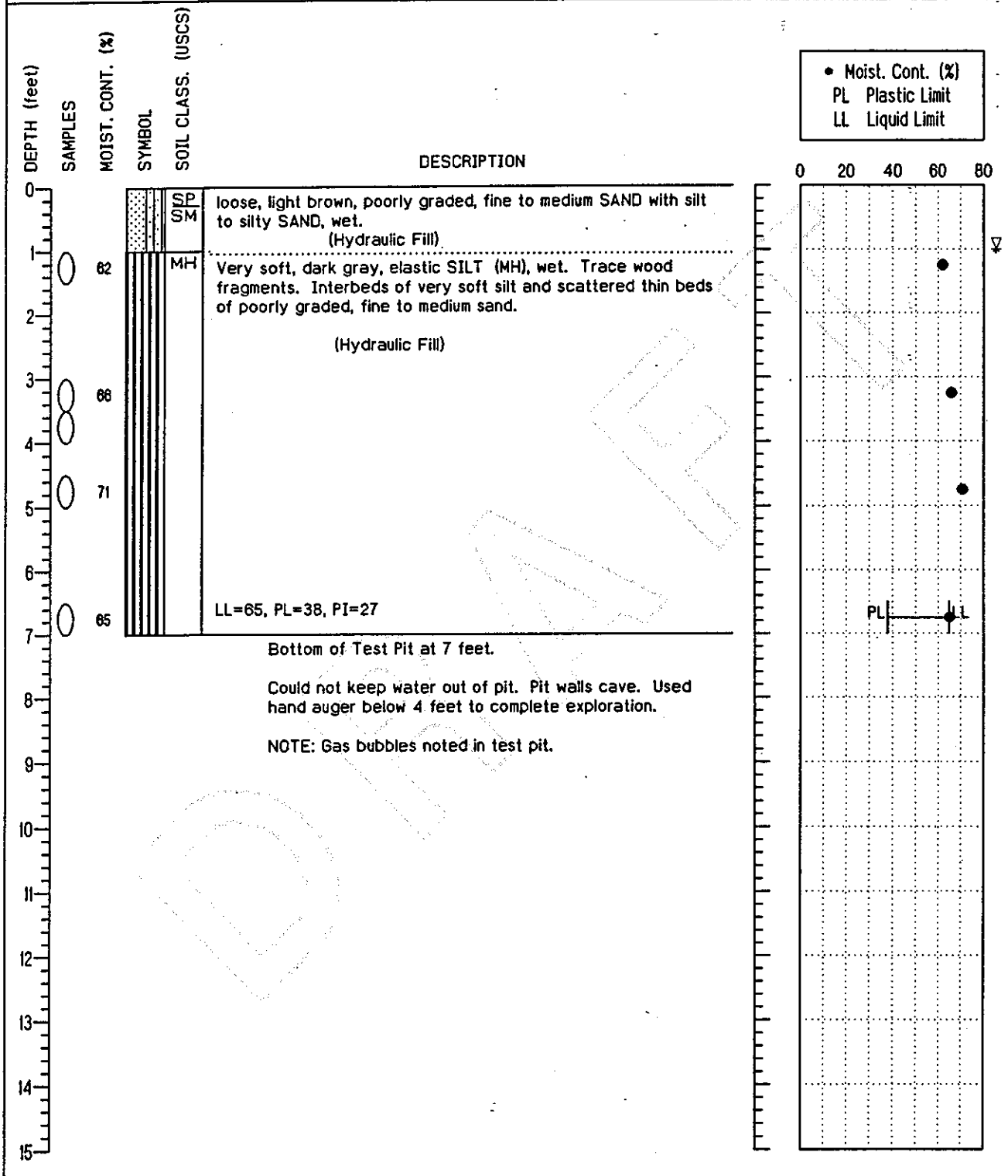
PROJECT NUMBER: 92055-2

HONG WEST & ASSOCIATES, INC.

TEST PIT LOG

EXCAVATION COMPANY: Neuharth Bros.
EXCAVATION METHOD: Kubota KB28 Trackhoe
SAMPLING METHOD: Grab

TOTAL DEPTH: 7 Feet
SURFACE ELEVATION: ±15.5 Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: CAPITOL LAKE

TEST PIT: TP-4

LOCATION: Olympia, Washington
DATE COMPLETED: 2/23/94
LOGGED BY: Rod Faubion

PROJECT NUMBER: 92055-2

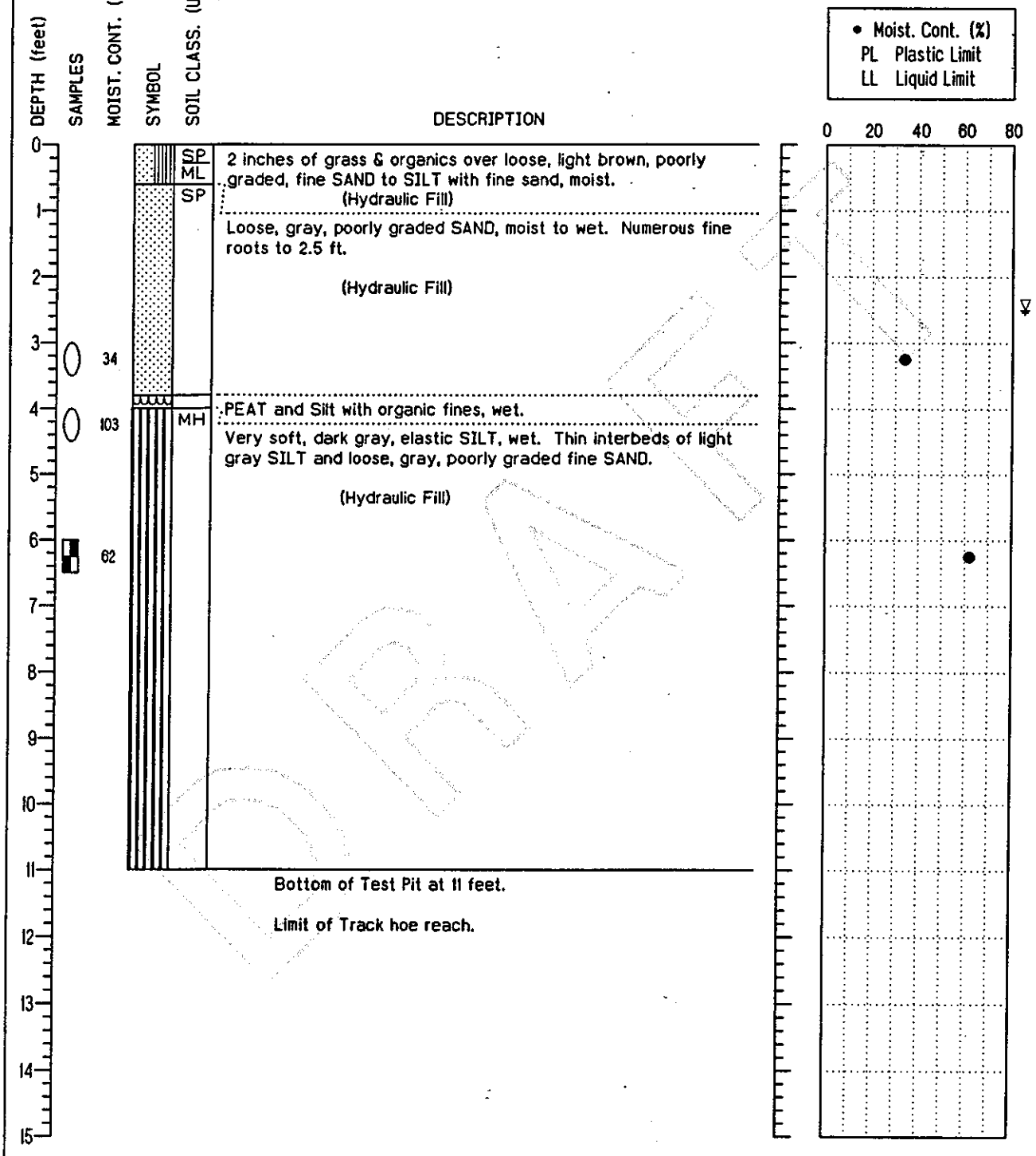
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

TEST PIT LOG

EXCAVATION COMPANY: Neuharth Bros.
EXCAVATION METHOD: Kubota KB28 Trackhoe
SAMPLING METHOD: Grab

TOTAL DEPTH: 11 Feet
SURFACE ELEVATION: ±13 Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: CAPITOL LAKE

TEST PIT: TP-5

LOCATION: Olympia, Washington
DATE COMPLETED: 2/23/94
LOGGED BY: Rod Faubion

PROJECT NUMBER: 92055-2

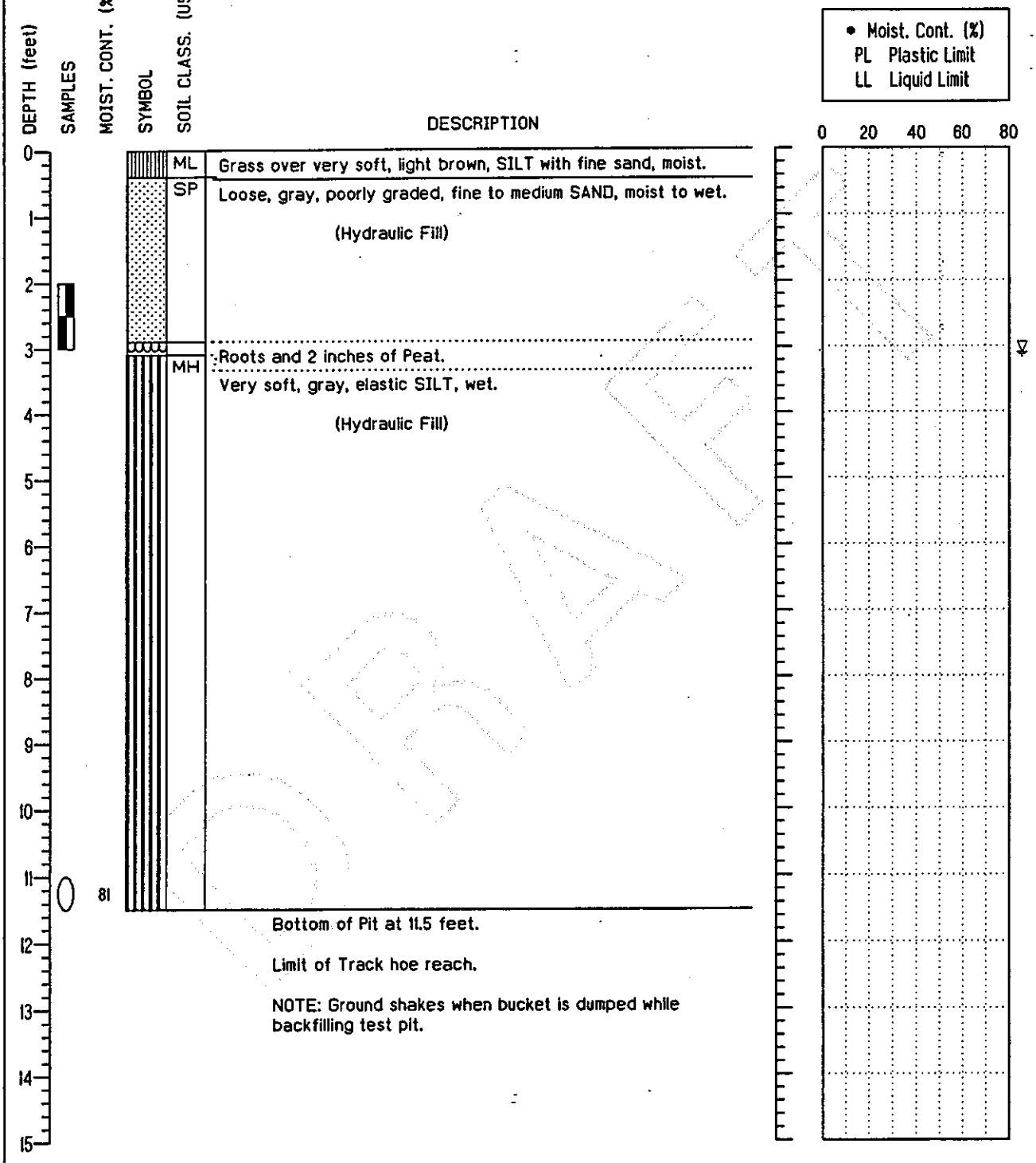
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

TEST PIT LOG

EXCAVATION COMPANY: Neuharth Bros.
EXCAVATION METHOD: Kubota KB28 Trackhoe
SAMPLING METHOD: Grab

TOTAL DEPTH: 11.5 Feet
SURFACE ELEVATION: ±12 Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: CAPITOL LAKE

TEST PIT: TP-6

LOCATION: Olympia, Washington
DATE COMPLETED: 2/23/94
LOGGED BY: Rod Faubion

PROJECT NUMBER: 92055-2

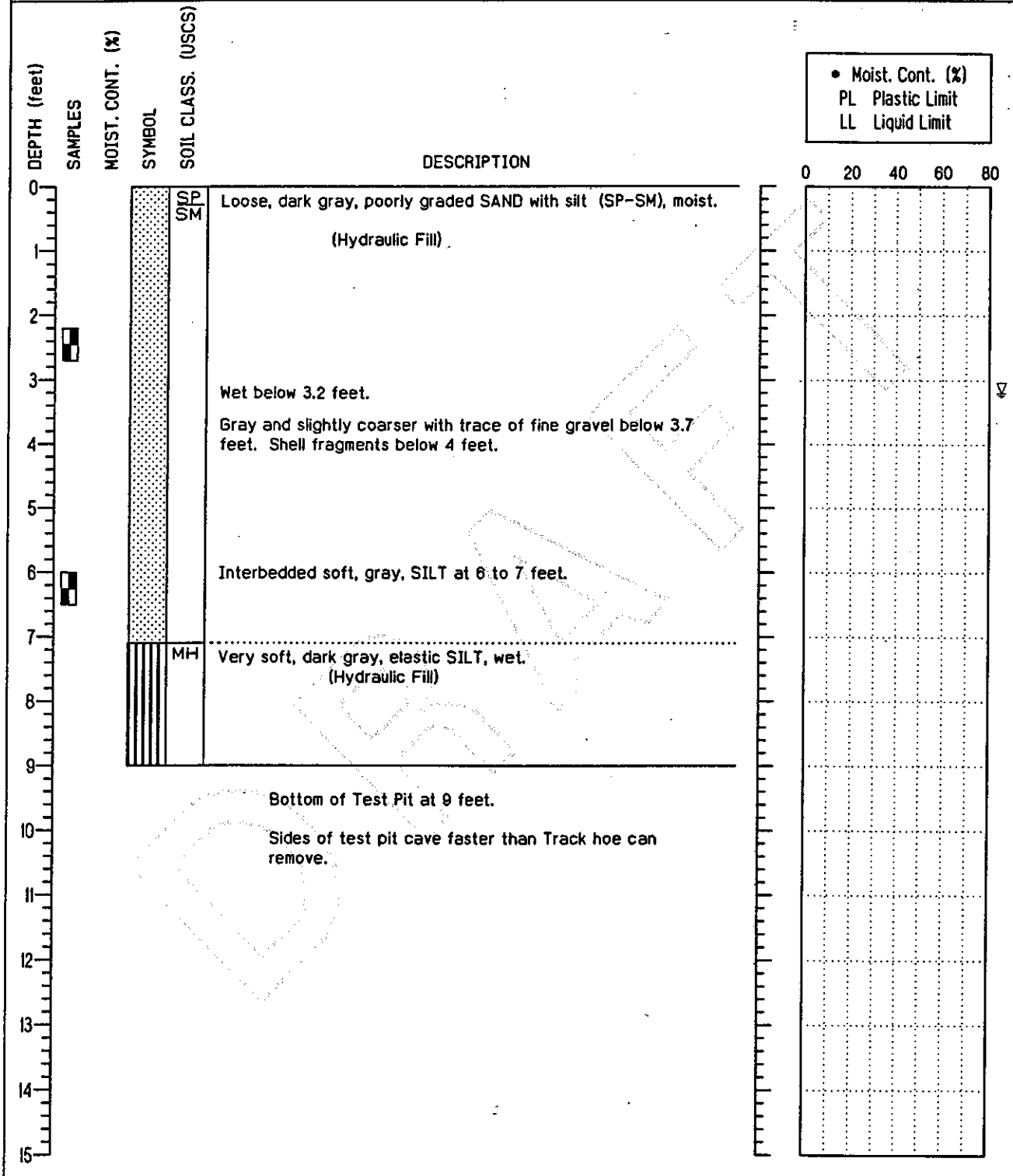
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

TEST PIT LOG

EXCAVATION COMPANY: Neuharth Bros.
EXCAVATION METHOD: Kubota KB28 Trackhoe
SAMPLING METHOD: Grab

TOTAL DEPTH: 9 Feet
SURFACE ELEVATION: ±15 Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: CAPITOL LAKE

TEST PIT: TP-7

LOCATION: Olympia, Washington
DATE COMPLETED: 2/23/94
LOGGED BY: Rod Faubion

PROJECT NUMBER: 92055-2

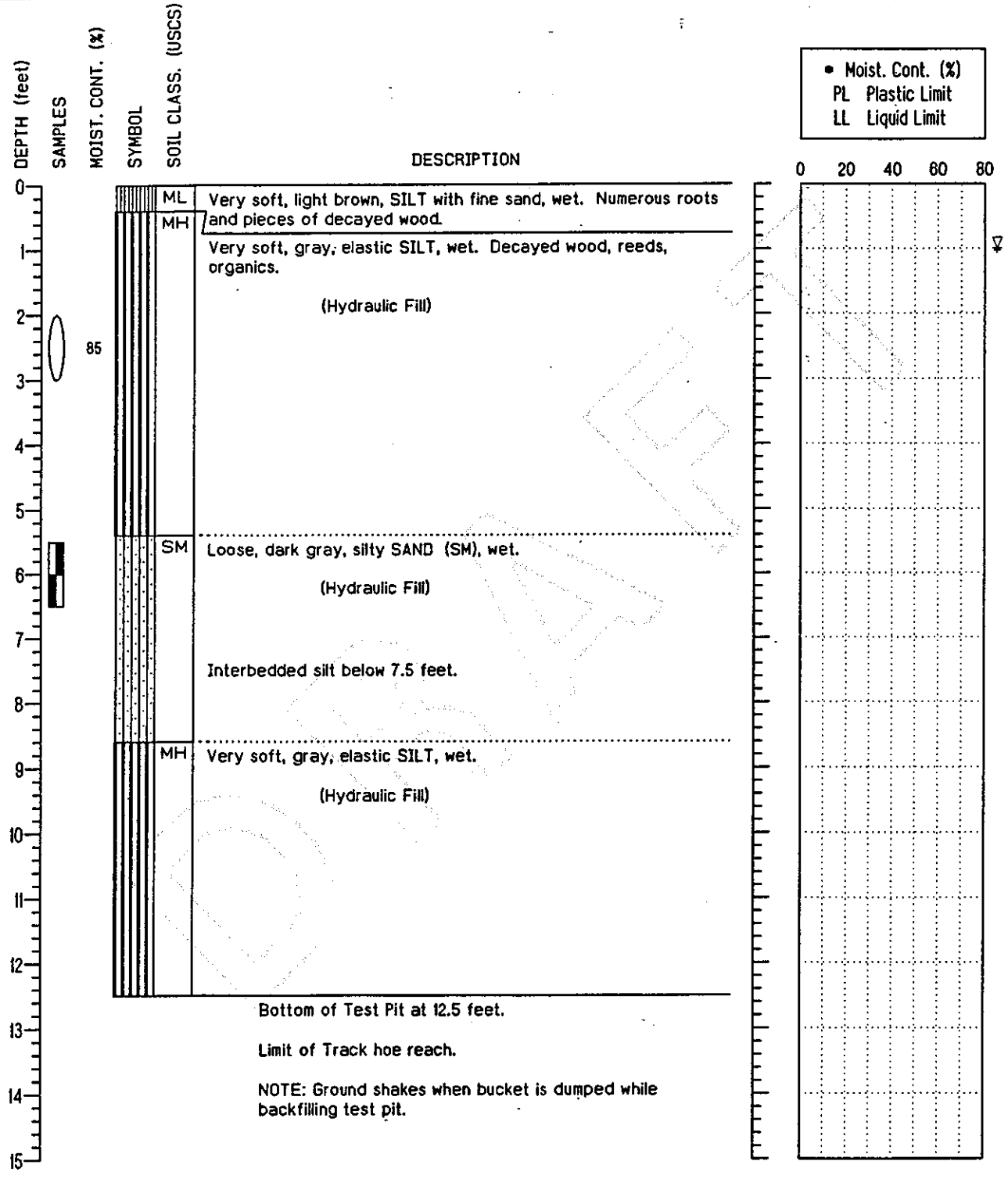
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

TEST PIT LOG

EXCAVATION COMPANY: Neuharth Bros.
EXCAVATION METHOD: Kubota KB28 Trackhoe
SAMPLING METHOD: Grab

TOTAL DEPTH: 12.5 Feet
SURFACE ELEVATION: ±14 Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: CAPITOL LAKE

LOCATION: Olympia, Washington
DATE COMPLETED: 2/23/94
LOGGED BY: Rod Faubion

TEST PIT: TP-8

PROJECT NUMBER: 92055-2

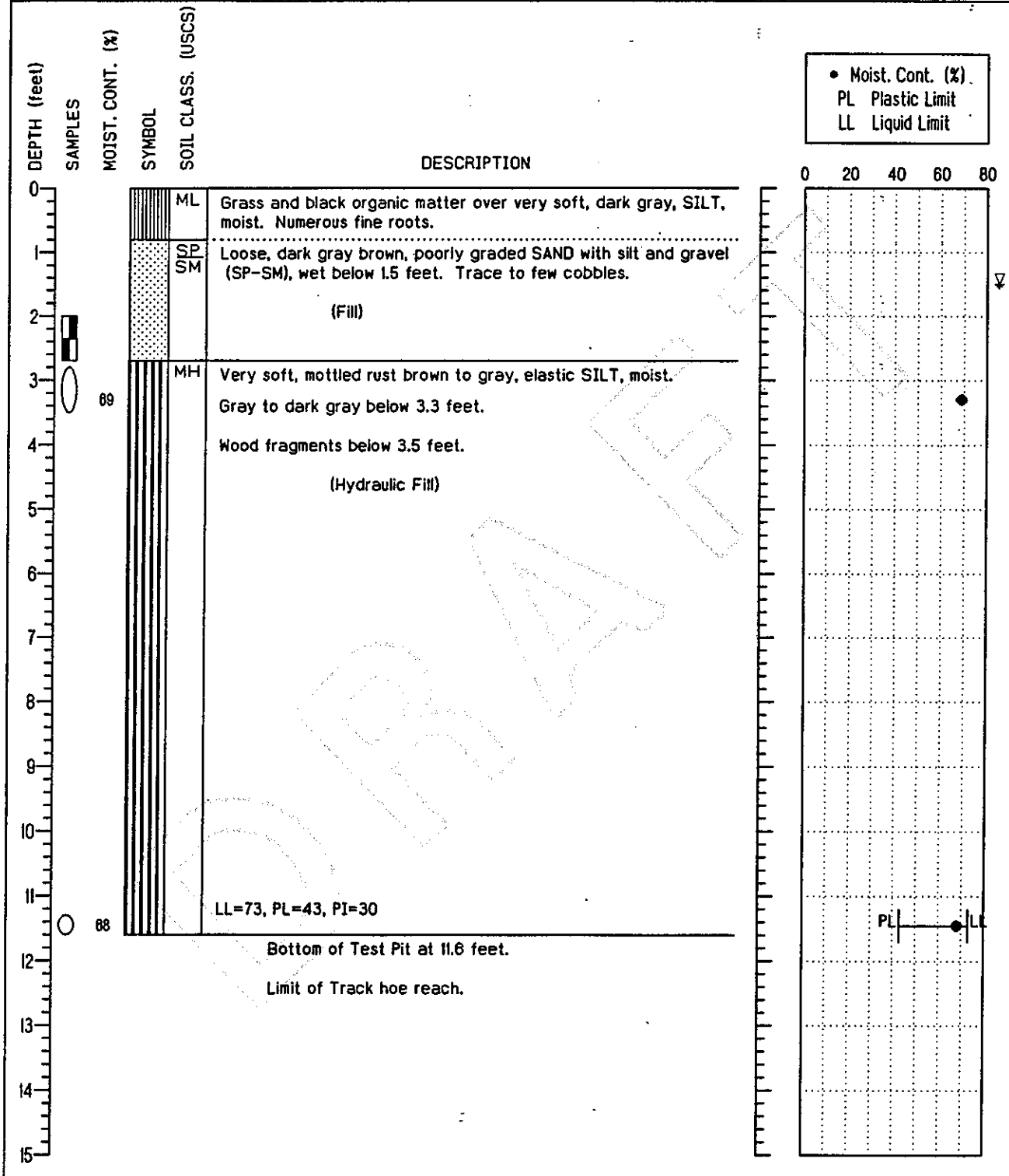
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

