

**REPORT  
GEOTECHNICAL ENGINEERING SERVICES  
14TH AVENUE FORCEMAIN AND  
GRAVITY SEWER EXTENSION  
OLYMPIA, WASHINGTON**

**APRIL 13, 2006**

**FOR  
HDR, INC.**

**Geotechnical Engineering Services**  
**File No. 11763-002-00**

**April 13, 2006**

**Prepared for:**

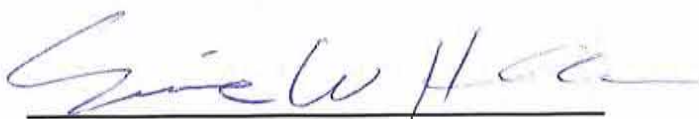
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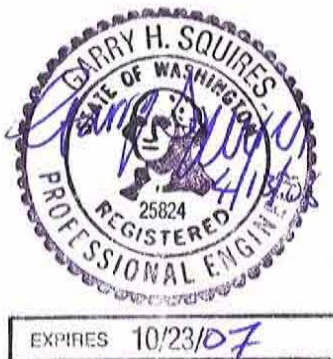
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**REPORT  
GEOTECHNICAL ENGINEERING SERVICES  
14TH AVENUE FORCEMAIN AND GRAVITY SEWER EXTENSION  
OLYMPIA, WASHINGTON  
FOR  
HDR, Inc.**

**INTRODUCTION AND PROJECT UNDERSTANDING**

This report represents the results of our subsurface exploration and geotechnical evaluation for the installation of approximately 1,800 lineal feet of sewer extension along 14th Avenue in Olympia, Washington. The project area is approximately as shown on the Vicinity Map, Figure 1.

We understand that approximately 1,100 lineal feet of forcemain and 700 lineal feet of gravity sewer are proposed along 14th Avenue. This will extend east/west along 14th Avenue, between the existing Kaiser Road Station forcemain (to the west) to connect with a gravity interceptor being constructed along Cooper Point Road to its intersection with 14th Avenue. The 1,100 feet of forcemain will be approximately 12-inch diameter, with 5 feet of cover. The 700 feet of gravity sewer will be approximately 12-inch diameter, with approximately 8 to 12 feet of cover.

**PURPOSE AND SCOPE**

The purpose of our services is to perform limited subsurface exploration, testing and analysis as a basis for evaluating potential geotechnical issues and constraints that should be considered in design. Our scope of services is as follows:

1. Reviewing selected existing geologic and soil reports and in-house files available in our library.
2. Drilling 10 borings along the proposed 1,800 feet of alignment. The borings were drilled to depths of 9 to 16-1/2 feet below ground surface (bgs).
3. Subcontracting traffic control services during drilling.
4. Performing laboratory tests to evaluate pertinent engineering properties of the encountered soils. Our testing includes moisture and density determinations and soil gradation analysis of selected samples. We also submitted four samples for Ductile Iron Pipe Research Association (DIPRA) soil evaluation (10-point procedure) to assess potential for presence of corrosive soils.
5. Evaluating potential geotechnical issues and constraints for the proposed sewer project. We include criteria for temporary slopes and assess the need for temporary shoring and/or dewatering to accomplish below grade construction.
6. Providing recommendations for site preparation and earth work, including an evaluation of the suitability of the site soils for use as structural fill, gradation criteria for imported soil, fill placement and compaction criteria, and wet weather construction considerations.

**GEOLOGY REVIEW**

Based on a review of available published geologic maps, the site and surrounding area is underlain by glacial deposits. The *Geologic Map of Thurston County, Washington* identifies the underlying soil as **Vashon Till (Qvt)**. This unit is described as a well-graded mixture of silt, sand and gravel with cobbles.

The till was deposited as both basal and ablation till. Basal till was deposited then overridden by the advancing glacier and is very dense and relatively impermeable. Ablation till was deposited on top of the Obasal till as the glacier melted and retreated, it is less dense than basal till with a higher permeability.

The site is not within the areas mapped by the Coastal Zone Atlas of Thurston County, Washington. The United States Department of Agriculture (USDA) Soil Conservation Service (SCS) Soil Survey of Thurston County Area, Washington identifies five soils along the project alignment. The soil units identified include **Alderwood gravelly sandy loam, 3 to 15 percent slopes (2)**; **Alderwood gravelly sandy loam, 15 to 30 percent slopes (3)**; **Giles silt loam, 3 to 15 percent slopes (39)**; **McKenna gravelly silt loam, 0 to 5 percent slopes (65)**; and **Norma silt loam (79)**. Erosion hazards for these soils are described as slight to moderate.

## SITE CONDITIONS

### PROJECT LOCATION

The project site is located in Olympia, Washington, in Township 18N, Range 2W, Section 48 (Willamette Meridian). The site is located along 14th Avenue and extends from the intersection with Cooper Point Road for approximately 1,800 feet to the west.

### SURFACE CONDITIONS

Fourteenth Avenue comprises of a two-lane asphalt concrete paved road with unimproved shoulders. The site is bounded on the north and south by residential development except for the western third of the south side which is bounded by Grass Lake Park. Roadway centerline grade at the west end of the site near Boring 1 is approximately Elevation 190 feet (Figure 2). The low point of the alignment occurs near Boring 4 at approximately Elevation 165 feet. The high point of the alignment occurs near Boring 7 at approximately Elevation 200 feet. Grade at the east end of the site near Boring 10 is approximately Elevation 180 feet. It appears that grade along portions of the roadway has been established by cutting and filling. Road cuts are present near the high points of the road. A culvert with a flowing creek intersects the road near the low point in the vicinity of Boring 3. We encountered fill to a depth of 12 feet in explorations located near the creek.

### SUBSURFACE EXPLORATIONS

We explored subsurface conditions at the site on February 9 and 10, 2006 by drilling 10 borings at the approximate locations indicated on Figure 2. The borings were drilled to depths ranging between 9 and 16-1/2 feet bgs. Details regarding the subsurface exploration program are included in Appendix A. Summary logs of the explorations are also included in Appendix A.

### SUBSURFACE CONDITIONS

We interpret the native soils encountered in the borings along the alignment to generally consist of glacial and post-glacial deposits. We characterized the encountered materials into three units, fill, silt and glacial till. In each of the borings, we drilled through the existing asphalt concrete (AC) pavement. The AC thickness ranges from 4-1/2 to 6 inches at the exploration locations.

