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01-135437-CO

PAVEMENT AND FOUNDATION EVALUATION
UPS PORTLAND SITE IMPROVEMENTS
~~5550 N. BASIN AVENUE~~
PORTLAND, OREGON

Prepared for

UNITED PARCEL SERVICE
6707 N. BASIN AVENUE
PORTLAND, OREGON 97217

Prepared by
Professional Service Industries, Inc.
6032 N. Cutter Circle, Suite 480
Portland, Oregon 97217
Telephone (503) 289-1778

PSI REPORT NO. 704-15070-1

April 18, 2001

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April 18, 2001

Ms. Chantal Garner
United Parcel Service
6707 N. Basin Avenue
Portland, Oregon 97217

Subject: Proposed Pavement and Foundation Evaluation
UPS Site Improvements
5550 N. Basin Avenue
Portland, Oregon
PSI Report Number 704-15070-1

Dear Ms. Garner:

Professional Service Industries, Inc. (PSI) is pleased to submit our Geotechnical Engineering Services report for the above-referenced project. The purpose of these services was to assist you, the architect, and the engineer in designing pavement foundations and preparing plans and specifications for construction of the proposed facilities. The evaluation was completed in general accordance with your signed authorization, dated March 27, 2001 and our proposal number 704-01-P036, dated March 21, 2001. We are enclosing this detailed geotechnical evaluation report for your review.

1.0 Summary of Results

Three Standard Penetration Test (SPT) soil borings (B-1 to B-3) were completed in the proposed project area. The general soil profile was 2 to 4 inches of asphaltic pavement over approximately 8 inches of base rock. This layer was underlain by loose to medium dense dredge sand fill soils extending to the maximum explored depth of our test borings of 16.5 feet below ground surface. Groundwater was not observed in the explorations at the time of our drilling.

2.0 Summary Recommendations

Based on the results of our soil test borings, it is our opinion that the proposed fuel tank slab and fuel island canopy can be supported on conventional shallow spread footings designed for a net maximum allowable soil bearing pressure of 2,500 pounds per square foot when founded on firm dredge sand fill or on an engineered structural fill bearing on this stratum. After the site has been stripped of asphaltic pavement, the concrete slab may be placed over the native dredge sand strata, once the subgrade has been proofrolled to confirm its firmness.

3.0 Project Description

Construction proposed at this site is anticipated to consist of a 12,000-gallon fuel tank on a 15.5 foot by 46 foot concrete pad. A 30 foot by 48 foot canopy may be placed over this pad area but its loads are not presently known. Consideration is also being given to repairing or replacing the asphaltic pavement.

4.0 Scope of Services

The purpose of our evaluation was to assess the subsurface soil conditions at the site in order to provide appropriate recommendations for site preparation, foundation design and pavement thickness recommendations. In general, our evaluation included the following authorized scope of work items:

4.1 Subsurface Exploration

In order to ascertain soil conditions at the site, three Standard Penetration Test soil borings (B-1 through B-3) were made using a CME 75 truck-mounted, hollow-stem power auger equipped with an automatic hammer. Soil boring locations are shown on the attached Soil Boring Location Plan located in the Appendix. Logs of the borings are also attached.

The Standard Penetration Test is performed by driving a 2-inch, O.D., split-spoon sampler into the undisturbed formation located at the bottom of the advanced auger with repeated blows of a 140-pound, pin-guided, automatic hammer falling a vertical distance of 30 inches. The number of blows required to drive the sampler one-foot is a measure of the soil consistency (cohesive soils) and density (non-cohesive soils). It should be noted that automatic hammers generally produce lower standard penetration test values thank those obtained using a traditional safety hammer. Studies have generally indicated that penetration resistances may vary by a factor of 1.5 to 2 between the two methods. We have considered this drilling and testing methodology in our description of soil consistency, and in our evaluation of soil strength and compressibility.

Soil samples were taken at 2.5-foot intervals for the first 10 feet, and then at 5-foot intervals to the termination depths of the borings. Samples were identified in the field, placed in sealed containers, and transported to the laboratory for further classification and testing.

