GEOTECHNICAL ENGINEERING INVESTIGATION
PROPOSED DEVELOPMENT FOR NW SCHOOL OF WOODEN BOATS
NEAR LOWER HADLOCK ROAD AND WATER STREET
PORT HADLOCK, WA

PROJECT NO. 102-04025
MARCH 31, 2004

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Prepared for:

Mr. Jeff Hammond
NW School of Wooden Boats
251 Otto Street
Port Townsend, Washington 98368

Prepared by:

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GEOTECHNICAL ENGINEERING • ENVIRONMENTAL ENGINEERING
CONSTRUCTION TESTING & INSPECTION

March 31, 2004

KA Project No. 102-04025

Mr. Jeff Hammond
Northwest School of Wooden Boats
251 Otto Street
Port Townsend, Washington 98368

RE: Geotechnical Engineering Investigation Report
Proposed NW School of Wooden Boats
Port Hadlock, Washington

Dear Mr. Hammond:

In accordance with your request, we have completed a Geotechnical Engineering Investigation for the referenced site. The results of our investigation are presented in the attached report.

If you have any questions or if we can be of further assistance, please do not hesitate to contact our office.

Respectfully submitted,

KRAZAN AND ASSOCIATES, INC.

Wesley R. Johnson, P.E.
Project Engineer

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PROPOSED WOODEN BOAT SCHOOL
NEAR LOWER HADLOCK ROAD AND WATER STREET
PORT HADLOCK, WASHINGTON

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INTRODUCTION

SITE LOCATION

This report presents the results of our Geotechnical Engineering Investigation for the Proposed Wooden Boat School facility to be located between Curtis Street and Lower Hadlock Road in Port Hadlock, Washington. According to the United States Geological Survey (USGS), 7.5 minute Port Townsend South Quad, Washington topographic quadrangle map, the property is located in the northwest quadrant of Section 33, Township 29 North, Range 1 west, and at Latitude 48.0338 degrees North, and Longitude 122.7524 degrees West. The site location is shown on the Site Vicinity Map, Figure 1.

PROPOSED CONSTRUCTION

Based on phone conversations with Jeff Hammond, of the Northwest School of Wooden Boats, we understand that it is proposed to develop the site with a several buildings, gravel drives and parking areas. The buildings will consist of student housing, shops, administration building and a classroom. The footprint of the proposed buildings will range from 600 to 9,800 square feet. We anticipate a shallow footing system will provide adequate support for the proposed structures. Footing loads for the structures are anticipated to be light to moderate. The proposed building layout and other structural elements associated with the proposed development are shown on the Site Plan Figure 2.

In the event the proposed construction information detailed in this report is inconsistent with the final design, we should be notified so that we may update this writing as applicable.

PURPOSE & SCOPE

This investigation was conducted to evaluate the soil and groundwater conditions at the site, to make geotechnical engineering recommendations for use in design of specific construction elements, building setbacks, and provide criteria for site preparation and the placement of structural fill.

Our scope of services was performed in general accordance with our proposal dated March 10, 2004 (KA Proposal No. PG04-047). The scope of work is as follows:

- An investigation of the site soils and groundwater condition by excavating 12 test pits. The depth of the test pits ranged from approximately 6 to 15 feet below existing site grades. Groundwater measurements were taken during the subsurface field exploration. The site was excavated utilizing a track-hoe subcontracted to Seton Construction, Inc.
- Use of on-site fill materials for structural fill.
- Performance of a laboratory-testing program appropriate to the soil conditions encountered and the planned construction. Laboratory tests for moisture content, grain size distribution, were performed.
- Performance of engineering analysis for recommendations regarding allowable soil bearing pressures, lateral earth pressures, and potential settlement.
- Slope stability analysis and building setback requirements.
- Preparation of this report of our conclusions and recommendations.

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SITE INVESTIGATION

SITE DESCRIPTION

The site is bordered to the west by an apartment complex, to the east by commercial buildings and Water Street, a residential development to the north, and to the south by Lower Hadlock Road. The north side of the property consists of a relatively level plateau that extends toward the top edge of a slope that trends south down into the quarry. Presently, a mobile home occupies the plateau. The mobile home will be razed prior to construction.

We understand that the area between Curtis Street and Lower Hadlock Road was a gravel quarry and concluded operation in the early 1990's. While the quarry was in operation a system of benches and slopes were graded during the mining operation. The gravel quarry is characterized by a plateau area along the north and east sides of the site. For the purposes of this report we have number the benches within the quarry area one through three as shown of Figure 2.

The site topology consist of slopes that trend down from the north to the south and from the west to the east. The taller slope trends down from the plateau down to Bench 1 with gradients in the range of 60 to 100 percent and has a vertical slope height of roughly 40 feet. Three slopes varying in height from 6 to 16 feet were observed below the remaining benches. The slope gradients along the slopes were roughly 50 to 60 percent. The benched area ranged from 50 to 200 feet in width and typically trended down from the north to south with a gradual slope gradient of roughly 5 to 10 percent.

The site is sparsely vegetated with tall grass and brush in the gravel quarry.

SLOPE RECONNAISSANCE AND HISTORICAL LANDSLIDE REVIEW

SLOPE RECONNAISSANCE

During our reconnaissance the slopes and adjacent properties were examined for indications of slope failures or instability. Indications of slope failure and/or instability include head scarps, hummocky terrain, inconsistent patterns of vegetation, tension cracks, seepage zones and course grain material overlaying silt and clay soils.

During the site reconnaissance, we observed the slopes have a weathered to a relatively stable configuration along the lower portion of the slope. Slope instabilities were not observed on adjacent properties.

HISTORICAL LANDSLIDE REVIEW

The "Coastal Zone Atlas of Washington", Volume 11, Jefferson County, Washington Department of Ecology, 1979 identifies slopes in the site vicinity as stable (S). Stable slopes are generally less than 15 percent but can include areas of steeper slopes that are stable due to low groundwater concentration or competent bedrock. The stable slope designation also includes areas underlain by weak material such as peat, which are stable because they have no significant slope.

GEOLOGIC SETTING

The subject site lies within the central Puget Lowland. The lowland is part of a regional north-south trending trough that extends from southwestern British Columbia to near Eugene, Oregon. North of Olympia, Washington, this lowland is glacially carved with a depositional and erosional history including at least four separate glacial advance/retreats. The Puget Lowland is bounded on the west by the Olympic Mountains and on the east by the Cascade Range. The lowland is filled with glacial and nonglacial sediments consisting of interbedded gravel, sand, and silt, with till, and peat lenses.

The Washington Division of Geology and Earth Resource (WDGER), Geologic Map of Washington - Northwest Quadrant, dated 2002, indicates that the property is located in an area of undifferentiated outwash consisting of recessional and proglacial deposits. These deposits are described as stratified sand, gravel, and cobbles with occasional silt and clay interbeds, and may include advance outwash.

The United States Department of Agriculture, Soil Conservation Service, Soil Survey of Jefferson County, 1975 (SCS) indicates that the site is located in an area of Hoypus gravelly sandy loam with 0 to 15 percent slopes. This soil has slow to medium runoff with a slight to moderate erosion hazard.

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SUBSURFACE EXPLORATION

The site's subsurface conditions were investigated by excavating 12 test pits to a maximum depth of 15 feet at the approximate locations shown on the attached Site Plan, Figure 2. The test pits were excavated in the locations of the proposed buildings, and parking areas. Logs of the test pits are presented in Appendix A.

SOIL

Fill was encountered in test pits TP-2, TP-3, TP-6 and TP-7 and ranged in depth from 4.5 to 15 feet below existing site grades. The fill was loose, silty sand with gravel and silt and consisted of a mixture of overburden soils and topsoil. The fill was underlain by dense well-graded gravel with sand and poorly graded sand with gravel.

The soils encountered in the remaining test pits consisted of dense well-graded gravel with sand and poorly graded sand with gravel. Please refer to the test pit logs in Appendix A for additional information.

GROUNDWATER

Groundwater was not encountered in the test pit excavations. Water table elevations fluctuate with time, being dependent upon seasonal precipitation, irrigation, land use, and climatic conditions, as well as other factors. Therefore, groundwater observations at the time of the field investigation may vary from those encountered during the construction phase of the project. The evaluation of such factors is beyond the scope of this report.

LABORATORY TESTING

Laboratory tests were performed on selected soil samples to evaluate their physical characteristics and engineering properties. Details of the laboratory test program and results of the laboratory tests are presented in Appendix A. This information, along with the field observations, was used to prepare the final test pit logs.

SEISMIC CONDITIONS

According to the *Seismic Zone Map of the United States* contained in the 1997 *Uniform Building Code,* the project site lies within Seismic Risk Zone 3. The overall soil profile generally corresponds to seismic soil profile S_C as defined by Table 16-J of the 1997 *Uniform Building Code.* Soil profile S_C applies to a profile consisting primarily of dense to very dense soils within the upper 100 feet of the profile. The United States Geologic Survey, Earthquake Hazards Program, National Seismic Hazard Mapping Project website indicates that the peak ground acceleration for the site with a probability of exceedence of 10 percent in 50 years is 0.29g.

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We estimate that the potential for liquefaction at the site the area proposed for development is low to nonexistent due to the dense granular soils encountered during our subsurface exploration.

CONCLUSIONS AND RECOMMENDATIONS

It is our opinion that the site does not meet landslide hazard, erosion hazard, and seismic hazard requirements as presented in the Jefferson County Code (Article VI-G. Geologically Hazardous Areas). We have provided building setback recommendations based on the encountered slope conditions and recommendations for site development.

It is our opinion that the proposed development can occur without adverse affects to the property or adjacent properties. Based on the results of our review and engineering analyses, it is our opinion the site can be developed generally as planned. Support for the planned buildings can be provided using conventional spread and continuous footing foundation systems bearing on native soil or site grades modified with structural fill.

SLOPE STABILITY

The slope area roughly 40 feet in height located below the student housing was analyzed using Cross Section A-A' illustrated on Figures 3. Slope stability analysis was not performed on the slope areas south of Bench 1. The slope stability analysis results are presented in Appendix B. The slope stability analyses were conducted using the commercially available software Gstabl7 with STEDwin by Gregory Geotechnical Software. Soil strength parameters used in our analysis were estimated based on the soil types encountered in the test pits. The engineering properties of the soil used in our analysis are presented in Table 1. For the purpose of our slope stability analysis, we have modeled the slope with a free draining condition. We do not anticipate that a perched groundwater condition will develop in the soil composing the slope areas.

