PBS
ENVIRONMENTAL

July 15, 1999

Mr. Duane R. Cole
City Manager
City of Newberg
414 E. First Street
Newberg, Oregon 97132

Re: **GEOTECHNICAL INVESTIGATION AND SEISMIC HAZARDS REPORT PROPOSED CITY HALL EXPANSION NEWBERG, OREGON**

Dear Mr. Cole:

PBS has completed a geotechnical investigation and seismic hazards report for the proposed Newberg City Hall Expansion located at 414 E. First Street, Newberg, Oregon. The purpose of the geotechnical investigation was to evaluate and establish existing subsurface conditions at specific locations, and to assist with the design as it relates to pavements, earthwork, retaining walls, foundations, and drainage. The seismic site hazards study/report was conducted to evaluate, on a site specific basis, the vulnerability of the site to seismically induced geologic hazards, and to provide related recommendations for foundations and design ground motions. This report presents the results of our investigation and includes geotechnical engineering recommendations to be incorporated into the plans and specifications, and related opinions for design and construction of the development.

This work was performed in general accordance with Section 1804 of the 1998 Edition of the Oregon Structural Specialty Code, which provides minimum requirements for the investigation and report. This report was prepared for your use in the design of the subject facility and should be made available to potential contractors and/or the Contractor as factual data only, i.e., field logs and samples. This report should not be used for contractual purposes as a warranty of interpreted subsurface conditions such as those indicated by the formal exploration logs and/or discussion of subsurface conditions contained herein

ENVIRONMENTAL
MANAGEMENT
AND CONSULTING

1220 SW Morrison Street, Suite 600 Portland, OR 97205 503/248-1939 Fax 503/248-0223

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PROJECT AND SITE DESCRIPTION

We understand the proposed project will consist of seismic upgrades and deepening of the existing basement as well as a three story building, with basement, addition to the existing City Hall structure.

The site is located in downtown Newberg, Oregon, at the southwest corner of Highway 99W (1st Street), and Howard Street. Presently, the site is occupied by the existing City Hall and a manufactured building located on the south end of the adjacent west lot. The elevation of the vacant lot is approximately 170 feet above mean sea level. The ground surface of this site is approximately 3 feet below the sidewalk and slopes gently to the south.

FIELD EXPLORATIONS

The field exploratory program consisted of two borings (B-1 and B-2) at the approximate locations shown on the Site Exploration Plan, Figure 1. A local contractor drilled and sampled the holes on June 23, 1998. A PBS geotechnical engineer, was on site throughout the explorations to collect samples and log the borings. B-1 was terminated at 51.5 feet and B-2 was terminated at 21.5 feet. Samples were taken at 2.5 and 5.0 foot intervals for the length of the holes.

Laboratory Testing

All samples were visually examined in our laboratory to refine the field classifications in general accordance with the Unified Soil Classification system (visual-manual procedure), described in Table 1 at the end of this report. Laboratory testing included:

- Moisture contents on all applicable samples (ASTM D-4959), test results are shown on the right side of the formal boring logs provided in Figures 2 and 3. Moisture contents of the upper Catastrophic Flood deposits varied from 28% to 48%. Moisture contents for the underlying Troutdale Formation ranged from 20% to 44%.

- Nine sieve tests were performed to determine fines content of the sands for use in the liquefaction analysis (ASTM D-1140; percent passing No. 200 sieve). Results indicate silt contents ranging from 5% to 57%. Fines contents are shown numerically on the right of the soil descriptions in the Formal Boring Logs.

SUBSURFACE CONDITIONS

The analysis, conclusions and recommendations contained in this report are based on site conditions as they existed at the time of exploration and assume the soil borings are representative of the subsurface conditions throughout the site. If, during construction, subsurface conditions differ from those encountered in the soil borings, we should be advised at once so that we may review these conditions and reconsider our recommendations where necessary.

The subsurface conditions at the site disclosed by the soil borings were relatively uniform. Both of the borings encountered a layer of stiff to very stiff, mottled brown, moist, low plasticity, silty fill material varying 2 to 3 feet in thickness. This material is overlain by a sod zone, approximately 3 inches thick, consisting of a dense layer of grass and grass roots.

Underlying the fill material are varying layers of silty sands and clayey silts. These layers are typically medium stiff to stiff in the fine grained areas and loose to medium dense in the granular segments. The colors change from mottled brown to green-grey beneath the historical water table. The fine grained material displayed low plasticity and the granular material was non-plastic. All samples were wet below a depth of 11 feet. This deposit is interpreted as Catastrophic Flood Deposits.

Underlying this unit are very stiff to hard, green-grey and brown mottled, wet, low plasticity layers of silty clay and clayey silt. This soil was observed to depths explored in B-1 (51.5 feet). This formation is interpreted as being the Troutdale Formation.

Groundwater Conditions

Saturated soils were encountered in both borings between 10 and 11 feet below the ground surface. Static water levels were observed between 6.5 and 7.0 feet below the ground surface upon completion of the soil borings. Holes were backfilled following the explorations.