**Fill** is described as loose to medium dense silty fine to coarse sand with gravel. Fill was encountered where the road crosses a swale area (Borings 3, 4 and 5) and near Cooper Point Road (Boring 10). The fill extends to depths ranging from 4-1/2 to 12 feet in the borings.

**Silt** is described as soft to medium stiff silt and sandy silt. The silt was encountered at depths ranging between 6 and 8 feet in Borings 3 and 4 in the swale area near the creek.

**Glacial till** comprises of silty fine to coarse sand or fine to coarse gravel with silt in the explorations. The till contains some cobbles. We encountered loose to medium dense ablation till and dense to very dense basal till. Till was typically encountered in explorations located in the higher elevations along the alignment. We did not encounter till to the depths explored in Borings 3, 4 or 5.

Groundwater was encountered in all explorations except Borings 2, 3, 5 and 6. In Borings 1 and 4, located near the creek, we encountered groundwater approximately 7 feet bgs. In explorations 7, 8 and 9, groundwater was encountered 7 to 15 feet bgs. In Boring 10, we encountered groundwater during drilling at approximately 15 feet bgs below a silt layer. The water level in the boring then rose to approximately 9 feet bgs after about 15 minutes

## **CONCLUSIONS AND RECOMMENDATIONS**

### **GENERAL**

Based on the results of our subsurface exploration and analyses, it is our opinion that the site is generally suitable for the proposed improvements. Based on our interpretation of the subsurface data and our understanding of the proposed improvements, we anticipate that medium to very dense native soils should be encountered at shallow depth along most of the site alignment, however, loose to medium dense fill soils and/or medium stiff silt could be present at or below utility grades near the stream.

The on-site fill and native soils contain a relatively high percentage of fines (particles passing the U.S. No. 200 sieve). These soils will be difficult to work when wet, or if compaction is performed during wet weather. Specific geotechnical recommendations for the development are presented in the following sections of this report.

### **SITE DEVELOPMENT AND EARTHWORK**

#### ***General***

We anticipate that site development work will include cutting through existing asphalt concrete, excavating for sewer trenches, and placing and compacting backfill materials. We expect that the majority of site grading can be accomplished with conventional earthmoving equipment in proper working order. The following sections provide recommendations for earthwork, site development and fill materials.

#### ***Temporary Excavation Support and Groundwater Handling***

Based on our explorations, shallow excavations will likely cave unless the sides are appropriately sloped. Excavations deeper than 4 feet should be shored or laid back at a stable slope if workers are required to enter. Shoring and temporary slope inclinations must conform to the provisions of Title 296 Washington Administrative Code (WAC), Part N, "Excavation, Trenching and Shoring." Regardless of the soil type encountered in the excavation, shoring, trench boxes or sloped sidewalls will be required under Washington Industrial Safety and Health Act (WISHA). The contract documents should specify that the contractor is responsible for selecting excavation and dewatering methods, monitoring the excavations for safety and providing shoring, as required, to protect personnel and structures.

In general, temporary cut slopes should be inclined no steeper than about 1-1/2H:1V (horizontal:vertical). This guideline assumes that all surface loads are kept at a minimum distance of at least one half the depth of the cut away from the top of the slope and that significant seepage is not present on the slope face. Flatter cut slopes will be necessary where significant seepage occurs or if large voids are created during excavation. Some sloughing and raveling of the cut slopes should be expected. Temporary covering with heavy plastic sheeting should be used to protect slopes during periods of wet weather.

Groundwater was encountered in six out of ten explorations completed for this study. Based on our explorations, we expect groundwater could be encountered during excavations and earthwork particularly near the east end of the site. Some perched groundwater could occur in the near surface soil depending on the time of year of construction. We anticipate that the groundwater handling needs will generally be lower during the late summer and early fall months. We anticipate that shallow perched groundwater can be handled adequately with sumps, pumps, and/or diversion ditches, as necessary. Ultimately, we recommend that the contractor performing the work be made responsible for controlling and collecting groundwater encountered.

## **FILL MATERIALS**

### ***General***

Material used for fill should be free of debris, organic contaminants and rock fragments larger than 6 inches. The workability of material for use as structural fill will depend on the gradation and moisture content of the soil. As the amount of fines (material passing the U.S. Standard No. 200 sieve) increases, soil becomes increasingly more sensitive to small changes in moisture content and adequate compaction becomes more difficult or impossible to achieve. If construction is performed during wet weather conditions, we recommend using fill consisting of well-graded sand and gravel containing less than 5 percent fines by weight based on the minus 3/4-inch fraction. If prolonged dry weather prevails during the earthwork phase of construction, a somewhat higher fines content may be acceptable.

### ***Pipe Bedding***

Trench backfill for the bedding and pipe zone should consist of well-graded granular material with a maximum particle size of 3/4-inch and less than 5 percent passing the U.S. No. 200 sieve. The material should be free of roots, debris, organic matter and other deleterious material. In the swale area near borings 3 and 4, silt could be encountered at subgrade elevations. If silt is encountered in the trench excavation the pipe subgrade should be overexcavated 12 inches and replaced with compacted structural fill.

### ***Trench Backfill***

We recommend that all trench backfill consist of material of approximately the same quality as “gravel borrow” described in Section 9-03.14(1) of the Standard Specifications with the additional requirement that the fill contains less than 5 percent fines by weight based on the minus 3/4-inch fraction. All fills should be constructed in horizontal lifts at the appropriate thickness for compaction. For compaction recommendations refer to the “Fill Placement and Compaction” section of this report.

### ***Use of On-Site Soil as Fill***

Based on our subsurface explorations, we conclude that the existing fill and inorganic granular mineral native soil on the site may be considered for use as trench backfill, provided it can be placed and

compacted as recommended. We recommend the native silt not be considered for use as trench backfill because of its high moisture sensitivity. The majority of the observed on site soil materials have moderate to high fines contents, which may make them difficult or impossible to compact when wet or if earthwork is performed during periods of extended wet weather.

## **FILL PLACEMENT AND COMPACTION**

Trench backfill should be compacted at a moisture content near optimum. The optimum moisture content varies with the soil gradation and should be evaluated during construction. Silty soil and other fine granular soil such as silt, silty sand, and sand with silt can be difficult or impossible to compact during persistent wet conditions.