Table 1
Engineering Properties of soil for Analyses

Soil Type	Dry Density (pcf)	Wet Density (pcf)	Cohesion(psf)	Friction (deg)
Dense Sand and Gravel	135	140	0	40
Overburden/fill	115	125	0	32.5

The psuedostatic method was used for our slope stability analyses to estimate the factor of safety under seismic conditions. The seismic coefficient used in a psuedostatic analysis is typically taken to be ½ of the peak ground acceleration (PGA) used in design. The PGA for the site is 0.30 g (see Seismic Zone, above). Therefore a seismic coefficient of 0.15 was used for the site.

The results of slope stability analyses are expressed as factors-of-safety against rotational failure. The factor-of-safety is the ratio of driving forces to resisting forces. A factor-of-safety of 1.0 is equilibrium;

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a factor-of-safety of less than 1.0 indicates failure. Typically, a factor-of-safety of at least 1.3 for static conditions and 1.1 for seismic conditions is considered adequate for the building setback requirements presented in our geotechnical engineering report. The results of our slope stability analyses are presented in Table 2 below and graphically in Appendix B.

Table 2
Stability Results for Existing Slope Configurations

ANALYZED CROSS SECTION	Static FOS	Seismic FOS
Stability of X-Sec A-A' (Figure 3)	1.14	.827

The computer slope stability analyses indicate that the present slope configuration does not have an adequate factor of safety against a rotational failure for both static and seismic loading as shown on Cross Section A-A'. The factor of safety for the cross section was below 1.5 (static conditions) and 1.1 (seismic conditions).

Due to the low factors of safety calculated for Cross Section A-A', slope re-grading will required to achieve an adequate factor of safety. We analyzed the re-graded 50 percent (2H:1V) (Horizontal:Vertical) slope as shown on cross section A-A'. The results of the reconfigured slop is presented in Table 3 below and graphically in Appendix B.

Table 3
Stability for Proposed Slope Configurations

ANALYZED CROSS SECTION	Static FOS	Seismic FOS
Stability of X-Sec A-A' (Figure 3)	1.79	1.42

The building setback from the top of slope for the student housing area was determined with the slope flattened to a 2H:1V slope configuration. The building setback for the slope area shown on cross section A-A' was determined by extending the slope failure circles in our slope stability analysis toward the proposed building area. The building set back distance was based on an adequate factor of safety achieved between the building and top portion of the slope.

EARTHWORK CONSIDERATIONS

Due to the granular nature and low fines content associated with the on-site soils, we do not anticipate significant construction difficulties during wet weather conditions.

General site clearing should include removal of vegetation, trees and associated root systems, wood, pavement, retaining walls, rubble, and rubbish. Site stripping should extend to a minimum depth of 6 to 12 inches, or until all organics in excess of 3 percent by volume are removed. Deeper stripping may be required in localized areas. These materials will not be suitable for use as fill for parking or building areas. However, stripped topsoil may be stockpiled and reused in landscape or non-structural areas.

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SITE PREPARATION

We anticipate that the uncontrolled fill encountered in the test pits will need to be removed from the proposed building areas. The building areas will require an over excavation of roughly two to three feet and other localized excavations greater than 3 feet may be required.

Buried structures encountered during construction should be properly removed and backfilled. Excavations, depressions, or soft and pliant areas extending below planned finish subgrade level should be cleaned to firm undisturbed soil, and backfilled with structural fill to planned finish subgrade. In general, any septic tanks, underground storage tanks, debris pits, cesspools, or similar structures should be entirely removed. Concrete footings should be removed to an equivalent depth of at least 3 feet below proposed footing elevations or as recommended by the Geotechnical engineer. The resulting excavations should be backfilled with structural fill to planned finish subgrade.

GROUNDWATER CONCERNS

Groundwater was not encountered in the test pits. However, based on the location of Port Townsend Bay, we anticipate a static ground water table may be at roughly the same elevation as Port Townsend Bay, roughly 50 to 60 feet below Bench 3. Water table elevations fluctuate with time, being dependent upon seasonal precipitation, irrigation, land use, tidal fluctuation and climatic conditions, as well as other factors. Therefore, water level observations at the time of the field investigation may vary from those encountered during the construction phase of the project. The evaluation of such factors is beyond the scope of this report.

EXCAVATIONS

It is our opinion that the dense well graded gravel with sand and poorly graded sand with gravel encountered in our subsurface investigation are a Type B material as defined by the Washington Industrial Safety and Health Act's (WISHA) regulations on excavation, trenching and shoring. Temporary slopes excavated in Type B material should be inclined no steeper than 1H:1V. The loose fill soils encountered along north side of the site's slope area should be classified as a Type C material, which should be inclined no steeper than 1.5H:1V temporary slope. Permanent cut and structural fill slopes (non reinforced) should be inclined no steeper than 2H:1V. A representative of our firm should evaluate temporary and permanent slopes to insure that they are appropriate for the soils encountered during construction.

In areas where it is not possible to maintain the recommended slopes due to space constraints, temporary shoring will be required. The contractor should be responsible for design and construction of the temporary system. We recommend that a structural engineer and Krazan & Associates review the proposed shoring system prior to construction.

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STRUCTURAL FILL

The on-site well graded gravel with sand and poorly graded sand with gravel are generally suitable for use as structural fill. Some of the soils encountered in our subsurface investigation had relatively high fines content, which may make them difficult to compact if they become too wet.

Structural fill material should consist of well graded gravel or a sand and gravel mixture with a maximum grain size of 1½ inches and less than 5 percent fines. All Structural fill material should be submitted for approval to the Geotechnical Engineer at least 48 hours prior to delivery to the site.

Structural fill should be placed in loose lifts no more than 12-inches thick, dried or wetted as necessary, (water content of soil should be within ±2 percent of optimum water content) and compacted to 95 percent of the maximum density based on ASTM Test Method D-1557. Additional lifts should not be placed if the previous lift did not meet the required dry density or if soil conditions are not stable. Note that, although density testing of structural fill is frequently used as the primary criteria for acceptance of fill, it should not be the only criteria. If, in the judgment of the geotechnical engineer or his representative, placed is not suitable it should be rejected regardless of density test results. As an example, fill that is compacted wet of the optimum moisture content may exhibit "pumpy" behavior even if density test results indicate better than 95 percent compaction has been achieved. In such a situation, the fill should be removed and replaced with drier material.

UTILITY TRENCH BACKFILL

Utility trenches should be excavated according to accepted engineering practice following WISHA standards by a contractor experienced in such work. The responsibility for the safety of open trenches should be borne by the contractor. Traffic and vibration adjacent to trench walls should be minimized. Cyclic wetting and drying of excavation side slopes should also be avoided.

All utility trench backfill should consist of structural fill. Utility trench backfill placed in or adjacent to buildings and exterior slabs should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. The upper 2 feet of utility trench backfill placed in areas that may be paved should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. Below 2 feet, utility trench backfill in pavement areas should be compacted to at least 90 percent of the maximum dry density based on ASTM Test Method D1557. Pipe bedding should be in accordance with pipe manufacturer's recommendations.

The contractor is responsible for removing all moisture sensitive soils from the trenches regardless of the backfill location and compaction requirements. The contractor should use appropriate equipment and methods to avoid damage to the utilities and/or structures during structural fill placement.

SLOPE FILL CONSTRUCTION

The student housing area, building one, will require the placement of fill on a slope area. The procedure for placing structural fill along the slope should consist of excavating a keyway 6 to 8 feet in width along the toe of the planned fill excavated into dense native soil a minimum of 2 feet. The slope above the keyway should then be cut into a series of horizontal to slightly inclined benches. The slope gradient may vary with the width of the benches. Typically, a wider bench will be required for a flatter slope. Permanent fill slopes should not exceed a grade of 2H:1V (Horizontal: Vertical) for this project. The keying and benching work should be inspected prior to fill placement. We do not recommend placing fill on slopes exceeding about 20 to 25 percent. Prior to placing any fill, the exposed subgrade should be observed by the geotechnical engineer.

We anticipate that the fill material will consist of on-site soils. The fill material should consist of non-expansive, non-deleterious material containing no more than 3% organics and approved by the geotechnical engineer prior to placement. The fill should be placed in horizontal lifts not exceeding 12 inches loose thickness, moisture conditioned as necessary and compacted to a minimum of 95 percent of maximum dry density based on ASTM Test Method D1557. The fill should be compacted with proper compaction equipment. In place density tests should be performed to verify suitable moisture contents and adequate compaction. If fill is placed during wet weather, we recommend the use of a free draining select structural fill. Imported structural fill material should consist of well-graded gravel or a sand and gravel mixture with a maximum grain size of 1 ½ inches and less than 5 percent fines. All Structural fill material should be submitted for approval to the Geotechnical Engineer at least 48 hours prior to delivery to the site.

FOUNDATION SUPPORT

It is our opinion the proposed building, can be adequately supported on shallow foundation system bearing on dense native soils or properly compacted structural fill. Organic laden soil, overburden, topsoil or uncontrolled fill should be removed below footing subgrade areas and placed in landscape areas.

For footings bearing on the existing structural fill or dense native soils an allowable bearing pressure of 2,500 pounds per square foot (psf) may be used. Prior to placing footings on the existing fill, we recommend a representative from Krazan observe footing subgrade areas for the wall and building. A 1/3 increase in the above values may be used for short duration, wind, and seismic loads. Structural fill placed on bearing native subgrade should be compacted to 95 percent of the maximum dry density based on ASTM Test Method D1557.

All footings should have a minimum embedment depth of 18 inches below adjacent grade and a minimum width of 16 inches. Resistance to lateral footing displacement can be computed using an allowable friction factor of 0.35 acting between the base of foundations and the supporting subgrade and allowable equivalent fluid passive pressure of 300 pounds per cubic foot (pcf) acting against the

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appropriate vertical footing faces for fill soils. The upper two feet of soil should be neglected when calculating the passive resistance.

We recommend that all overexcavated areas be inspected by Krazan & Associates to verify that suitable material is reached. Deeper overexcavation may be required if the conditions encountered warrant. All material proposed for use as structural fill should be approved by a representative of our firm. Structural fill should be placed and compacted in accordance with the recommendations presented in the Structural Fill Section of this report.

ESTIMATED SETTLEMENT

We estimate that settlements for the continuous and spread footings under the anticipated maximum loads of 2,500 psf will be less than 1 inch. We anticipate differential settlements of no more than ½ the total settlement over the width of the building. The settlements will be elastic in nature and should occur essentially as the loads are applied. If the final design of the foundations results in footings with larger dimensions than those given above, we should be contacted so that we can revise our settlement estimates.