Site Geology

Site geology is interpreted from site explorations that provided data to a depth of 51.5 feet. Published geologic information was utilized for geologic interpretation below this depth. Our interpretation of the subsurface geologic profile is as follows:

Depth	Soil Unit and Consistency
0-3 feet	Stiff to very stiff silt, Fill.
3-32 feet	Loose/medium stiff silty sands and clayey silts, Catastrophic Flood Deposits
32-150 feet	Stiff to hard silt and clay, Troutdale Formation
~150 feet +	Sandstone bedrock, Spencer Formation

Regional Geology

Newberg is located approximately 20 miles southwest of Portland, Oregon on Highway 99W. The project site is underlain by a layer of Quaternary soils that were deposited some 10,000 years ago during the Catastrophic Floods, originating from ice damming at the Clarks Fork River in Idaho and Grand Coulee, Washington. Beneath this formation, and extending to depths of approximately 150 feet is the Troutdale Formation. The underlying bedrock is indurated marine sediments and volcanic rocks of the Spencer Formation (Yeats, 1991).

SEISMIC CHARACTERIZATION

Sources

In the Pacific Northwest, little information is known about which faults may be active, their potential earthquake magnitudes and recurrence intervals. Therefore a deterministic method of developing design earthquakes is used herein, as opposed to a probabilistic method, based on instrument recorded fault activity.

In the past 10 years, several studies have been made of potential earthquake sources in the Pacific Northwest, and these studies have identified three general source zones that appear to be capable of major earthquakes. These source zones consist of the following:

1. Large Subduction Zone earthquakes could be generated along the Cascadia Subduction Zone (CSZ) interface. The nearest segment of the seismogenic portion of the interface zone to the Newberg area is interpreted to be approximately 120 km (62 miles) west, based on the tectonic model discussed by Wong and Silva (1998). An earthquake with a moment magnitude of 8.5 (M_W=8.5) was selected as the likely maximum plausible event from that part of the subduction zone by Weaver and Shedlock (1989).

2. Deep-Focus earthquakes could originate from within the subducting oceanic plate. Such events, called intraplate earthquakes, could be as large as M_W=7.5 originating 65 km beneath Newberg (Geomatrix, 1995). However, the resulting ground shaking produced by such an intraplate earthquake would be of lower intensity and less prolonged in the Newberg area than ground motions generated by a significant subduction zone or crustal fault event, and as a result this source is not considered further.

3. Shallow-Focus crustal earthquakes could be generated by fault rupture within the crust of the North American Plate in the Newberg area and little is known about which faults are active within the immediate vicinity. The Mt. Angel Fault is a potentially active fault with a probability for activity of 0.6 (scale 0.0-1.0) and is situated approximately 20 miles southeast of Newberg. A series of small earthquakes occurred near Woodburn in 1990 along this fault. A larger M_C=5.6 occurred near the town of Scotts mills in March 1993, about 8 km northwest of the mapped surface trace of the Mount Angel fault.

A Geologic Study (Yeats and others, 1991) identifies various geologic features, most notably local faulting features in the Woodburn area, and specifically the Mt. Angel Fault. Currently, the Mt. Angel fault is considered to be active, and it's movement is expected to be primarily lateral (strike slip with the northeast side moving in the direction of Portland), but may also contain a smaller vertical component (thrust with upside to the northeast). Werner and others (1992), after discussing the vertical and horizontal components of nearly identical sets of seismograms recorded during a 1990 swarm of small earthquakes below Woodburn, states that a pure strike slip mechanism is acceptable.

Additional faulting has been identified with a structure known as the Newberg fault. This is a northwest-trending fault which has been mapped over a length of 8 km. Because no evidence to suggest that the Newberg fault has been active in the Quaternary (2-3 million years), Geomatrix (1995) assigned a low probability of activity. However, due to the alignment with the Mt. Angel Fault and recent events along the Mt. Angel alignment, it is our opinion that the fault should be presumed active.

Historic Seismicity

The Scotts Mills earthquake of March 25, 1993, at M_W=5.5, is the largest instrumentally recorded earthquake located in western Oregon. At least 17 events of M_W=4.0 and larger have occurred in the Portland area in historic time; six events have been M_W=5.0 or greater (Bott and Wong, 1993). However, the historical record for the Portland Region is only about 150 years long, and prior to

1980, when the University of Washington expanded its regional network of seismographs into northwestern Oregon, few stations operated in Oregon; and thus, very little direct information is available to determine earthquake recurrence intervals, active fault locations, and resulting probability based design parameters.

Recently (1983-1990), several smaller earthquakes (M_W=2.0 to 3.0) were recorded in the vicinity of Woodburn (Werner and others, 1992). Werner believes that the locations are only accurate to about +/- 2 kilometers, but that some occurred on the same fault plane due to the similarity of the recordings. Werner also concluded that the faulting occurred some 15 to 20 kilometers below the surface.

Although there is no historical record of large subduction zone earthquakes in the Pacific Northwest, sufficient geologic evidence exists in coastal estuaries to hypothesize great Cascadia Subduction Zone (CSZ) earthquakes with an average recurrence interval as low as 500 years (Crouse, 1994). The evidence is in the form of repeated catastrophic flooding and associated uplift and down drops in the geologic record.