Backfill material should be placed in uniform, horizontal lifts and uniformly densified with vibratory compaction equipment. The maximum lift thickness will vary depending on the material and compaction equipment used, but should generally not exceed 10 to 12 inches in loose thickness.

We recommend that the initial lift of fill over the pipe be thick enough to reduce the potential for damage during compaction but generally should not be greater than about 18 inches. In addition, rock fragments greater than about 1 inch in maximum dimension should be excluded from this lift.

Trench backfill in the upper 2 feet of trenches should be uniformly compacted in horizontal lifts to at least 95 percent of the MDD (ASTM D 1557). Fill placed below a depth of 2 feet in pavement areas should be compacted to at least 90 percent of the MDD (ASTM D 1557). In nonstructural areas, trench backfill should be compacted to a firm condition that can support construction equipment. Suitable native soils or select granular soils should be acceptable in non-structural areas.

## **LIMITATIONS**

We have prepared this report for the exclusive use by HDR, Inc., and their authorized agents for the 14th Avenue Forcemain and Gravity Sewer Extension project located in Olympia, Washington.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. No warranty or other conditions, express or implied, should be understood.

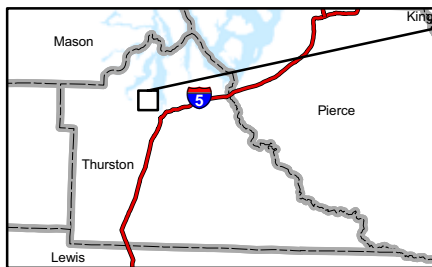
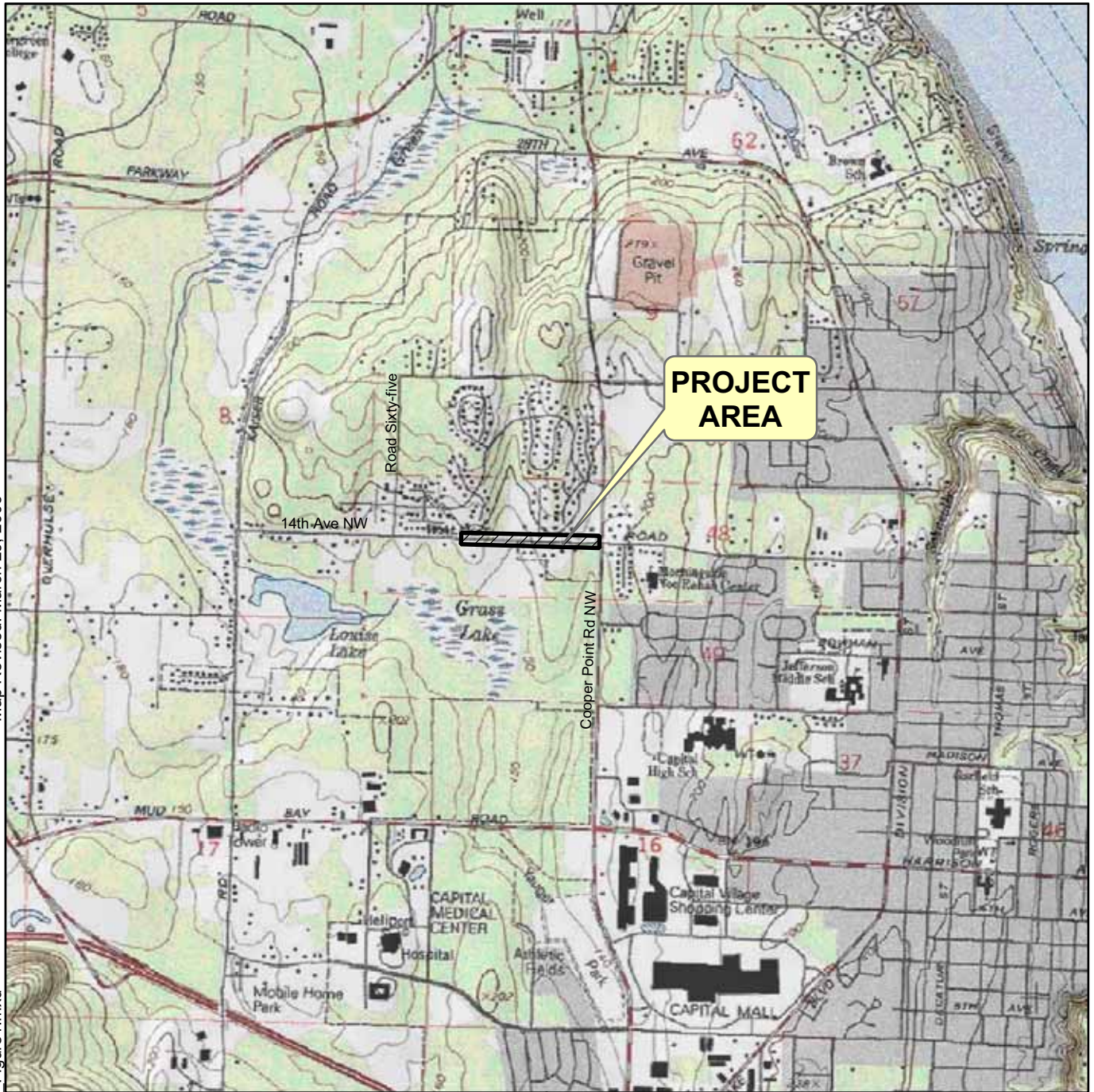
Please refer to Appendix B titled "Report Limitations and Guidelines for Use" for additional information pertaining to use of this report.