TEST PIT LOG

EXCAVATION COMPANY: Neuharth Bros.
EXCAVATION METHOD: Kubota KB28 Trackhoe
SAMPLING METHOD: Grab

TOTAL DEPTH: 11.6 Feet
SURFACE ELEVATION: ±18 Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: CAPITOL LAKE

TEST PIT: TP-9

LOCATION: Olympia, Washington
DATE COMPLETED: 2/24/94
LOGGED BY: Rod Faubion

PROJECT NUMBER: 92055-2

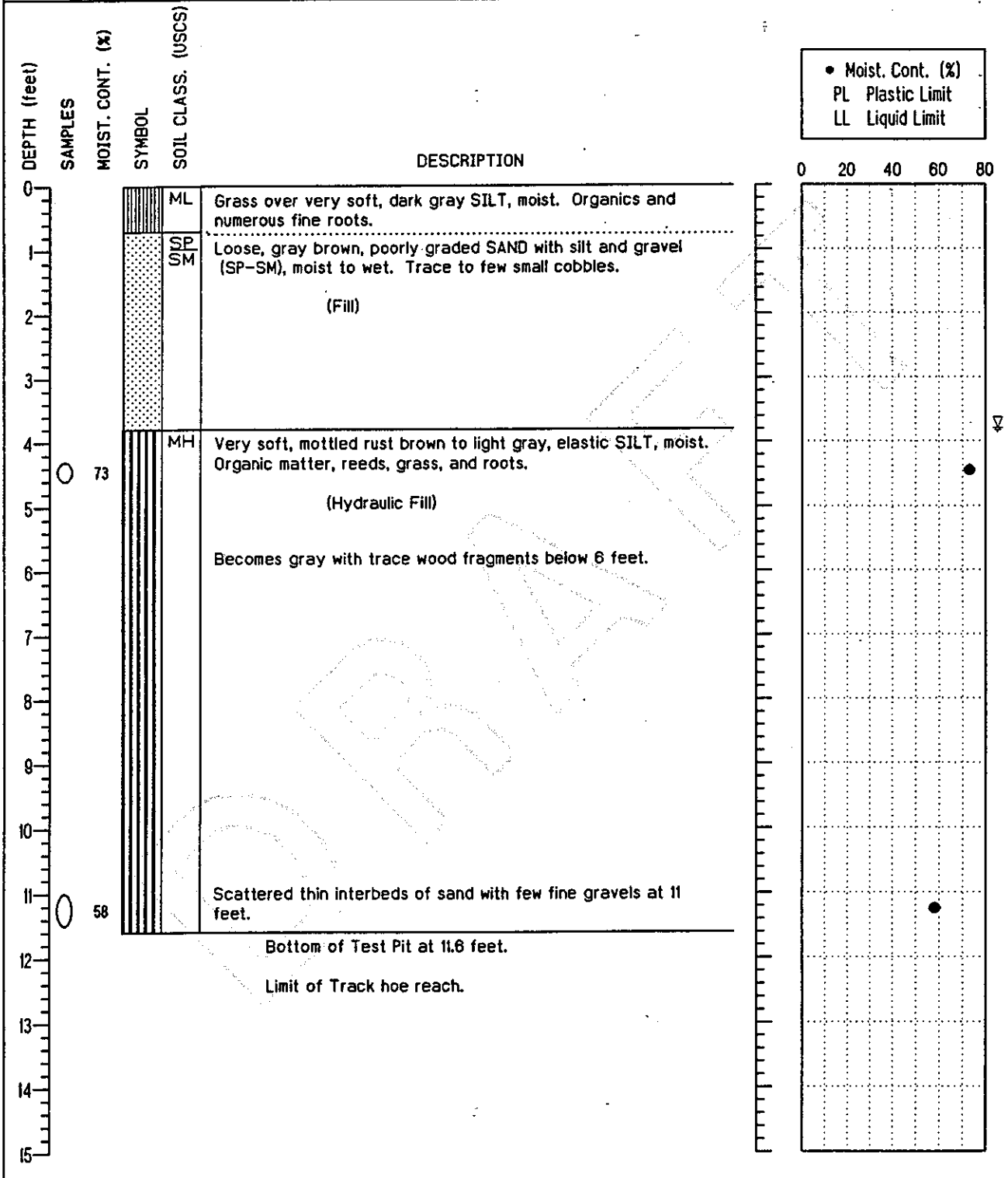
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

TEST PIT LOG

EXCAVATION COMPANY: Neuharth Bros.
EXCAVATION METHOD: Kubota KB28 Trackhoe
SAMPLING METHOD: Grab

TOTAL DEPTH: 11.6 Feet
SURFACE ELEVATION: ±19.5 Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: CAPITOL LAKE

TEST PIT: TP-10

LOCATION: Olympia, Washington
DATE COMPLETED: 2/24/94
LOGGED BY: Rod Faubion

PROJECT NUMBER: 92055-2

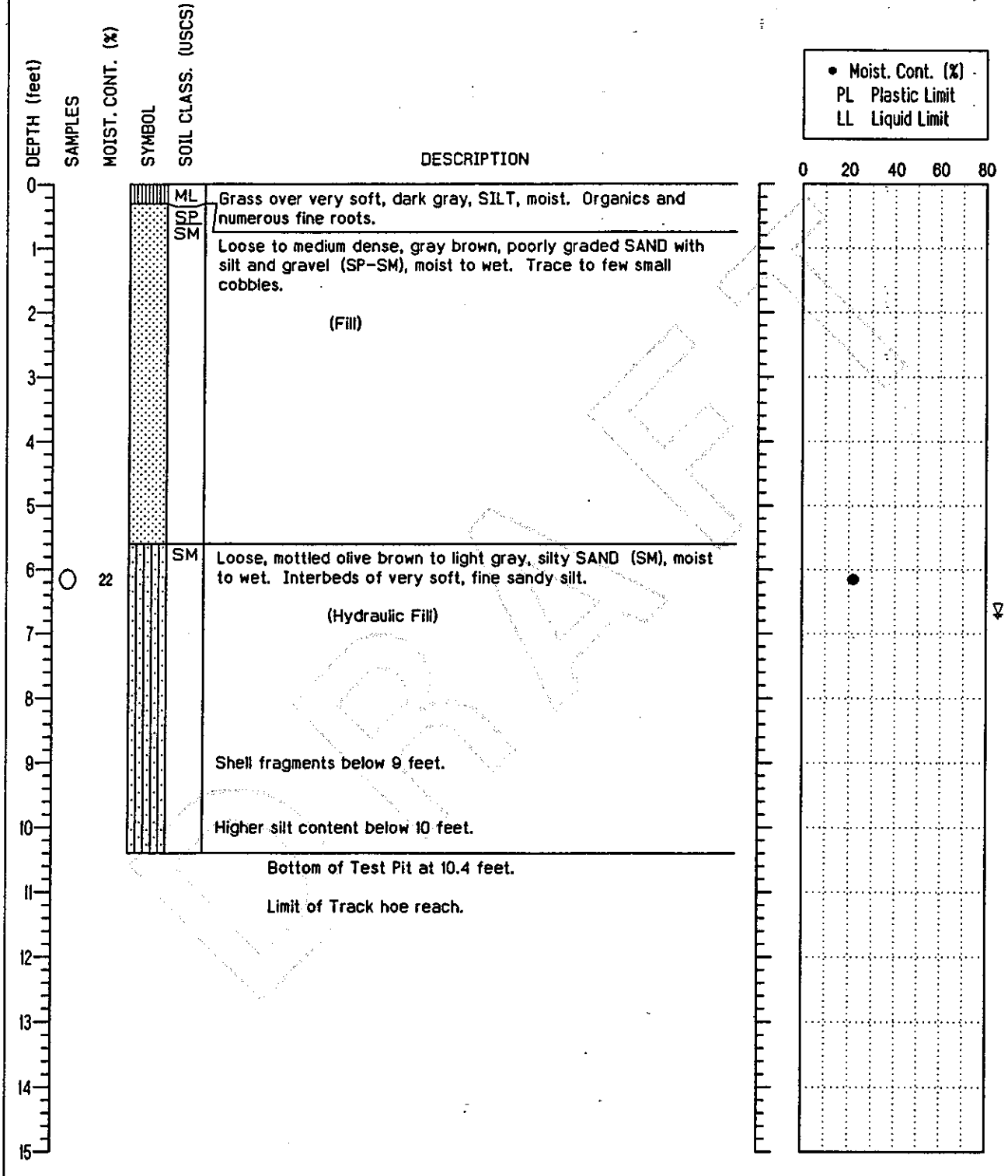
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

TEST PIT LOG

EXCAVATION COMPANY: Neuharth Bros.
EXCAVATION METHOD: Kubota KB28 Trackhoe
SAMPLING METHOD: Grab

TOTAL DEPTH: 10.4 Feet
SURFACE ELEVATION: ±18 Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: CAPITOL LAKE

TEST PIT: TP-11

LOCATION: Olympia, Washington
DATE COMPLETED: 2/24/94
LOGGED BY: Rod Faubion

PROJECT NUMBER: 92055-2

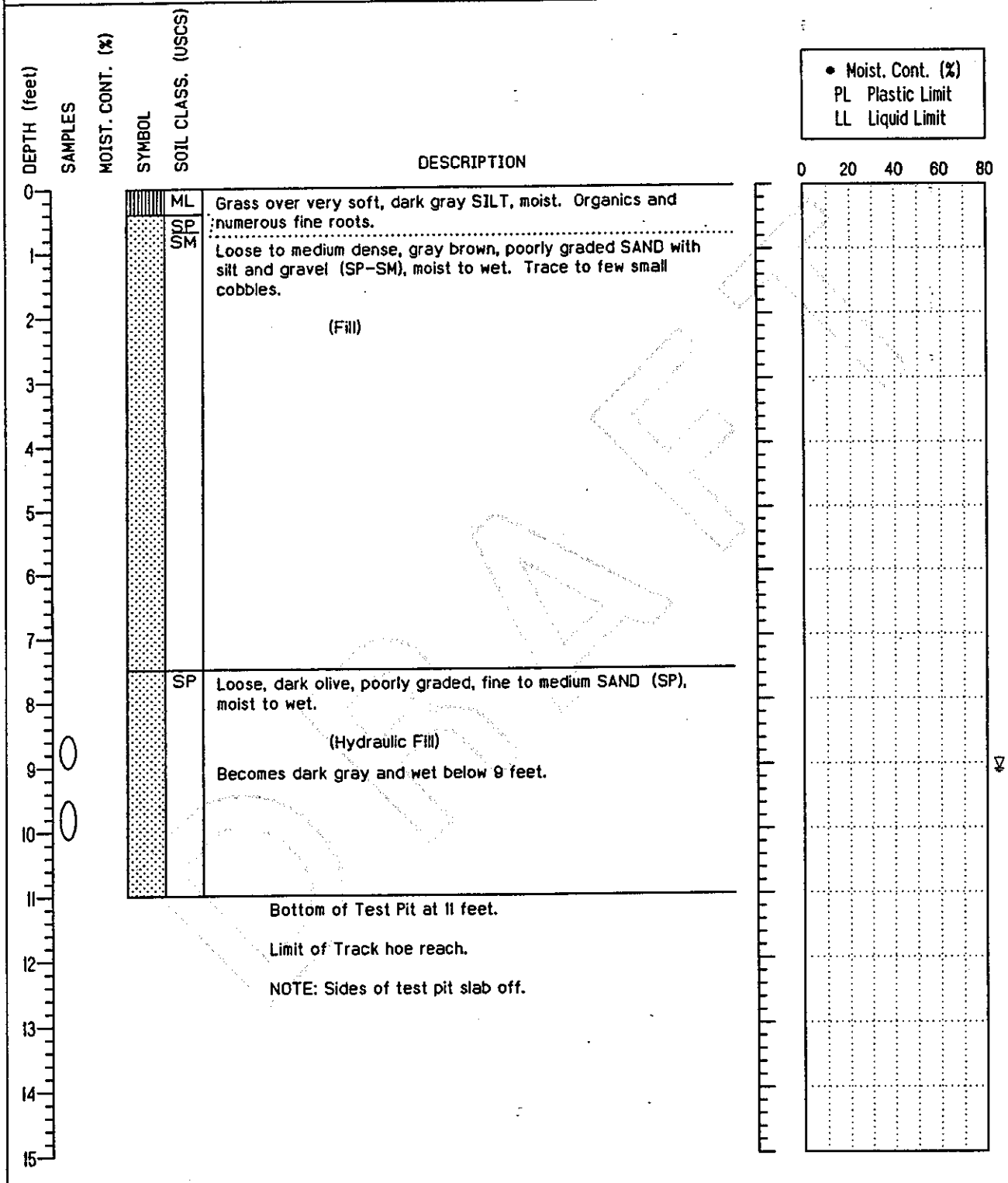
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

TEST PIT LOG

EXCAVATION COMPANY: Neuharth Bros.
EXCAVATION METHOD: Kubota KB28 Trackhoe
SAMPLING METHOD: Grab

TOTAL DEPTH: 11 Feet
SURFACE ELEVATION: ±16 Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: CAPITOL LAKE

TEST PIT: TP-12

LOCATION: Olympia, Washington
DATE COMPLETED: 2/24/94
LOGGED BY: Rod Faubion

PROJECT NUMBER: 92055-2

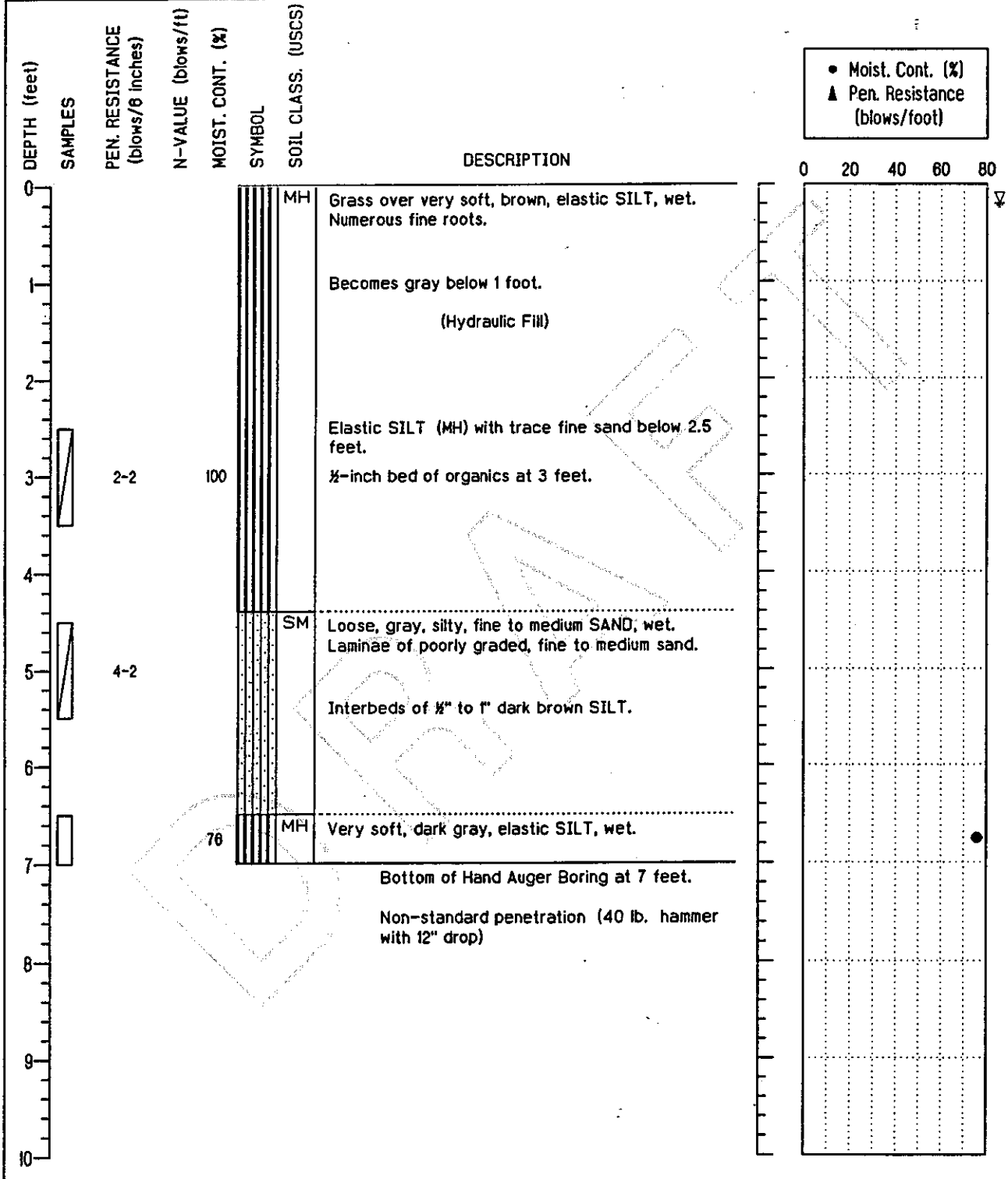
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

BORING LOG

DRILLING COMPANY: Hong West & Associates
DRILLING METHOD: Hand Auger, 3-inch O.D.
SAMPLING METHOD: Grab, Non-Standard Penetration

TOTAL DEPTH: 7 Feet
SURFACE ELEVATION: ±13 Feet
MEASURING POINT EL.: Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: CAPITOL LAKE

BORING: HA-1

LOCATION: Olympia, Washington
DATE COMPLETED: 2/23/94
LOGGED BY: Bob Metcalfe & David Sowers

PROJECT NUMBER: 92055-2

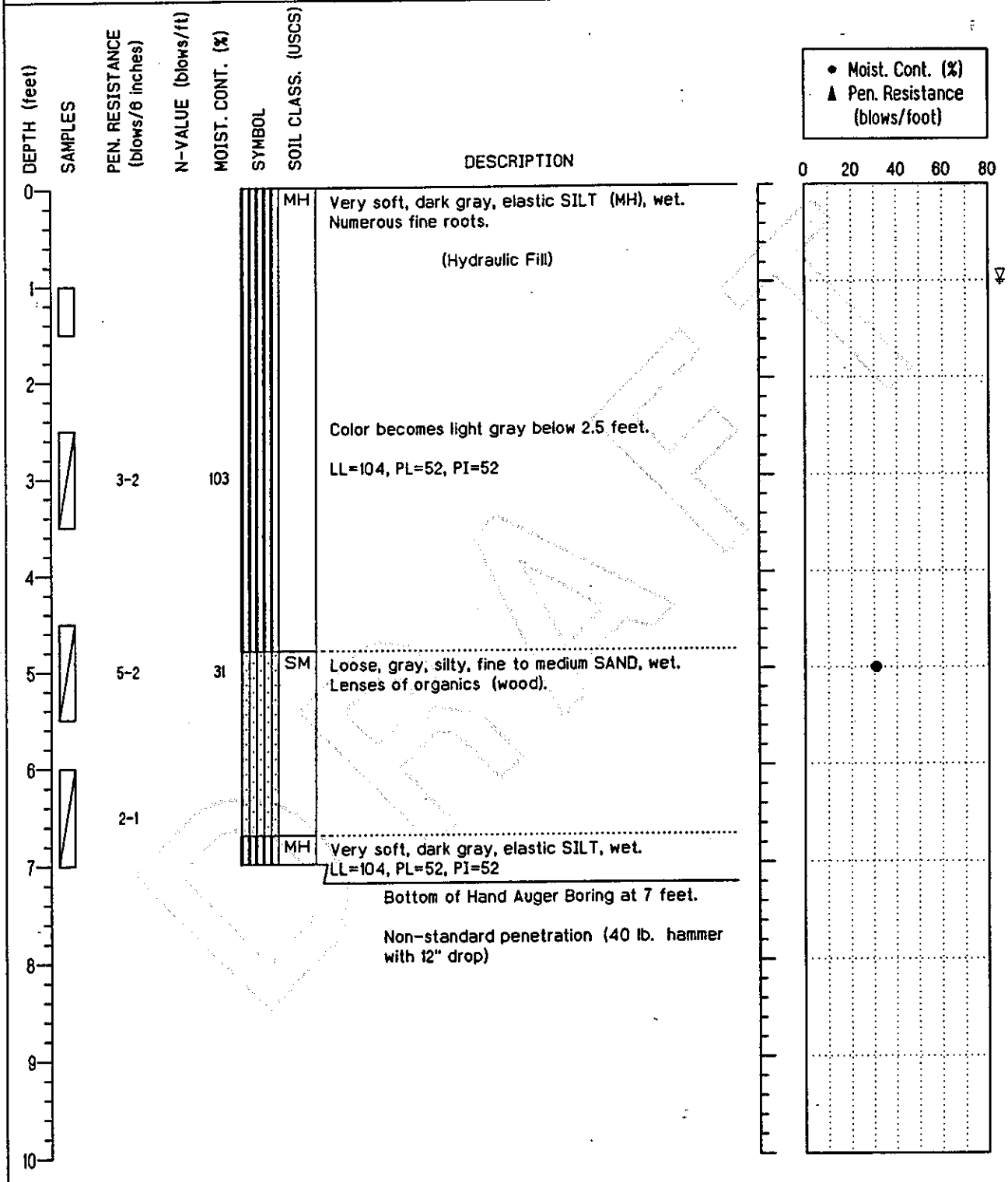
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

BORING LOG

DRILLING COMPANY: Hong West & Assoc.
DRILLING METHOD: Hand Auger, 3-inch O.D.
SAMPLING METHOD: Grab, Non-Standard Penetration

TOTAL DEPTH: 7 Feet
SURFACE ELEVATION: ±12.5 Feet
MEASURING POINT EL.: Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: CAPITOL LAKE

BORING: HA-2

LOCATION: Olympia, Washington
DATE COMPLETED: 2/23/94
LOGGED BY: Bob Metcalfe & David Sowers