Seismic Design

The Design Basis Ground Motion defined in the Uniform Building Code (UBC) should, as a minimum, be one having a 10% probability of occurrence in 50 years (approximately 1 per 500 years). The following design earthquakes and corresponding design basis ground motions represent the results of our deterministic study.

For comparison, the default UBC ground motions are also shown in the table.

Site-Specific Design Basis Ground Motions and UBC Default Motions

Earthquake Source	Moment Magnitude	Distance	Mean Peak Bedrock Acceleration	Seismic Coefficient C_a	Seismic Coefficient C_v
CSZ	8.5	120 km	0.15	0.22	0.32
Mt. Angel/ Newberg	6.0	5 km	0.27	0.34	0.50
UBC	--	--	0.30	0.36	0.54

The subduction zone earthquake selected (M_W=8.5, R=120 km) would produce, on average, a peak horizontal bedrock acceleration of 0.15 g based on recent ODOT studies (Geomatrix, 1995). The local Crustal event selected (M_W=6.0, R=5 km) would produce mean peak bedrock accelerations on the order of 0.27 g based on crustal fault bedrock records (GeoMatrix, 1995). The above Coefficients C_a and C_v are based on Soil Type S_D as defined in the UBC.

Based on this study, the UBC Zone 3 coefficient of Z=0.3 and Soil Type S_D, appear to conservatively envelop the design earthquake ground motions anticipated. Based on our site-specific analysis, the Design Basis Ground Motions tabulated above for the random crustal event are the minimum that should be utilized for structural design. Alternatively, the above default UBC coefficients may be used.

Seismic Hazards

We have evaluated the seismic hazards listed below and in our opinion these hazards do not exist at this site:

- earthquake induced landslide
- fault displacement beneath the structure
- tsunami or seich
- seismic induced settlement

Liquefaction- Our liquefaction evaluation was based on the simplified method as modified by Seed and Harder (1990). The areas determined to be liquefiable under the design earthquake are and sieve analysis results are shown on the Formal Boring Logs. Liquefiable soils were encountered between 9 and 17 feet below the ground surface in B-1 and between 8 to 22 feet in B-2.

Following preliminary engineering, the project design team reached a consensus regarding foundation options when considering the liquefaction potential. We are in agreement that a slab foundation is the most practical foundation system. In our opinion, the slab foundation reduces the risk of unacceptable foundation settlement (bearing failure) to acceptable levels.

GEOTECHNICAL DESIGN RECOMMENDATIONS

Earthwork

General - We recommend performing earthwork between August and November when water tables are expected to be at seasonal lows.

All excavations in the fine grained soils should be performed by an excavator or back-hoe equipped with a smooth-faced bucket (no teeth), and in such a manner that positive drainage is provided during the excavation of the final 3 feet.

Excavations - In our opinion, all excavations can be accomplished with conventional excavating equipment. Because of safety considerations and the nature of temporary excavations, the Contractor should be made responsible for maintaining safe temporary cut slopes, shorings and supports for utility trenches, etc. We recommend that the Contractor incorporate all pertinent safety codes during construction including the latest OR-OSHA revised excavation rules, and based on soil conditions and groundwater evidenced in cuts made during construction.

Structural Fills - Structural fills are anticipated to be limited to the slab base and wall backfill area of the building footprint. Basement wall backfill should be constructed to the general requirements provided in Figure 4 or other approved methods for draining basement walls. The thickness of the lifts will need to be determined in the field and based upon equipment utilized by the contractor. For small plate compactors, the lifts should be restricted to about 4 inches loose measure. Slab base (fill) methods and requirements are provided in the Slab Foundation Preparation section of this report.

Foundations

Foundation Design - Based on the field exploration program and our understanding of the proposed project, it is our opinion that the proposed structure can be satisfactorily supported on a slab foundation founded on undisturbed native soils or compacted base rock.

Based on the field explorations, testing, and liquefaction assessment, we recommend a maximum allowable bearing pressure of 800 pounds per square foot (psf) including seismic loads.

Additional design information is included in the "Seismic Design" section (page 6) of this report.

Slab Foundation Preparation - To minimize the potential for disturbance of the soil during excavation for the footings, it is recommended that slab excavations be made by an excavator or back-hoe equipped with a smooth-faced bucket (no teeth). Each foundation excavation should be evaluated by a qualified Geotechnical Engineer or their representative to confirm consistent and acceptable bearing conditions for placement of base rock. If unsuitable soil is encountered at footing locations, we recommend that the unsuitable soil be over-excavated and backfilled with structural fill.

Settlement - Based on our preliminary knowledge of the project, and for foundations designed as described in the preceding paragraphs, we estimate a maximum settlement of 1 inch or less. Differential settlement will be in the order of 50 to 75 percent of the maximum over 50 feet. Our settlement estimate assumes that no disturbance to the foundations soils would be permitted during excavation and construction, and that footings are prepared as described in the preceding paragraphs.