Map Revised: March 29, 2006

Path: P:\1111763002\00\GIS\1176300200 Figure1.mxd

Office: TAC



\*The Project Area is in the west 1/2 of Section 48, Township 18 North, and Range 02 West



PROJECT AREA



Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
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Data Sources: U.S. Topographic map from National Geographic Society (obtained March 2006). Interstates, state routes, and roads from TIGER 2000. County boundaries, cities, and waterbodies from Department of Ecology. Lambert Conformal Conic, Washington State Plane North, North American Datum 1983

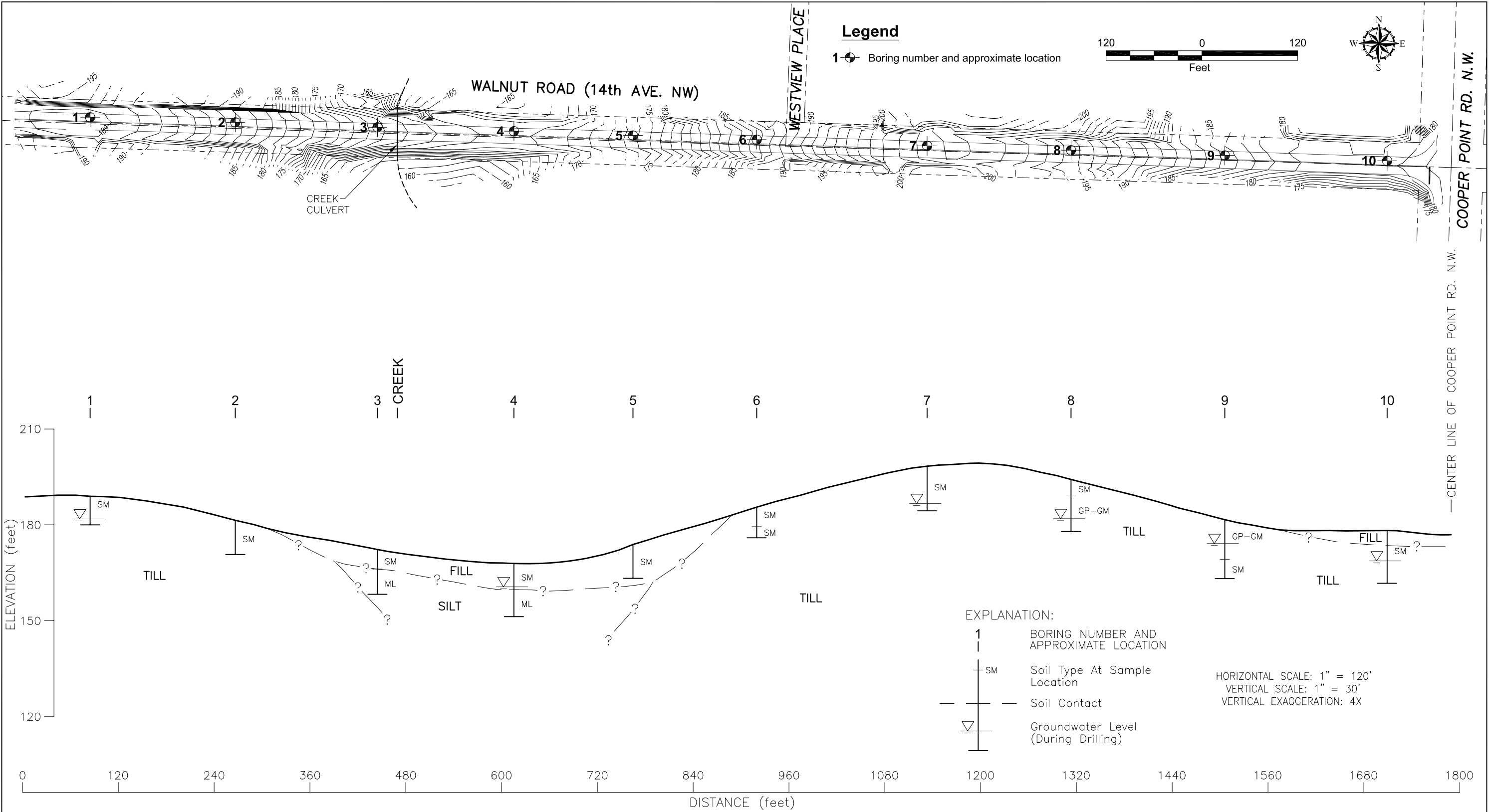
Vicinity Map

14th Avenue Forcemain and  
Gravity Sewer Extension  
Olympia, Washington



Figure 1

TACO11\11763002\00\CAD\1176300200\_FIG-2.dwg EWH:SCY 03/23/06 rev 04/13/06



Notes:

1. The locations of all features shown are approximate.

2. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.

3. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure.

The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document.

The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

Reference: Drawing provided by JVH Construction Surveying.

<b>Site Plan and Cross Section</b>	
14th Ave. Forcemain & Gravity Sewer Extension Olympia, Washington	
<b>GEOENGINEERS</b>	<b>Figure 2</b>

***APPENDIX A***  
***SUBSURFACE EXPLORATIONS AND LABORATORY***  
***TESTING***

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## APPENDIX A SUBSURFACE EXPLORATIONS AND LABORATORY TESTING

### SUBSURFACE EXPLORATIONS

We explored subsurface conditions at the site on February 9 and 10, 2006. The explorations were located in the field by our representative by measuring from existing site features. The approximate locations of the explorations are indicated on the Site Plan, Figure 2.

Our representative continuously monitored the explorations, maintained logs of the subsurface conditions and obtained representative samples as needed. The soils encountered were visually classified in general accordance with the system described in Figure A-1, American Society for Testing and Materials (ASTM) D 2488.

The test borings were advanced using a truck-mounted hollow-stem auger drill rig. Soil samples were obtained from the borings at 5-foot depth intervals using a 2.4-inch-inside-diameter split-barrel ring sampler driven into the soil using a 300-pound hammer free-falling a distance of 30 inches. The number of blows required to drive the sampler the last 12 inches or other indicated distance is recorded on the logs as the blow count. A key to the symbols used on the boring logs is included as Figure A-1. The boring logs are included as Figures A-2 through A-11.

### LABORATORY TESTING

#### *General*

Soil samples obtained from the borings were transported to GeoEngineers laboratory. Representative soil samples were selected for laboratory tests to evaluate pertinent geotechnical engineering characteristics of the site soils and to confirm our field classification. The following paragraphs provide a description of the tests performed.

#### *Moisture Content and Density*

The moisture content and density of selected samples were determined in general accordance with ASTM Test Methods D 2216 and D 2937, respectively. The test results are used to aid in soil classification and correlation with other pertinent engineering soil properties. The test results are presented on the boring logs in Appendix A.

#### *Particle Size Analysis*

Particle size analyses were performed on selected samples in general accordance with ASTM Test Method D 422. This test method covers the quantitative determination of the distribution of particle sizes in soils. Typically the distribution of particle sizes larger than 75 micrometers ( $\mu\text{m}$ ) is determined by sieving. The results of the tests were used to verify field soil classifications. Figure A-12 presents the test results.