PROJECT NUMBER: 92055-2

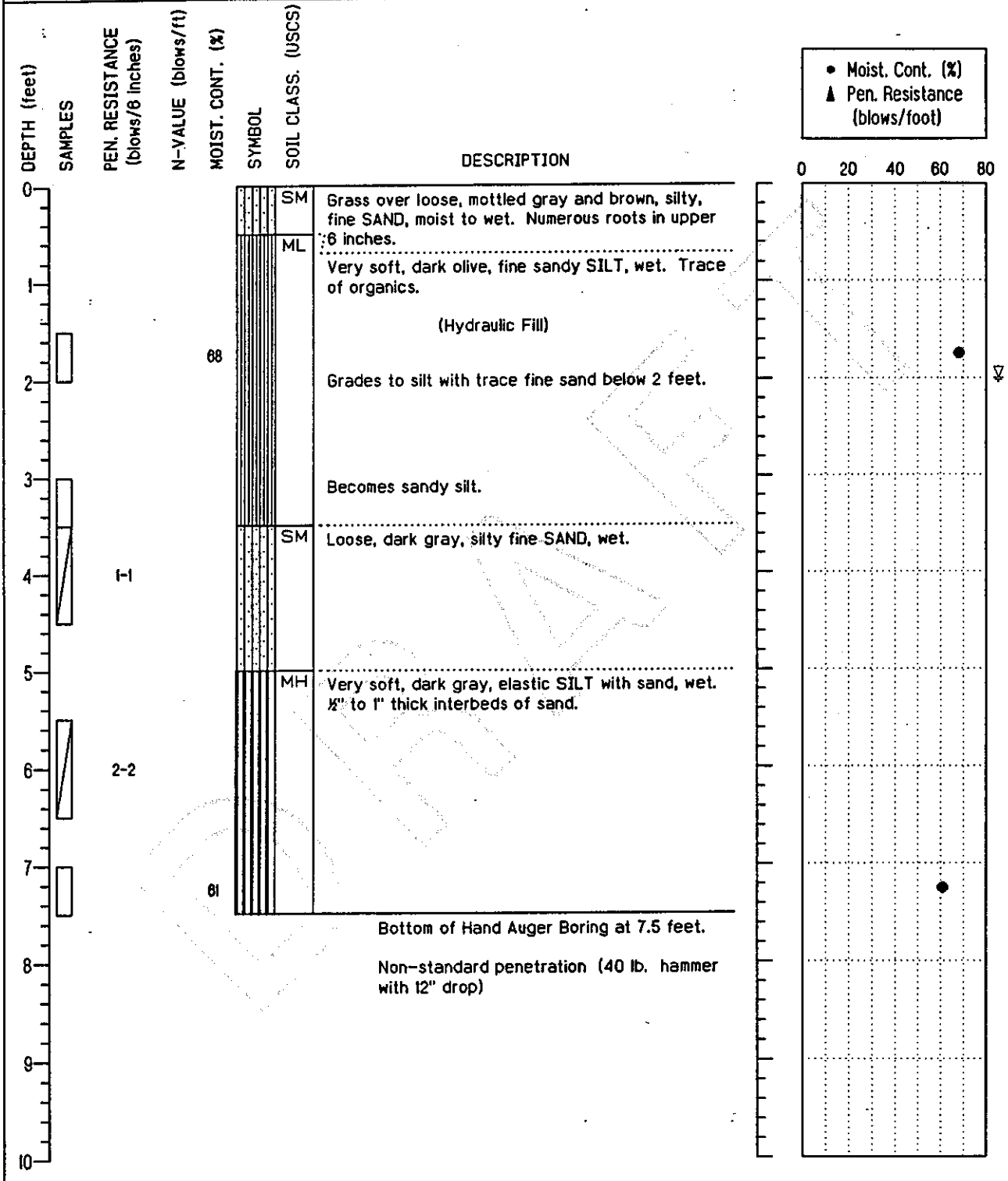
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

BORING LOG

DRILLING COMPANY: Hong West & Assoc.
DRILLING METHOD: Hand Auger, 3-inch O.D.
SAMPLING METHOD: Grab, Non-Standard Penetration

TOTAL DEPTH: 7.5 Feet
SURFACE ELEVATION: ±13 Feet
MEASURING POINT EL.: Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: CAPITOL LAKE

BORING: HA-3

LOCATION: Olympia, Washington
DATE COMPLETED: 2/23/94
LOGGED BY: Bob Metcalfe & David Sowers

PROJECT NUMBER: 92055-2

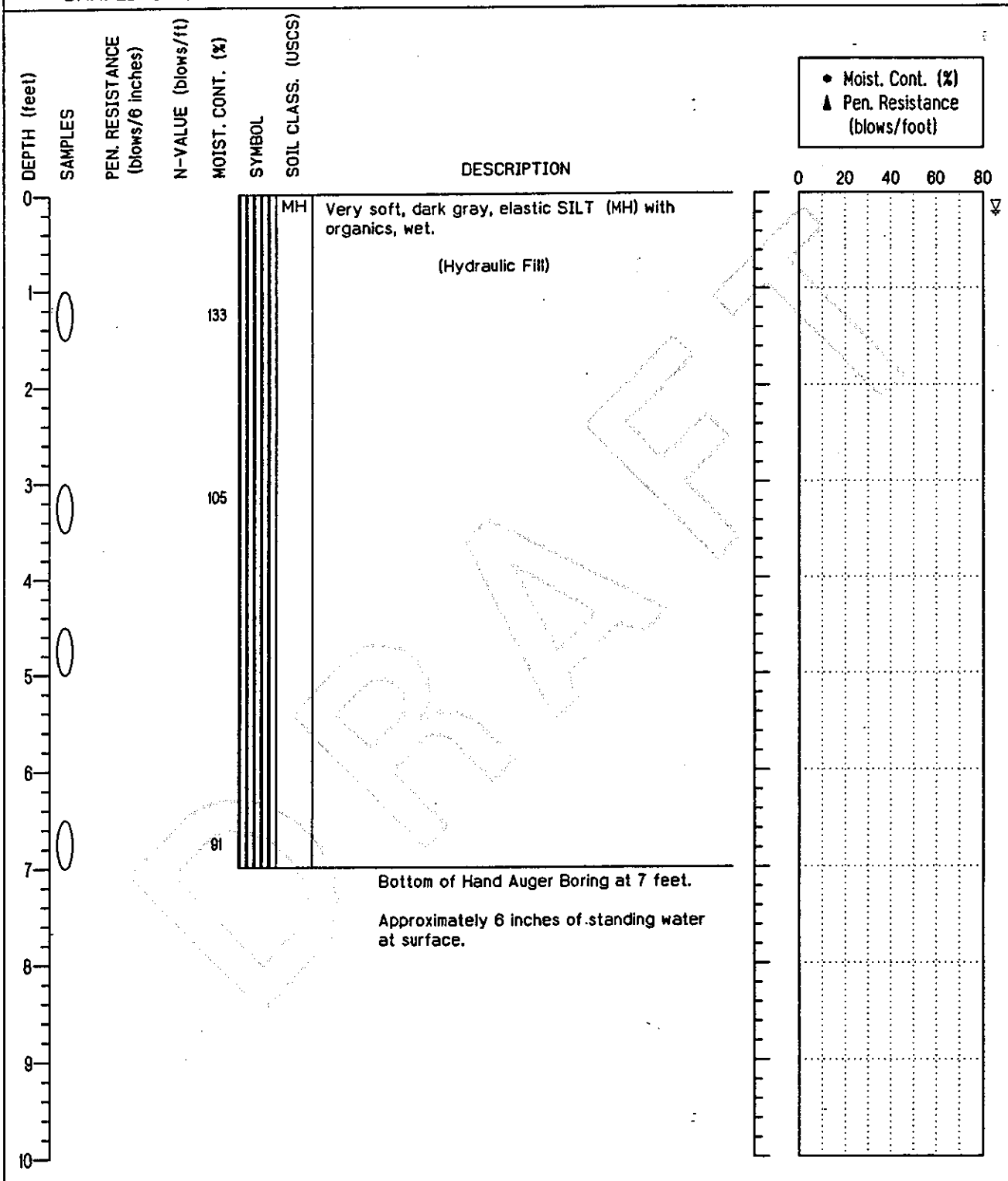
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

BORING LOG

DRILLING COMPANY: Hong West & Assoc.
DRILLING METHOD: Hand Auger, 3-inch O.D.
SAMPLING METHOD: Grab

TOTAL DEPTH: 7 Feet
SURFACE ELEVATION: ±13 Feet
MEASURING POINT EL.: Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: CAPITOL LAKE

BORING: HA-4

LOCATION: Olympia, Washington
DATE COMPLETED: 2/23/94
LOGGED BY: Bob Metcalfe & David Sowers

PROJECT NUMBER: 92055-2

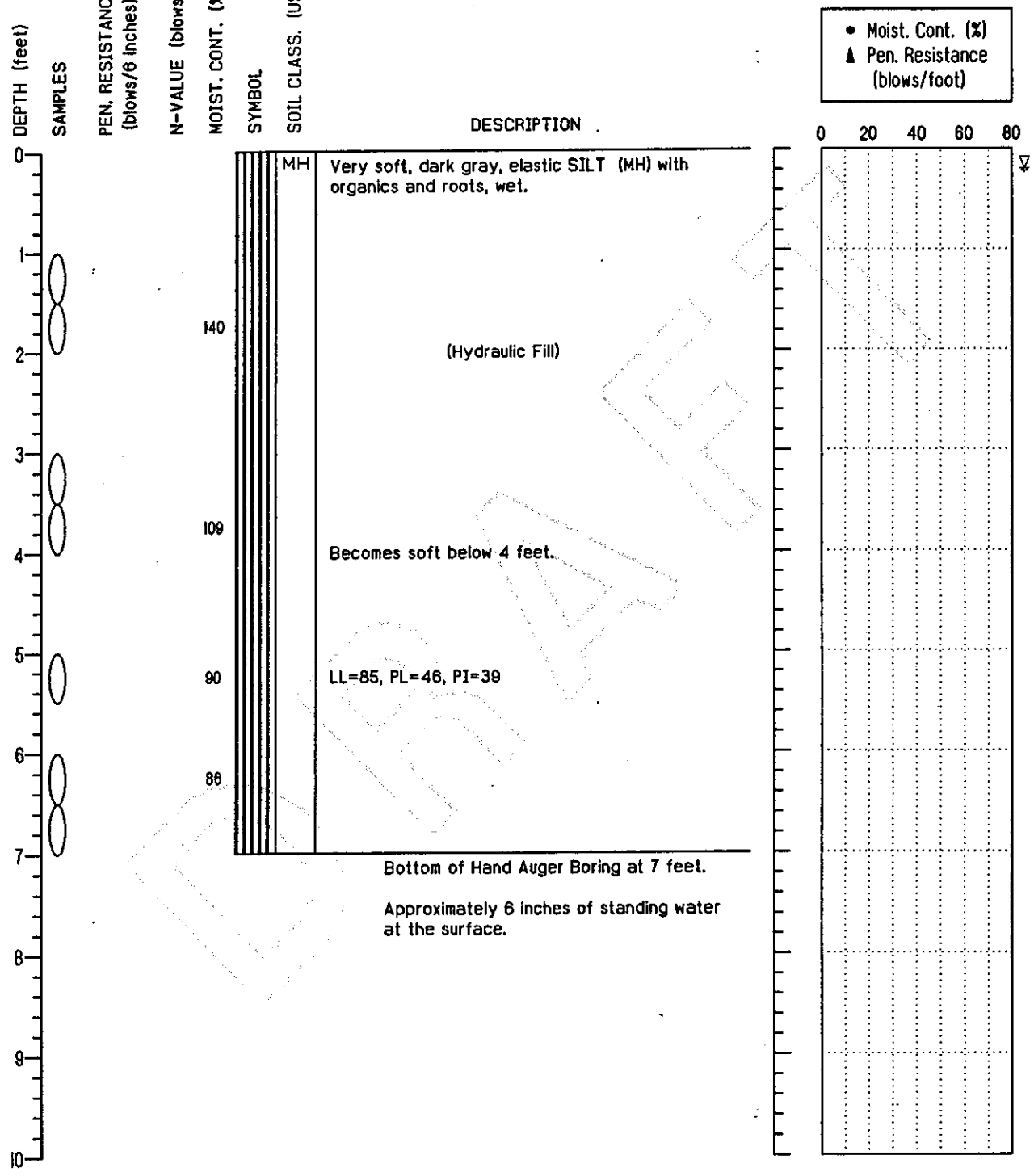
PAGE: 1 OF 1

HONG WEST & ASSOCIATES, INC.

BORING LOG

DRILLING COMPANY: Hong West and Assoc.
DRILLING METHOD: Hand Auger, 3-inch O.D.
SAMPLING METHOD: Grab

TOTAL DEPTH: 7 Feet
SURFACE ELEVATION: ±12 Feet
MEASURING POINT EL.: Feet



NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated.

PROJECT: CAPITOL LAKE

BORING: HA-5

LOCATION: Olympia, Washington
DATE COMPLETED: 2/23/94
LOGGED BY: Bob Metcalfe & David Sowers

PROJECT NUMBER: 92055-2

PAGE: 1 OF 1

APPENDIX B

LABORATORY TESTING

(SOIL SAMPLES FROM HWA EXPLORATIONS)

APPENDIX B

LABORATORY TESTING
(SOIL SAMPLES FROM HWA EXPLORATIONS)

Moisture Content Testing

Hong West & Associates laboratory personnel conducted moisture content testing on selected soil samples, in general accordance with ASTM D 2216. The results are shown on the appropriate hand auger boring and test pit logs in Appendix A.

Plasticity Analysis

Plasticity tests (Atterberg Limits) were performed on four fine-grained samples, three obtained from explorations within Wetland B and one from test pit TP-9 located on the northwest side of the possible new dewatering basin. The tests were conducted in accordance with ASTM D 4318. The results are plotted on Figure B-1 and the liquid limit (LL), plastic limit (PL) and plasticity index (PI) results are shown on the hand auger boring and test pit logs in Appendix A, at the appropriate sample depths. Results from tests performed on the four samples indicated the sediments consisted of elastic silt (MH) or possibly organic silt (OH).

Grain Size Analysis

Grain size distributions of representative soil samples collected from within the existing dewatering facility were determined in accordance with ASTM D 422. The grain size distributions were plotted and classified according to the Unified Soil Classification System (USCS), as shown on Figures B-2 through B-13.

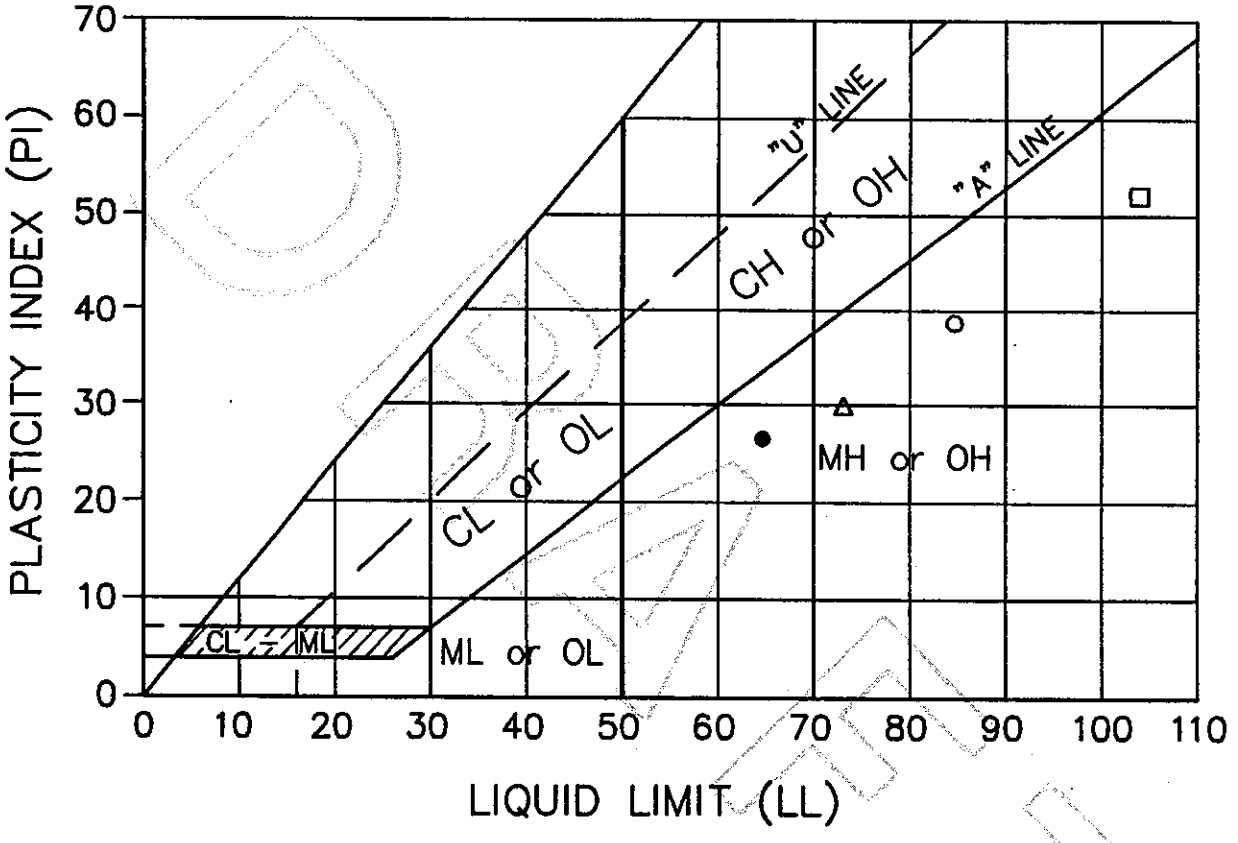
Moisture/Density Relationship

The maximum dry density/optimum moisture content relationship of four samples of coarse grained material encountered at the site was tested in accordance with ASTM D 1557 (Modified Proctor). The "Proctor" curves are shown on Figures B-14 through B-17.

Soil Fertility and Micro-Nutrient Analysis

Under subcontract to HWA, Soil and Plant Laboratory, Inc. of Bellevue, Washington performed soil fertility and micro-nutrient analyses on three samples of fine grained soil collected from within the Wetland B area and one from test pit TP-4 located on the west side of the south basin. The topsoil samples were analyzed for gradation, organic content, pH, and USDA classification. Based on the test results, Soil and Plant Laboratory, Inc.

prepared an assessment of the recommended fertilizers, along with their recommendations for an organic matter enhancement program, if the soils are used as topsoil. Soil and Plant Laboratory's test results and recommended application rates for fertilizers and organic matter are attached in this appendix.



SYMBOL	EXPLORATION	DEPTH (FEET)	LL (%)	PI (%)
●	TP-4	6.5-7	65	27
△	TP-9	11.3-11.6	73	30
□	HA-2	3-3.5	104	52
○	HA-5	5-5.5	85	39

HWA HONGWEST & ASSOCIATES, INC.

CAPITOL LAKE
SEDIMENT CONTROL PROJECT

PLASTICITY CHART

PROJECT NO.: 92055-2 FIGURE: B-1

c:\projects\92055-2\a-005.dwg

HONG WEST & ASSOCIATES, INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Sediment Control Project
Location: Olympia, Washington
Project Number: 92055-2
Date Tested: 3-15-94
Remarks: Dark olive, poorly graded SAND (SP)

Test Hole Number: TP-1
Sample Number: 1
Depth: 0.5-1.5 feet
Sample Description:
Gravel: 10.2
Sand: 89.4
Fines: 0.4

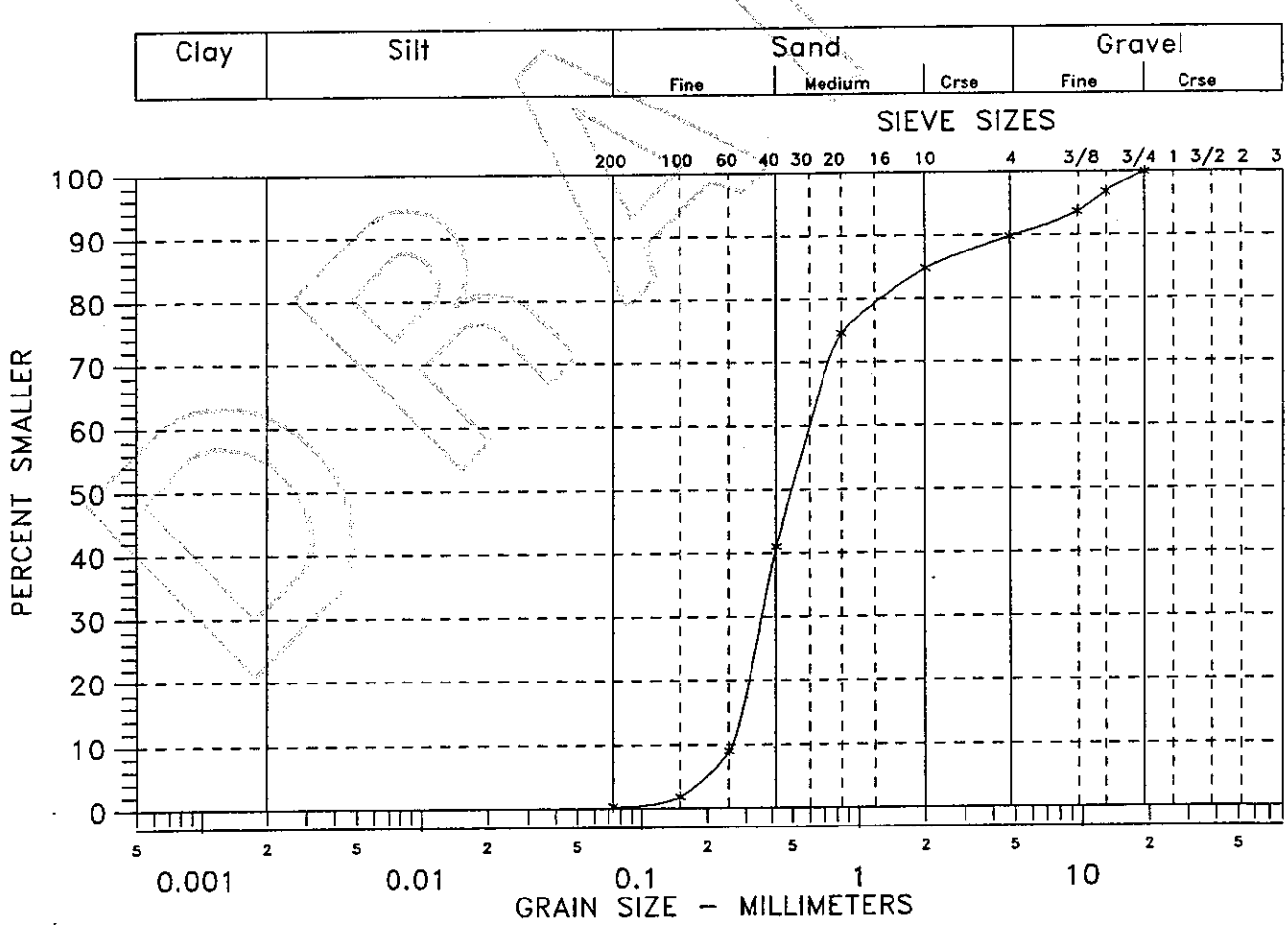


Figure B-2

HONG WEST & ASSOCIATES,INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Sediment Control Project
Location: Olympia, Washington
Project Number: 92055-2
Date Tested: 3-15-94
Remarks: Dark brown, poorly graded SAND (SP)

Test Hole Number: TP-2
Sample Number: 3
Depth: 2.0-2.5 feet
Sample Description:
Gravel: 12.8
Sand: 85.2
Fines: 2.0