The foundation slab for the existing City Hall basement addition should be founded on an 8-inch layer of free-draining, well-graded, aggregate base with a maximum particle size between 3/4 and 1-1/2 inches. Slabs on grade for the new construction should be founded on a minimum 12-inch layer of the same material. Additional stabilization rock or thickened section may be required depending on conditions encountered, and we recommend that the Geotechnical Engineer be present during the final 18-inches of the excavation. The base rock should not contain more than 5 percent passing the No. 200 sieve (ASTM D 1140) and be compacted to a dry density between 95 and 98 percent of the standard Proctor maximum dry density (ASTM D 698). A moisture vapor barrier and/or waterproofing is also recommended beneath the slab in finished. Prior to placing slab rock, subgrades are to be compacted to 95% in the upper 12 inches if moisture contents and weather conditions allow.

Lateral Loading

Tables 1 through 4, located at the end of this report provide formulas to develop the lateral loads over a wide range of conditions anticipated at the basement walls. Loading of these walls comes from 2 sources, lateral earth (soil) pressures and lateral loading from adjacent structures. The lateral footing load (q), from adjacent structures, was unknown in each case. In order to calculate the total lateral loading, the equation at the right of the each table must have the footing load (q) incorporated into it. The units of the footing load should be inputted as lb/ft.

Assumptions used during the development of lateral loads included:

- temporary drained conditions (during construction)
- permanent drained conditions (post construction)
- calculations are based on dimensions provided
- soil density is assumed to be 105 lb/cu.ft.

The Contractor shall be responsible for the design and safety of all shoring required along excavation walls.

Drainage

The Contractor should be made responsible for temporary drainage of surface and groundwater as necessary to prevent standing water within 3 feet of the proposed subgrade and at the working surface. Under-slab drains should be placed on a maximum spacing of 25 feet and include a drain at the perimeter. Interior and perimeter slab subdrains should be placed 6-12 inches below slab subgrades and be constructed with a filter sock wrapped perf-pipe embedded in a sand filled 8-12 inch wide trench. All drain pipes should be a minimum of 4 inches in diameter.

All utility trenches in paved areas should be backfilled with granular material containing less than 10% fines (passing #200 sieve).

Quality Control

For this site, we recommend the following quality control program:

- observation of excavation,
- observation and compaction testing of slab section subgrades,
- engineering observation of foundation bearing surfaces,
- compaction testing of structural fills.

The observation and testing should be performed by an individual experienced in earth work construction methods, as well as the recommendations included herein. We recommend that PBS provide this service.

LIMITATIONS

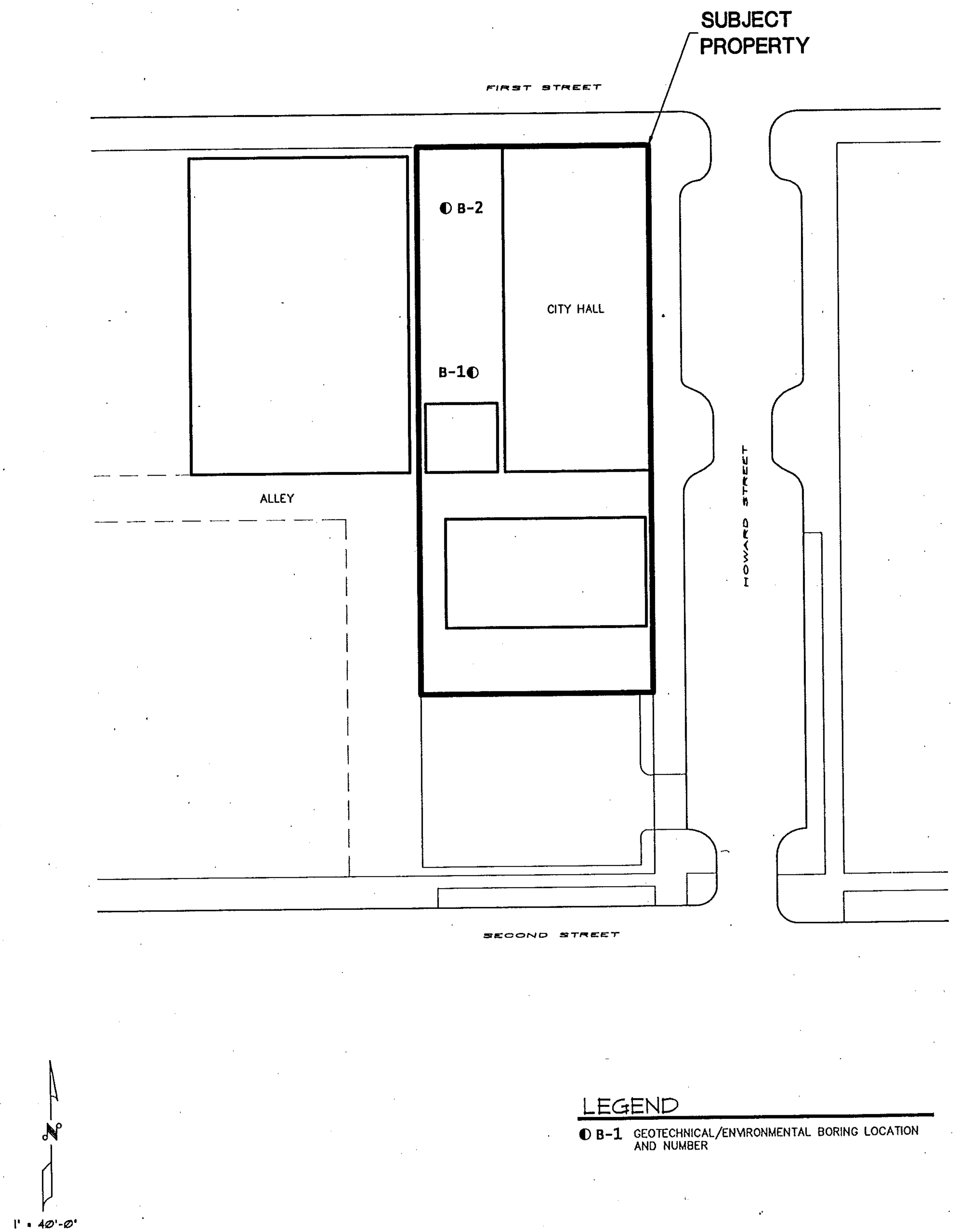
If there is a substantial lapse of time between the submission of this report and the start of work at the site, if conditions have changed due to natural causes or construction operations at or adjacent to the site, or if the basic project scheme is significantly modified from that assumed, it is recommended that this report be reviewed to determine the applicability of the conclusions and recommendations considering the changed conditions and time lapse.