4.2 Laboratory Evaluation

Selected samples of the subsurface soils encountered were returned to our laboratory for further evaluation to aid in classification of the materials, and to help assess their strength and compressibility characteristics. The laboratory evaluation consisted of visual and textural examinations.

4.3 Engineering Analysis

Engineering analyses and recommendations regarding general foundation design including allowable bearing pressures, minimum footing width and depth requirements and estimates of foundation settlement are included in this report. In addition, recommendations were developed addressing asphaltic pavements.

The geotechnical recommendations presented in this report are based on the available project information, building locations, and the subsurface materials described in this report. If any of the noted information is incorrect, please inform us in writing so that we may amend the recommendations presented in this report, if appropriate and if desired by the client. PSI will not be responsible for the implementation of its recommendations when it is not notified of changes in the project.

The scope of services did not include a Seismic Site Hazard Investigation in accordance with Section 1804.2.1 of the 1998 State of Oregon Structural Specialty Code, or an environmental assessment for determining the presence or absence of wetland, or hazardous or toxic materials in the soil, bedrock, surface water, groundwater, or air, on or below, or around this site. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for information purposes. If a site-dependant earthquake response spectra or other specific design parameters are deemed necessary by the project structural engineer, or are required by the local governmental agency who has jurisdiction over the project, the geotechnical engineer should be promptly informed for further evaluation.

5.0 Site and Subsurface Conditions

5.1 Site Description

At the time of our field services, the project site was a nearly level asphaltic paved area around the existing facility. The new structures will be constructed in the previously asphaltic paved areas.

5.2 Soils and Geology

The site is located in an area known as Mock's Bottom, a part of the former Willamette River flood plain. The property is known to have been filled numerous times between 1957 and 1982 by hauling and hydraulic pumping of sand from the Willamette River. Subsurface explorations in the vicinity show the presence of a unit of sand "fill" on the site to be on the order of 15 plus feet and is known to be underlain by alluvial clay and silt, which are in turn underlain by more competent sand.

Specific soil units encountered in the explorations are briefly discussed below:

As mentioned in the Pavement Services Inc. report dated March 2, 2000, badly deteriorating asphaltic pavement of 2 to 4 inches was encountered in the borings. Pavement deterioration consisted primarily of varying degrees of alligator cracking. The asphalt pavement was underlain by the loose to medium dense sand fill strata placed over the years during dredging and extended in depth to 16.5 feet in thickness in our borings.

The soil profile described above is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The boring logs included in the appendix should be reviewed for specific information at individual test locations. These records include soil descriptions, stratifications, penetration resistances, locations of the samples and laboratory test data. The stratifications shown on the logs represent the conditions only at the actual boring locations. Variations may occur and should be expected between boring locations. The stratifications represent the approximate boundary between subsurface materials and the actual transition may be gradual. The samples that were not altered by laboratory testing will be retained for 60 days from the date of this report and then will be discarded.

5.3 Groundwater

Groundwater was not encountered in the borings at the time of drilling. However, we anticipate that the groundwater table may rise during months of peak runoff. Variations in groundwater levels should be expected seasonally, annually and from location to location. We recommend the contractor determine the actual groundwater levels at the site at the time of the construction activities.

5.4 Seismic Considerations

The site is located within Seismic Zone 3 with a seismic zone factor (z) of 0.3 as classified by the 1997 Uniform Building Code. Based on the local geology and the soil conditions encountered, we recommend that the soil profile at the site is S_D with site coefficients of C_a = 0.36 and C_v = 0.54 (Table 16Q and 16R of UBC). Our evaluation of the subsurface conditions at the site did not indicate a significant potential for soil liquefaction or landslide hazards associated with a seismic event at the site or in the vicinity of the project site. However, it should be noted that a site-specific seismic evaluation was beyond the present scope of services for this project. Such an evaluation could be performed at an additional fee with your written authorization.

6.0 Conclusions and Recommendations

Based on the results of our fieldwork, laboratory evaluation, and engineering analyses, it is our opinion that the site is suitable for the proposed structure and associated improvements provided the following recommendations are incorporated into the design and construction of the project.