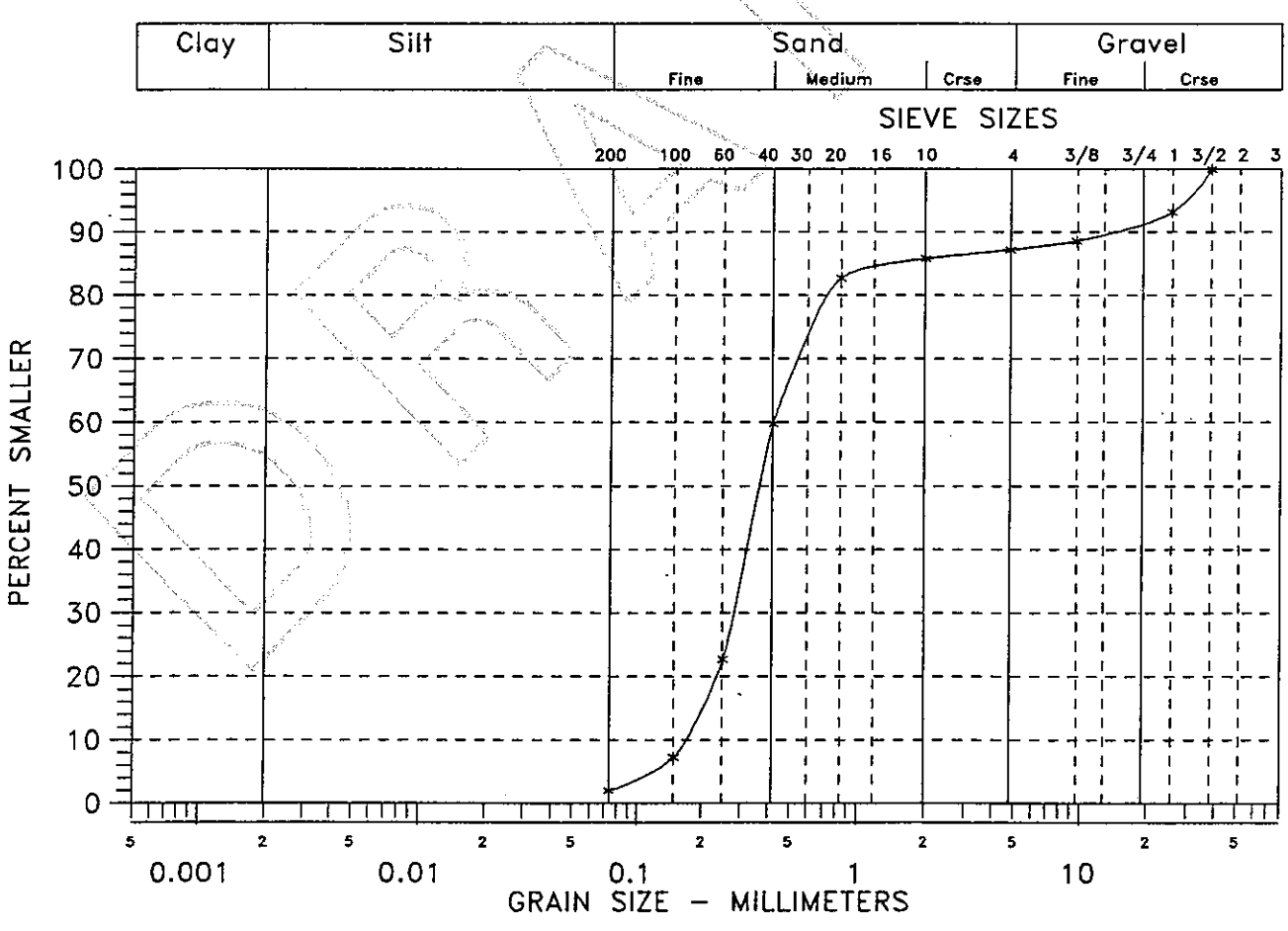


Figure B-3

HONG WEST & ASSOCIATES, INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Sediment Control Project
Location: Olympia, Washington
Project Number: 92055-2
Date Tested: 3-15-94
Remarks: Dark gray, elastic SILT (MH)
Atterberg Limits: LL=65
PL=38
PI=27

Test Hole Number: TP-4
Sample Number: 4
Depth: 4.5-5.0 feet
Sample Description:
Gravel: 0.0
Sand: 13.7
Silt: 82.3
Clay: 4.0

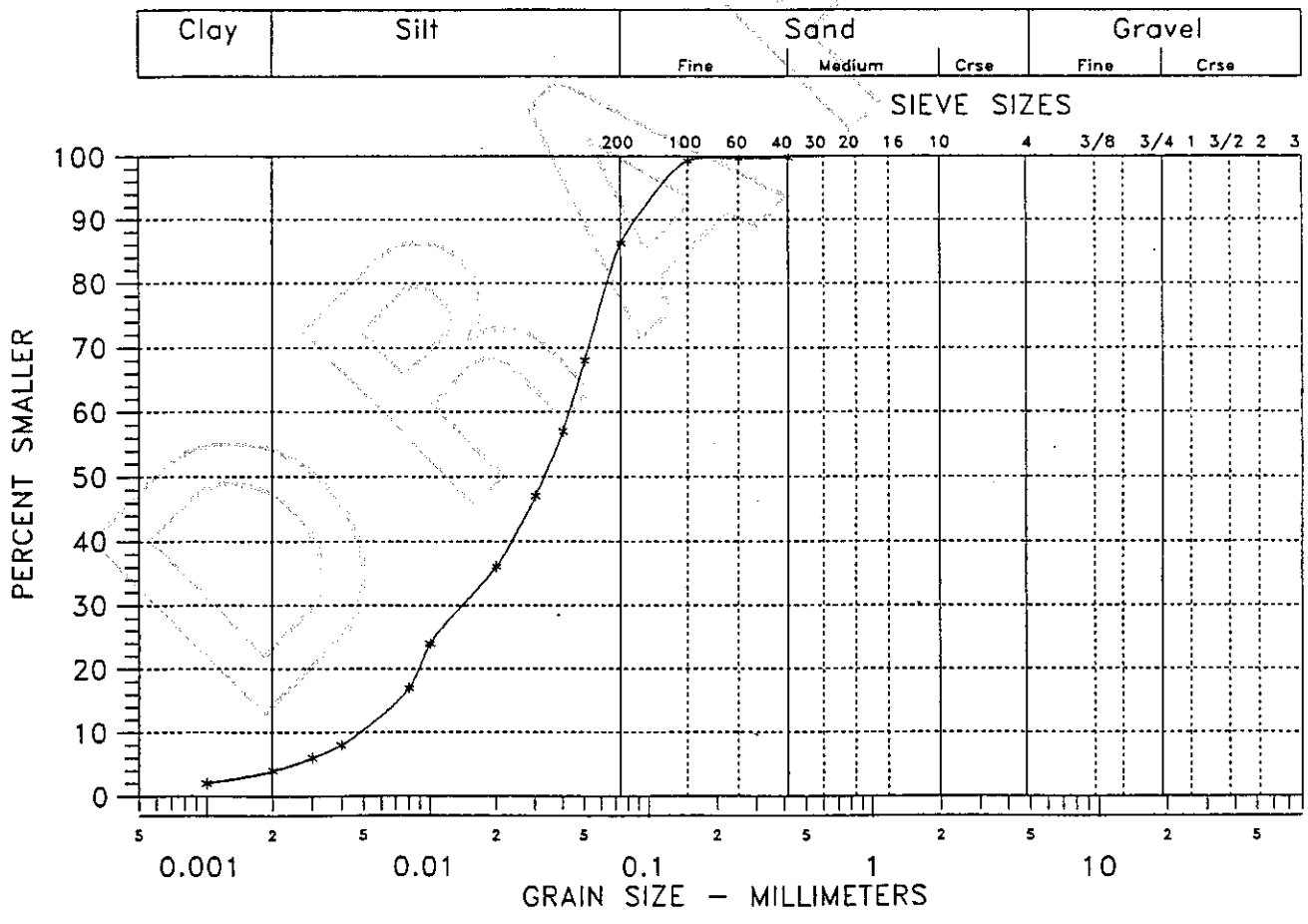


Figure B-4

HONG WEST & ASSOCIATES,INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Sediment Control Project
Location: Olympia, Washington
Project Number: 92055-2
Date Tested: 3-15-94
Remarks: Dark gray, poorly graded SAND with silt (SP-SM)

Test Hole Number: TP-7
Sample Number: 1
Depth: 2.2-2.7 feet
Sample Description:
Gravel: 0.0
Sand: 94.6
Fines: 5.4

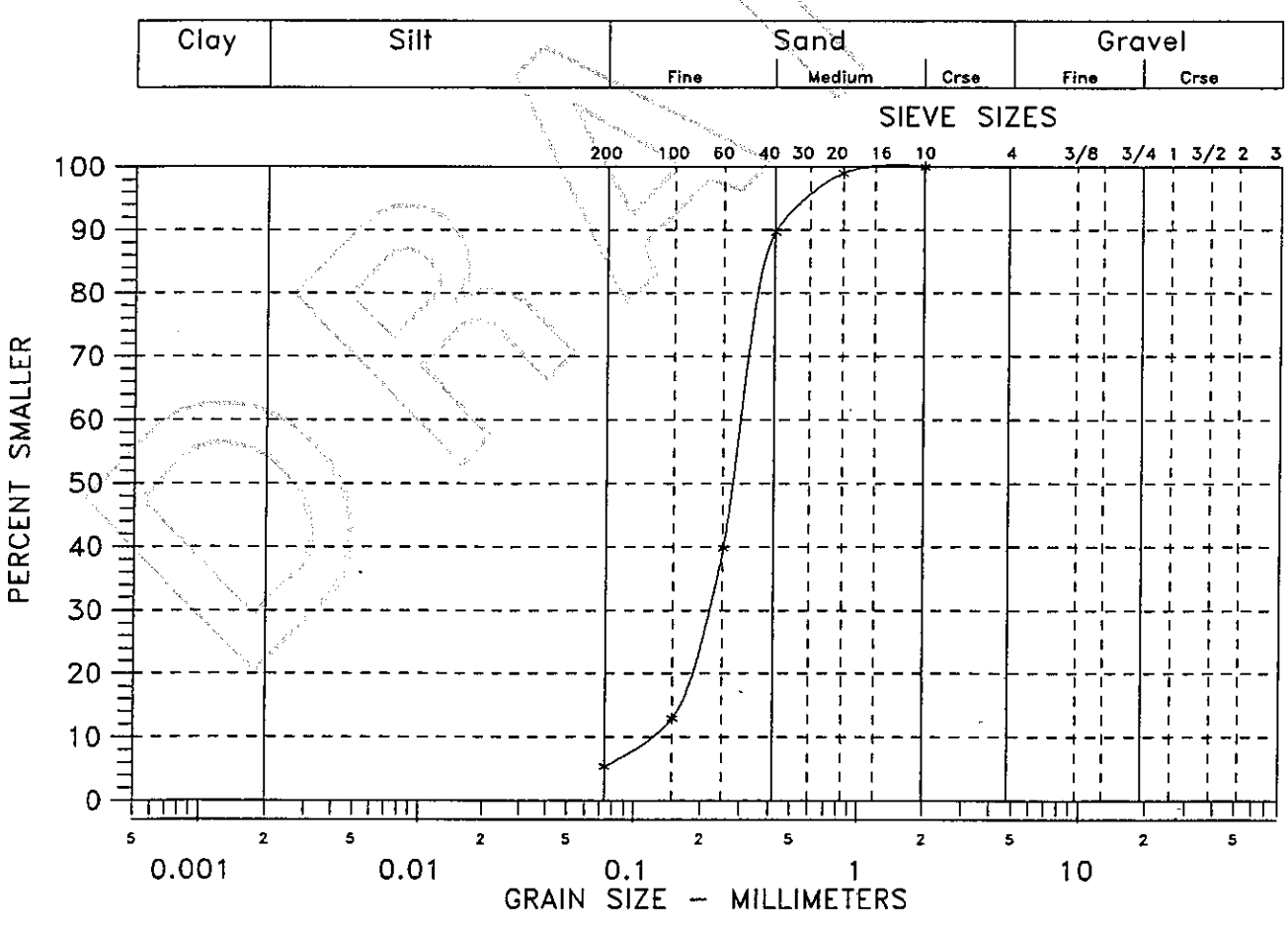


Figure B-5

HONG WEST & ASSOCIATES,INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Sediment Control Project
Location: Olympia, Washington
Project Number: 92055-2
Date Tested: 3-15-94
Remarks: Dark gray, silty SAND (SM)

Test Hole Number: TP-8
Sample Number: 2
Depth: 5.5-6.5 feet
Sample Description:
Gravel: 0.0
Sand: 86.5
Fines: 13.5

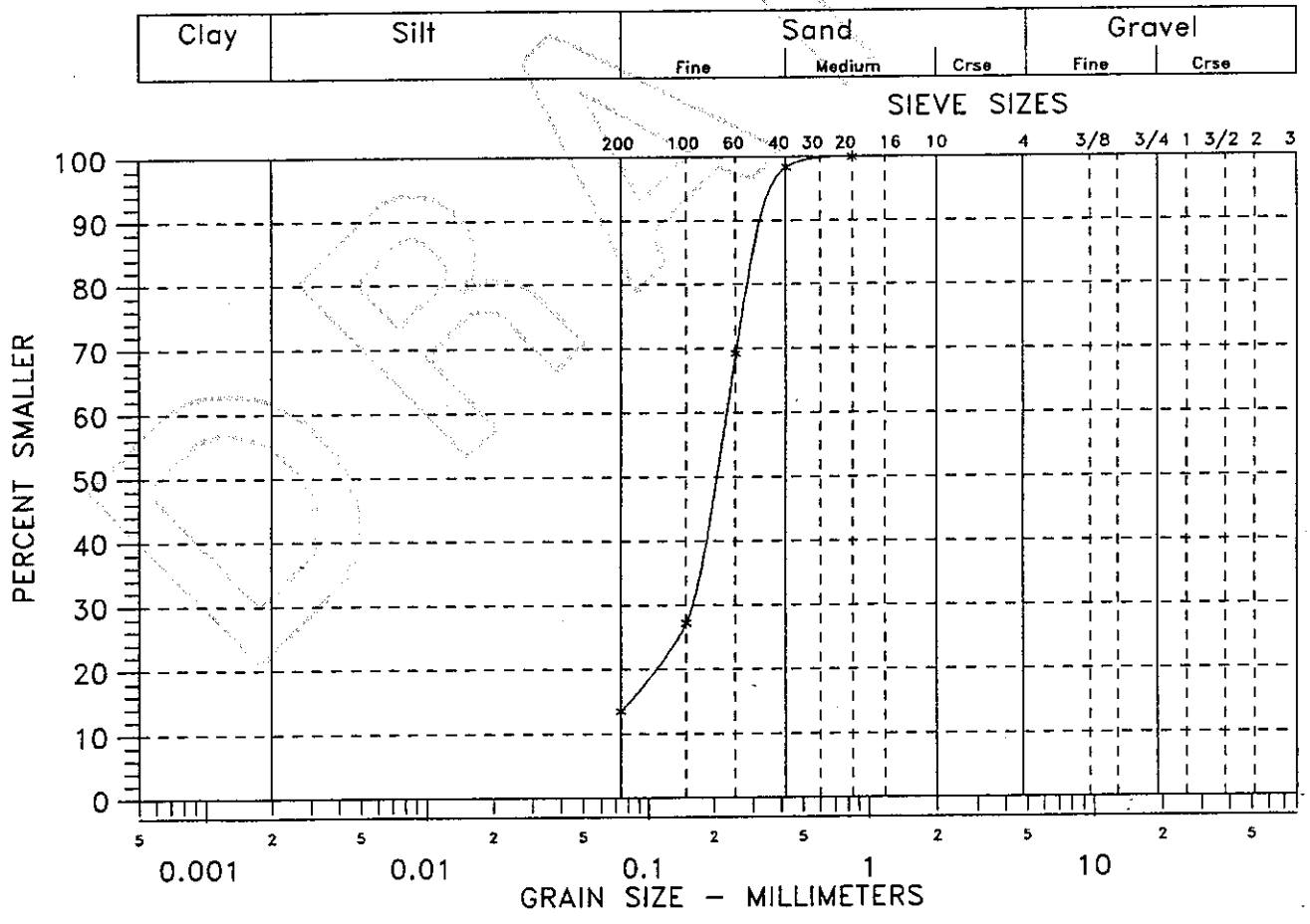


Figure B-6

HONG WEST & ASSOCIATES,INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Sediment Control Project
Location: Olympia, Washington
Project Number: 92055-2
Date Tested: 3-15-94
Remarks: Dark gray brown, poorly graded SAND with silt and gravel (SP-SM)

Test Hole Number: TP-9
Sample Number: 1
Depth: 2.0-2.7 feet
Sample Description:
Gravel: 44.2
Sand: 47.8
Fines: 8.0

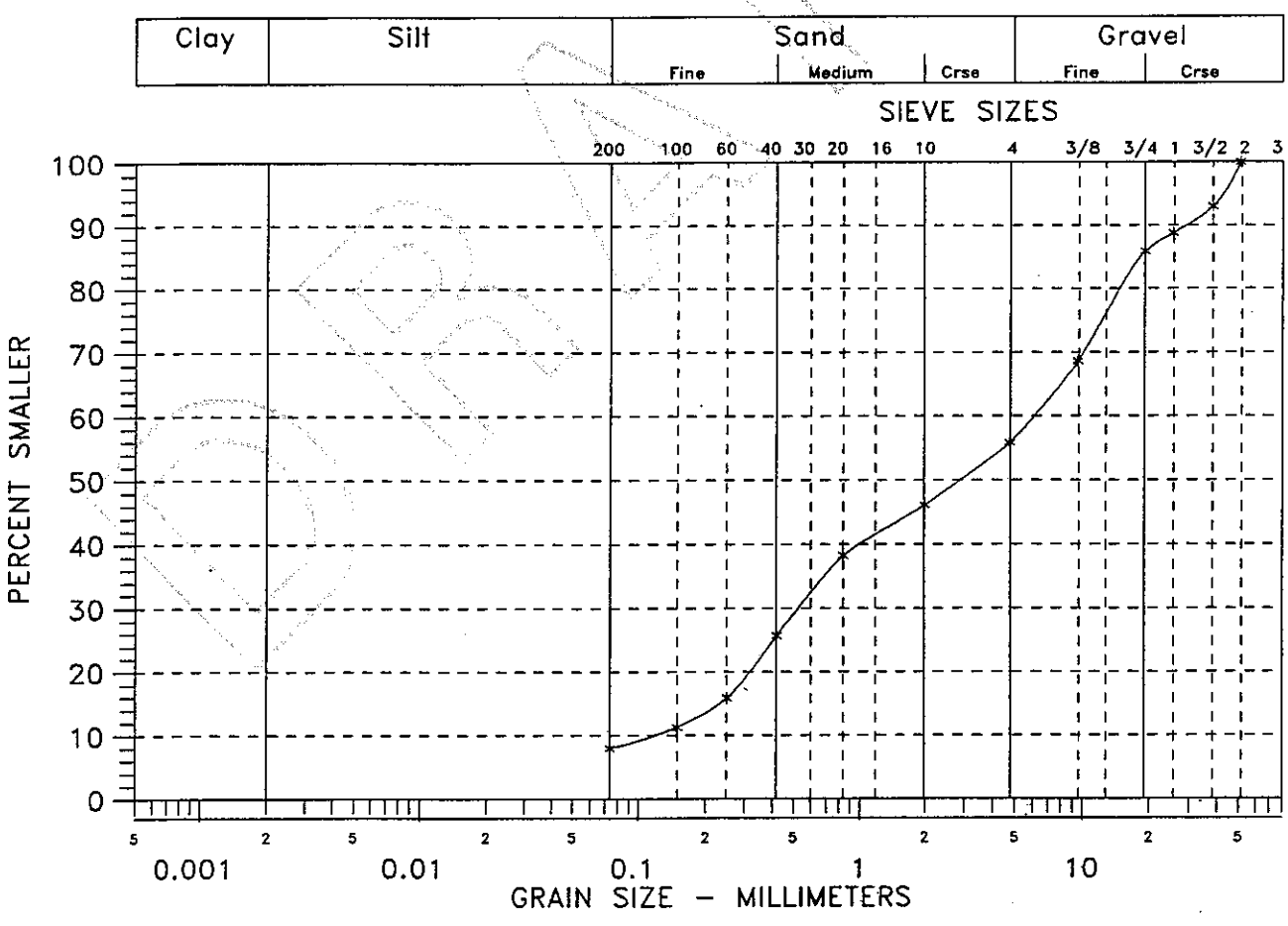


Figure B-7

HONG WEST & ASSOCIATES,INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Sediment Control Project
Location: Olympia, Washington
Project Number: 92055-2
Date Tested: 3-15-94
Remarks: Olive brown, silty SAND (SM)

Test Hole Number: TP-11
Sample Number: 1
Depth: 6.0-6.3 feet
Sample Description:
Gravel: 1.1
Sand: 77.2
Fines: 21.7

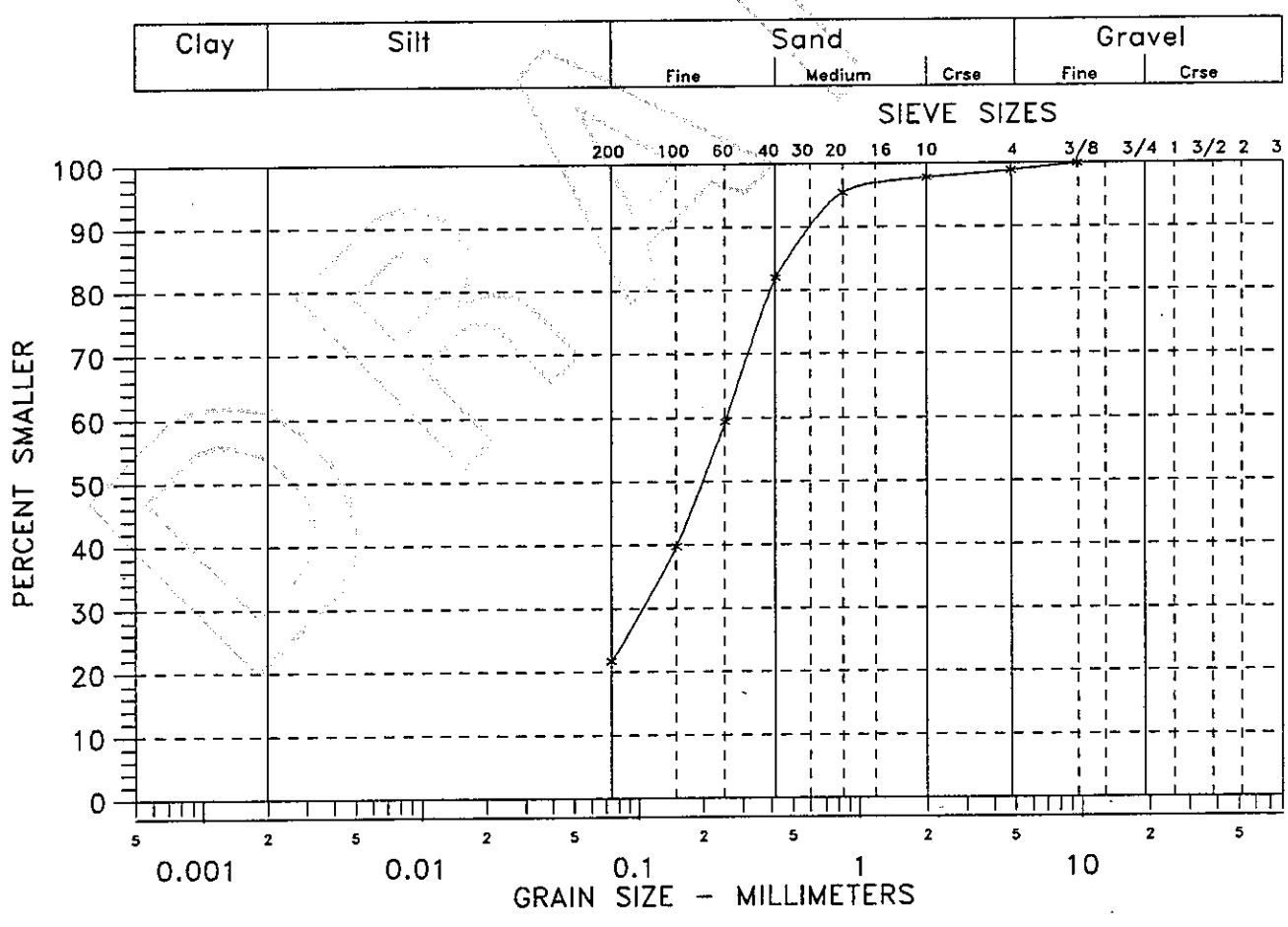


Figure B-8

HONG WEST & ASSOCIATES,INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Sediment Control Project
Location: Olympia, Washington
Project Number: 92055-2
Date Tested: 3-15-94
Remarks: Dark olive, poorly graded SAND (SP)

Test Hole Number: TP-12
Sample Number: 2
Depth: 9.5-10.1 feet
Sample Description:
Gravel: 0.0
Sand: 96.3
Fines: 3.7