FLOOR SLABS

We recommend that, at a minimum, 1 foot of the existing fill be removed below the floor slab area. The subsequent floor slab subgrade area should be compacted and proof rolled prior to placing structural fill. The over-excavated area should be backfilled to the planned floor slab subgrade level with structural fill.

In areas where it is desired to reduce floor slab dampness, such as areas covered with moisture sensitive floor coverings, we recommend that concrete slab-on-grade floors should be underlain by a water vapor retarder system. The water vapor retarder system should be installed in accordance with ASTM Specification E1643-94 and Standard Specifications E1745-97. According to ASTM Guidelines, the water vapor retarder system should consist of a vapor retarder sheeting underlain by a minimum of 4-inches of compacted clean, open-graded coarse rock of ¾-inch maximum size. Please allow Krazan representative to observed slab-on-grade areas to determine if water retarder system is necessary.

LATERAL EARTH PRESSURES FOR PERMANENT STRUCTURES

We have developed criteria for design of permanent subgrade walls and other permanent retaining structures. Walls that are free to rotate away from the retained soil may be designed using "active" earth pressures for the retained soil. Acceptable lateral movement equal to at least 0.2 percent of the wall height at the top of the wall would be required to use "active" earth pressure values for design. Walls that are not free to rotate, such as walls that are to be part of a building or walls for which any significant movement is unacceptable, should be designed using the "at-rest" earth pressures for the retained soil.

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Table 4, below, presents the recommended lateral earth pressure coefficients along with the equivalent fluid unit weights for retaining walls with level backfill. Note that for the active and at rest cases the slope is above the wall, while for the passive case assumes a level area below the wall. Krazan & Associates, Inc. should be notified if a retaining wall system other than reinforced concrete is to be used and slope areas will exist above or below the wall.

Table 4
Lateral Earth Pressures

Slope	Active Case		At Rest Case		Passive Case	
	Coefficient K_a	Eq. Fluid Unit Wt., pcf	Coefficient K_0	Eq. Fluid Unit Wt., pcf	Coefficient K_p	Eq. Fluid Unit Wt., pcf
Level	0.27	34	0.44	53	2.46	325

The Passive case above includes a factor of safety of 1.5. The stated lateral earth pressures do not include the effects of hydrostatic pressures generated by water accumulation behind retaining walls; seismic loads; or loads imposed by construction equipment, foundations or roadways.

To prevent the buildup of hydrostatic pressure against the walls, continuous footing drains (with cleanouts) should be provided at the base of the walls. The footing drains should consist of perforated pipe, sloped to drain, with perforations placed down and enveloped by 6 inches of pea gravel in all directions. The pipe and pea gravel should be wrapped with filter fabric to prevent migrations of fines. The backfill adjacent to and extending a lateral distance of at least 2 feet behind the walls should consist of free-draining granular material. All free draining backfill should contain less than 3 percent fines (passing the No. 200 sieve) based

upon the fraction passing the U.S. No. 4 sieve with at least 30 percent retained on the U.S. No. 4 sieve. Note that the purpose of the free-draining material is to prevent the buildup of hydrostatic pressure, not to prevent moisture from migrating through the wall. If moisture migration through the wall may be an issue, waterproofing of some sort should be applied to the wall.

The backfill should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. Soil compactors place transient surcharges on the backfill. Consequently, only light hand operated equipment is recommended within 3 feet of walls so that excessive stress is not imposed on the walls.

The potential seismic force on the wall can be modeled as a uniform pressure on the back of the wall equal to 16H times the height of the wall (in feet). The units for this force are pounds per square foot.

DRAINAGE

The ground surface should slope away from building pad and pavement areas toward appropriate drop inlets or other surface drainage devices. We recommend that adjacent exterior grades be sloped a

minimum of 2 percent for a minimum distance of 5 feet away from structures. Roof drains should be tightlined away from foundations. Subgrade soils in areas that may be paved should be sloped a minimum of 1 percent and drainage gradients maintained to carry all surface water to collection facilities. These grades should be maintained for the life of the project. If the footing are placed in native granular soils well graded gravel or poorly graded sand soils, we do not anticipate footing drains will be required for the building subgrade areas.

EROSION CONTROL

Erosion and sediment control (ESC) is used to minimize the transportation of sediment to wetlands, streams, lakes, drainage systems, and adjacent properties. As the site is not directly adjacent to surface waters, we anticipate that standard erosion and sediment control measures (such as silt fences at the perimeter of the construction area, and protection for any existing storm sewer inlets that may be affected by the construction) for this site will be sufficient.

BUILDING SETBACK REQUIREMENTS

We have performed a site-specific slope stability analysis and provided recommendations for re-grading the slope below the student housing area to provide an adequate factor of safety. it is our opinion that a setback of 35 feet will be necessary between the student housing and the 2H:1V permanent slope. The setback measurement will be determined from the furthest projecting footing element and the top edge of the slope. We recommend a 20 foot setback distance along the toe of slope located above Bench 1. In our opinion, drive and parking areas can be placed in setback areas. We have provided building setback requirements on Figure 2.

In our opinion, the administration building should be moved from the proposed location based on building setback requirements of 20 feet along a toe of slope in that area.

We understand the grading plan and building locations have not been finalized. We recommend that a representative from Krazan observe the proposed building location and determine the required setback distance from the top of slope and toe of slope areas. Note deepened footing can also be used to meet building setback requirements. We have delineated area of concern in red hatching on Figure 2.

TESTING AND INSPECTION

A representative of Krazan & Associates, Inc. should be present at the site during the earthwork activities to confirm that actual subsurface conditions are consistent with the exploratory fieldwork. This activity is an integral part of our services as acceptance of earthwork construction is dependent upon compaction testing and stability of the material. This representative can also verify that the intent of these recommendations is incorporated into the project design and construction. Krazan & Associates, Inc. will not be responsible for grades or staking. Krazan should be specifically on-site to

observe grading activities, structural fill placement, utilities, footing subgrade verification and building setback criteria.

LIMITATIONS

Geotechnical engineering is one of the newest divisions of Civil Engineering. This branch of Civil Engineering is constantly improving as new technologies and understanding of earth sciences improves. Although your site was analyzed using the most appropriate current techniques and methods, undoubtedly there will be substantial future improvements in this branch of engineering. In addition to improvements in the field of Geotechnical engineering, physical changes in the site either due to excavation or fill placement, new agency regulations or possible changes in the proposed structure after the time of completion of the soils report may require the soils report to be professionally reviewed. In light of this, the Owner should be aware that there is a practical limit to the usefulness of this report without critical review. Although the time limit for this review is strictly arbitrary, it is suggested that two years be considered a reasonable time for the usefulness of this report.

Foundation and earthwork construction is characterized by the presence of a calculated risk that soil and groundwater conditions have been fully revealed by the original foundation investigation. This risk is derived from the practical necessity of basing interpretations and design conclusions on limited sampling of the earth. The recommendations made in this report are based on the assumption that soil conditions do not vary significantly from those disclosed during our field investigation. If any variations or undesirable conditions are encountered during construction, the Geotechnical engineer should be notified so that supplemental recommendations can be made.

The conclusions of this report are based on the information provided regarding the proposed construction. If the proposed construction is relocated or redesigned, the conclusions in this report may not be valid. The Geotechnical engineer should be notified of any changes so the recommendations can be reviewed and reevaluated.

This report is a geotechnical engineering investigation with the purpose of evaluating the soil conditions in terms of foundation design. The scope of our services did not include any environmental site assessment for the presence or absence of hazardous and/or toxic materials in the soil, groundwater or atmosphere, or the presence of wetlands. Any statements, or absence of statements, in this report or on any test pits log regarding odors, unusual or suspicious items, or conditions observed are strictly for descriptive purposed and are not intended to convey engineering judgment regarding potential hazardous and/or toxic assessment.

The geotechnical information presented herein is based upon professional interpretation utilizing standard engineering practices and a degree of conservatism deemed proper for this project. It is not warranted that such information and interpretation cannot be superseded by future geotechnical developments. We emphasize that this report is valid for this project as outlined above, and should not be used for any other site.

If you have any questions, or if we may be of further assistance, please do not hesitate to contact our office at (360) 598-2126.

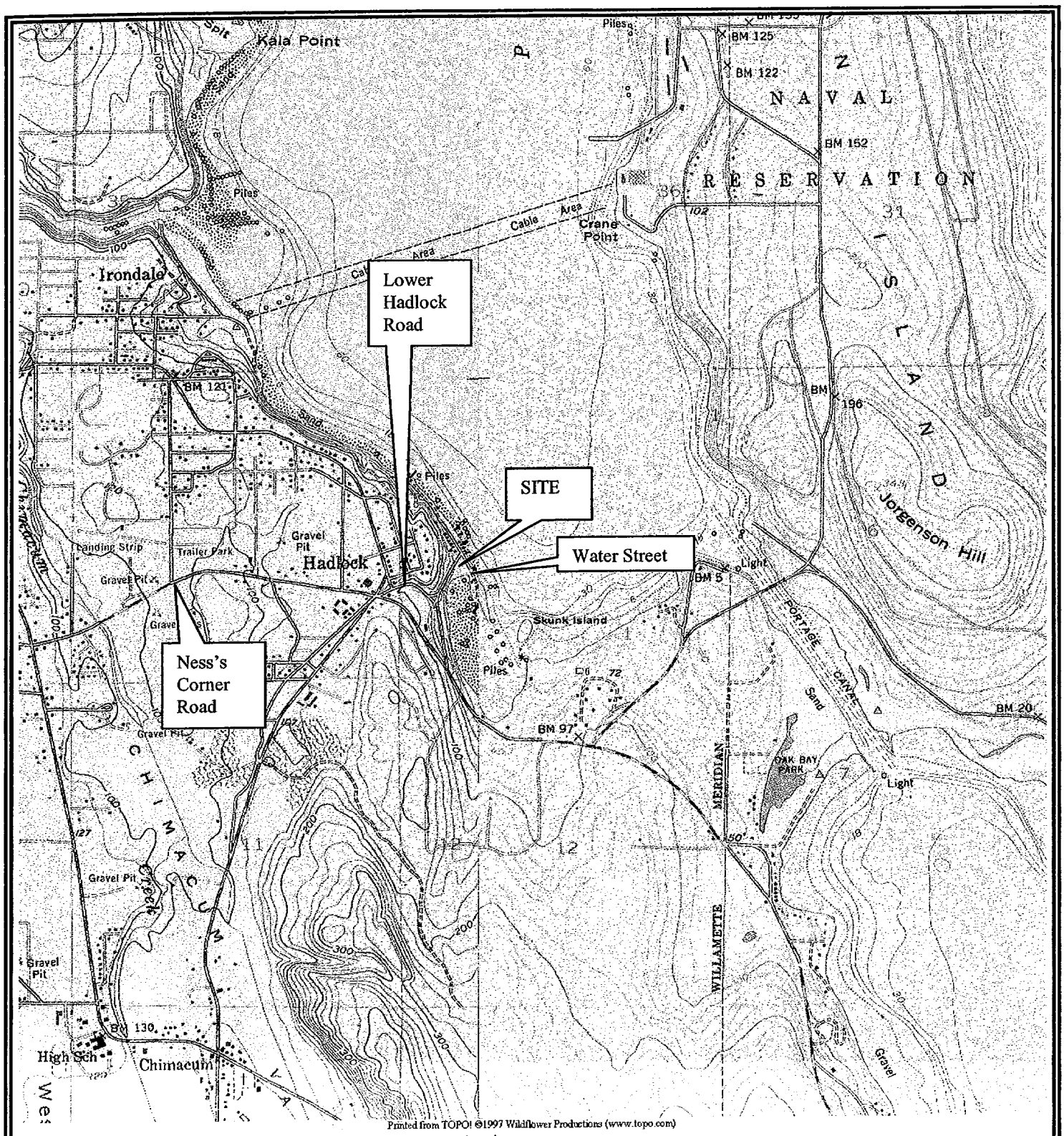
Respectfully submitted,
KRAZAN & ASSOCIATES, INC.