#### *Percent Passing U.S. No. 200 Sieve (%F)*

Selected samples were “washed” through the U.S. No. 200-mesh sieve to estimate the relative percentages of coarse and fine-grained particles in the soil. The percent passing value represents the percentage by weight of the sample finer than the U.S. No. 200 sieve. These tests were conducted to

check field descriptions and to estimate the fines content for analysis purposes. The tests were conducted in general accordance with ASTM D 1140, and the test results are shown on the exploration logs at the respective sample depths.

### ***Soil Corrosivity***

Soil resistivity, pH, redox potential, sulfides and moisture were determined in general accordance with the Ductile Iron Pipe Research Association (DIPRA) soil evaluation, DIPRA 10-Point Soil Evaluation procedure (ANSI/AWWA C105/A21.5 and ASTM Standard A674). Soil samples from borings 1, 4 and 8 were tested. Test results are presented in Figure A-13.



## SOIL CLASSIFICATION CHART

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

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

### Sampler Symbol Descriptions

	2.4-inch I.D. split barrel
	Standard Penetration Test (SPT)
	Shelby tube
	Piston
	Direct-Push
	Bulk or grab

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

A "P" indicates sampler pushed using the weight of the drill rig.

## ADDITIONAL MATERIAL SYMBOLS

SYMBOLS		TYPICAL DESCRIPTIONS
GRAPH	LETTER	
	CC	Cement Concrete
	AC	Asphalt Concrete
	CR	Crushed Rock/Quarry Spalls
	TS	Topsoil/Forest Duff/Sod



Measured groundwater level in exploration, well, or piezometer



Groundwater observed at time of exploration



Perched water observed at time of exploration



Measured free product in well or piezometer

### Stratigraphic Contact

	Distinct contact between soil strata or geologic units
	Gradual change between soil strata or geologic units
	Approximate location of soil strata change within a geologic soil unit

### Laboratory / Field Tests

%F	Percent fines
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
OC	Organic content
PM	Permeability or hydraulic conductivity
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
VS	Vane shear

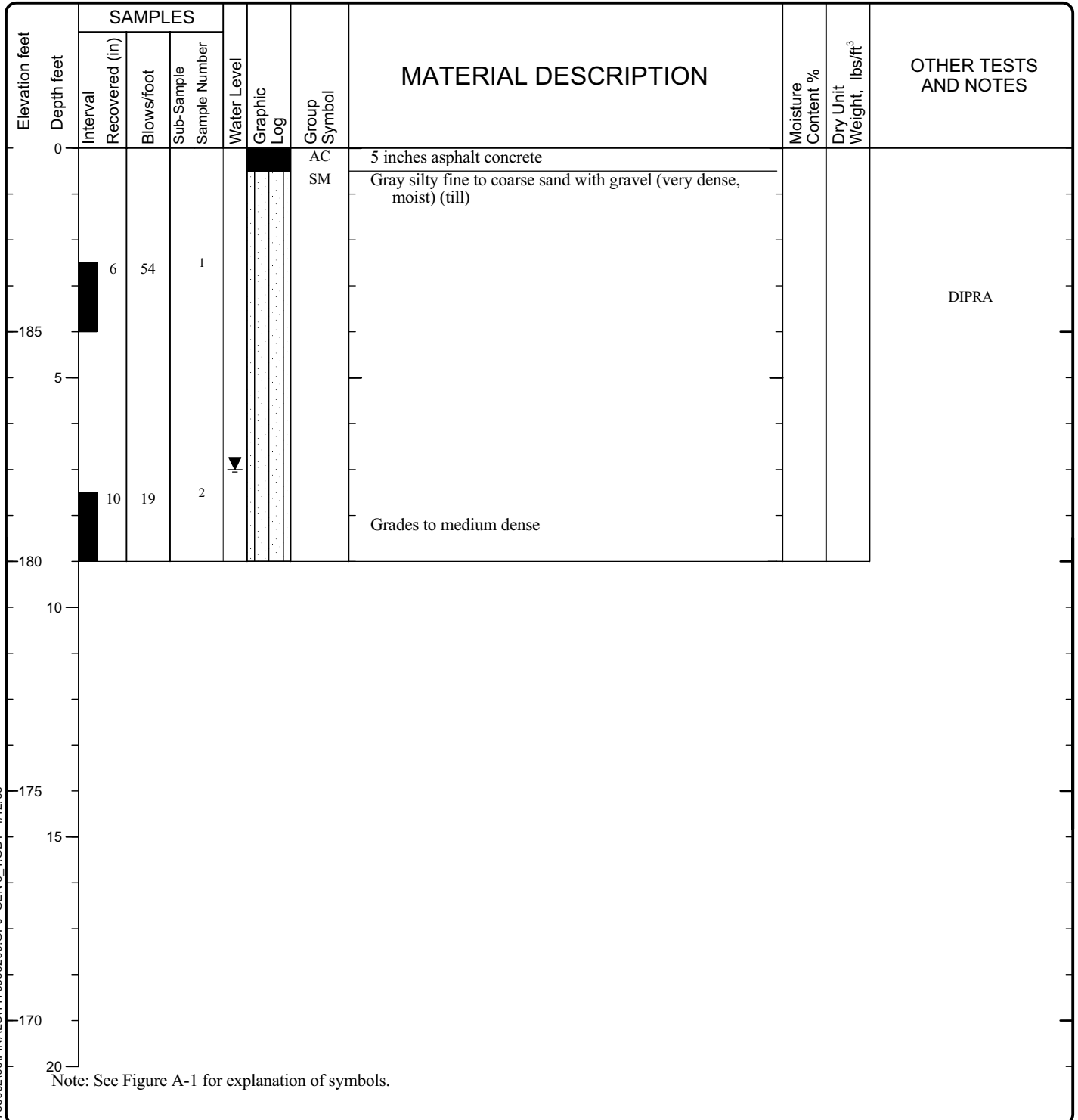
### Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen
NT	Not Tested

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

## KEY TO EXPLORATION LOGS

Date(s) Drilled	02/09/06	Logged By	LJS	Checked By	EWB
Drilling Contractor	Holt Drilling	Drilling Method	HSA	Sampling Methods	2.4-inch ID Split Barrel
Auger Data	8-inch Continuous Flight	Hammer Data	300 lb hammer/30 in drop	Drilling Equipment	Mobile B-59
Total Depth (ft)	9	Surface Elevation (ft)	189	Groundwater Elevation (ft)	182
Vertical Datum		Datum/System		Easting(x): Northing(y):	