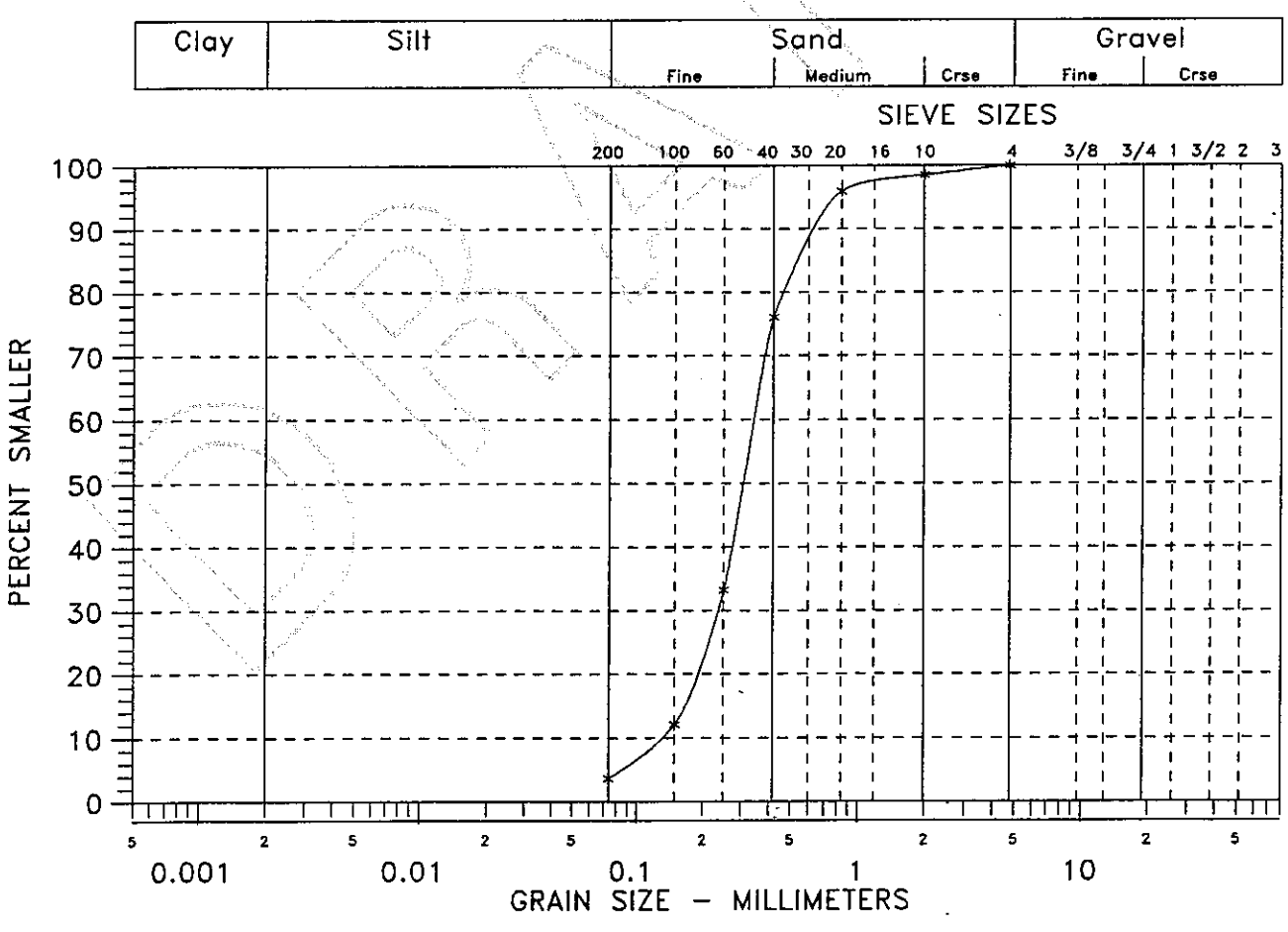


Figure B-9

HONG WEST & ASSOCIATES,INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Sediment Control Project
Location: Olympia, Washington
Project Number: 92055-2
Date Tested: 3-15-94
Remarks: Dark gray, elastic SILT (MH)

Test Hole Number: HA-1
Sample Number: 1
Depth: 2.5-3.5 feet
Sample Description:
Gravel: 0.0
Sand: 2.9
Silt: 85.1
Clay: 12.0

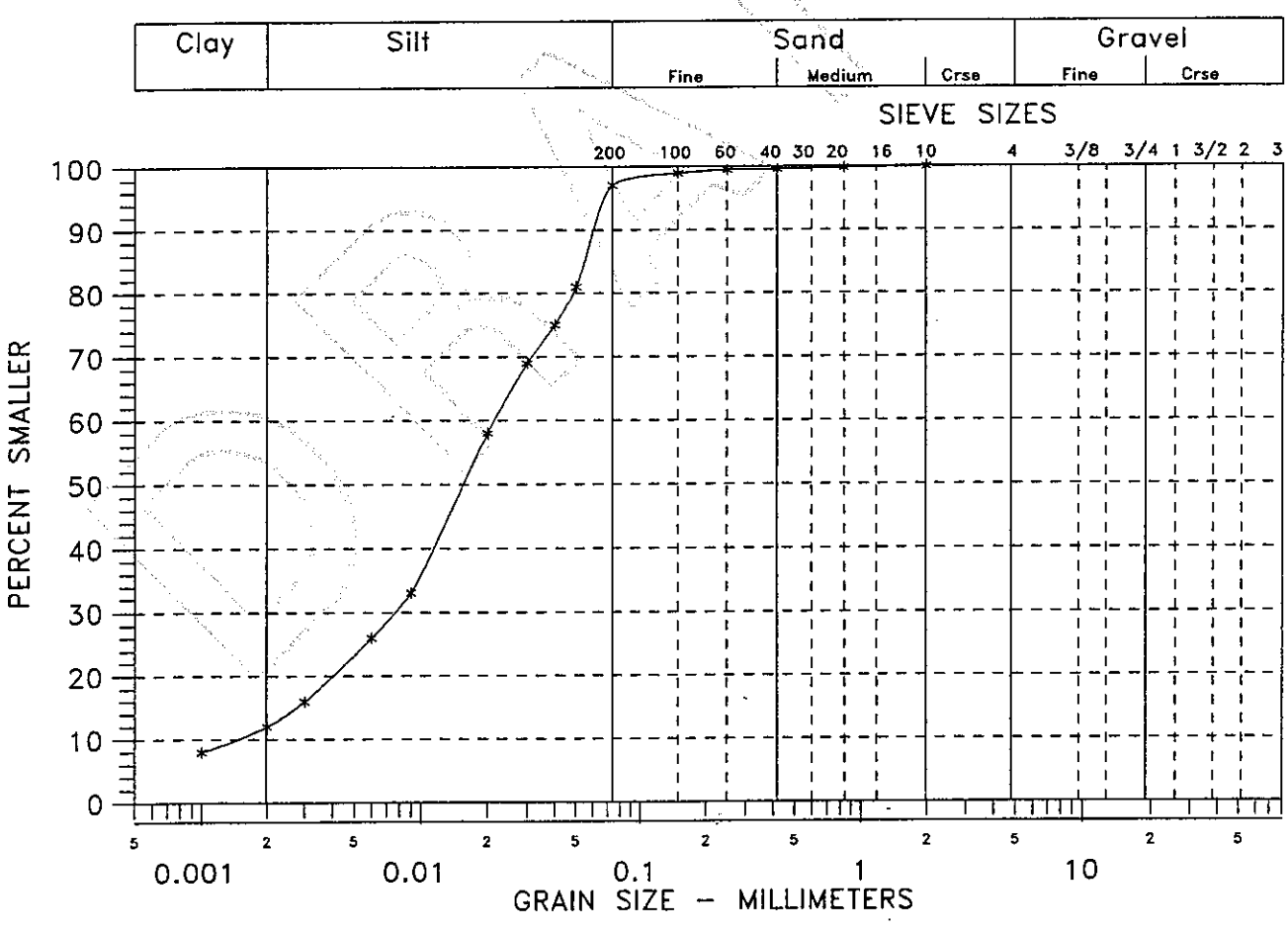


Figure B-10

HONG WEST & ASSOCIATES, INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Sediment Control Project
Location: Olympia, Washington
Project Number: 92055-2
Date Tested: 3-15-94
Remarks: Dark olive, sandy SILT (ML)

Test Hole Number: HA-3
Sample Number: 2
Depth: 3.0-3.5 feet
Sample Description:
Gravel: 0.0
Sand: 35.2
Fines: 64.8

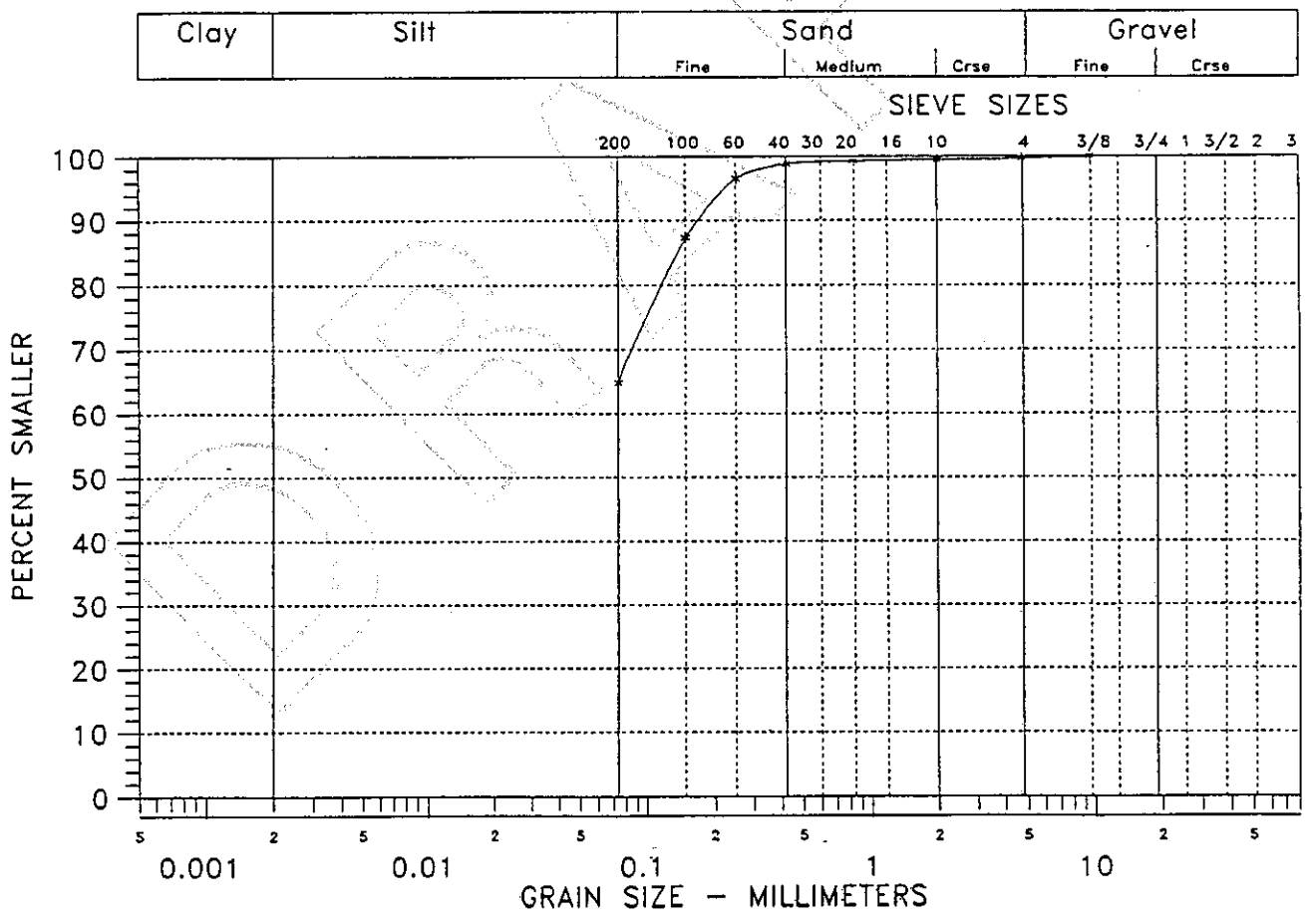


Figure B-11

HONG WEST & ASSOCIATES,INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Sediment Control Project
Location: Olympia, Washington
Project Number: 92055-2
Date Tested: 3-15-94
Remarks: Dark gray, elastic SILT (MH)

Test Hole Number: HA-4
Sample Number: 2
Depth: 3.0-3.5 feet
Sample Description:
Gravel: 0.0
Sand: 4.6
Silt: 86.4
Clay: 9.0

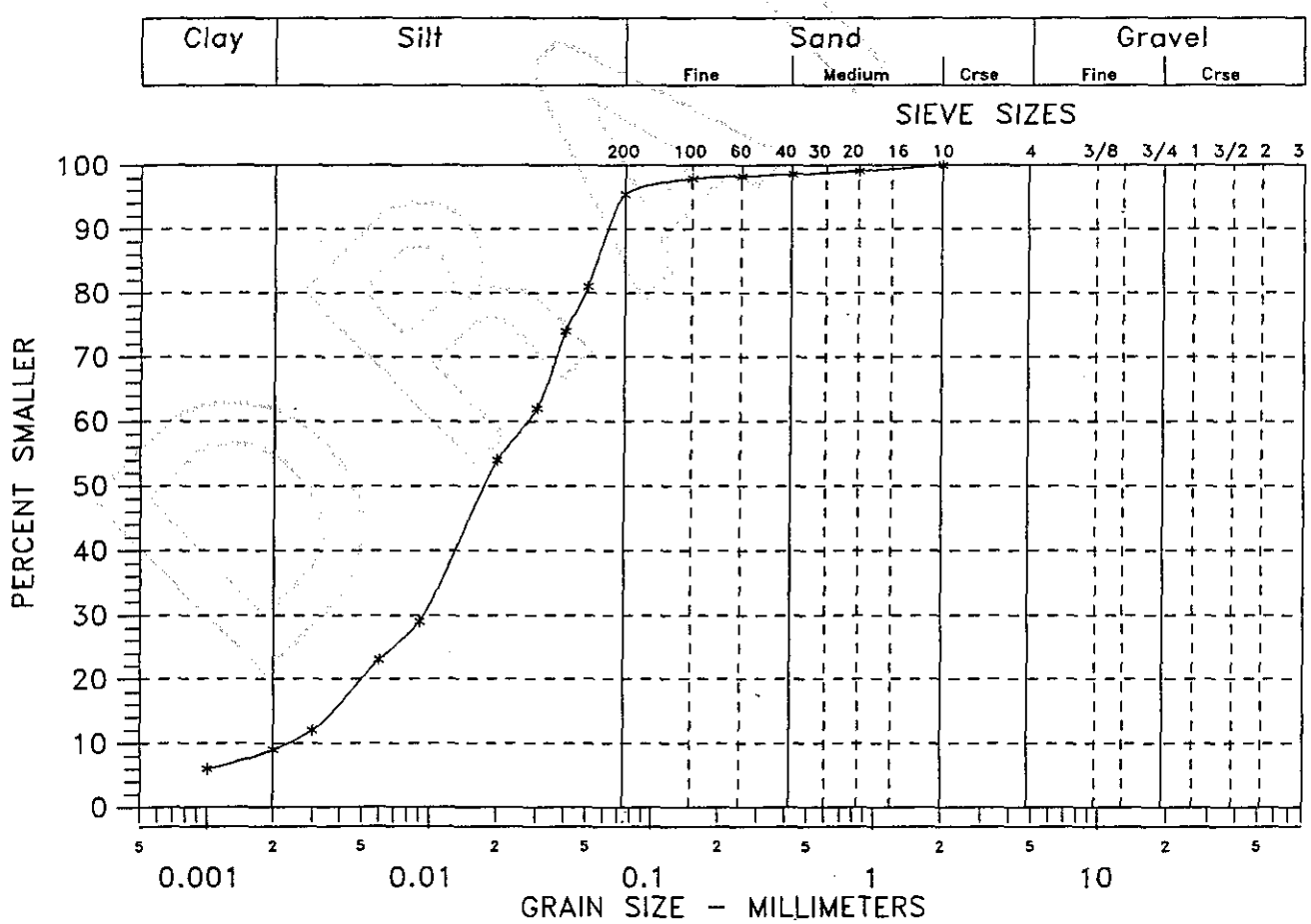


Figure B-12

HONG WEST & ASSOCIATES, INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Sediment Control Project
Location: Olympia, Washington
Project Number: 92055-2
Date Tested: 3-15-94
Remarks: Dark gray, elastic SILT (MH)
Atterberg Limits: LL=85
PL=46
PI=39

Test Hole Number: HA-5
Sample Number: 5
Depth: 5.0-5.5 feet
Sample Description:
Gravel: 0.0
Sand: 1.9
Silt: 87.1
Clay: 11.0

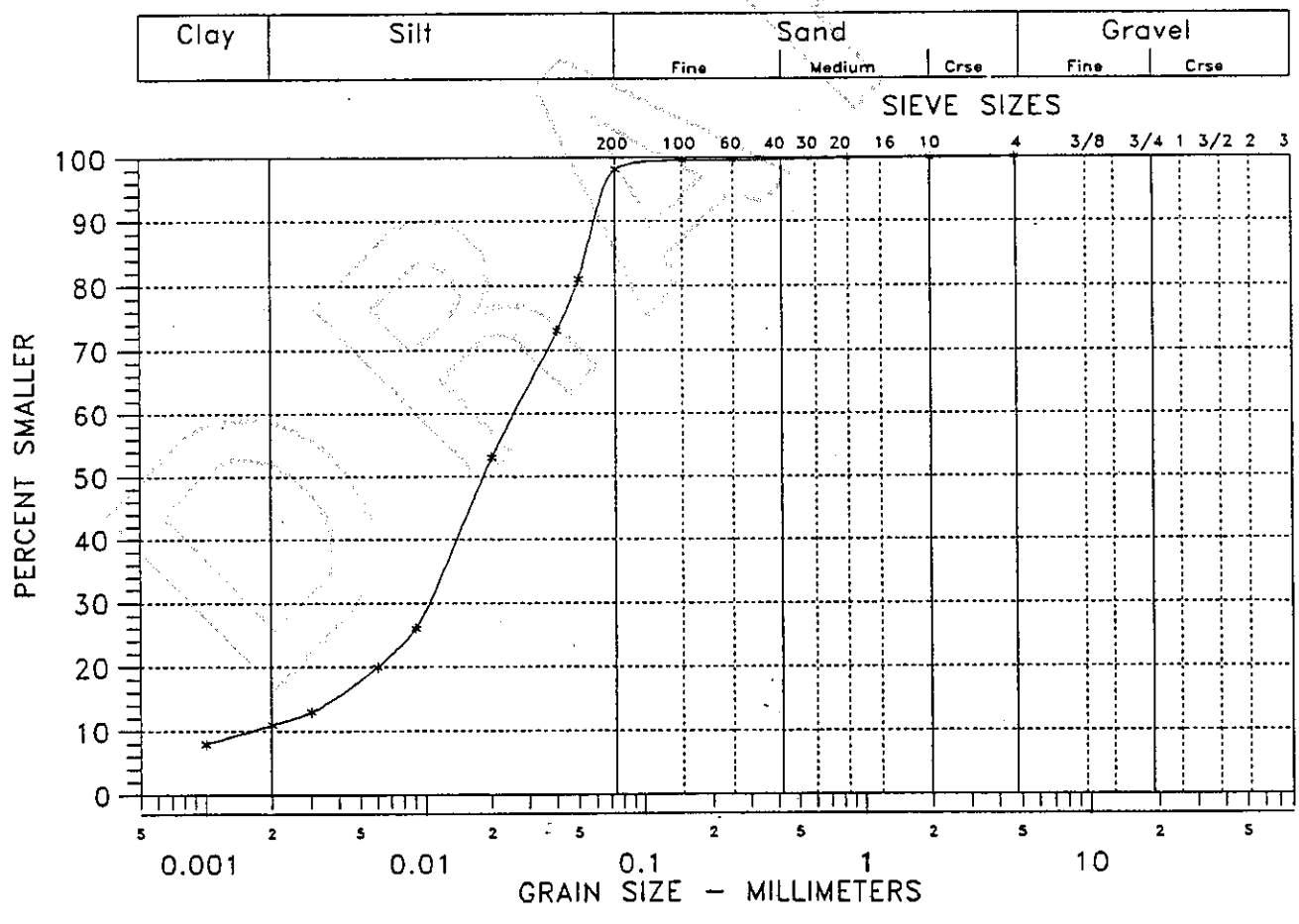


Figure B-13

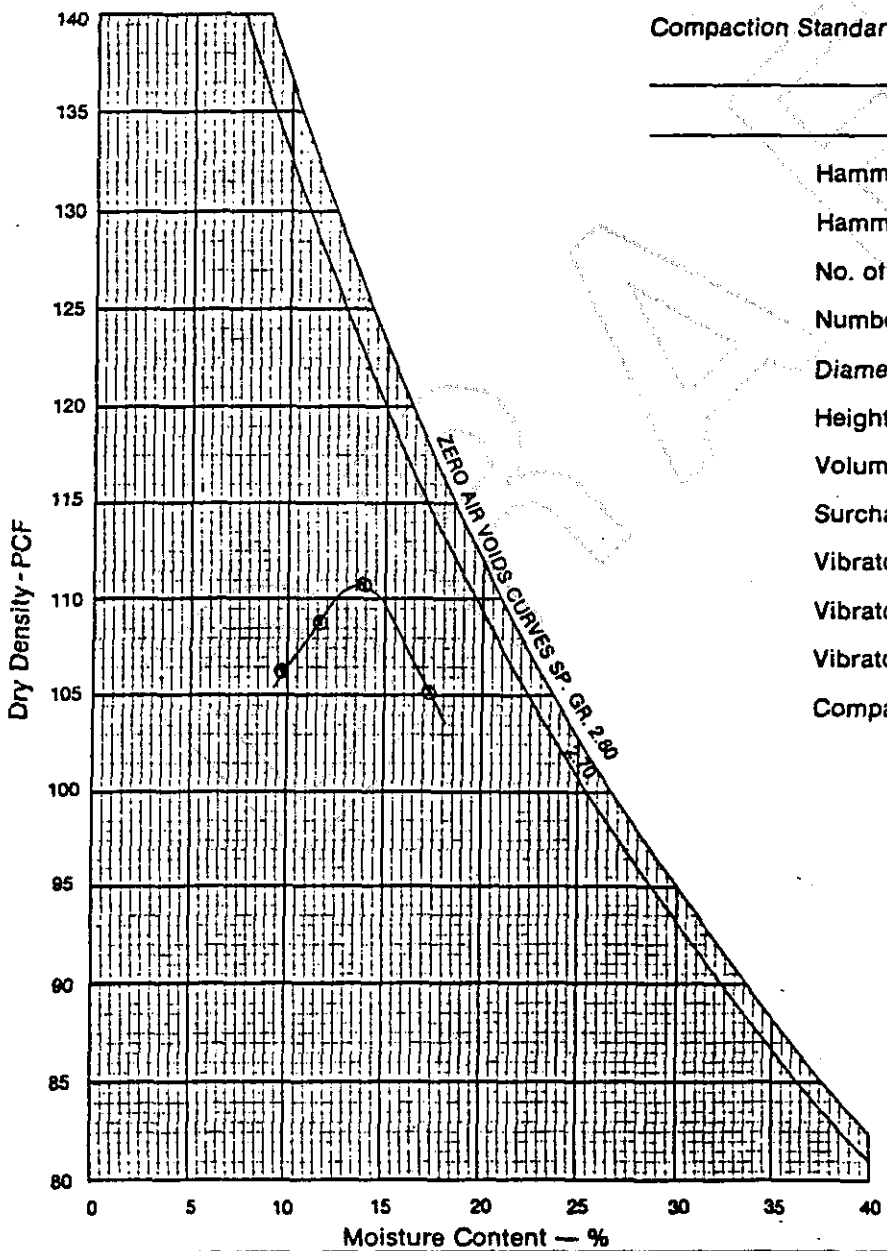
HONG WEST & ASSOCIATES

• Geotechnical Engineering • Hydrogeology • Materials Testing • Construction Inspection •

COMPACTION TEST RESULTS

Project: Capitol Lake Sediment Control
Address: Olympia, Washington
Job Number: 92055-2
Date Tested: 3-2-94 By: WF
Client: ENTRANCO ENGINEERING
Attention:

Sample Number: TP-2, S-3 TRS No.: 112
Sample Location: 2-2, 5'
Sample Description: Dark brown, poorly graded SAND (SP)
Minimum Dry Density: PCF
Maximum Dry Density: 111 PCF
Optimum Moisture Content: 13.5 %
Natural Moisture Content: 17.1 %
Compaction Standard: ASTM D 1557



Hammer Weight: 10 lbs.
Hammer Drop: 18 ins.
No. of layers: 5
Number of blows/layer: 25
Diameter of mold: 4 ins.
Height of mold: 4.584 ins.
Volume of mold: 1/30 cu.ft.
Surcharge Weight: lbs.
Vibratory Amplitude: ins.
Vibratory Frequency: vib./min.
Vibratory Time: min.
Compactive Effort: ft.lbs./cu.ft.