6.1 Site Preparation

In general, we recommend that all structural improvement areas be drained of surface water and stripped of surface asphaltic pavement and any other deleterious materials encountered at the time of construction.

All required structural fill materials placed in the building area should be moisture conditioned to +/- 2 percent of optimum moisture content and compacted by mechanical means to a minimum of 95 percent of the material's maximum dry density as determined in accordance with ASTM D1557 (Modified Proctor). Fill materials should be placed in layers that, when compacted, do not exceed about 8 inches.

6.2 Excavations/Slopes

Temporary earth slopes may be cut near vertical to heights of 4 feet. Excavations deeper than 4 feet should be performed in accordance with Department of Labor Occupational Safety and Health Administration (OSHA) guidelines. Job site safety is the responsibility of the project contractor.

In Federal Register, Volume 54, No. 209 (October 1989), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) amended its "Construction Standards for Excavations, 29 CFR, part 1926, subpart P". This document was issued to better insure the safety of personnel entering trenches or excavations. It is mandated by this federal regulation that excavations, whether they be utility trenches, basement excavations, or footing excavations, be constructed in accordance with the new OSHA guidelines. It is our understanding that these regulations are being strictly enforced and, if they are not closely followed, the owner and the contractor could be liable for substantial penalties.

The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety procedures. In no case should slope height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal state regulations.

We are providing this information solely as a service to our client. PSI does not assume responsibility for construction site safety or the contractor's or other parties' compliance with local, state, and federal safety or other regulations.

6.3 Foundation Support

Based on the results of our soil borings, it is our opinion that the proposed tank and canopy foundations can be supported on conventional shallow spread footings designed for a net maximum allowable soil bearing pressure of 2,500 pounds per square foot (psf) when founded on the firm, undisturbed fill soil stratum, or on an engineered structural fill placed on this stratum. Footings should also be designed with a minimum continuous footing width of 18 inches. Isolated footings should be no less than 24" wide. Footings should also be set a minimum of 18" below finished grade to provide for frost protection.

The allowable soil bearing pressure of 2,500 psf is intended for dead loads and sustained live loads and can be increased by one-third for the total of all loads, including short-term wind or seismic loads.

We estimate that foundations designed and constructed in accordance with the above recommendations will experience total settlements generally less than 1-inch and differential settlement generally less then ½-inch.

If the footings are constructed during wet weather, it may be necessary to protect the foundation excavation bottoms from disturbance during construction activities. In this regard, we recommend that a 3 to 4-inch thickness of crushed rock be placed at the bottom of the footing excavations immediately after the excavation is completed. If footings are constructed during the drier summer months, this crushed rock layer should not be required.

6.4 Concrete Slab Support

The proposed slab-on-grade may be supported on structural fills placed over dredge fill subgrade after the removal of the asphaltic pavement, and the upper soils have been proof rolled with a fully loaded dump truck in order to confirm their firmness. Any soft or otherwise unsuitable areas observed should be over-excavated down to firm subgrade and replaced with structural fill.

In order to provide uniform subgrade reaction beneath any proposed floor slab-on-grade, we recommend that floor slabs be underlain by a minimum of 6 inches of free-draining (a maximum particle size of ¾ inch with less than 5 percent material passing the No. 200 sieve), well-graded gravel or crushed rock base course. This material should be moisture conditioned to within +/- 2 percent of optimum moisture content and compacted by mechanical means to a minimum of 95 percent of the material's maximum dry density as determined in accordance with ASTM D 1557 (Modified Proctor). Fill materials should be placed in layers that, when compacted, do not exceed about 8 inches.

The crushed rock should provide a capillary break to limit migration of moisture through the slab. If additional protection against moisture vapor is desired, a vapor retarding membrane may also be incorporated into the design. Factors such as cost, special considerations for construction, and the floor coverings suggest that decisions on the use of vapor retarding membranes be made by the architect and owner.