### LOG OF BORING B-1



Project: 14th Avenue Forcemain and Gravity Sewer Extension  
 Project Location: Olympia, Washington  
 Project Number: 11763-002-00

Figure A-2  
 Sheet 1 of 1

Date(s) Drilled	02/09/06	Logged By	LJS	Checked By	EWB
Drilling Contractor	Holt Drilling	Drilling Method	HSA	Sampling Methods	2.4-inch ID Split Barrel
Auger Data	8-inch Continuous Flight	Hammer Data	300 lb hammer/30 in drop	Drilling Equipment	Mobile B-59
Total Depth (ft)	11.5	Surface Elevation (ft)	182	Groundwater Elevation (ft)	Not Encountered
Vertical Datum		Datum/System		Easting(x): Northing(y):	

Elevation feet	SAMPLES					Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft <sup>3</sup>	OTHER TESTS AND NOTES
	Interval	Recovered (in)	Blows/foot	Sub-Sample Sample Number	Water Level					
0	15	35		1		AC	6 inches asphalt concrete			
						SM	Gray silty fine to coarse sand with gravel (dense, moist) (till)			
180										
5	0	26		2			Grades to medium dense			
175						SM	Brown silty fine to coarse sand (dense, moist to wet) (till)			
10	18	40		3				16	112	%F=22
170										
15										
165										
20										

Note: See Figure A-1 for explanation of symbols.

### LOG OF BORING B-2



Project: 14th Avenue Forcemain and Gravity Sewer Extension  
Project Location: Olympia, Washington  
Project Number: 11763-002-00

Figure A-3  
Sheet 1 of 1



Date(s) Drilled	02/09/06	Logged By	LJS	Checked By	EWB
Drilling Contractor	Holt Drilling	Drilling Method	HSA	Sampling Methods	2.4-inch ID Split Barrel
Auger Data	8-inch Continuous Flight	Hammer Data	300 lb hammer/30 in drop	Drilling Equipment	Mobile B-59
Total Depth (ft)	14	Surface Elevation (ft)	172	Groundwater Elevation (ft)	Not Encountered
Vertical Datum		Datum/System		Easting(x): Northing(y):	

Elevation feet	SAMPLES				Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft <sup>3</sup>	OTHER TESTS AND NOTES
	Interval	Recovered (in)	Blows/foot	Sub-Sample Sample Number							
0							AC	4.5 inches asphalt concrete			
							SM	Brown silty fine to coarse sand with gravel (medium dense, moist) (fill)			
170											
	10		18	1							
5											
							ML	Gray sandy silt (medium stiff, moist to wet) (silt)			
165											
	0		7	2							
10											
160											
	6		6	3					33	87	
15											
155											
20											

Note: See Figure A-1 for explanation of symbols.

### LOG OF BORING B-3



Project: 14th Avenue Forcemain and Gravity Sewer Extension  
Project Location: Olympia, Washington  
Project Number: 11763-002-00

Figure A-4  
Sheet 1 of 1

Date(s) Drilled	02/09/06	Logged By	LJS	Checked By	EWB
Drilling Contractor	Holt Drilling	Drilling Method	HSA	Sampling Methods	2.4-inch ID Split Barrel
Auger Data	8-inch Continuous Flight	Hammer Data	300 lb hammer/30 in drop	Drilling Equipment	Mobile B-59
Total Depth (ft)	16.5	Surface Elevation (ft)	169	Groundwater Elevation (ft)	162
Vertical Datum		Datum/System		Easting(x): Northing(y):	

Elevation feet	SAMPLES				Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft <sup>3</sup>	OTHER TESTS AND NOTES
	Interval	Recovered (in)	Blows/foot	Sub-Sample Sample Number							
0	12	20		1			AC	5.5 inches asphalt concrete			
							SM	Brown silty fine to coarse sand with gravel (medium dense, moist) (fill)			
5	8	15		2					13		SA
10	12	6		3			ML	Light brown sandy silt, trace gravel, occasional organics (medium stiff, wet) (silt)			DIPRA
15	3	7		4							
20											

Note: See Figure A-1 for explanation of symbols.

### LOG OF BORING B-4



Project: 14th Avenue Forcemain and Gravity Sewer Extension  
Project Location: Olympia, Washington  
Project Number: 11763-002-00

Figure A-5  
Sheet 1 of 1



Date(s) Drilled	02/09/06	Logged By	LJS	Checked By	EWB
Drilling Contractor	Holt Drilling	Drilling Method	HSA	Sampling Methods	2.4-inch ID Split Barrel
Auger Data	8-inch Continuous Flight	Hammer Data	300 lb hammer/30 in drop	Drilling Equipment	Mobile B-59
Total Depth (ft)	11.5	Surface Elevation (ft)	186	Groundwater Elevation (ft)	Not Encountered
Vertical Datum		Datum/System		Easting(x): Northing(y):	

Elevation feet	SAMPLES				Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft <sup>3</sup>	OTHER TESTS AND NOTES
	Interval	Recovered (in)	Blows/foot	Sub-Sample Sample Number							
0		16	40	1			AC	5.5 inches asphalt concrete			
185							SM	Gray silty fine to coarse sand with gravel, cobbles (dense, moist) (till)			
5		4	33	2							No ring recovery
180											
10		0	54	3			SM	Gray silty fine to coarse sand with gravel (very dense, moist) (till)			No ring recovery
175											
15											
170											
20											

Note: See Figure A-1 for explanation of symbols.

### LOG OF BORING B-6



Project: 14th Avenue Forcemain and Gravity Sewer Extension  
Project Location: Olympia, Washington  
Project Number: 11763-002-00

Figure A-7  
Sheet 1 of 1

Date(s) Drilled	02/09/06	Logged By	LJS	Checked By	EWB
Drilling Contractor	Holt Drilling	Drilling Method	HSA	Sampling Methods	2.4-inch ID Split Barrel
Auger Data	8-inch Continuous Flight	Hammer Data	300 lb hammer/30 in drop	Drilling Equipment	Mobile B-59
Total Depth (ft)	14	Surface Elevation (ft)	199	Groundwater Elevation (ft)	186
Vertical Datum		Datum/System		Easting(x): Northing(y):	

Elevation feet	SAMPLES				Water Level	Graphic Log	Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft <sup>3</sup>	OTHER TESTS AND NOTES
	Interval	Recovered (in)	Blows/foot	Sub-Sample Sample Number							
0							AC	4.5 inches asphalt concrete			
							SM	Gray silty fine to coarse sand with gravel (very dense, moist) (till)			
195	18	78		1					7		SA
5											
190	12	71		2							
10											
185	18	67		3				Grades to wet			
15											
180											
20											

Note: See Figure A-1 for explanation of symbols.