Unanticipated soil conditions and seasonal soil moisture variations are commonly encountered and cannot be fully determined by merely taking soil samples, or soil borings. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra cost.

Sincerely,
PBS Environmental

Alan P. Bean, P.E.
Senior Geotechnical Engineer

Attachments: Figures 1 through 4, Table 1, Appendix 1



12748.00 JULY 1998	SITE EXPLORATION PLAN NEWBERG CITY HALL 414 EAST FIRST STREET NEWBERG, OREGON	PBS ENVIRONMENTAL	1220 SW MORRISON PORTLAND, OREGON 97205 (503) 248-1939 FAX (503) 248-0223	FIGURE 1

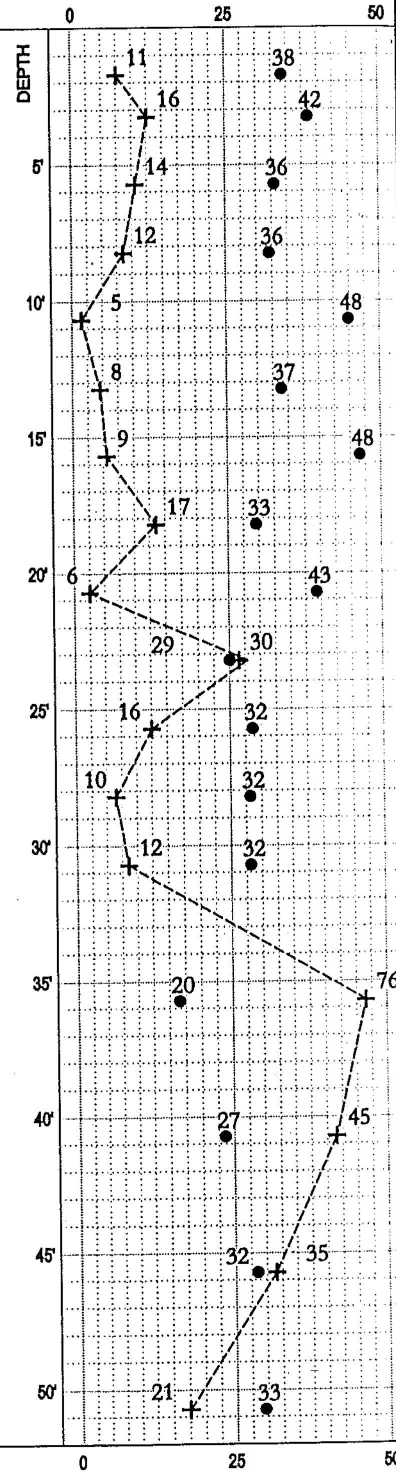
7/9/99 15:26 P:\12000\12748\Site Plan.dwg

EXPLORATORY BORING RECORD

Project Name:	NEWBERG CITY HALL	Date:	JUNE 23, 1998
Project Number:	12748.00	Completed Depth:	50'
Drilled By:	CRISMAN	Reference Elevation:	N/A
Drill Type:	HOLLOW STEM 0' TO 15' - MUD ROTARY 15' TO 50'	Recorded By:	G.J.K.

USC	SOIL DESCRIPTION	SAMPLES	FINES CONTENT
ML	**CLAYEY SILT**, medium soft to stiff, brown mottled, moist, low plasticity, trace sand, 2" topsoil.	S-1	
		S-2	
SM	**SILT**, slightly sandy, stiff, brown mottled, moist, low plasticity, trace clay.	S-3	
ML	**CLAYEY SILT**, stiff, brown mottled, moist, low plasticity	S-4 (water level observed)	
SM	**SILTY SAND to SANDY SILT**, loose becoming medium dense, brown and grey green, wet, with low plasticity clay lenses.	S-5	48%
ML		S-6	20%
SM		S-7	57%
SM		S-8	55%
MH	**CLAYEY SILT**, medium stiff, blue green, wet, medium plasticity.	S-9	
MH	**SILTY CLAY**, medium stiff, blue green, wet, medium plasticity, (Willamette Silt Formation).	S-10	
		S-11	
		S-12	
		S-13	
CH	**SILTY CLAY**, very stiff, green grey mottled, wet, medium plasticity.	S-14	
		S-15	
ML	**CLAYEY SILT**, very stiff to hard, brown mottled, wet, low plasticity, trace sand and rock fragments (Troutdale Formation).	S-16	
	Bottom of boring (completed June 23, 1998).	S-17	