Figure B-14

All tests performed in accordance with ASTM

HONG WEST & ASSOCIATES

• Geotechnical Engineering • Hydrogeology • Materials Testing • Construction Inspection •

COMPACTION TEST RESULTS

Project: Capitol Lake Sediment Control

Address: Olympia, Washington

Job Number: 92055-2

Date Tested: 3-1-94 By: WF

Client: ENTRANCO ENGINEERING

Attention:

Sample Number: TP-7, S-1 TRS No.: 112

Sample Location: Depth: 2.2 - 2.7'

Sample Description: Very dark grayish brown SAND with silt (SP-SM)

Minimum Dry Density: PCF

Maximum Dry Density: 110.5 PCF

Optimum Moisture Content: 15.5 %

Natural Moisture Content: 29.6 %

Compaction Standard: ASTM D 1557

Hammer Weight: 10 lbs.

Hammer Drop: 18 ins.

No. of layers: 5

Number of blows/layer: 25

Diameter of mold: 4 ins.

Height of mold: 4.584 ins.

Volume of mold: 1/30 cu.ft.

Surcharge Weight: lbs.

Vibratory Amplitude: ins.

Vibratory Frequency: vib./min.

Vibratory Time: min.

Compactive Effort: ft.lbs./cu.ft.

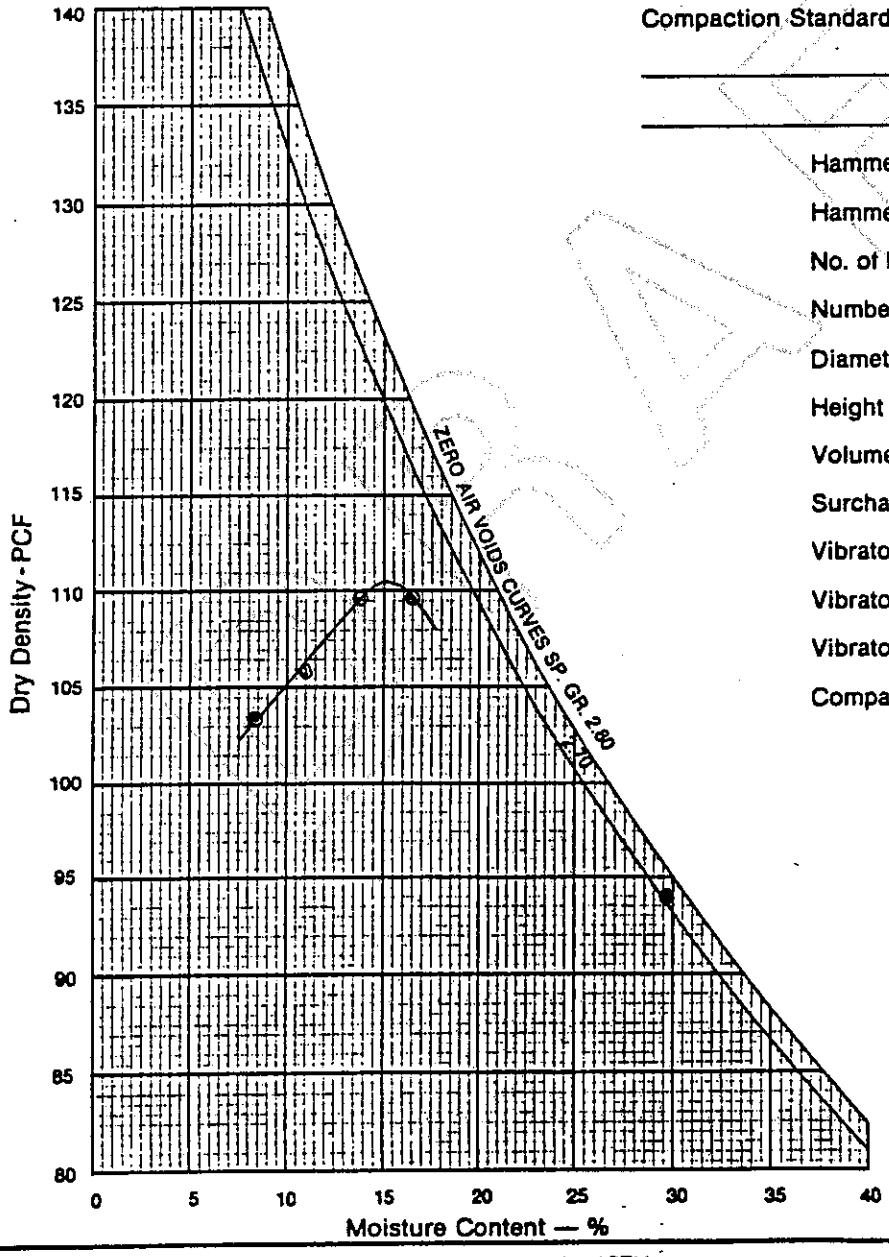


Figure B-15

All tests performed in accordance with ASTM

HONG WEST & ASSOCIATES

• Geotechnical Engineering • Hydrogeology • Materials Testing • Construction Inspection •

COMPACTION TEST RESULTS

Project: Capitol Lake Sediment Control

Address: Olympia, Washington

Job Number: 92055-2

Date Tested: 3-3-94 By: WF

Client: ENTRANCO ENGINEERING

Attention:

Sample Number: TP-8, S-2 TRS No.: 121

Sample Location: Depth: 5.5 - 6.5'

Sample Description: Very dark gray silty SAND (SM)

Minimum Dry Density: PCF

Maximum Dry Density: 110.5 PCF

Optimum Moisture Content: 17.0 %

Natural Moisture Content: 32.6 %

Compaction Standard: ASTM D 1557

Hammer Weight: 10 lbs.

Hammer Drop: 18 ins.

No. of layers: 5

Number of blows/layer: 25

Diameter of mold: 4 ins.

Height of mold: 4.584 ins.

Volume of mold: 1/30 cu.ft.

Surcharge Weight: lbs.

Vibratory Amplitude: ins.

Vibratory Frequency: vib./min.

Vibratory Time: *min.*

Compactive Effort: ft.lbs./cu.ft.

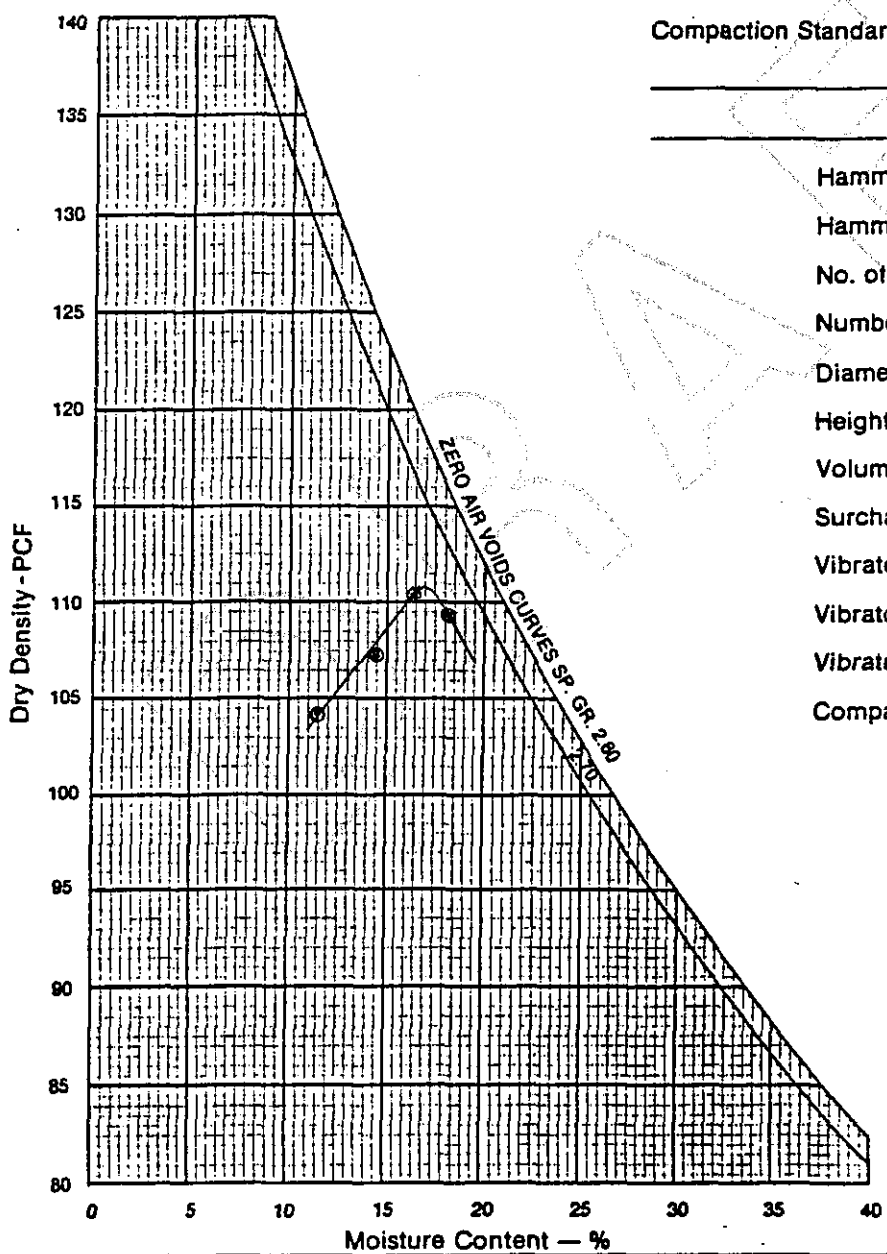


Figure B-16

All tests performed in accordance with ASTM

Northwest Office
March 30, 1994 - Lab. No. 65169

HONG WEST & ASSOCIATES INC.
19730 64th Avenue W.
Lynnwood, WA 98036

SOIL AND PLANT LABORATORY, INC.

CAPITOL LAKE SEDIMENT CONTROL PROJECT-OLYMPIA, WA
HWA Project No. 92055, Task 2

On accompanying data sheets are results of analyses performed on the samples submitted for complete soil evaluations. Data interpretation and recommendations follow.

The soils range from strongly acid to slightly acid in reaction or pH. Salinities vary, but are safely low for samples two and three and slightly elevated in samples one and four. Major element fertility analyses indicate low to slightly low levels of nitrogen and phosphorus for all soils tested. Additionally, calcium is near ideal but out of balance with very well supplied potassium and magnesium in each case. All minor elements are well supplied for each of the soils tested except sample two where a small amount of zinc and boron are required.

Agricultural suitability analyses indicate that sodium is sufficiently high to restrict growth of sensitive crops in the soils represented by samples two, three and four. Boron is in a range considered slightly toxic in samples one, three and four, and would result in growth restriction of sensitive crops. Organic matter content is excellent in samples three and four, and fair in sample two. There was insufficient sample quantity to perform organic content analysis on sample one. Particle size distribution data indicate desirably low gravel fractions in all soils tested. Of those particles passing the 2 millimeter sieve we note that a very high combined silt and clay content exists for samples one, three and four; resulting in a USDA soil classification of silt loam for each of these. Sample two, on the other hand, has considerably less combined silt and clay and is classified as sandy loam based on USDA standards.

Agricultural suitability analyses dictate that all soils will require treatment with gypsum and lime followed by leaching irrigations prior to fertility improvement. Ideally, once these soils have been treated and leached as indicated, additional samples should be submitted for agricultural suitability tests (test code AO2) to determine if suitability improvement has been achieved. Based on the data at hand, the soils should be treated with the amendments indicated in the chart below and leached with water as indicated:

**AGRICULTURAL SUITABILITY AMENDMENTS
LBS./1000 SQ.FT. (UNIFORMLY BROADCAST
FOLLOWED BY ROTOTILLING TO A 6-8" DEPTH)**

Sample No.	Calcium carbonate limestone	Dolomite limestone	Gypsum
1	70	70	100
2	20	20	150
3	30	30	150
4	50	50	150

HONG WEST & ASSOCIATES

• Geotechnical Engineering • Hydrogeology • Materials Testing • Construction Inspection •

COMPACTION TEST RESULTS

Project: Capitol Lake Sediment Control
Address: Olympia, Washington
Job Number: 92055-2
Date Tested: 2-25-94 By: WF
Client: ENTRANCO ENGINEERING
Attention:

Sample Number: TP-9 -S-1 TRS No.: 112
Sample Location: Depth: 2-2.7'
Sample Description: Very dark grayish brown SAND with silt and gravel (SP-SM)

Minimum Dry Density: PCF
Maximum Dry Density: 139 PCF
Optimum Moisture Content: 7.1 %
Natural Moisture Content: 9.5 %
Compaction Standard: ASTM D 1557

Hammer Weight: 10 lbs.
Hammer Drop: 18 ins.
No. of layers: 5
Number of blows/layer: 56
Diameter of mold: 6 ins.
Height of mold: 4.584 ins.
Volume of mold: .075 cu.ft.
Surcharge Weight: lbs.
Vibratory Amplitude: ins.
Vibratory Frequency: vib./min.
Vibratory Time: min.
Compactive Effort: ft.lbs./cu.ft.

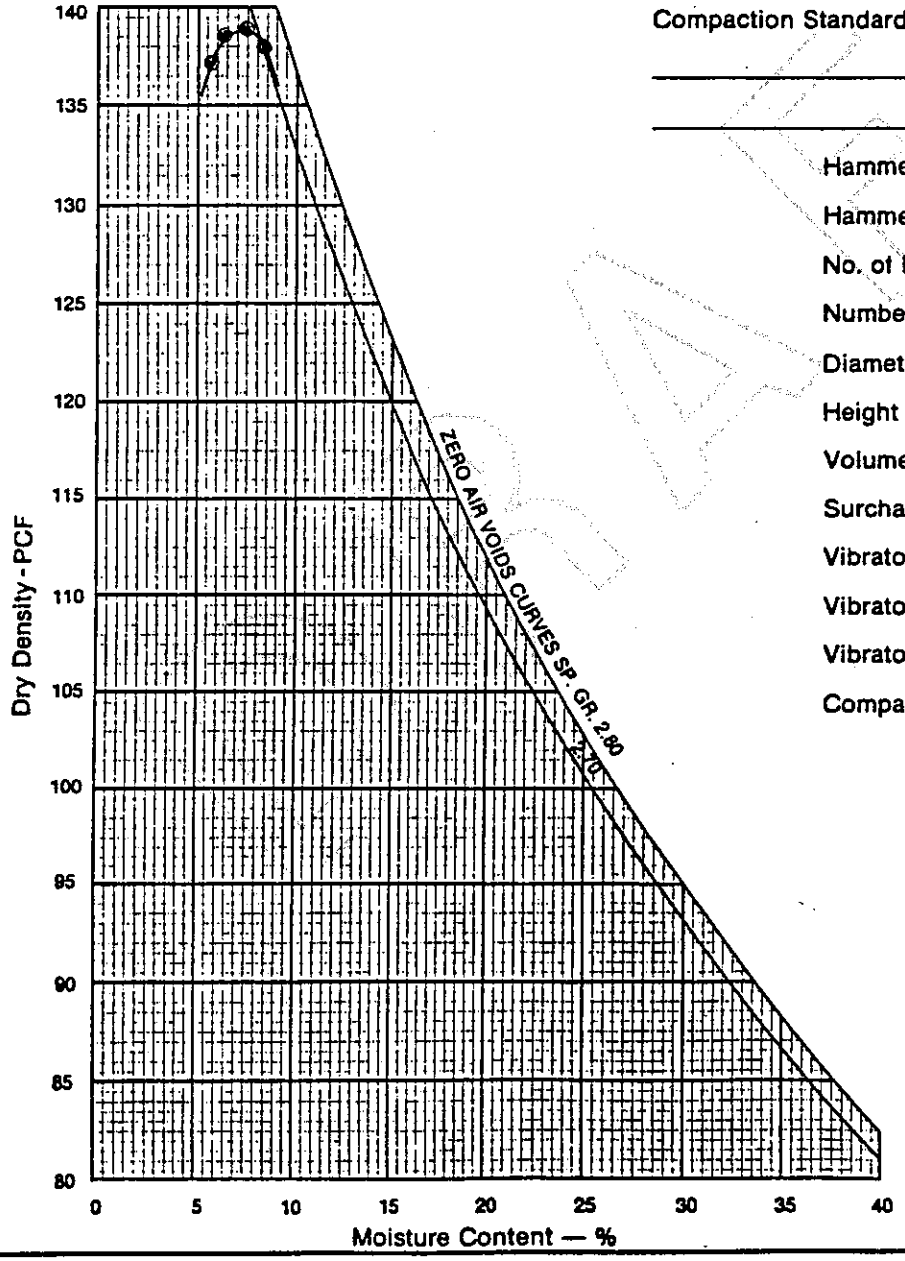


Figure B-17

All tests performed in accordance with ASTM

After the soils have been amended according to the above listing, leaching irrigations will be necessary to assist in the removal of sodium and boron. The chart below indicates the amount of leaching water required per one foot soil depth, and the approximate maximum rate that this water can be applied to allow for infiltration:

Sample No.	Am't. Leaching Water Per 1' Depth	Approximate Maximum Irrigation Rate
1	3 ft.	0.3 inches/hr.
2	1 ft.	0.4 inches/hr.
3	3 ft.	0.3 inches/hr.
4	4 ft.	0.3 inches/hr.

As indicated previously in this report, once the above amending and leaching has taken place, samples should be resubmitted for agricultural suitability analyses. Since there is going to be a reduction in other salts (nitrate/potassium/magnesium, etc.) the soils should be tested once more for fertility in order for us to provide nutrient addition recommendations.

If you have questions regarding the foregoing information, please do not hesitate to contact us.

Sincerely,

Dirk W. Muntean

DIRK W. MUNTEAN, M.A.

DWM/bsk

Soil and Plant Laboratory, Inc.

P.O. Box 6566, Orange, California 92613-6566/(714) 282-8777/FAX (714) 282-8575
P.O. Box 153, Santa Clara, California 95052-0153/(408) 727-0330/FAX (408) 727-5125
P.O. Box 1648, Bellevue, Washington 98008-1648/(206) 746-6665/FAX (206) 562-9531

HONG WEST ASSOCIATES, INC
19730 64TH Avenue West
Lynnwood, WA 98036

COMPLETE SOIL
EVALUATION
(AO5)

Northwest Office
Lab No. 65169
CAPITOL LAKE SEDIMENT

Samples Taken: 3/17/94 Samples Rec'd:

Sample #	Half Sat%/ TEC	-Parts Per Million Parts Dry Soil- NO3 N	NH4 N	PO4 P	K	Ca	Mg	pH/ Qual Lime	----Saturation Extract Values------ ECe	Ca me/l	Mg me/l	Na me/l	K me/l	B ppm	Cl me/l	SAR	Sample Description & Log Number
1	50	4	56	39	480	3280	1144	5.1	3.8	17.0	15.5	14.4	1.0	1.33		3.6	HA-2, S-1, 1.0-1.5 feet 94-A9747 32 2
			0.6	0.8	1.6	0.9	2.9	None									

Sample #	Org %	Percent of Sample Passing 2 mm Screen ---Gravel-- Coarse 5-12	Fine 2-5	---------Sand---------- Very Coarse 1-2	Coarse 0.5-1	Med. to V. Fine 0.05-.5	Silt .002-.05	Clay 0-.002	USDA Soil Classification	Sample Description & Log Number
1		1.7	1.9	2.0	1.8	16.6	66.6	13.0	silt loam	HA-2, S-1, 1.0-1.5 feet 94-A9747 32 2

A29	A29 Requested	
Sat SO4	= 49.4	me/l
DTPA PREP	= 1.25	
Cu	= 8.	ppm
Fe	= 1076.	ppm
Mn	= 148.	ppm
DTPA ZN	= 12.	ppm
B Factor	= 4.4	
Cu Factor	= 5.3	
Fe Factor	= 21.5	
Mn Factor	= 9.9	
Zn Factor	= 2.4	
Raw Cu	= 0.2	ppm
Raw Fe	= 26.9	ppm
Raw Mn	= 3.7	ppm
Raw Zn	= 0.3	ppm

3/25/94

Half Saturation %=approximate field moisture capacity. Salinity = ECe(dS/m at 25 degree C). Gravel fraction expressed as percent by weight of oven-dried sample passing a 12mm (1/2 inch) sieve. Particle sizes in millimeters. SAR = Sodium Adsorption Ratio.
Interpretation guide below each element (1.0=predicted sufficiency level for average fertility requiring crops).
TEC (listed below Half Sat. when requested) = Estimated Total Exchangeable Cations in milliequivalents per kilogram (meq/kg)

Soil and Plant Laboratory, Inc.

P.O. Box 6566, Orange, California 92613-6566/(714) 282-8777/FAX (714) 282-8575
P.O. Box 153, Santa Clara, California 95052-0153/(408) 727-0330/FAX (408) 727-5125
P.O. Box 1648, Bellevue, Washington 98008-1648/(206) 746-6665/FAX (206) 562-9531

HONG WEST ASSOCIATES, INC
19730 64TH Avenue West
Lynnwood, WA 98036

COMPLETE SOIL
EVALUATION
(AO5)

Northwest Office
Lab No. 65169
CAPITOL LAKE SEDIMENT

Samples Taken: 3/17/94 Samples Rec'd:

Sample #	Half Sat%/ TEC	-Parts Per Million Parts Dry Soil- NO3 N	NH4 N	PO4 P	K	Ca	Mg	pH/ Qual Lime	----Saturation Extract Values---- ECe	Ca me/l	Mg me/l	Na me/l	K me/l	B ppm	Cl me/l	SAR	Sample Description & Log Number
2	26	1	8	12	180	1320	659	6.0	0.6	0.8	0.6	4.6	0.1	0.28		5.5	HA-3, S-1, 1.5-2.0 feet 94-A9748. 32 2
		0.2	0.5	1.2	0.7	3.2		None									

Sample #	Org %	Percent of Sample Passing 2 mm Screen ---Gravel--- Coarse 5-12	Fine 2-5	---------Sand---------- Very Coarse 1-2	Coarse 0.5-1	Med. to V. Fine 0.05-.5	Silt .002-.05	Clay 0-.002	USDA Soil Classification	Sample Description & Log Number
2	1.9	0.0	0.1	0.2	0.4	51.1	42.8	5.5	sandy loam	HA-3, S-1, 1.5-2.0 feet 94-A9748 32 2

A29	A29 Requested	
Sat SO4	= 2.0	me/l
DTPA PREP	= 5.00	
Cu	= 3.	ppm
Fe	= 368.	ppm
Mn	= 49.	ppm
DTPA ZN	= 2.	ppm
B Factor	= 0.9	
Cu Factor	= 3.8	
Fe Factor	= 14.2	
Mn Factor	= 6.3	
Zn Factor	= 0.8	
Raw Cu	= 0.3	ppm
Raw Fe	= 36.8	ppm
Raw Mn	= 4.9	ppm
Raw Zn	= 0.2	ppm

3/25/94

Half Saturation %=approximate field moisture capacity. Salinity = ECe(dS/m at 25 degree C). Gravel fraction expressed as percent by weight of oven-dried sample passing a 12mm (1/2 inch) sieve. Particle sizes in millimeters. SAR = Sodium Adsorption Ratio.
Interpretation guide below each element (1.0=predicted sufficiency level for average fertility requiring crops).
TEC (listed below Half Sat. when requested) = Estimated Total Exchangeable Cations in milliequivalents per kilogram (meq/kg)

Soil and Plant Laboratory, Inc.