Wesley R. Johnson, P.E.
Project Engineer

WRJ:sew

WESLEY R. JOHNSON
STATE OF WASHINGTON
38359
REGISTERED
PROFESSIONAL ENGINEER

EXPIRES 5/7/05



Note: Map adapted from TOPO! © 1997, Wildflower Productions.

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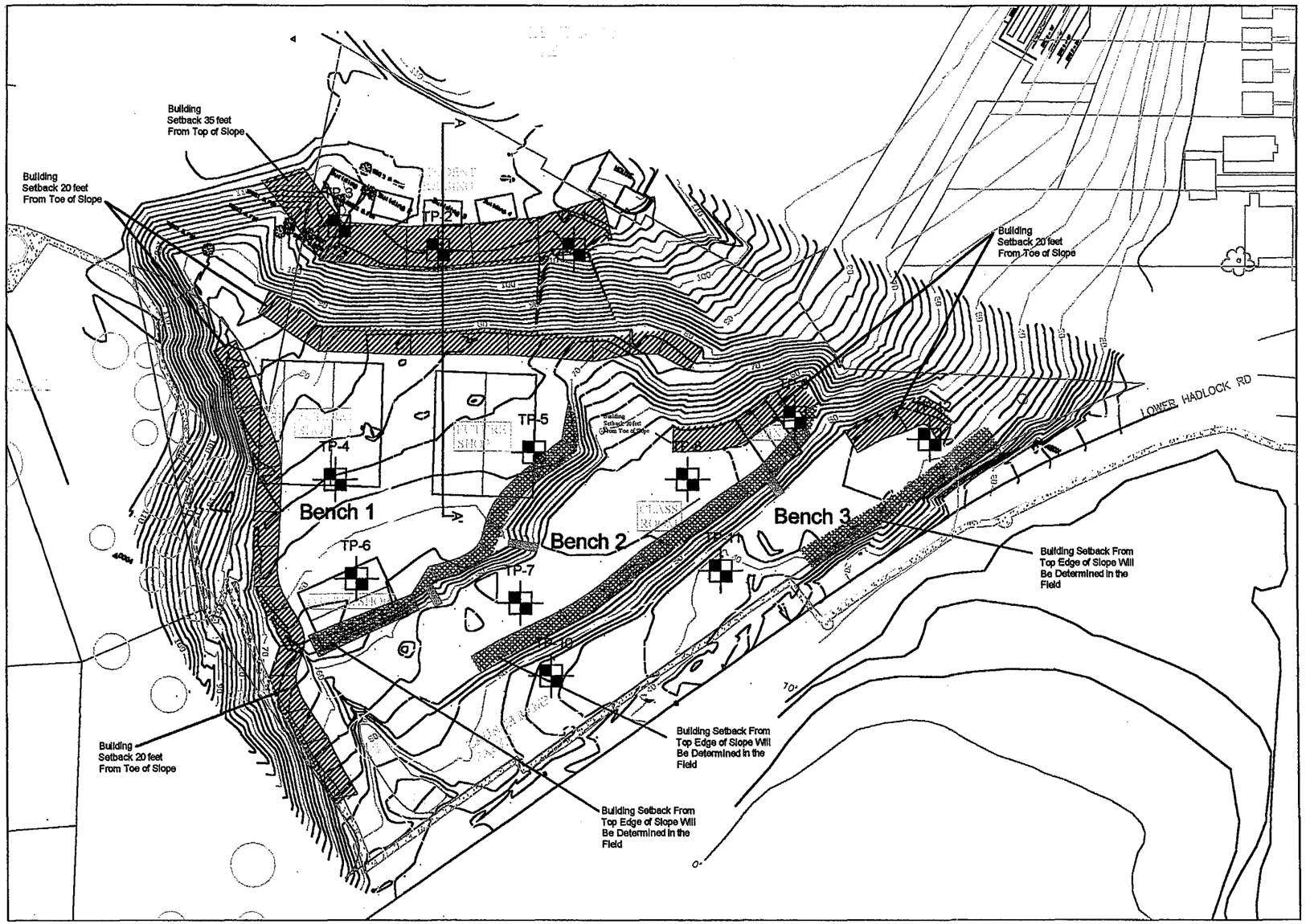
20714 State Route 305-Suite 3C
Poulsbo, WA 98370
360-598-2126

FIGURE 1 – SITE VICINITY MAP

Job name: Northwest School of Wooden Boats II
Location: Port Hadlock, Washington
Job No. : 102-04025
Client: Northwest School of Wooden Boats
Date: 4/02/04

N



N

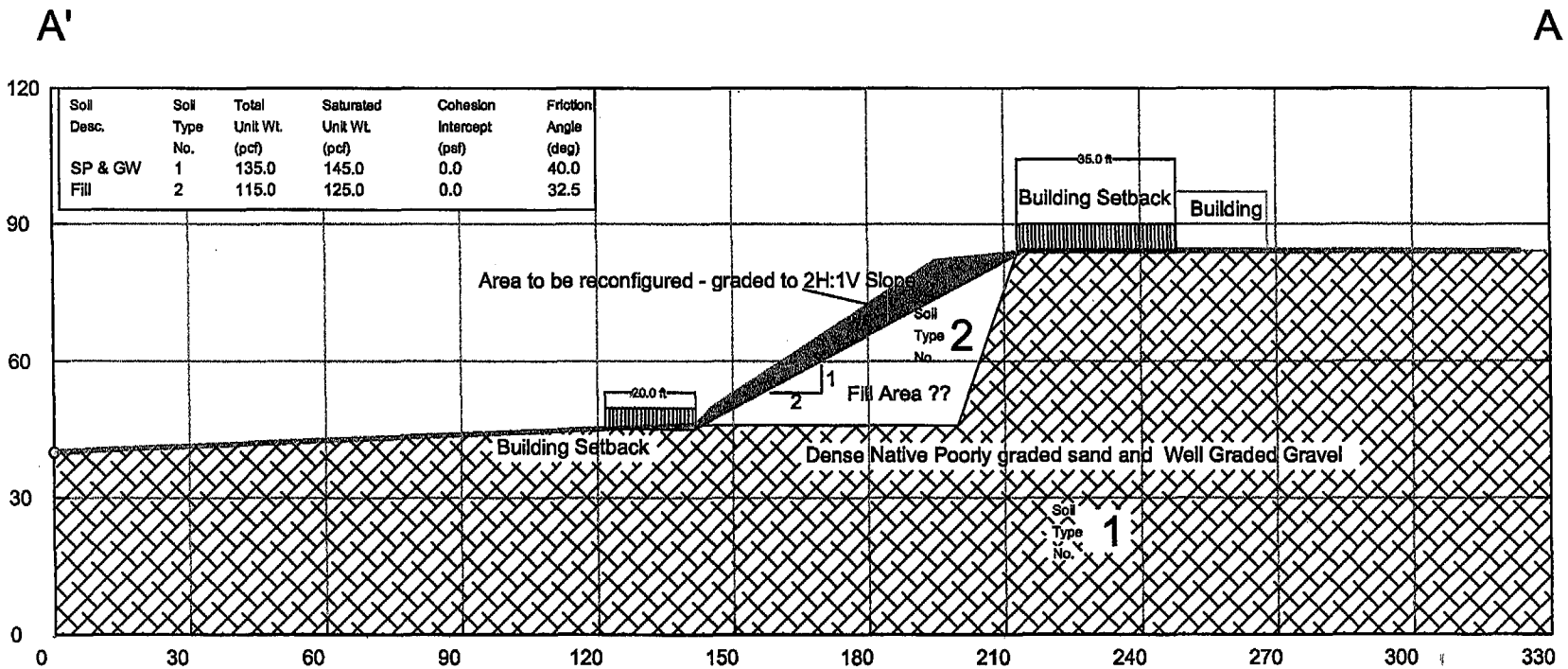
Legend

Setbacks	
Building Setback From Top Edge of Slope Will Be Determined in the Field	
Proposed Building Area Subject To Change	
Test Pit Location	TP-4

Site Plan

North West School of Wooden Boats II		Figure 2
Scale 1" = 100 ft	Job Number: 102-04025	Drawn By: HLH Revised By: WRJ
Date: April 2, 2004	Krazan & Associates, Inc.	Drawing Number: 1 Drawing Type: Site Map

Site plan Developed by Laurence LLCraig Architect, 608 NE Hostmark St. Poulsbo, WA. 98370



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)
SP & GW	1	135.0	145.0	0.0	40.0
Fill	2	115.0	125.0	0.0	32.5

Cross Section developed from plans provided by Laurence L. Craig Architects

Wooden Boats II		
Cross Section A-A'		Figure 3
Approx. Scale: 1 in = 40 ft	Job Number: 102-04025	Drawn By: WRJ Revised By: Drawing Number: 1
Date: April 1, 2004	Krazan & Associates, Inc.	Drawing Type: Site Map

Appendix A

APPENDIX A

FIELD AND LABORATORY INVESTIGATIONS

Field Investigation

The field investigation consisted of a surface reconnaissance and a subsurface exploratory program. The subsurface exploratory program consisted of the excavation of 12 test pits. The test pit locations are shown on the site plan (Figure 2). The depths shown on the attached logs are from the existing ground surface at the time the test pits were excavated.