TEST RESULTS



LEGEND

- DISTURBED GRAB SAMPLE
- * SAMPLE NOT RECOVERED
- ▼ WATER LEVEL (OBSERVED)
- + = STANDARD PENETRATION TEST, BLOWS PER FOOT
- ● = MOISTURE CONTENT %

B-1

FORMAL LOG

1220 SW MORRISON
PORTLAND, OREGON
97205
(503) 248-1939
FAX
(503) 248-0223

NOTES

1. SOIL INTERFACES AND DESCRIPTIONS ARE INTERPRETIVE AND ACTUAL CHANGES AND TRANSITIONS MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.

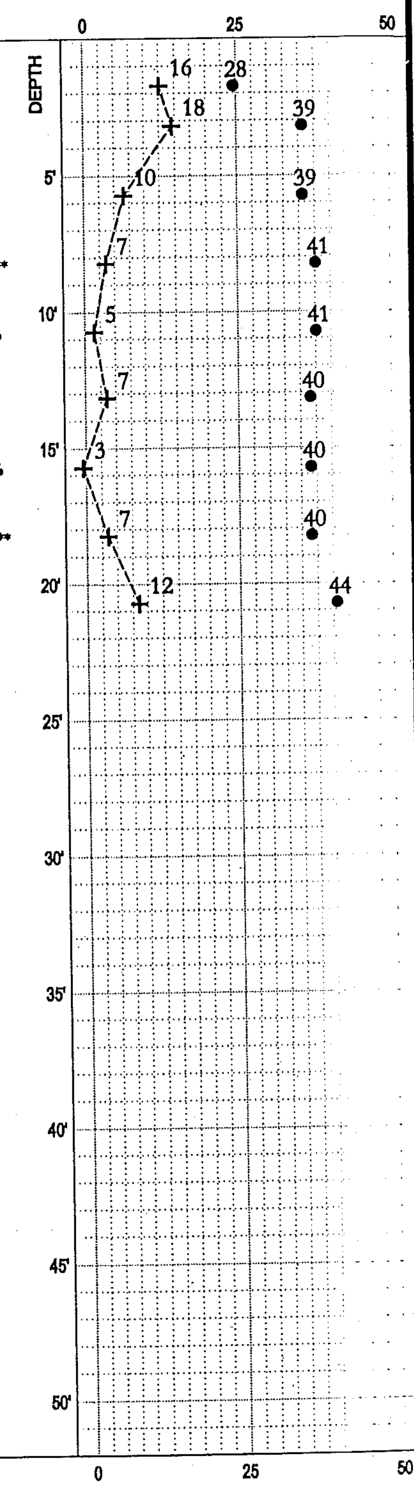
FIGURE 2

EXPLORATORY BORING RECORD

Project Name: NEWBERG CITY HALL
Project Number: 12748.00
Drilled By: CRISMAN
Drill Type: HOLLOW STEM AUGER

Date: JUNE 23, 1998
Completed Depth: 50'
Reference Elevation: N/A
Recorded By: G.J.K.

USC	SOIL DESCRIPTION	SAMPLES	FINES CONTENT
ML	**SILTY CLAY**, stiff, mottled brown, moist, low plasticity, (compacted native fill in upper 3 feet).	S-1	
		S-2	
		S-3	
SM	**SILTY SAND**, loose becoming medium dense at 20 feet, brown and grey green, wet, low plasticity clay lenses, (Willamette Silt Formation).	S-4	24%**
		S-5	50%
		S-6	5%
		S-7	44%
		S-8	21%**
	Bottom of boring (completed June 23, 1998).	S-9	



LEGEND

DISTURBED GRAB SAMPLE

* SAMPLE NOT RECOVERED

WATER LEVEL (OBSERVED)