P.O. Box 6566, Orange, California 92613-6566/(714) 282-8777/FAX (714) 282-8575
P.O. Box 153, Santa Clara, California 95052-0153/(408) 727-0330/FAX (408) 727-5125
P.O. Box 1648, Bellevue, Washington 98008-1648/(206) 746-6665/FAX (206) 562-9531

HONG WEST ASSOCIATES, INC
19730 64TH Avenue West
Lynnwood, WA 98036

COMPLETE SOIL EVALUATION (AO5)

Northwest Office
Lab No. 65169
CAPITOL LAKE SEDIMENT

Samples Taken: 3/17/94 Samples Rec'd:

Sample #	Half Sat%/ TEC	-Parts Per Million Parts Dry Soil- NO3 N	NH4 N	PO4 P	K	Ca	Mg	pH/ Qual Lime	----Saturation Extract Values---- ECe	Ca me/l	Mg me/l	Na me/l	K me/l	B ppm	Cl me/l	SAR	Sample Description & Log Number
3	46	4	47	43	520	3080	1184	5.9	2.5	6.1	6.1	14.8	0.7	1.17		6.0	HA-5, S-2, 1.5-2.0 feet 94-A9749 32 2
			0.6	0.9	1.9	1.0	3.2	None									

Sample #	Org %	Percent of Sample Passing 2 mm Screen ---Gravel--- Coarse 5-12	Fine 2-5	---------Sand---------- Very Coarse 1-2	Coarse 0.5-1	Med. to V. Fine 0.05-.5	Silt .002-.05	Clay 0-.002	USDA Soil Classification	Sample Description & Log Number
3	5.9	0.0	0.3	0.6	0.7	10.1	68.6	20.0	silt loam	HA-5, S-2, 1.5-2.0 feet 94-A9749 32 2

A29		A29 Requested	
Sat SO4	=	49.3	me/l
DTPA PREP	=	1.25	
Cu	=	8.	ppm
Fe	=	804.	ppm
Mn	=	132.	ppm
DTPA ZN	=	12.	ppm
B Factor	=	3.9	
Cu Factor	=	5.8	
Fe Factor	=	17.5	
Mn Factor	=	9.6	
Zn Factor	=	2.6	
Raw Cu	=	0.2	ppm
Raw Fe	=	20.1	ppm
Raw Mn	=	3.3	ppm
Raw Zn	=	0.3	ppm

3/25/94

Half Saturation %=approximate field moisture capacity. Salinity = ECe(dS/m at 25 degree C). Gravel fraction expressed as percent by weight of oven-dried sample passing a 12mm (1/2 inch) sieve. Particle sizes in millimeters. SAR = Sodium Adsorption Ratio.
Interpretation guide below each element (1.0=predicted sufficiency level for average fertility requiring crops).
TEC (listed below Half Sat. when requested) = Estimated Total Exchangeable Cations in milliequivalents per kilogram (meq/kg)

Soil and Plant Laboratory, Inc.

P.O. Box 6566, Orange, California 92613-6566/(714) 282-8777/FAX (714) 282-8575
P.O. Box 153, Santa Clara, California 95052-0153/(408) 727-0330/FAX (408) 727-5125
P.O. Box 1648, Bellevue, Washington 98008-1648/(206) 746-6665/FAX (206) 562-9531

HONG WEST ASSOCIATES, INC
19730 64TH Avenue West
Lynnwood, WA 98036

COMPLETE SOIL EVALUATION (AO5)

Northwest Office
Lab No. 65169
CAPITOL LAKE SEDIMENT

Samples Taken: 3/17/94 Samples Rec'd:

Sample #	Half Sat%/ TEC	-Parts Per Million Parts Dry Soil- NO3 N	NH4 N	PO4 P	K	Ca	Mg	pH/ Qual Lime	----Saturation Extract Values------ ECe	Ca me/l	Mg me/l	Na me/l	K me/l	B ppm	Cl me/l	SAR	Sample Description & Log Number
4	46	4	71	40	640	2800	1260	5.6	3.6	10.6	12.5	18.6	1.6	1.51		5.5	TP-4, S-2, 3.0-3.5 feet 94-A9750 32 2
			0.8	0.9	2.3	0.9	3.4	None									

Sample #	Org %	Percent of Sample Passing 2 mm Screen ---Gravel-- Coarse 5-12	Fine 2-5	---------Sand---------- Very Coarse 1-2	Coarse 0.5-1	Med. to V. Fine 0.05-.5	Silt .002-.05	Clay 0-.002	USDA Soil Classification	Sample Description & Log Number
4	5.5	1.1	0.4	0.4	0.6	14.4	69.6	15.0	silt loam	TP-4, S-2, 3.0-3.5 feet 94-A9750 32 2

A29	A29 Requested	
Sat SO4 =	37.9	me/l
DTPA PREP =	1.25	
Cu =	8.	ppm
Fe =	796.	ppm
Mn =	104.	ppm
DTPA ZN =	8.	ppm
B Factor =	5.0	
Cu Factor =	5.8	
Fe Factor =	17.3	
Mn Factor =	7.5	
Zn Factor =	1.7	
Raw Cu =	0.2	ppm
Raw Fe =	19.9	ppm
Raw Mn =	2.6	ppm
Raw Zn =	0.2	ppm

3/25/94

Half Saturation %=approximate field moisture capacity. Salinity = ECe(dS/m at 25 degree C). Gravel fraction expressed as percent by weight of oven-dried sample passing a 12mm (1/2 inch) sieve. Particle sizes in millimeters. SAR = Sodium Adsorption Ratio.
Interpretation guide below each element (1.0=predicted sufficiency level for average fertility requiring crops).
TEC (listed below Half Sat. when requested) = Estimated Total Exchangeable Cations in milliequivalents per kilogram (meq/kg)

APPENDIX C

LABORATORY TESTING

(LAKEBED SEDIMENT SAMPLES OBTAINED BY ENTRANCO)

APPENDIX C

LABORATORY TESTING
(LAKEBED SEDIMENT SAMPLES OBTAINED BY ENTRANCO)

Ten lakebed sediment samples were collected by Entranco from the middle basin of Capitol Lake and delivered to HWA's laboratory for testing. Grain size distribution analyses were conducted on the ten samples in accordance with ASTM D 422. The grain size distributions were plotted and classified according to the Unified Soil Classification System (USCS), as shown on Figures C-1 through C-10.

HONG WEST & ASSOCIATES,INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Dredging Study
Location: Olympia, Washington
Project Number: 92055, Task 2
Date Tested: 3-30-94
Remarks: Dark olive, silty SAND (SM)

Test Hole Number:
Sample Number: 1-A
Depth:
Sample Description:
Gravel: 0.0
Sand: 79.9
Silt: 20.1
Clay: 0.0

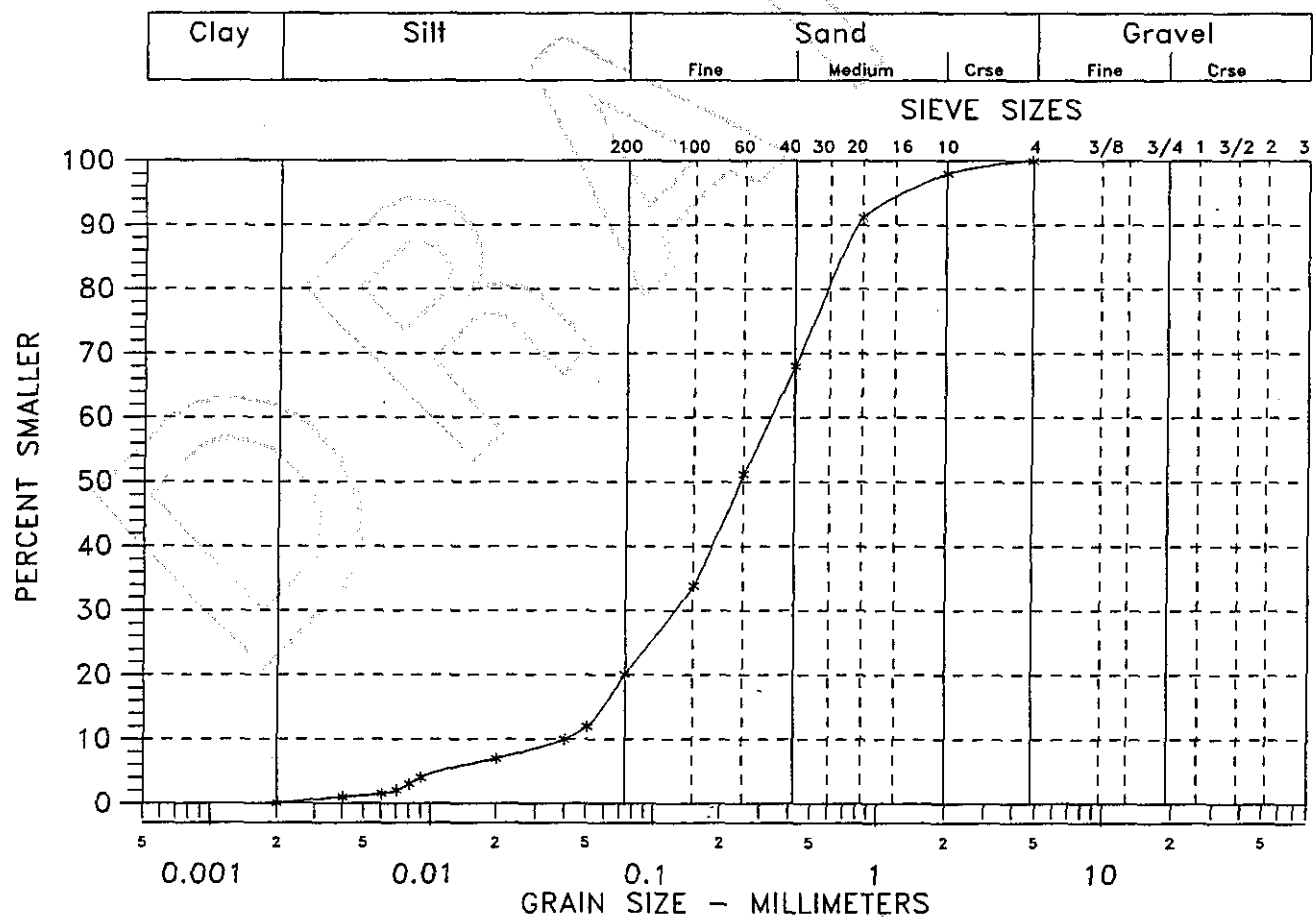


Figure C-1

HONG WEST & ASSOCIATES, INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Dredging Study
Location: Olympia, Washington
Project Number: 92055, Task 2
Date Tested: 3-30-94
Remarks: Dark olive, SILT with sand (ML)

Test Hole Number:
Sample Number: 1-B
Depth:
Sample Description:
Gravel: 0.0
Sand: 28.1
Silt: 67.9
Clay: 4.0

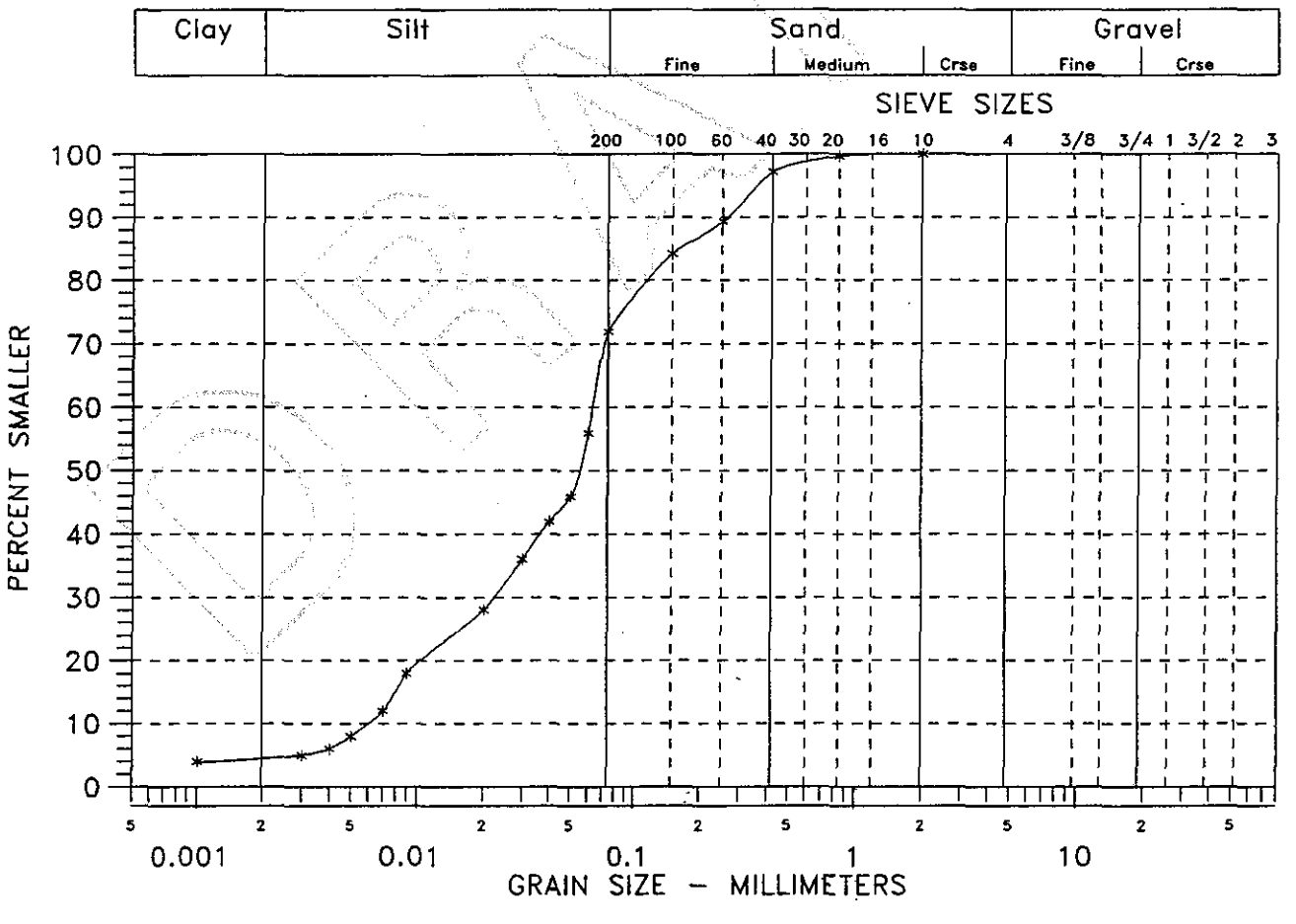


Figure C-2

HONG WEST & ASSOCIATES,INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Dredging Study
Location: Olympia, Washington
Project Number: 92055, Task 2
Date Tested: 3-30-94
Remarks: Dark olive, SILT with sand (ML)

Test Hole Number:
Sample Number: 2-1
Depth:
Sample Description:
Gravel: 0.0
Sand: 21.1
Silt: 70.9
Clay: 8.0

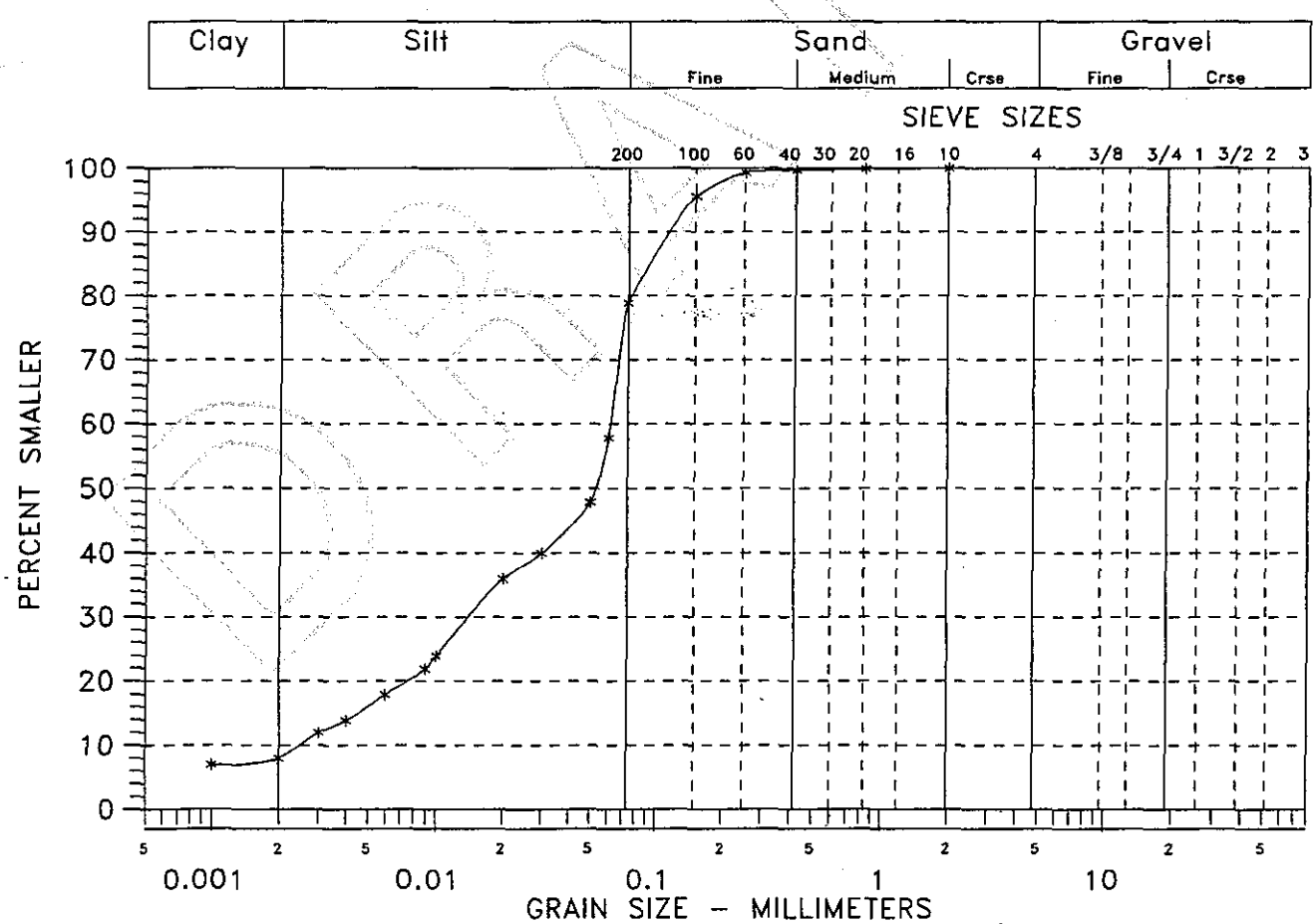


Figure C-3

HONG WEST & ASSOCIATES,INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Dredging Study
Location: Olympia, Washington
Project Number: 92055, Task 2
Date Tested: 3-30-94
Remarks: Dark olive, silty SAND (SM)

Test Hole Number:
Sample Number: 2-2
Depth:
Sample Description:
Gravel: 0.0
Sand: 80.7
Silt: 16.3
Clay: 3.0

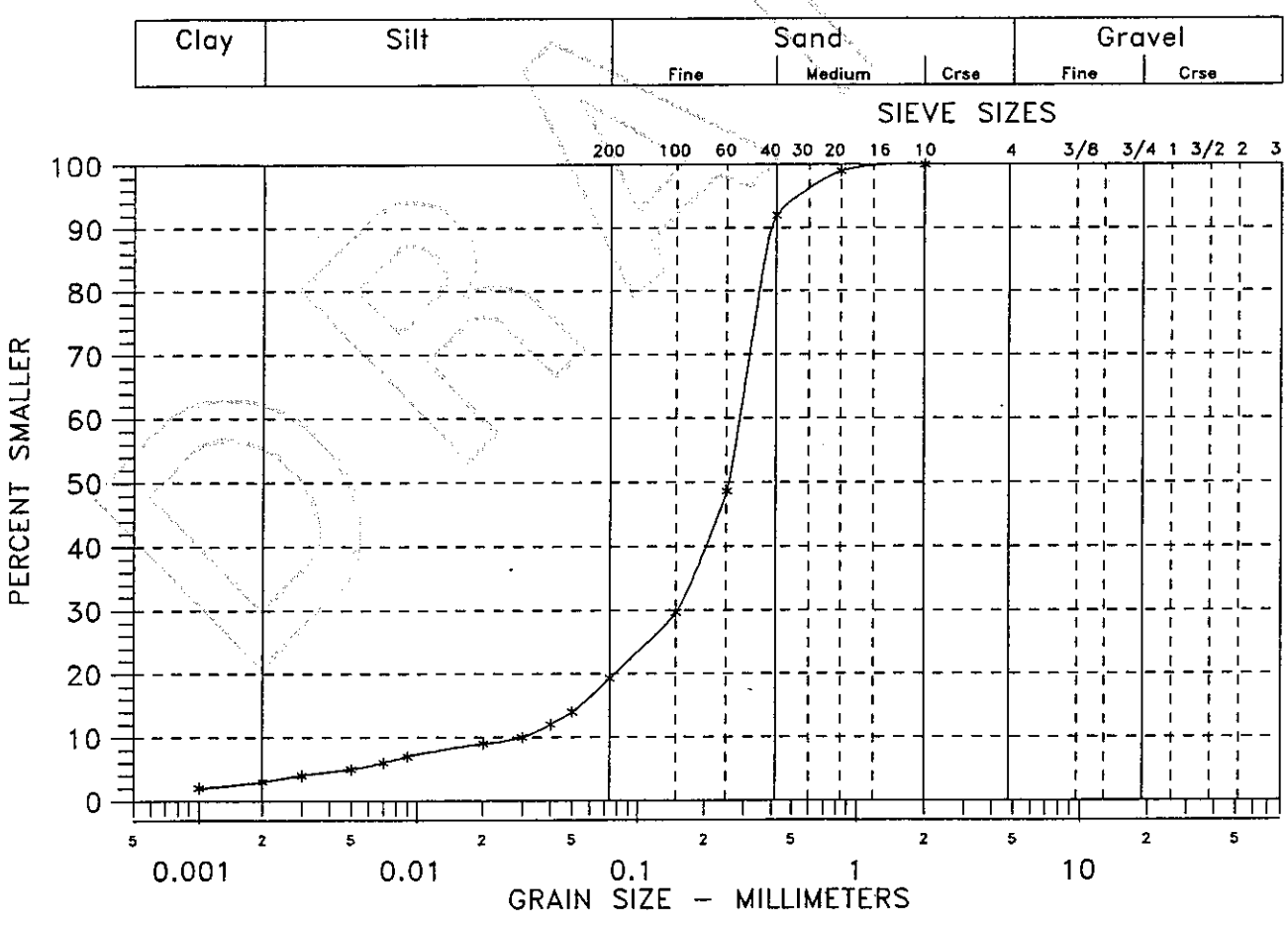


Figure C-4

HONG WEST & ASSOCIATES,INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Dredging Study
Location: Olympia, Washington
Project Number: 92055, Task 2
Date Tested: 3-30-94
Remarks: Dark olive, SILT (ML)

Test Hole Number:
Sample Number: 3-1
Depth:
Sample Description:
Gravel: 0.0
Sand: 7.8
Silt: 85.3
Clay: 6.9