6.5 Pavement Recommendations

The following recommendations are presented for your consideration. The recommendations for heavily travelled truck traffic area have been made based on a 20-year pavement design life. Based on our conversations with Mr. Jeff Wellman of WPH Architecture, we have used an initial traffic load of 200 ESAL's (Equivalent Single Axle Loads) per day. With the traffic load growing at a rate of 4% per year, we have arrived at a final traffic load, after 20 years, of 420 ESAL's per day. For more lightly loaded car traffic areas, we have not been provided with any information and have assumed, for design purposes, a traffic loading pattern of 9 ESAL's per day. The civil engineer for the project may have more traffic and project design data available than is presently known and may wish to modify and refine these pavement sections. We will, upon request, provide a more detailed pavement design if more definite traffic plans become available.

Prior to placing the base or leveling course, the subgrade should be proofrolled with a loaded dump truck to detect areas or pockets of soft material. These areas, if encountered, should be overexcavated and replaced with structural fill. A geotextile fabric (Manufacturers and Brands: Mirafi 500X, Amoco CEF Style 2002, or an approved alternate) should be placed over any fine-grained soils (silts and clays) encountered prior to placement of base rock to prevent subgrade intrusion into the granular structural fill.

6.5.1 Asphalt Pavement

Based on our experience, for an assumed design California Bearing Ratio (CBR) value of 4 for silts and sandy silt subgrades, a pavement thickness determination using a design life period of 20 years suggests the following pavement thicknesses. For entrance, truck and driveway areas, we have used 310 equivalent 18-kip single axle loads (ESAL's) per day. This value is based on the average of the initial traffic load of 200 ESAL's per day and a final traffic load, after 4% growth for 20 years, of 420 ESAL's. For car parking areas, we have not been provided with any information and have assumed, for design purposes, 9 ESAL's per day. If the anticipated traffic exceeds these values, we should be informed so that a specific pavement design is made for the project or the design can me modified by the site civil engineer.

Based on our analysis utilizing the AASHTO Guide for Design of Pavement Structures, a typical asphalt pavement section for the anticipated traffic loads would be:

	Thickness	
Material	Entrance Service Roads	Car Parking
Asphalt Pavement (Oregon Class 'B')	4 inches	2 ½ inches
Crushed Rock Base (Oregon St. Spec.)	14 inches	8 inches

Asphalt pavement base course materials should consist of well-graded 1 ½-inch or ¾-inch minus crushed rock, having less than 5 percent material passing the #200 sieve. The base course and asphaltic concrete materials should conform to the requirements set forth in the latest edition of the State of Oregon Standard Specifications for Highway Construction. The base course material should be moisture conditioned to within +/- 2 percent of optimum moisture content and compacted by mechanical means to a minimum of 95 percent of the maximum dry density as determined by the ASTM D1557 (Modified Proctor). Fill materials should be placed in layers that, when compacted, do not exceed about 8 inches. The asphaltic concrete material should be compacted to at least 92 percent of the theoretical maximum density as determined by ASTM D2041 (Rice Specific Gravity).

6.5.2 Concrete Pavement

We recommend that concrete pavement be designed for a modulus of subgrade reaction of 150 pci. A typical concrete pavement section would be:

	Thickness	
Material	Entrance Service Roads	Car Parking
Concrete (4,000 psi)	8 inches	4 inches
Leveling Course (Sand or All-Weather Base)	2 inches	2 inches

6.6 Construction Monitoring

It is recommended that PSI be retained to examine and identify soil exposures created during project excavations in order to verify that soil conditions are as anticipated. We further recommend that structural fills be continuously observed and tested by our representative in order to evaluate the thoroughness and uniformity of their compaction. If possible, samples of fill materials should be submitted to our laboratory for evaluation prior to placement of fills on site.

It is also recommended that PSI be retained to provide observation and testing of construction activities involved in the foundation, earthwork, and related activities of this project. PSI cannot accept any responsibility for any conditions that deviated from those described in this report, nor for the performance of the foundation if not engaged to also provide construction observation and testing for this project.

Costs for the recommended observations during construction are beyond the scope of this current consultation. Such future services would be at an additional charge.