\+ = STANDARD PENETRATION TEST, BLOWS PER FOOT

● = MOISTURE CONTENT %

** - INDICATES SIEVE TEST PERFORMED ON SANDY PORTION OF SAMPLE

PBS ENVIRONMENTAL
1220 SW MORRISON
PORTLAND, OREGON
97205
(503) 248-1939
FAX
(503) 248-0223

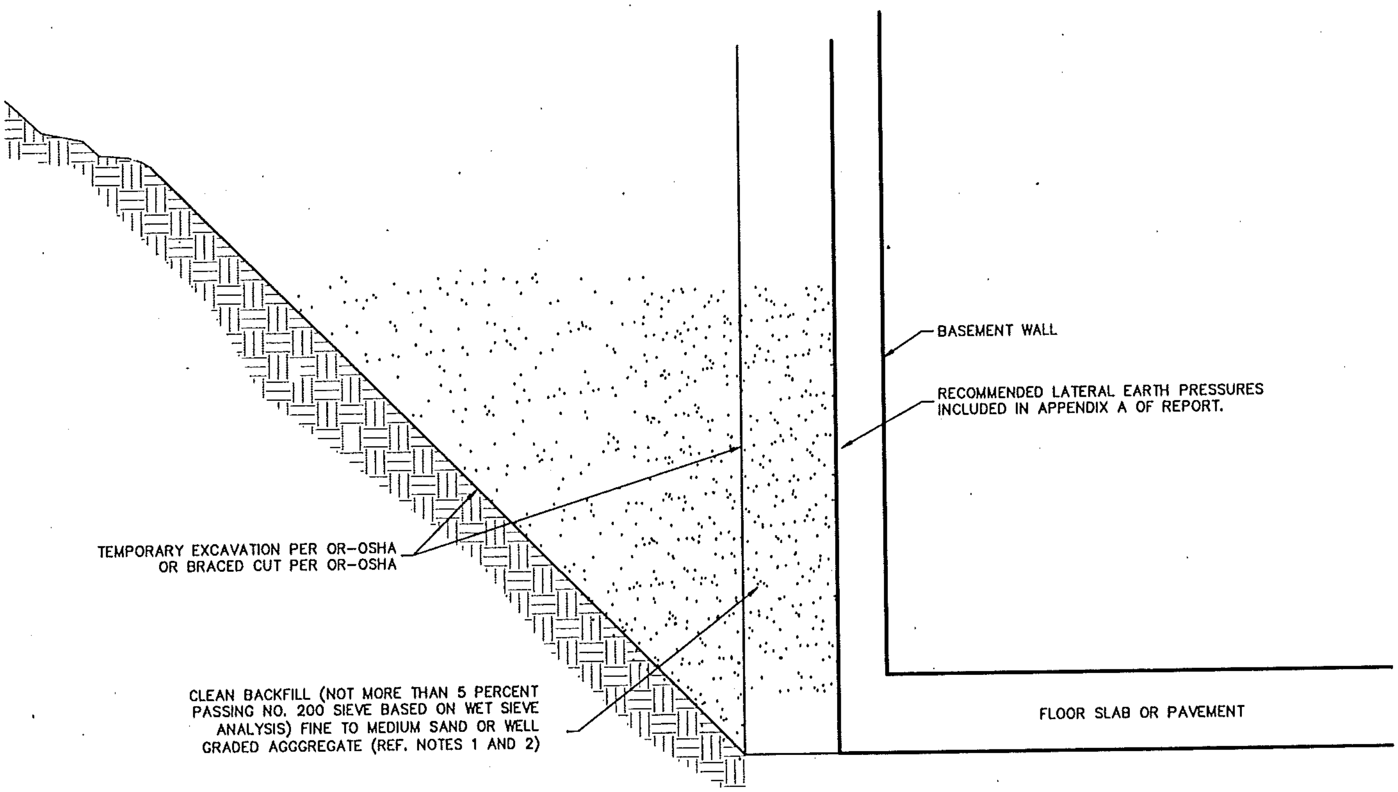
B-2

FORMAL LOG

NOTES

1. SOIL INTERFACES AND DESCRIPTIONS ARE INTERPRETIVE AND ACTUAL CHANGES AND TRANSITIONS MAY BE GRADUAL.
2. WATER LEVEL IS FOR DATE SHOWN AND MAY VARY WITH TIME OF YEAR.

FIGURE3



(1) BASEMENTWALL BACKFILL AND DRAINAGE DETAIL

NOT TO SCALE

NOTES

1. COMPACT CLEAN SAND TO 92 PERCENT OF STANDARD PROCTOR MAXIMUM DRY DENSITY.

12784.00 JUNE 1998	BASEMENTWALL BACKFILL DETAIL PROPOSED NEWBERG CITY HALL NEWBERG, OREGON	PBS ENVIRONMENTAL 1220 SW MORRISON PORTLAND, OREGON 97205 (888) 248-1939 FAX (503) 248-0223	FIGURE 4

7/14/99 14:29 P:\12000\12860\FIGURE 8.dwg

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TABLE 1: Soil Classification Criteria and Terminology.

Classification of Terms and Content

NAME — MINOR Constituents (12-50%) MAJOR Constituents (>50%)
Slightly (5-12%)
Relative Density or Consistency
Color
Moisture Content
Plasticity
Trace Constituents (0-5%)
Other: Grain Shape, Approximate gradation, Organics, Cement, Structure, Odor...
Geologic Name or Formation: (Fill, Willamette Silt, Till, Alluvium...)