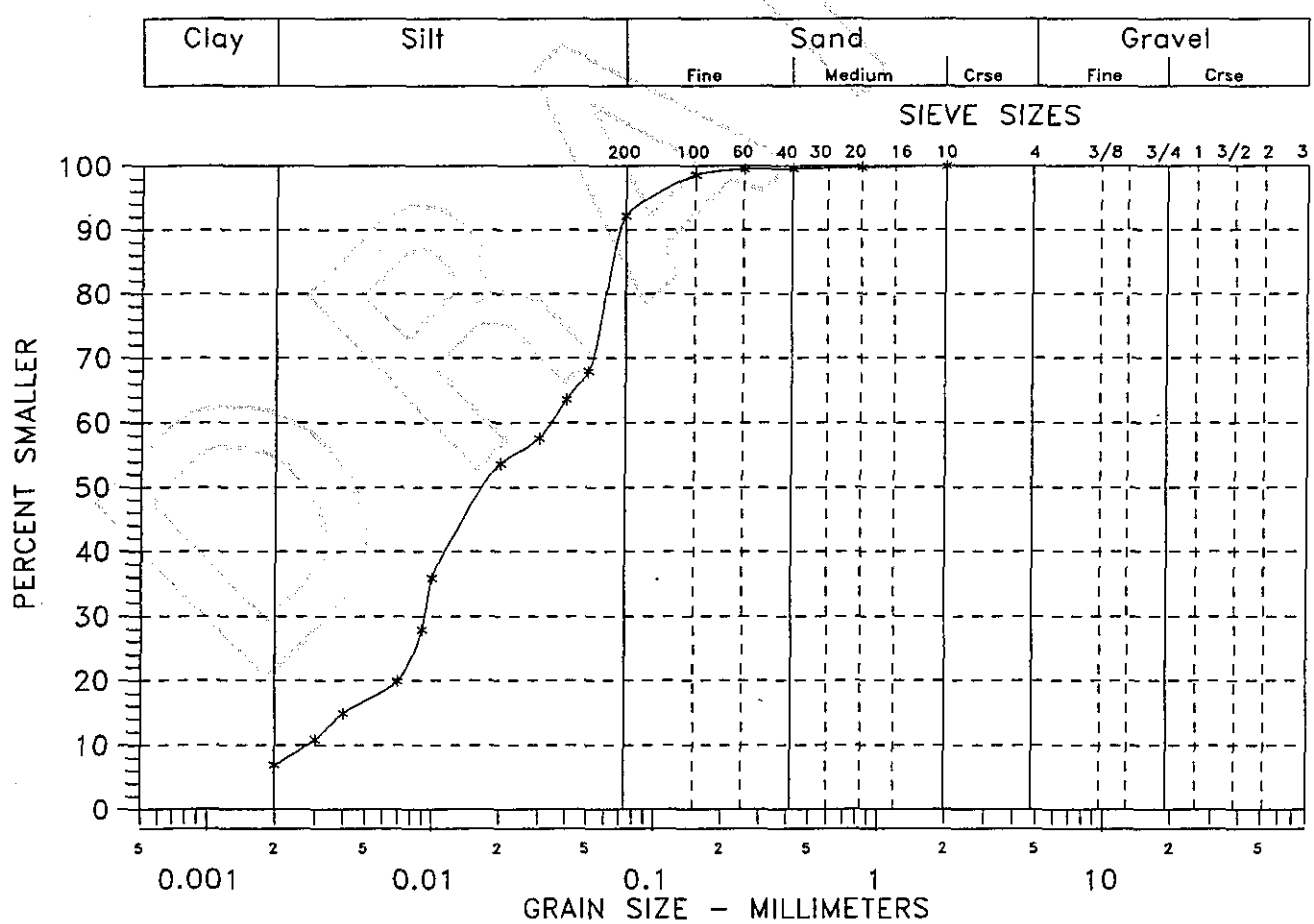


Figure C-5

HONG WEST & ASSOCIATES,INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Dredging Study
Location: Olympia, Washington
Project Number: 92055, Task 2
Date Tested: 3-30-94
Remarks: Dark olive, SILT with sand (ML)

Test Hole Number:
Sample Number: 3-2
Depth:
Sample Description:
Gravel: 0.0
Sand: 20.0
Silt: 74.0
Clay: 6.0

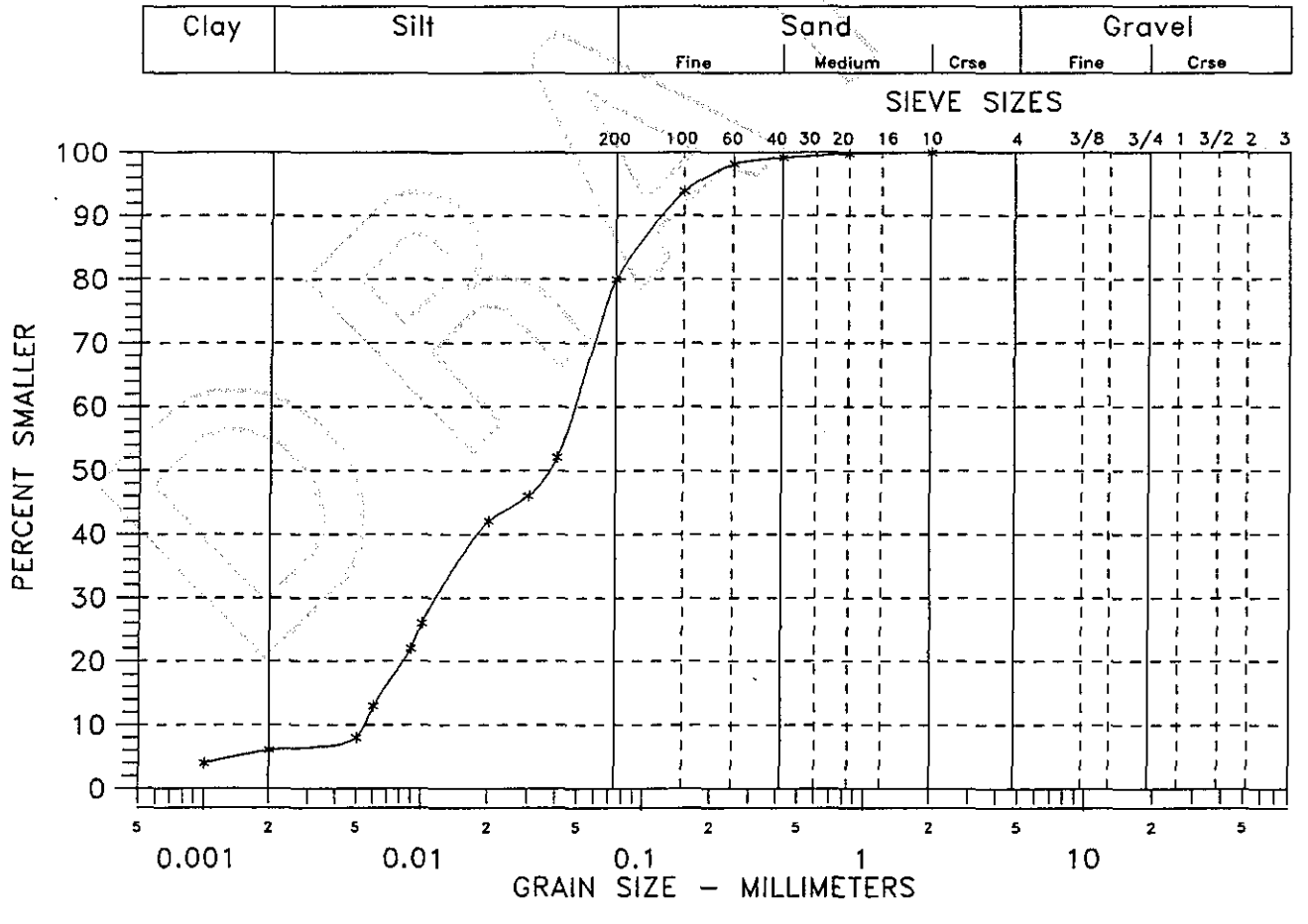


Figure C-6

HONG WEST & ASSOCIATES,INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Dredging Study
Location: Olympia, Washington
Project Number: 92055, Task 2
Date Tested: 3-30-94
Remarks: Dark olive, SILT with sand (ML)

Test Hole Number:
Sample Number: 4-1
Depth:
Sample Description:
Gravel: 0.0
Sand: 17.5
Silt: 75.5
Clay: 7.0

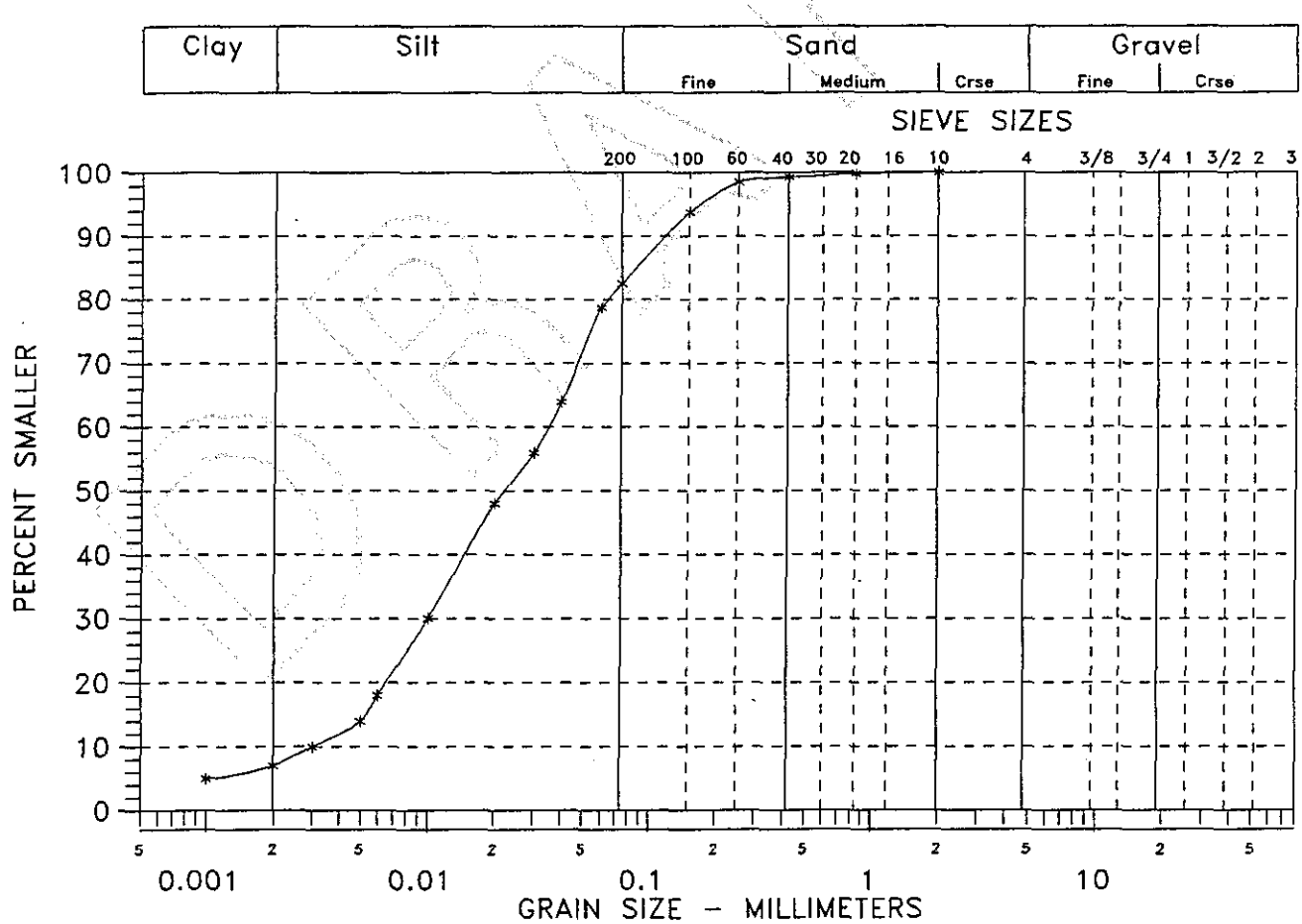


Figure C-7

HONG WEST & ASSOCIATES,INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Dredging Study
Location: Olympia, Washington
Project Number: 92055, Task 2
Date Tested: 3-30-94
Remarks: Dark olive, SILT with sand (ML)

Test Hole Number:
Sample Number: 4-2
Depth:
Sample Description:
Gravel: 0.0
Sand: 17.6
Silt: 74.5
Clay: 7.9

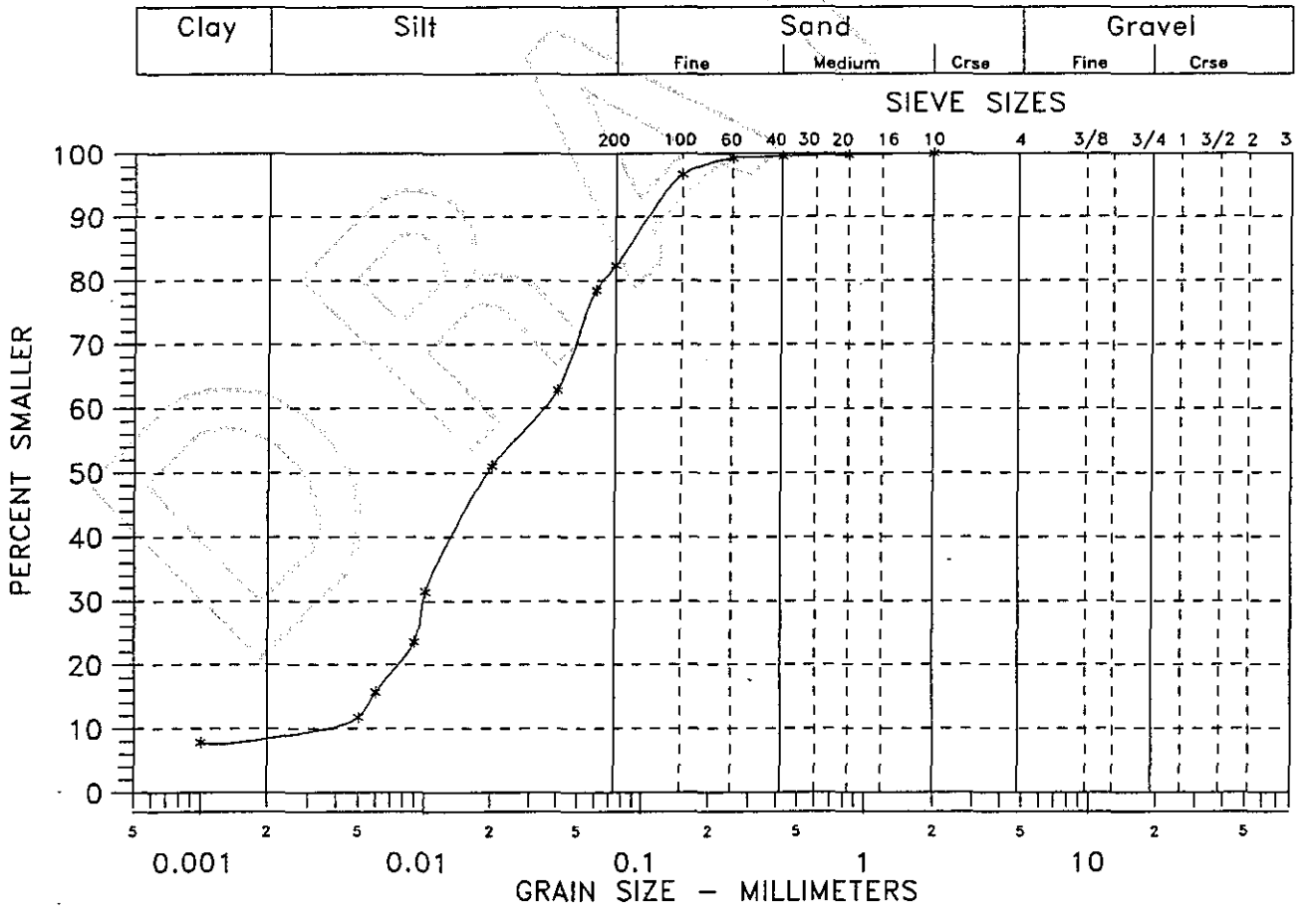


Figure C-8

HONG WEST & ASSOCIATES,INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Dredging Study
Location: Olympia, Washington
Project Number: 92055, Task 2
Date Tested: 3-30-94
Remarks: Dark olive, SILT (ML)

Test Hole Number:
Sample Number: 5-1
Depth:
Sample Description:
Gravel: 0.0
Sand: 3.4
Silt: 84.6
Clay: 12.0

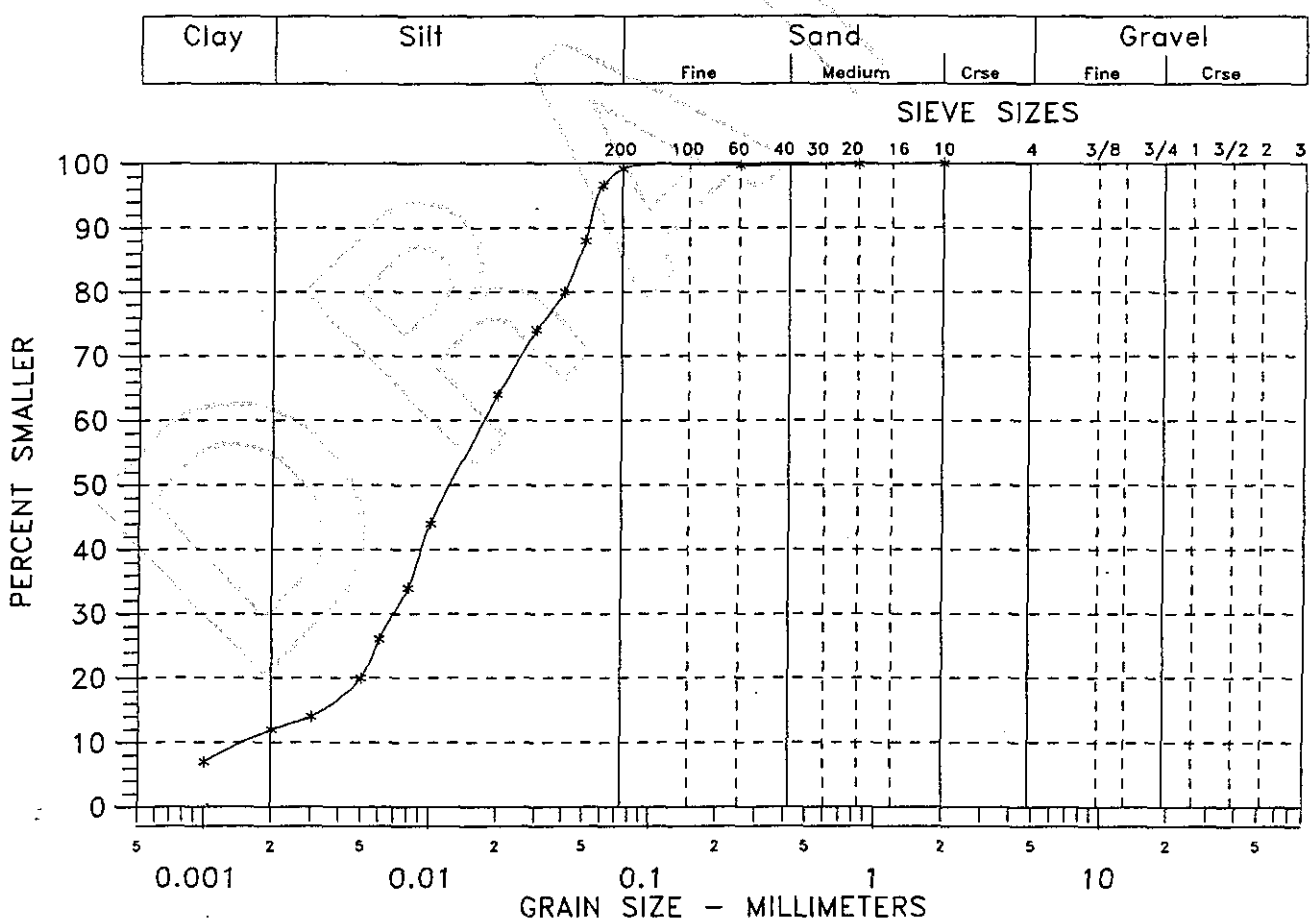


Figure C-9

HONG WEST & ASSOCIATES,INC.
GRAIN SIZE DISTRIBUTION

Project: Capitol Lake Dredging Study
Location: Olympia, Washington
Project Number: 92055, Task 2
Date Tested: 3-30-94
Remarks: Dark olive, SILT (ML)

Test Hole Number:
Sample Number: 5-3
Depth:
Sample Description:
Gravel: 0.0
Sand: 9.3
Silt: 82.8
Clay: 7.9

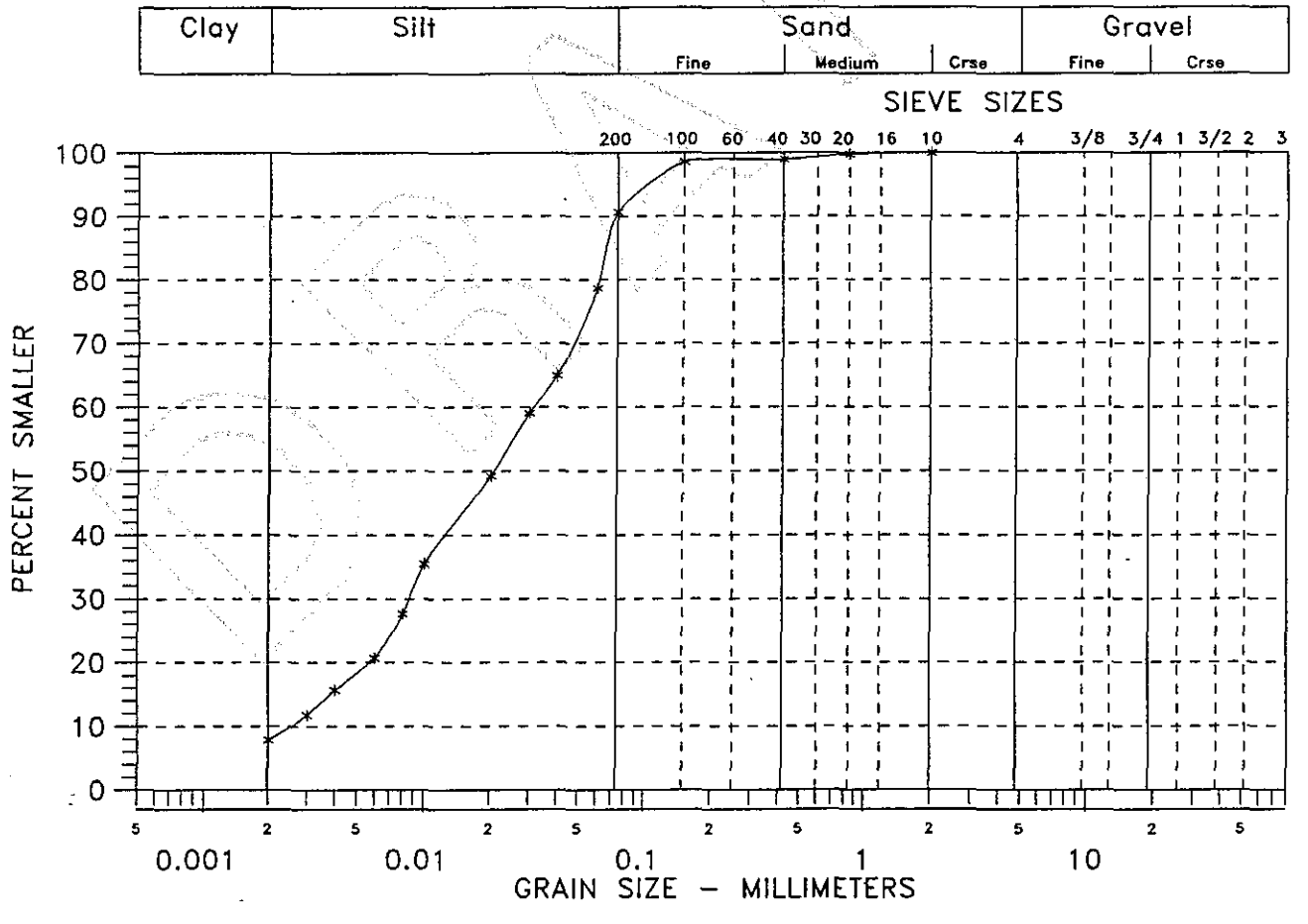


Figure C-10