V6\_GTBORING P:\11763002\00\FINAL\1176300200.GPJ GEIV6 1.GDT 4/12/06

### LOG OF BORING B-7



Project: 14th Avenue Forcemain and Gravity Sewer Extension  
 Project Location: Olympia, Washington  
 Project Number: 11763-002-00

Figure A-8  
 Sheet 1 of 1





Date(s) Drilled	02/10/06	Logged By	LJS	Checked By	EW. .
Drilling Contractor	Holt Drilling	Drilling Method	HSA	Sampling Methods	2.4-inch ID Split Barrel
Auger Data	8-inch Continuous Flight	Hammer Data	300 lb hammer/30 in drop	Drilling Equipment	Mobile B-59
Total Depth (ft)	16.5	Surface Elevation (ft)	181	Groundwater Elevation (ft)	172
Vertical Datum		Datum/ System		Easting(x): Northing(y):	

Elevation feet	SAMPLES					Group Symbol	MATERIAL DESCRIPTION	Moisture Content %	Dry Unit Weight, lbs/ft <sup>3</sup>	OTHER TESTS AND NOTES
	Interval	Recovered (in)	Blows/foot	Sub-Sample Sample Number	Water Level					
0	12	22		1		AC	4.25 inches asphalt concrete			
180						SP-SM	Brown fine to coarse sand with silt and gravel (medium dense, moist) (fill)			
5	10	8	2			SM	Brown silty fine to coarse sand with gravel (loose, moist) (till)			
175										
10	6	15	3				Gray fine to medium sand with silt, gravel (medium dense, moist)	14		%F=21
170										
15	10	20	4			ML	Gray silt (medium stiff, moist)			
165						SM	Gray silty fine to medium sand, occasional gravel (medium dense, wet)			
20										

Note: See Figure A-1 for explanation of symbols.

### LOG OF BORING B-10



Project: 14th Avenue Forcemain and Gravity Sewer Extension  
 Project Location: Olympia, Washington  
 Project Number: 11763-002-00

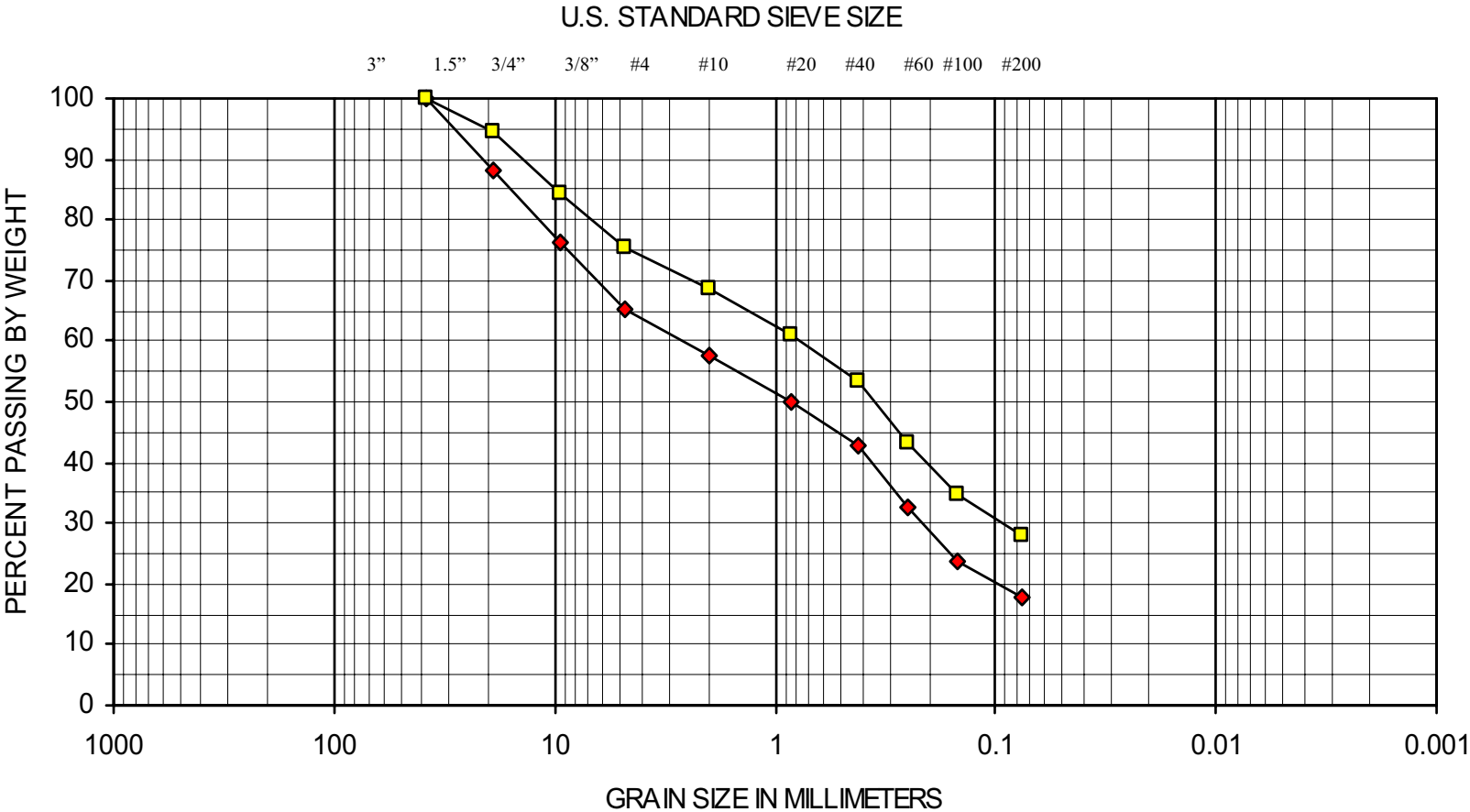
Figure A-11  
 Sheet 1 of 1






SIEVE ANALYSIS RESULTS

FIGURE A-12



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	EXPLORATION NUMBER	DEPTH (ft)	SOIL CLASSIFICATION
	4	6.0	Silty fine to coarse sand with gravel (SM)
	7	3.5	Silty fine to coarse sand with gravel (SM)