7.0 General

Our conclusions and recommendations described in this report are subject to the following general conditions:

7.1 Use of Report

This report is for the exclusive use of the addressee and their representative to use to design the proposed structure described herein and prepare construction documents. The data, analyses, and recommendations may not be appropriate for other structures or purposes. We recommend that parties contemplating other structures or purposes contact us. In the absence of our written approval, we make no representation and assume no responsibility to other parties regarding this report.

7.2 Level of Care

The recommendations contained in this report are based on the available subsurface information obtained by PSI, and design details furnished for the proposed project. If there are any revisions to the plans for this project, or if deviations from the subsurface conditions noted in this report are encountered during construction, PSI should be notified immediately to determine if changes in the foundation recommendations are required. If PSI is not retained to perform these functions, PSI will not be responsible for the impact of those conditions on the project.

Services performed by the geotechnical engineer for this project have been conducted with that level of care and skill ordinarily exercised by members of the profession currently practicing in this area. Nor warranty, expressed or implied, is made.

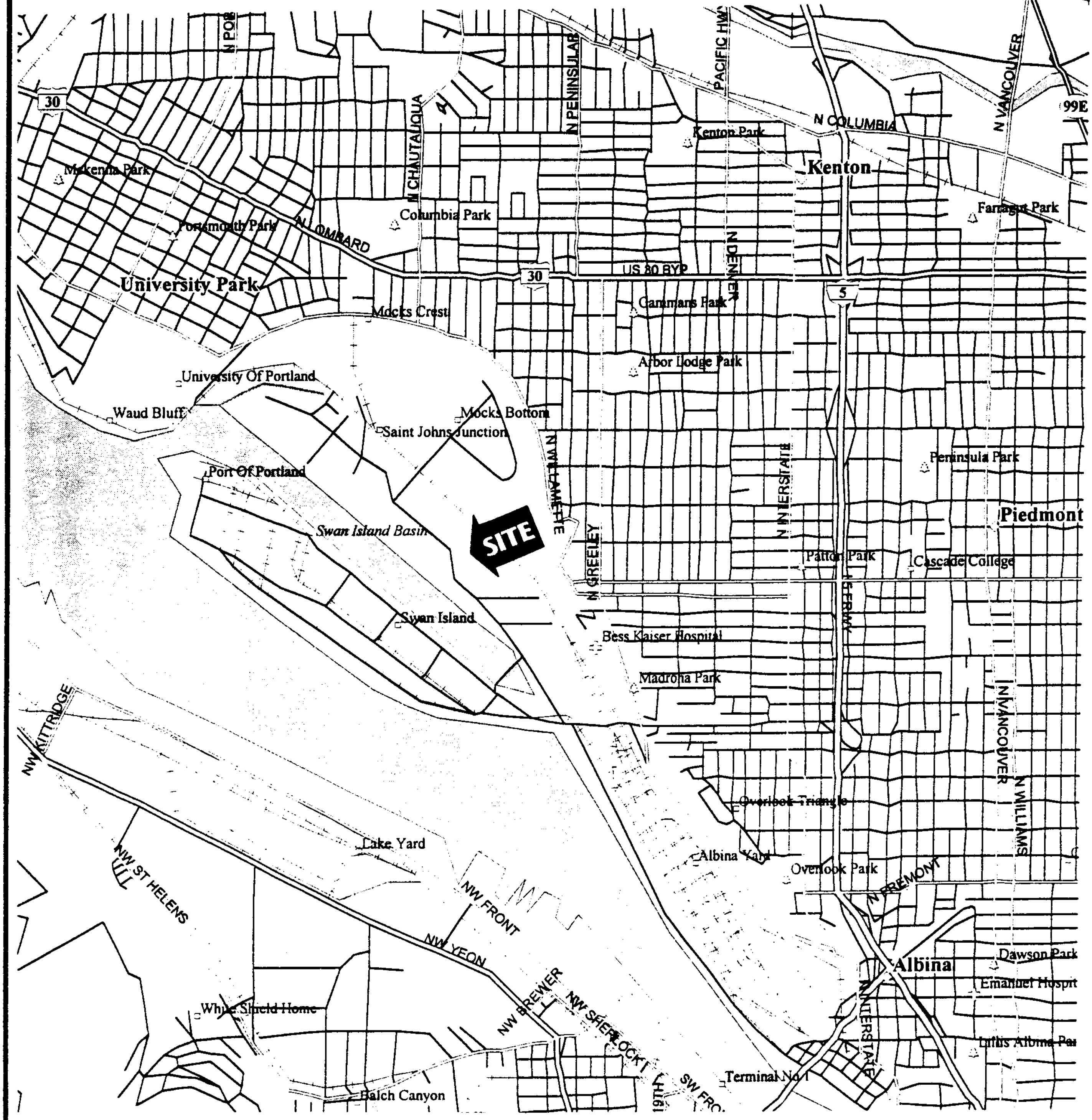
Respectfully Submitted,
Professional Service Industries, Inc.