USCS Grain Size

Fines		<#200 (.08mm)
Sand	Fine	#200 - #40 (.4mm)
	Medium	#40 - # 10 (5mm)
	Coarse	#10 - #4 (5mm)
Gravel	Fine	#4 - .75 inch
	Coarse	.75 inch - 3 inches
Cobbles		3 to 12 inches; scattered <15% est., 'numerous >15% est.
Boulders		> 12 inches

Relative Density or Consistency

Granular Material

SPT Blows/ft	Density
0-4	Very Loose
4-10	Loose
10-30	Medium Dense
30-50	Dense
> 50	Very Dense

Fine Grained (cohesive) Materials

SPT Blows/ft	Consistency	Torvane.tsf Shear Strength	Pocket Pen. tsf Unconfined	Manual Penetration Test
<2	Very Soft	<0.13	<0.25	Easy several inches by fist
2 - 4	Soft	0.13 - 0.25	0.25 - 0.50	Easy several inches by thumb
4 - 8	Medium Stiff	0.25 - 0.50	0.50 - 1.00	Moderate several inches by thumb
8 - 15	Stiff	0.50 - 1.00	1.00 - 2.00	Readily indented by thumb
15 - 30	Very Stiff	1.00 - 2.00	2.00 - 4.00	Readily indented by thumbnail
>30	Hard	>2.00	>4.00	Difficult by thumbnail

Moisture Content

Dry: Absence of moisture, dusty, dry to the touch
Damp: Some moisture but leaves no moisture on hand
Moist: Leaves moisture on hand
Wet: Visible free water, from below water table

	Plasticity	Dry Strength	Dilatancy	Toughness
ML	Non to Med	None to Low	Slow to Rapid	Low, can't roll
CL	Low to Med	Medium to High	None to Slow	Medium
MH	Med- High	Low to Medium	None to Slow	Low to Medium
CH	Med-High	High to V. High	None	High

Structure

Stratified: Alternating layers of material or color >6mm
Laminated: Alternating layers <6mm thick
Fissured: Breaks along definite fracture planes
Slickensided: Striated, polished, or glossy fracture planes
Blocky: Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lenses: Has small pockets of different soils, note thickness
Homogeneous: Same color and appearance throughout

Unified Soil Classification Chart (Visual-Manual Procedure); (similar to ASTM Designation D2488)

Major Divisions			Group Symbols	Typical Names
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels: 50% or more retained on the No. 4 sieve	Clean Gravels	GW	Well-graded gravels and gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines
		Gravels with Fines	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	Sands: more than 50% passing the No. 4 sieve	Clean Sands	SW	Well-graded sands and gravelly sands, little or no fines
			SP	Poorly graded sands and gravelly sands, little or no fines
		Sands with Fines	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
Fine-Grained Soils 50% or more passes No. 200 sieve	Silt and Clays Low Plasticity Fines		ML	Inorganic silts, rock flour, clayey silts
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
	Silt and Clays High Plasticity Fines		MH	Inorganic silts, clayey silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity
Highly Organic Soils			PT	Peat, muck, and other highly organic soils

APPENDIX A

Lateral Forces on Existing City Hall

Table 1

North and East Walls of Existing Structure

x= 3 n=z/H
H= 3 EFP=35
m=X/H 1.0

below footing	n	footing load	q	earth pressure	combined loading (lb/ft)
0.5	0.167	0.067	q	157.5	.067q+157.5
1	0.333	0.115	q	175.0	.115q+175.0
1.5	0.500	0.136	q	192.5	.136q+192.5
2	0.667	0.136	q	210.0	.136q+210.0
2.5	0.833	0.123	q	227.5	.123q+227.5
3	1.000	0.106	q	245.0	.106q+245.0

q=load from footing

Table 2

South Wall of Existing Structure

x= 3 n=z/H
H= 4.5 EFP=35
m=X/H 0.67

below footing	n	footing load	q	earth pressure	combined loading (lb/ft)
0.5	0.111	0.067	q	157.5	.067q+157.5
1	0.222	0.115	q	175.0	.115q+175.0
1.5	0.333	0.136	q	192.5	.136q+192.5
2	0.444	0.136	q	210.0	.136q+210.0
2.5	0.556	0.123	q	227.5	.123q+227.5
3	0.667	0.106	q	245.0	.106q+245.0
3.5	0.778	0.089	q	262.5	.089q+262.5
4	0.889	0.073	q	280.0	.073q+280.0
4.5	1.000	0.060	q	297.5	.060q+297.5

q=load from footing

Note:
West Wall of Existing Stucture will not Experience Lateral Earth Pressures.

Lateral Forces on New Structure

Table 3

West Wall of New Structure

x= 0.25 n=z/H
H= 6 EFP=35
m=X/H 0.04

below footing	n	footing load	q	earth pressure	combined loading (lb/ft)
0.5	0.083	0.407	q	17.5	.407q+17.5
1	0.167	0.070	q	35.0	.070q+35.0
1.5	0.250	0.022	q	52.5	.022q+52.5
2	0.333	0.010	q	70.0	.010q+70.0
2.5	0.417	0.005	q	87.5	.005q+87.5
3	0.500	0.003	q	105.0	.003q+105.0

q=load from footing

Note:
East Wall of New Structure will not Experience Lateral Earth Pressures.

Table 4

North and South Walls of New Structure

H=9 EFP=35

depth below ground surface	earth pressure (lb/ft)
0.5	87.5
1.0	105.0
1.5	122.5
2.0	140.0
2.5	157.5
3.0	175.0
3.5	192.5
4.0	210.0
4.5	227.5
5.0	245.0
5.5	262.5
6.0	280.0
6.5	297.5
7.0	315.0
7.5	332.5
8.0	350.0
8.5	367.5
9.0	385.0