The soils encountered were logged in the field during the exploration and, with supplementary laboratory test data, are described in accordance with the Unified Soil Classification System.

All samples were returned to our Poulsbo laboratory for evaluation.

Laboratory Investigation

The laboratory investigation was used to estimate the physical and mechanical properties of the foundation soil underlying the site. Test results were used as criteria for determining the engineering suitability of the surface and subsurface materials encountered.

In situ moisture contents, fines content, and grain size distribution, were performed on samples representative of the subsurface materials. These tests, supplemented by visual observation, comprised the basis for our evaluation of the site material. Results of the moisture content and fines content tests are presented on the test pit logs. Results of the grain size distribution tests are presented on Figure A-13 and A-15.

The logs of the test pits and laboratory determinations are presented in this Appendix.

WinLoG Symbol Legend

USCS

- Well Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
- Poorly Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
- Silty Gravels, Gravel-Sand-Silt Mixtures
- Clayey Gravels, Gravel-Sand-Clay Mixtures
- Well Graded Sands, Gravelly Sands, Little or No Fines
- Poorly Graded Sands, Gravelly Sands, Little or No Fines
- Silty Sands, Sand-Silt Mixtures
- Clayey Sands, Sand-Clay Mixtures
- Inorganic Silts and Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands
- Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty
- Organic Silts and Organic Silty Clays of Low Plasticity
- Inorganic Silts, Micaceous or Diatomaceous Fine Sandy or Silty Soils, Elastic
- Inorganic Clays of High Plasticity, Fat Clays
- Organic Clays of Medium to High Plasticity, Organic Silts
- Peat, Humus, Swamp and Other Highly Organic Soils

Well Symbols

Pipes and Screens

- NONE None
- Pipe
- Double Walled Pipe
- Sealed Pipe
- Fine Screen
- Coarse Screen
- Screen 1
- Screen 2

Top Fittings

- NONE None
- Cap
- Flush-mount Cap
- Above-ground Cap
- Connector
- Reducer
- Pipe Break
- Packer

Bottom Fittings

- NONE None
- Cap
- Cone
- Screw-on Cap
- Connector
- Enlarger
- Pipe Break
- Packer

Packing and Backfill

- NONE None
- Bentonite
- Clay
- Silt
- Cement
- Sand
- Sand and Gravel
- Gravel

Sample Symbols

- Split Spoon
- Auger
- Core
- G Grab
- Shelby Tube
- Excavation
- Undisturbed
- No Recovery

Log of Test Pit TP-1

Project: Wooden Boat Site II
Client: N.W. School of Wooden Boats
Location: Port Hadlock, WA
Depth to Water: Not Encountered

Project No: 102-04025
Figure No.: A-1
Logged By: J.M./D.H.
Elevation: ~114 feet

SUBSURFACE PROFILE			SAMPLE DATA				
Depth (ft)	Symbol	Description	Sample Number	Fines %	Type	Moisture%	Water Content (%) 10 20 30 40 50
0		Ground Surface					
		TOPSOIL					
1		*WELL GRADED GRAVEL WITH SAND (GW)* Dense, medium to coarse grained sand, brown, moist.					
2			S-1		Grab	5.5	■
3							
4							
5							
6		Becomes dense to very dense, coarse grained sand and gray, and contains cobbles at 6 feet.	S-2	0.8	Grab	4.6	■
7							
8							
9							
10							
11							
12		End of Test Pit					
13							
14							
15							
16							
17							
18							
19							
20							

Method: John Deere 120
Excavator: Seton
Operator:

Krazan and Associates
20714 State Highway 305 N.E.
Suite 3C
Poulsbo, Washington 98370

Excavation Date: 3/15/04

Sheet: 1 of 1

Project: Wooden Boat Site II

Log of Test Pit TP-2

Project No: 102-04025

Client: N.W. School of Wooden Boats

Figure No.: A-2

Location: Port Hadlock, WA

Logged By: J.M./D.H.

Depth to Water: Not Encountered

Elevation: ~114 feet

SUBSURFACE PROFILE			SAMPLE DATA				
Depth (ft)	Symbol	Description	Sample Number	Fines %	Type	Moisture%	Water Content (%) 10 20 30 40 50
		Ground Surface					
0		*WELL GRADED GRAVEL WITH SAND (GW)* Loose to medium dense, medium to coarse grained sand, brown, moist. (FILL)					
1							
2			S-1		Grab	7.2	■
3							
4		*WELL GRADED GRAVEL WITH SAND (GW)* Dense to very dense, coarse grained sand, gray, moist. Contains cobbles. (NATIVE)					
5							
6							
7							
8		End of Test Pit					
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Method: John Deere 120

Excavator: Seton

Operator:

Krazan and Associates
20714 State Highway 305 N.E.
Suite 3C
Poulsbo, Washington 98370

Excavation Date: 3/15/04

Sheet: 1 of 1

Log of Test Pit TP-3

Project: Wooden Boat Site II
Client: N.W. School of Wooden Boats
Location: Port Hadlock, WA
Depth to Water: Not Encountered

Project No: 102-04025
Figure No.: A-3
Logged By: J.M./D.H.
Elevation: ~113 feet

SUBSURFACE PROFILE			SAMPLE DATA				
Depth (ft)	Symbol	Description	Sample Number	Fines %	Type	Moisture%	Water Content (%) 10 20 30 40 50
0		Ground Surface					
1		*WELL GRADED GRAVEL WITH SAND (GW)* Loose to medium dense, medium to coarse grained sand, brown, moist. Contains metal and organic debris. (FILL)					
2			S-1		Grab	5.0	■
3							
4							
5							
6							
7							
8							
9							
10							
11		*WELL GRADED GRAVEL WITH SAND (GW)* Medium dense to dense, medium grained sand, brown, dry. Becomes desne and gray at 12 feet. (NATIVE)					
12							
13							
14			S-2		Grab	2.3	■
15		End of Test Pit					
16							
17							
18							
19							
20							

Method: John Deere 120
Excavator: Seton
Operator:

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Suite 3C
Poulsbo, Washington 98370

Excavation Date: 3/15/04

Sheet: 1 of 1

Log of Test Pit TP-4

Project: Wooden Boat Site II
Client: N.W. School of Wooden Boats
Location: Port Hadlock, WA
Depth to Water: Not Encountered

Project No: 102-04025
Figure No.: A-4
Logged By: J.M./D.H.
Elevation: ~76 feet

SUBSURFACE PROFILE			SAMPLE DATA				
Depth (ft)	Symbol	Description	Sample Number	Fines %	Type	Moisture%	Water Content (%) 10 20 30 40 50
		Ground Surface					
0		*WELL GRADED GRAVEL WITH SAND (GW)* Dense, medium to coarse grained sand, brown, moist.					
1			S-1		Grab	7.4	■
2		Becomes gray and coarse grained at 3 feet.					
3			S-2		Grab	3.8	■
4							
5							
6							
7		Contains cobbles at 7 feet.	S-3		Grab	5.4	■
8							
9							
10		End of Test Pit					
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Method: John Deere 120
Excavator: Seton
Operator:

Krazan and Associates
20714 State Highway 305 N.E.
Suite 3C
Poulsbo, Washington 98370

Excavation Date: 3/15/04

Sheet: 1 of 1

Log of Test Pit TP-5

Project: Wooden Boat Site II
Client: N.W. School of Wooden Boats
Location: Port Hadlock, WA
Depth to Water: Not Encountered

Project No: 102-04025
Figure No.: A-5
Logged By: J.M./D.H.
Elevation: ~73 feet

SUBSURFACE PROFILE			SAMPLE DATA				
Depth (ft)	Symbol	Description	Sample Number	Fines %	Type	Moisture%	Water Content (%) 10 20 30 40 50
0		Ground Surface					
		TOPSOIL					
1		*WELL GRADED GRAVEL WITH SAND (GW)* Very dense, coarse grained sand, gray, moist.					
2			S-1		Grab	3.6	■
3							
4							
5							
6		Contains cobbles at 6 feet.					
7							
8							
9			S-2		Grab	2.3	■
10		End of Test Pit					
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Method: John Deere 120
Excavator: Seton
Operator:

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Poulsbo, Washington 98370

Excavation Date: 3/15/04

Sheet: 1 of 1

Log of Test Pit TP-6

Project: Wooden Boat Site II
Client: N.W. School of Wooden Boats
Location: Port Hadlock, WA
Depth to Water: Not Encountered

Project No: 102-04025
Figure No.: A-6
Logged By: J.M./D.H.
Elevation: ~69 feet

SUBSURFACE PROFILE			SAMPLE DATA				
Depth (ft)	Symbol	Description	Sample Number	Fines %	Type	Moisture%	Water Content (%) 10 20 30 40 50
		Ground Surface					
0		*TOPSOIL*					
1							
2		*POORLY GRADED SAND WITH GRAVEL (SP)* Very dense, medium to coarse grained sand, brown, moist.	S-1		Grab	6.3	
3							
4		Becomes gray at 4 feet.	S-2	0.3	Grab	3.9	
5							
6							
7							
8							
9		Contains cobbles at 9 feet.	S-3		Grab	5.4	
10		End of Test Pit					
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Method: John Deere 120
Excavator: Seton
Operator:

Krazan and Associates
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Suite 3C
Poulsbo, Washington 98370

Excavation Date: 3/15/04

Sheet: 1 of 1

Log of Test Pit TP-7

Project: Wooden Boat Site II
Client: N.W. School of Wooden Boats
Location: Port Hadlock, WA
Depth to Water: Not Encountered

Project No: 102-04025
Figure No.: A-7
Logged By: J.M./D.H.
Elevation: ~60 feet

APR 13 2004

SUBSURFACE PROFILE			SAMPLE DATA				
Depth (ft)	Symbol	Description	Sample Number	Fines %	Type	Moisture%	Water Content (%) 10 20 30 40 50
0		Ground Surface					
		TOPSOIL					
1		*WELL GRADED GRAVEL WITH SAND (GW)* Very dense, medium to coarse grained sand, brown, moist. Becomes dense and gray at 4 feet.	S-1		Grab	6.1	
2							
3			S-2		Grab	4.0	
4							
5							
6							
7		End of Test Pit					
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Method: John Deere 120
Excavator: Seton
Operator:

Krazan and Associates
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Suite 3C
Poulsbo, Washington 98370

Excavation Date: 3/15/04

Sheet: 1 of 1

Log of Test Pit TP-8

Project: Wooden Boat Site II
Client: N.W. School of Wooden Boats
Location: Port Hadlock, WA
Depth to Water: Not Encountered

Project No: 102-04025
Figure No.: A-8
Logged By: J.M./D.H.
Elevation: ~54 feet

SUBSURFACE PROFILE			SAMPLE DATA				
Depth (ft)	Symbol	Description	Sample Number	Fines %	Type	Moisture%	Water Content (%) 10 20 30 40 50
		Ground Surface					
0		*WELL GRADED GRAVEL WITH SAND (GW)* Very dense, medium to coarse grained sand, brown, moist. Becomes dense and gray at 3 feet.					
1							
2			S-1		Grab	7.3	
3			S-2		Grab	3.9	
4							
5							
6							
7							
8							
9							
10		End of Test Pit					
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Method: John Deere 120
Excavator: Seton
Operator:

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Suite 3C
Poulsbo, Washington 98370

Excavation Date: 3/15/04

Sheet: 1 of 1

Log of Test Pit TP-9

Project: Wooden Boat Site II
Client: N.W. School of Wooden Boats
Location: Port Hadlock, WA
Depth to Water: Not Encountered

Project No: 102-04025
Figure No.: A-9
Logged By: J.M./D.H.
Elevation: ~54 feet

SUBSURFACE PROFILE			SAMPLE DATA				
Depth (ft)	Symbol	Description	Sample Number	Fines %	Type	Moisture%	Water Content (%) 10 20 30 40 50
		Ground Surface					
0		*WELL GRADED GRAVEL WITH SAND (GW)* Very dense, medium to coarse grained sand, brown, moist.					
1							
2			S-1		Grab	4.0	
3		*POORLY GRADED SAND WITH GRAVEL(SP)* Dense, medium to coarse grained sand, gray, moist.					
4			S-2	1.2	Grab	3.2	
5							
6							
7							
8							
9							
10		End of Test Pit					
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Method: John Deere 120
Excavator: Seton
Operator:

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Poulsbo, Washington 98370

Excavation Date: 3/15/04

Sheet: 1 of 1

Project: Wooden Boat Site II

Log of Test Pit TP-10

Project No: 102-04025

Client: N.W. School of Wooden Boats

Figure No.: A-10

Location: Port Hadlock, WA

Logged By: J.M./D.H.

Depth to Water: Not Encountered

Elevation: ~46 feet

SUBSURFACE PROFILE			SAMPLE DATA				
Depth (ft)	Symbol	Description	Sample Number	Fines %	Type	Moisture%	Water Content (%) 10 20 30 40 50
0		Ground Surface					
		TOPSOIL					
1		*WELL GRADED GRAVEL WITH SAND (GW)* Very dense, medium to coarse grained sand, brown, moist.	S-1		Grab	4.9	■
2							
3		Becomes gray at 3 feet.	S-2		Grab	3.2	■
4							
5							
6							
7		Contains cobbles at 7 feet.	S-3		Grab	4.7	■
8		End of Test Pit					
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Method: John Deere 120

Excavator: Seton

Operator:

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Suite 3C
Poulsbo, Washington 98370

Excavation Date: 3/15/04

Sheet: 1 of 1

Log of Test Pit TP-11

Project: Wooden Boat Site II
Client: N.W. School of Wooden Boats
Location: Port Hadlock, WA
Depth to Water: Not Encountered

Project No: 102-04025
Figure No.: A-11
Logged By: J.M./D.H.
Elevation: ~40 feet

SUBSURFACE PROFILE			SAMPLE DATA				
Depth (ft)	Symbol	Description	Sample Number	Fines %	Type	Moisture%	Water Content (%) 10 20 30 40 50
0		Ground Surface					
		TOPSOIL					
1		*WELL GRADED GRAVEL WITH SAND (GW)* Very dense, medium to coarse grained sand, brown, moist.	S-1		Grab	2.8	■
2							
3		Becomes dense, gray, and contains cobbles at 3 feet.					
4							
5			S-2		Grab	3.1	■
6							
7		End of Test Pit					
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Method: John Deere 120
Excavator: Seton
Operator:

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Poulsbo, Washington 98370

Excavation Date: 3/15/04

Sheet: 1 of 1

Log of Test Pit TP-12

Project: Wooden Boat Site II
Client: N.W. School of Wooden Boats
Location: Port Hadlock, WA
Depth to Water: Not Encountered

Project No: 102-04025
Figure No.: A-12
Logged By: J.M./D.H.
Elevation: ~40 feet

SUBSURFACE PROFILE			SAMPLE DATA				
Depth (ft)	Symbol	Description	Sample Number	Fines %	Type	Moisture%	Water Content (%) 10 20 30 40 50
0		Ground Surface					
		TOPSOIL					
1		*WELL GRADED GRAVEL WITH SAND (GW)* Very dense, medium to coarse grained sand, brown, moist.	S-1		Grab	3.9	
2							
3		Becomes dense, gray, and contains cobbles at 3 feet.					
4			S-2		Grab	2.5	
5							
6		End of Test Pit					
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

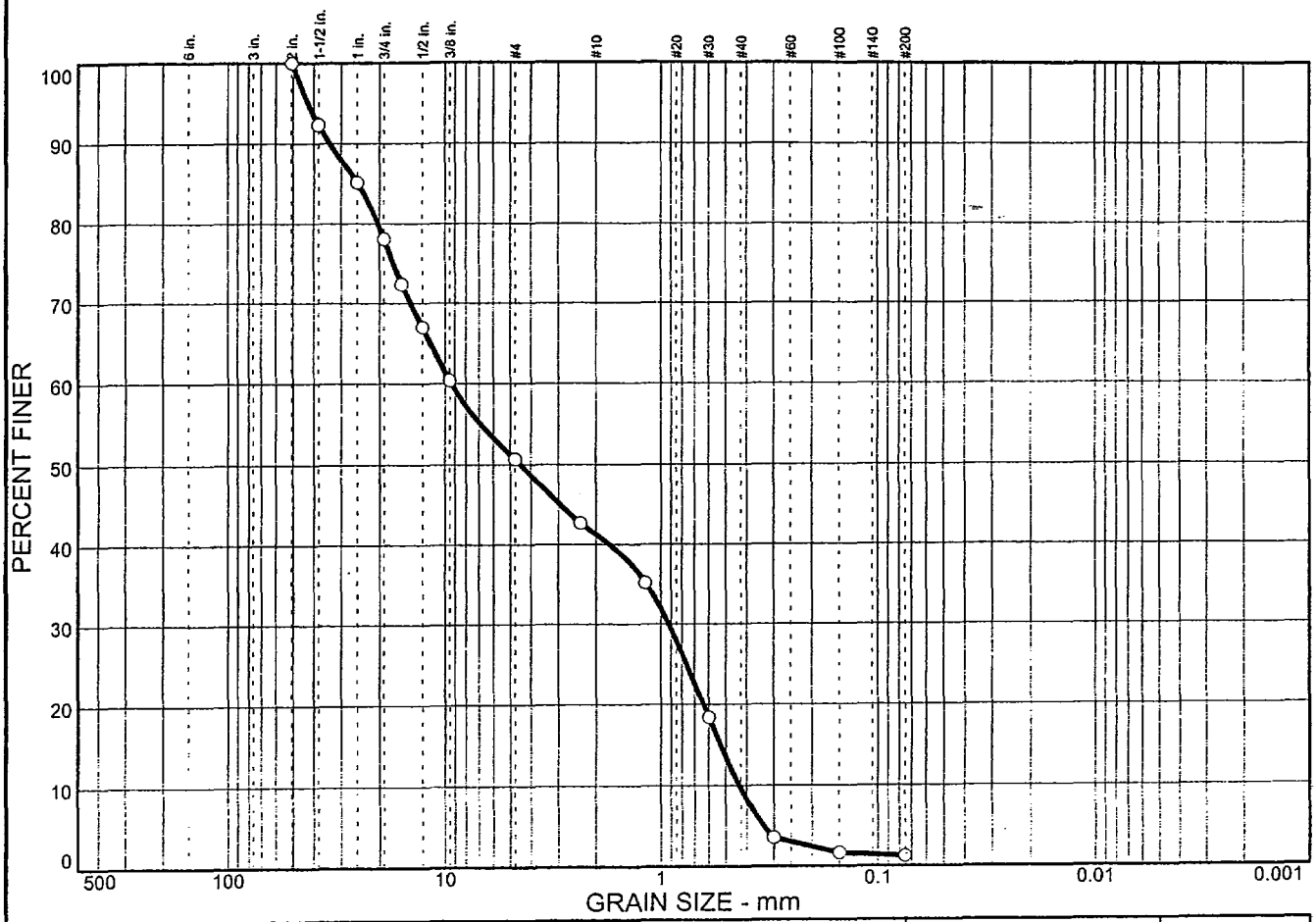
Method: John Deere 120
Excavator: Seton
Operator:

Krazan and Associates
20714 State Highway 305 N.E.
Suite 3C
Poulsbo, Washington 98370

Excavation Date: 3/15/04

Sheet: 1 of 1

GRAIN SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	49.3	49.5	1.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2.0 in.	100.0		
1.5 in.	92.3		
1.0 in.	85.1		
0.75 in.	78.1		
0.625 in.	72.4		
0.5 in.	67.0		
0.375 in.	60.4		
#4	50.7		
#8	42.7		
#16	35.2		
#30	18.4		
#50	3.5		
#100	1.6		
#200	1.2		

* (no specification provided)

Soil Description

USCS: POORLY GRADED SAND WITH GRAVEL (SP)
MOISTURE CONTENT = 3.2%

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 25.3 D_{60}= 9.34 D_{50}= 4.47
D_{30}= 0.924 D_{15}= 0.529 D_{10}= 0.433
C_u= 21.59 C_c= 0.21

Classification

USCS= SP AASHTO=

Remarks

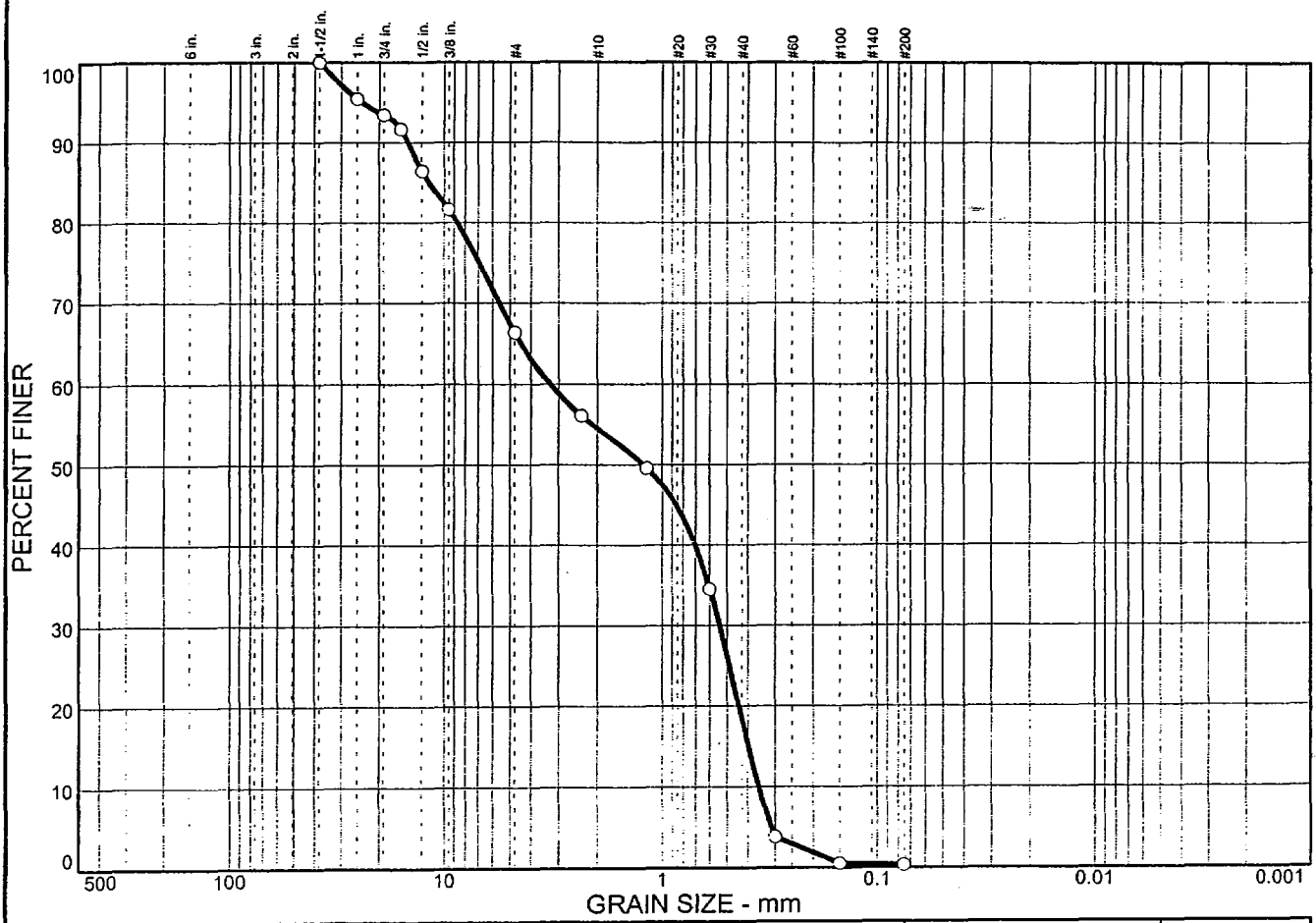
SAMPLE #: TP-9; S-2
REPORT #: 33789
DATE: 03-15-2004

Sample No.: TP-9; S-2 **Source of Sample:** 15 MAR 2004 **Date:** 03-15-2004
Location: TP-9 **Elev./Depth:**

KRAZAN & ASSOCIATES, INC.

Client: NW SCHOOL OF WOODEN BOATS
Project: WOODEN BOATS II
Project No: 102-04025 **Figure** A-15

GRAIN SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	33.6	66.1	0.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1.0 in.	95.4		
0.75 in.	93.4		
0.625 in.	91.6		
0.5 in.	86.4		
0.375 in.	81.6		
#4	66.4		
#8	56.1		
#16	49.6		
#30	34.5		
#50	3.8		
#100	0.5		
#200	0.3		

* (no specification provided)

Soil Description

USCS: POORLY GRADED SAND WITH GRAVEL (SP)
MOISTURE CONTENT = 3.9%

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 11.8 D_{60}= 3.28 D_{50}= 1.22
D_{30}= 0.541 D_{15}= 0.398 D_{10}= 0.357
C_u= 9.18 C_c= 0.25

Classification

USCS= SP AASHTO=

Remarks

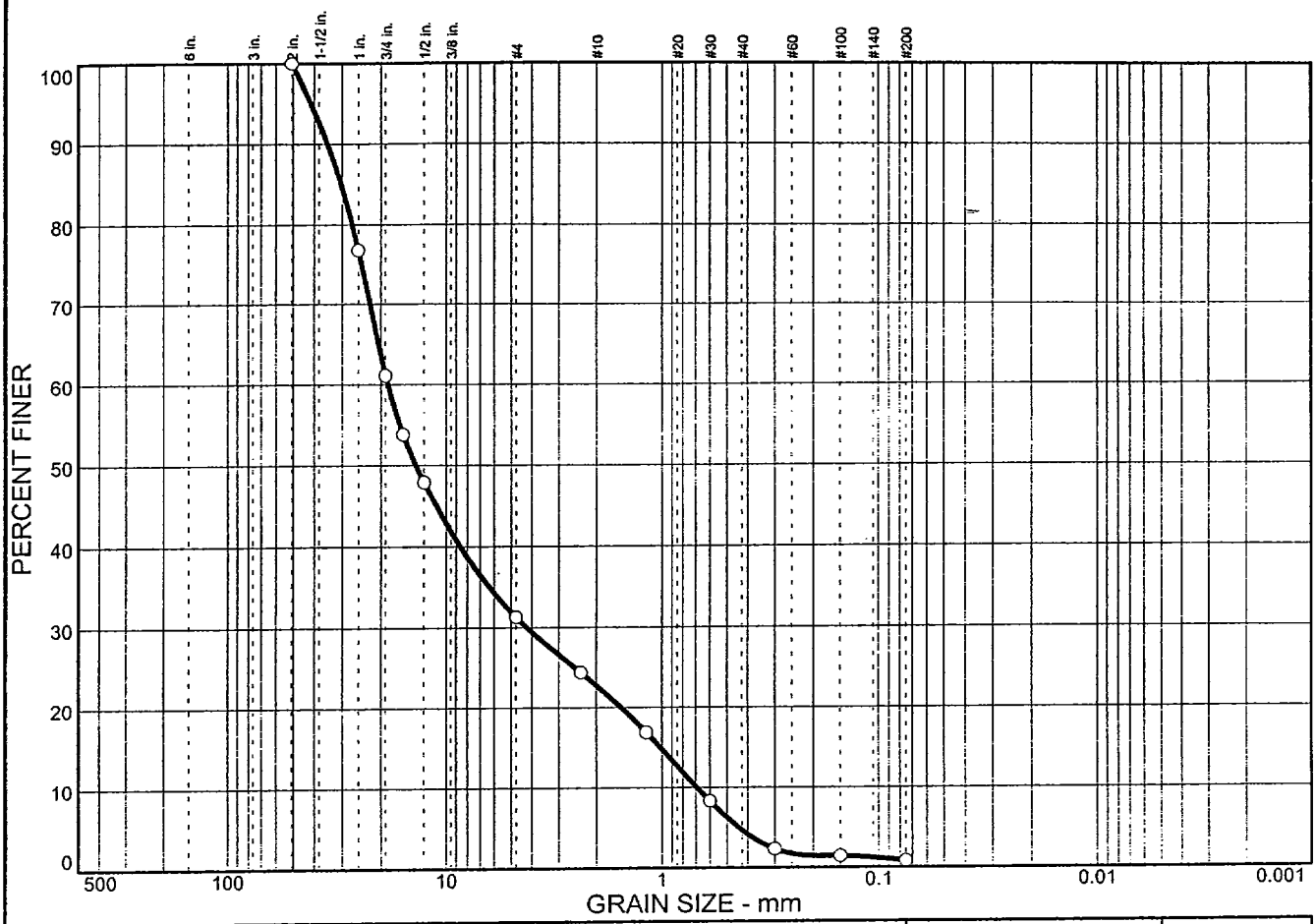
SAMPLE #: TP-6; S-2
REPORT #: 33789
DATE: 03-15-2004

Sample No.: TP-6; S-2 **Source of Sample:** 15 MAR 2004 **Date:** 03-15-2004
Location: TP-6 **Elev./Depth:**

KRAZAN & ASSOCIATES, INC.

Client: NW SCHOOL OF WOODEN BOATS
Project: WOODEN BOATS II
Project No: 102-04025 **Figure** A-14

GRAIN SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	68.7	30.5	0.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2.0 in.	100.0		
1.0 in.	76.8		
0.75 in.	61.1		
0.625 in.	53.8		
0.5 in.	47.9		
#4	31.3		
#8	24.4		
#16	16.9		
#30	8.3		
#50	2.3		
#100	1.4		
#200	0.8		

* (no specification provided)

Soil Description

USCS: WELL-GRADED GRAVEL WITH SAND (GW)
MOISTURE CONTENT = 4.6%

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 30.4 D_{60}= 18.6 D_{50}= 13.9
D_{30}= 4.23 D_{15}= 1.02 D_{10}= 0.689
C_u= 27.00 C_c= 1.39

Classification

USCS= GW AASHTO=

Remarks

SAMPLE #: TP-1; S-2
REPORT #: 33789
DATE: 03-15-2004

Sample No.: TP-1; S-2 Source of Sample: 15 MAR 2004 Date: 3-15-2004
Location: TP-1 Elev./Depth:

KRAZAN & ASSOCIATES, INC.

Client: NW SCHOOL OF WOODEN BOATS
Project: WOODEN BOATS II
Project No: 102-04025 Figure A-13

Appendix B

APPENDIX B
SLOPE STABILITY ANALYSES

Slope stability analyses were performed on one Cross-Section. The location of the cross-section is are indicated on the Site Plan, Figure 2. Topography used in the analysis was based on the site plan provided by Lawrence L. Craig Architects. The slope stability analyses were conducted using the commercially available software Gstabl7 with STEDwin by Gregory Geotechnical Software. Soil strength parameters used in our analysis were estimated from observations of the soils encountered in the test pits. The engineering properties of the soil used in our analysis are presented on Cross Section A-A'. The cross section illustrates existing slope configuration and modified slope configuration.

The psuedostatic method was used for our slope stability analysis was used to estimate the factor of safety under seismic conditions. The United States Geologic Survey, Earthquake Hazards Program – National Seismic Hazard Mapping Project, indicates that a peak ground acceleration (PGA) of 0.30 g has a 10 percent probability of exceedence in 50 years (500 year return period). The seismic coefficient is typically taken to be ½ of the PGA. A seismic coefficient of 0.15 was used in our analyses.

The results of slope stability analyses are expressed as factors-of-safety against rotational failure. The factor-of-safety is the ratio of driving forces to resisting forces. A factor-of-safety of 1.0 is equilibrium; a factor-of-safety of less than 1.0 indicates failure. Typically, a factor-of-safety of 1.5 for static conditions and a factor of safety of 1.1 or higher is acceptable for seismic conditions is considered adequate. The calculated minimum factor of safety for the slope is presented on the figures in this appendix.

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Wooden Boats II Job Number 102-04025

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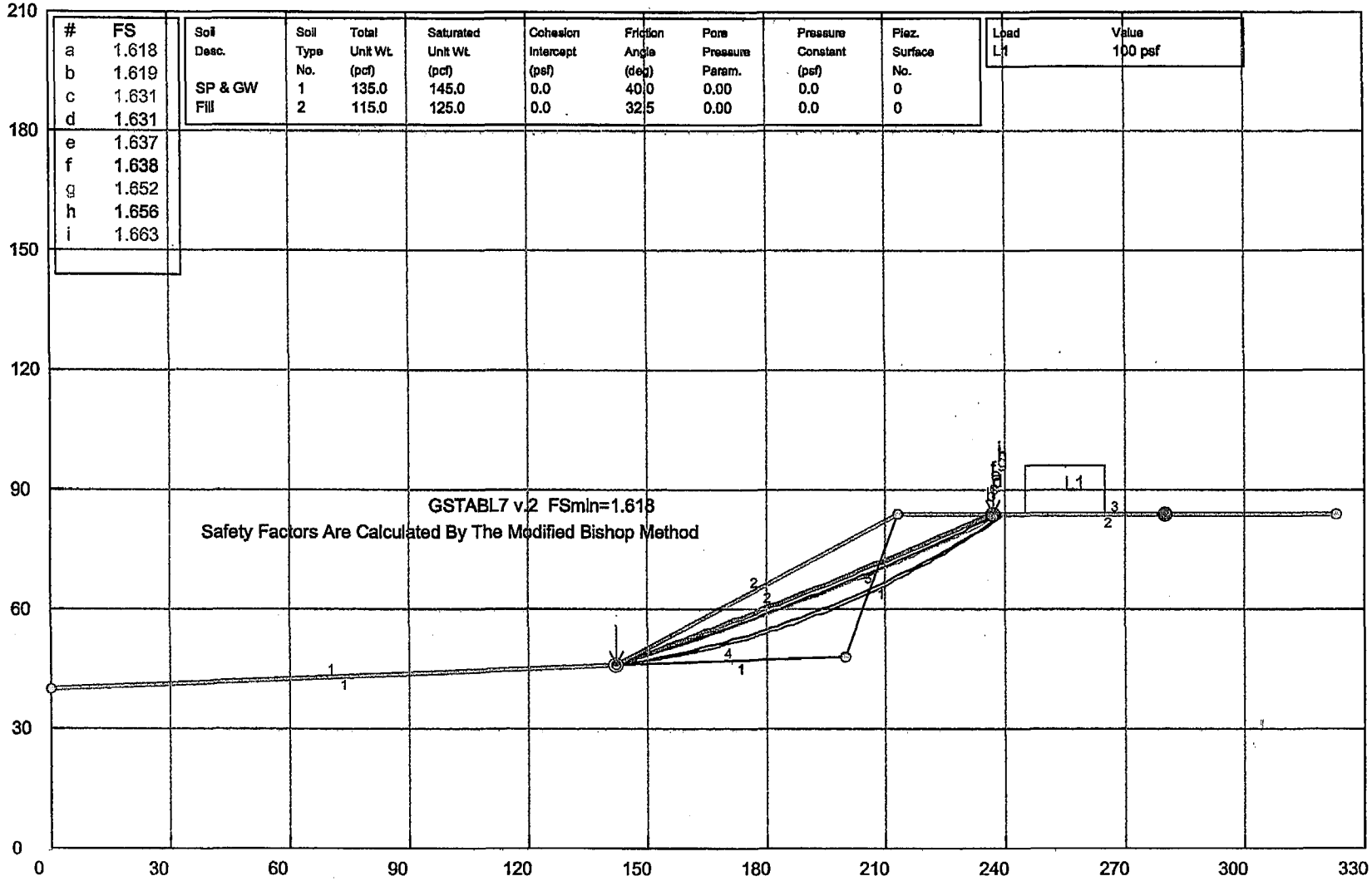

#	FS
a	1.618
b	1.619
c	1.631
d	1.631
e	1.637
f	1.638
g	1.652
h	1.656
i	1.663

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
SP & GW	1	135.0	145.0	0.0	40.0	0.00	0.0	0
Fill	2	115.0	125.0	0.0	32.5	0.00	0.0	0

Load	Value
L1	100 psf

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Wooden Boats II		
Slope Stability Graph (Static)		Appendix B.2
Approx. Scale: 1 in = 40 ft	Job Number: 102-04025	Drawn By: WRJ Revised By:
Date: April 1, 2004	Krazan & Associates, Inc.	Drawing Number: 1 Drawing Type: Site Map

Wooden Boats II Job Number 102-04025

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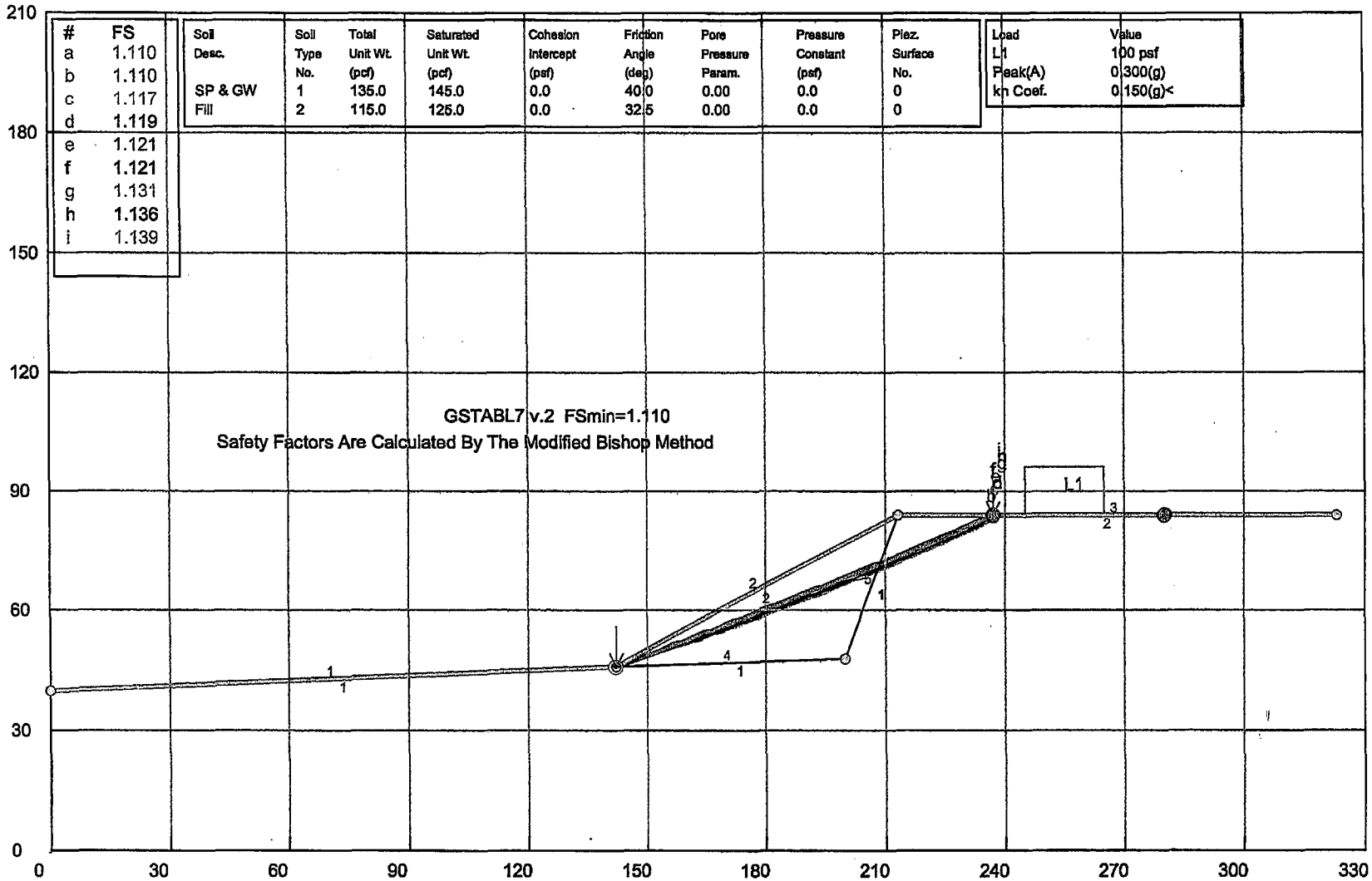

#	FS
a	1.110
b	1.110
c	1.117
d	1.119
e	1.121
f	1.121
g	1.131
h	1.136
i	1.139

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
SP & GW	1	135.0	145.0	0.0	40.0	0.00	0.0	0
Fill	2	115.0	125.0	0.0	32.5	0.00	0.0	0

Load	Value
L1	100 psf
Peak(A)	0.300(g)
kh Coef.	0.150(g)<

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Wooden Boats II		
Slope Stability Graph (Seismic)		Appendix B.2
Approx. Scale: 1 in = 40 ft	Job Number: 102-04025	Drawn By: WRJ Revised By:
Date: April 1, 2004	Krazan & Associates, Inc.	Drawing Number: 1 Drawing Type: Site Map