REGISTERED PROFESSIONAL ENGINEER
19206PE
OREGON
JULY 15, 1997
TROY M. HULL

EXPIRES: 6/30 01

Andrew V. Goodell, G.I.T.
Project Geologist

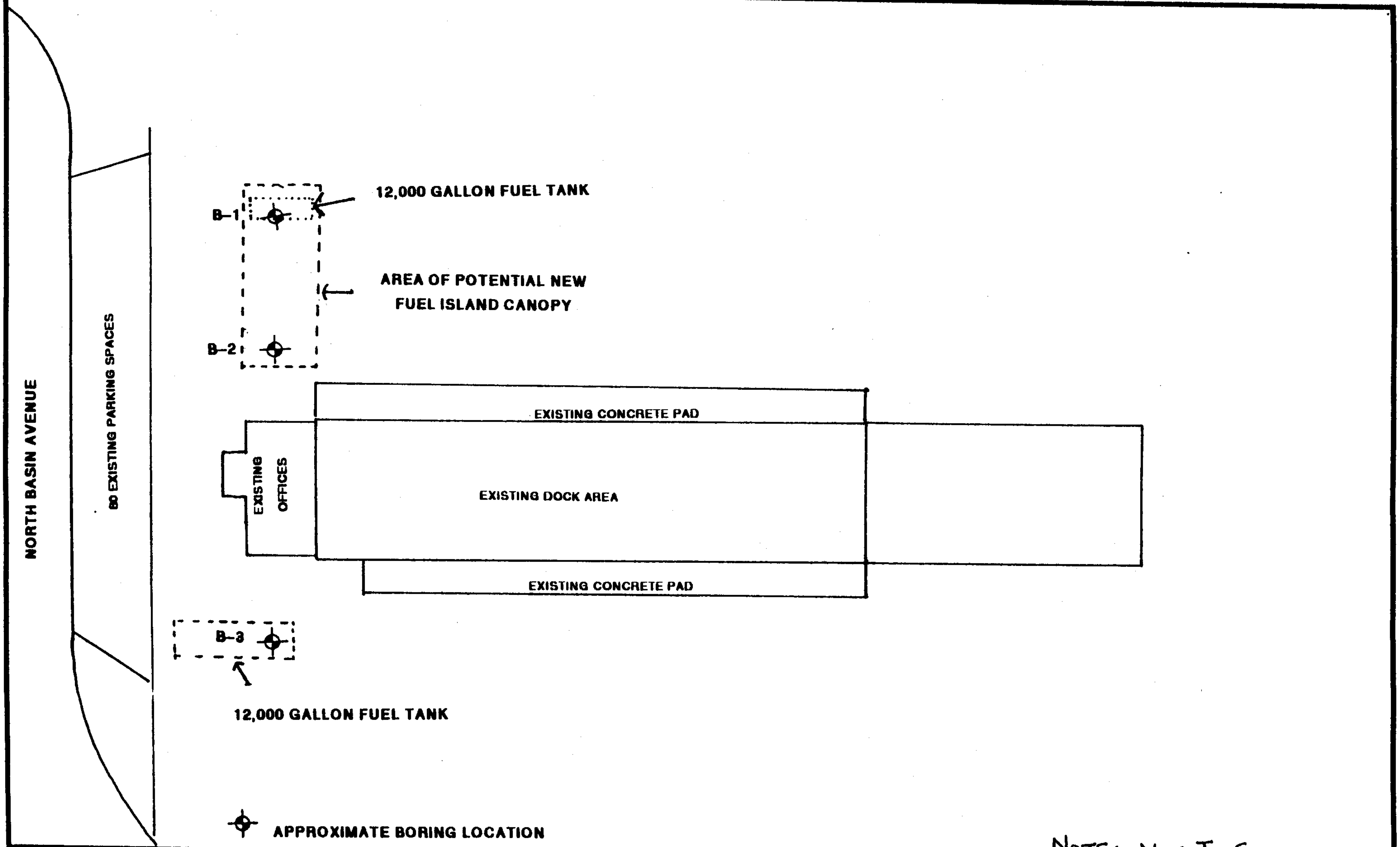
Troy M. Hull, P.E.
Senior Geotechnical Engineer