Job Name: 14th Ave. Sewer				Job #: 11763-002-00	
Date: 3-16-06		Tested by: Jake			
Boring #: B-1				DIPRA PTS.	
Sample #: 1		Resistivity :	3.4 x 10 <sup>4</sup>	0	
Depth: 3.0'		pH :	7.1	0	
Soil Description : Gray silty		Redox Potential :	163.4	0	
fine to medium sand		Sulfides :	Negative	0	
with gravel		Moisture :	Poor	2	
(SM)			Total Pts.	2	
Boring #: B-4				DIPRA PTS.	
Sample #: 3		Resistivity :	1.5 x 10 <sup>4</sup>	0	
Depth: 11.0'		pH :	5.1	0	
Soil Description : Brown silty		Redox Potential :	164.0	0	
fine to medium sand		Sulfides :	Negative	0	
with gravel		Moisture :	Poor	2	
(SM)			Total Pts.	2	
Boring #: B-8				DIPRA PTS.	
Sample #: 3		Resistivity :	1.3 x 10 <sup>4</sup>	0	
Depth: 11.0'		pH :	7.2	0	
Soil Description : Gray silty		Redox Potential :	163.8	0	
fine to medium sand		Sulfides :	Negative	0	
with gravel		Moisture :	Poor	2	
(SM)			Total Pts.	2	

**APPENDIX B**  
***REPORT LIMITATIONS AND GUIDELINES FOR USE***

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## **APPENDIX B REPORT LIMITATIONS AND GUIDELINES FOR USE<sup>1</sup>**

This appendix provides information to help you manage your risks with respect to the use of this report.

### **GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS**

This report has been prepared for the exclusive use of HDR, Inc., and their authorized agents. This report is not intended for use by others, and the information contained herein is not applicable to other sites.

GeoEngineers structures our services to meet the specific needs of our clients. For example, a geotechnical or geologic study conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect that are involved in the same project. Because each geotechnical or geologic study is unique, each geotechnical engineering or geologic report is unique, prepared solely for the specific client and project site. Our report is prepared for the exclusive use of our Client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. This is to provide our firm with reasonable protection against open-ended liability claims by third parties with whom there would otherwise be no contractual limits to their actions. Within the limitations of scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted geotechnical practices in this area at the time this report was prepared. This report should not be applied for any purpose or project except the one originally contemplated.

### **A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS**

This report has been prepared for the 14th Avenue Forcemain and Gravity Sewer Extension project located in Olympia, Washington. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, do not rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

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<sup>1</sup> Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; [www.asfe.org](http://www.asfe.org).

If important changes are made after the date of this report, GeoEngineers should be given the opportunity to review our interpretations and recommendations and provide written modifications or confirmation, as appropriate.

## **SUBSURFACE CONDITIONS CAN CHANGE**

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by manmade events such as construction on or adjacent to the site, or by natural events such as floods, earthquakes, slope instability or ground water fluctuations. Always contact GeoEngineers before applying a report to determine if it remains applicable.

## **TOPSOIL**

For the purposes of this report, we consider topsoil to consist of generally fine-grained soil with an appreciable amount of organic matter based on visual examination, and to be unsuitable for direct support of the proposed improvements. However, the organic content and other mineralogical and gradational characteristics used to evaluate the suitability of soil for use in landscaping and agricultural purposes was not determined, nor considered in our analyses. Therefore, the information and recommendations in this report, and our logs and descriptions should not be used as a basis for estimating the volume of topsoil available for such purposes.

## **MOST GEOTECHNICAL AND GEOLOGIC FINDINGS ARE PROFESSIONAL OPINIONS**

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

## **GEOTECHNICAL ENGINEERING REPORT RECOMMENDATIONS ARE NOT FINAL**

Do not over-rely on the preliminary construction recommendations included in this report. These recommendations are not final, because they were developed principally from GeoEngineers' professional judgment and opinion. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for this report's recommendations if we do not perform construction observation.

Sufficient monitoring, testing and consultation by GeoEngineers should be provided during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective method of managing the risks associated with unanticipated conditions.

## **A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT COULD BE SUBJECT TO MISINTERPRETATION**

Misinterpretation of this report by other design team members can result in costly problems. You could lower that risk by having GeoEngineers confer with appropriate members of the design team after submitting the report. Also retain GeoEngineers to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering or geologic report. Reduce that risk by having GeoEngineers participate in pre-bid and preconstruction conferences, and by providing construction observation.

## **DO NOT REDRAW THE EXPLORATION LOGS**

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognize that separating logs from the report can elevate risk.

## **GIVE CONTRACTORS A COMPLETE REPORT AND GUIDANCE**

Some owners and design professionals believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering or geologic report, but preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer. A pre-bid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might an owner be in a position to give contractors the best information available, while requiring them to at least share the financial responsibilities stemming from unanticipated conditions. Further, a contingency for unanticipated conditions should be included in your project budget and schedule.

## **CONTRACTORS ARE RESPONSIBLE FOR SITE SAFETY ON THEIR OWN CONSTRUCTION PROJECTS**

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and to adjacent properties.

## **READ THESE PROVISIONS CLOSELY**

Some clients, design professionals and contractors may not recognize that the geoscience practices (geotechnical engineering or geology) are far less exact than other engineering and natural science disciplines. This lack of understanding can create unrealistic expectations that could lead to disappointments, claims and disputes. GeoEngineers includes these explanatory "limitations" provisions in our reports to help reduce such risks. Please confer with GeoEngineers if you are unclear how these "Report Limitations and Guidelines for Use" apply to your project or site.

## **GEOTECHNICAL, GEOLOGIC AND ENVIRONMENTAL REPORTS SHOULD NOT BE INTERCHANGED**

The equipment, techniques and personnel used to perform an environmental study differ significantly from those used to perform a geotechnical or geologic study and vice versa. For that reason, a geotechnical engineering or geologic report does not usually relate any environmental findings, conclusions or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Similarly, environmental reports are not used to address geotechnical or geologic concerns regarding a specific project.

## **BIOLOGICAL POLLUTANTS**

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention, or assessment of the presence of Biological Pollutants in or around any structure. Accordingly, this report includes no interpretations, recommendations, findings, or conclusions for the purpose of detecting, preventing, assessing, or abating Biological Pollutants. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and/or any of their byproducts.