REFERENCE: DeLORME MAPPING 1993

SITE LOCATION MAP
UPS SITE IMPROVEMENTS
5550 N. BASIN AVENUE
PORTLAND, OREGON

DRAWN BY: AVG
JOB NO: 704-15070
DATE: 04/16/2001
FIGURE NO: 1
SCALE: 1:31,250



NOTE: NOT TO SCALE

BORINGLOCATION PLAN
UPS SITE IMPROVEMENTS
5550 N. BASIN AVENUE
PORTLAND, OREGON

DRAWN BY: AVG
JOB NO: 704-15070
DATE: 04/16/2001
FIGURE NO: 2

LOG OF TEST BORING NO. B-1

CLIENT: UPS
PROJECT: UPS Pavement and Foundation Evaluation
LOCATION: 5550 N. Basin Avenue Portland, OR.
PSI PROJECT NUMBER: 704-15070

DATE OF EXPLORATION: 03/30/2001
EQUIPMENT: CME75 mounted hollow stem auger
LOGGED BY: A.Goodell, GIT
BORING LOCATION: 108' north of buildings northwest corner

DEPTH, FT.	SAMPLES	SOIL DESCRIPTION	SYMBOL	U.S.C.S. CLASS	MOISTURE CONTENT(%)	N-VALUE (BLOWS PER FT.)	POCKET PEN(tsf)	% PASSING #200 SIEVE	REMARKS
	SPT 1	Approximately 2" of asphalt pavement							
		Approximately 8" of crushed gravel base course		GW		42			
		SAND - interbedded with occasional silts, loose to medium dense, moist, brown to gray		SW					
	SPT 2					21			
5	SPT 3	trace organics present				9			
	SPT 4					9			
10	SPT 5					17			
15	SPT 6	trace organic overlying small gravels				14			
20									
25									
30									

Boring terminated at 16.5' below grade. Backfilled with granular bentonite on 3/30/01. Groundwater was not encountered at the time of our drilling.

Stratification lines and depths shown are approximate. Actual soil conditions encounteed during construction may vary from those described above.

N-values shown above have been corrected (original values were multiplied by 1.5) to correspond to the safety hammer.

BL PTLD UPS.GPJ PSI CORP.GDT 4/3/01

psi
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LOG OF TEST BORING NO. B-2

CLIENT: UPS

PROJECT: UPS Pavement and Foundation Evaluation

LOCATION: 5550 N. Basin Avenue Portland, OR.

PSI PROJECT NUMBER: 704-15070

DATE OF EXPLORATION: 03/30/2001

EQUIPMENT: CME75 mounted hollow stem auger

LOGGED BY: A.Goodell, GIT

BORING LOCATION: 52' north of buildings northwest corner

DEPTH, FT.	SAMPLES	SOIL DESCRIPTION	SYMBOL	U.S.C.S. CLASS	MOISTURE CONTENT(%)	N-VALUE (BLOWS PER FT.)	POCKET PEN(tsf)	% PASSING #200 SIEVE	REMARKS
	SPT 1	Approximately 2" of asphalt pavement							
		Approximately 8" of crushed gravel base course		GW		54			
		SAND - interbedded with occasional silts, loose to dense, moist, brown to gray		SW					
	SPT 2					11			
5	SPT 3					20			
	SPT 4					9			
10	SPT 5					12			
15	SPT 6					42			
		some gravels present							
20									
25									
30									

Boring terminated at 16.5' below grade. Backfilled with granular bentonite on 3/30/01. Groundwater was not encountered at the time of our drilling.

Stratification lines and depths shown are approximate. Actual soil conditions encounteed during construction may vary from those described above.

N-values shown above have been corrected (original values were multiplied by 1.5) to correspond to the safety hammer.

BL PTLD UPS.GPJ PSI CORP.GDT 4/3/01

psi
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LOG OF TEST BORING NO. B-3

CLIENT: UPS

PROJECT: UPS Pavement and Foundation Evaluation

LOCATION: 5550 N. Basin Avenue Portland, OR.

PSI PROJECT NUMBER: 704-15070

DATE OF EXPLORATION: 03/30/2001

EQUIPMENT: CME75 mounted hollow stem auger

LOGGED BY: A.Goodell, GIT

BORING LOCATION: 2' east, 63' south of buildings southwest corner

DEPTH, FT.	SAMPLES	SOIL DESCRIPTION	SYMBOL	U.S.C.S. CLASS	MOISTURE CONTENT(%)	N-VALUE (BLOWS PER FT.)	POCKET PEN(tsf)	% PASSING #200 SIEVE	REMARKS
	SPT 1	Approximately 4" of asphalt pavement							
		Approximately 8" of crushed gravel base rock		GW		66			
		SAND to SILTY SAND - very loose to medium dense, gray, moist, varying silt content		SW					
	SPT 2					23			
5	SPT 3					17			
	SPT 4	trace of organics				3			
10	SPT 5					12			
		some small gravels present							
15	SPT 6					33			
		Boring terminated at 16.5' below grade. Backfilled with granular bentonite on 3/30/01. Groundwater was not encountered at the time of our drilling.							
20		Stratification lines and depths shown are approximate. Actual soil conditions encounteed during construction may vary from those described above.							
		N-values shown above have been corrected (original values were multiplied by 1.5) to correspond to the safety hammer.							
25									
30									

BL PTLD UPS.GPJ PSI CORP.GDT 4/3/01

psi
6032 North Cutter Circle, Suite 480
Portland, Oregon 97217-0126
(800) 783-6985

GENERAL NOTES

SAMPLE IDENTIFICATION

The Unified Soil Classificaton System is used to identify the soil unless otherwise noted.

SOIL PROPERTY SYMBOLS

N: Standard "N" penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2 inch O.D. split-spoon.

Qu: Unconfined compressive strength, TSF.

Qp: Penetrometer value, unconfined compressive strength, TSF.

Mc: Water content, %.

LL: Liquid limit, %.

PI: Plasticity index, %.

δd: Natural dry density, PCF.

▼: Apparent groundwater level at time noted after completion of boring.

DRILLING AND SAMPLING SYMBOLS

SS: Split-Spoon - 1 3/8" I.D., 2" O.D., except where noted.
ST: Shelby Tube - 3" O.D., except where noted.
AU: Auger Sample.
DB: Diamond Bit.
CB: Carbide Bit.
WS: Washed Sample.

RELATIVE DENSITY AND CONSISTENCY CLASSIFICATION

TERM (NON-COHESIVE SOILS)	STANDARD PENETRATION RESISTANCE
Very Loose	0-4
Loose	4-10
Medium	10-30
Dense	30-50
Very Dense	Over 50

TERM (COHESIVE SOILS)	Qu - (TSF)
Very Soft	0 - 0.25
Soft	0.25 - 0.50
Firm (Medium)	0.50 - 1.00
Stiff	1.00 - 2.00
Very Stiff	2.00 - 4.00
Hard	4.00+

PARTICLE SIZE

Boulders	8 in.+	Coarse Sand	5mm-0.6mm	Silt	0.074mm-0.005mm
Cobbles	8 in.-3 in.	Medium Sand	0.6mm-0.2mm	Clay	-0.005mm
Gravel	3 in.-5mm	Fine Sand	0.2mm-0.074mm		

SOIL CLASSIFICATION CHART

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS