Geotechnical Engineering Services

Liberty Park Library
Renton, Washington

for
King County Library System

December 20, 2012

GeoEngineers
Earth Science + Technology

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GeoEngineers

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Liberty Park Library
Renton, Washington

File No. 1784-018-00

December 20, 2012

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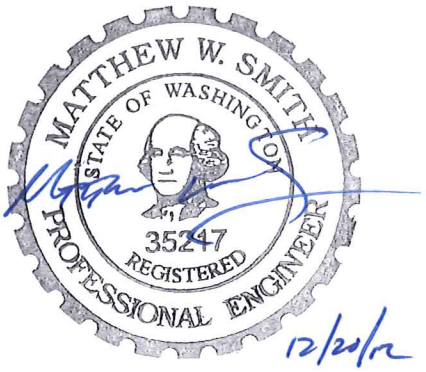

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INTRODUCTION

This report summarizes the results of GeoEngineers' geotechnical engineering services in support of the proposed renovation to the King County Library System (KCLS) Downtown Renton Library located adjacent to Liberty Park in Renton, Washington. The library address is 100 Mill Avenue South. The site is located in downtown Renton and consists of a one-story building that spans over the Cedar River. The property is bounded by Liberty Park to the north, Cedar River to the east and west, and a paved surface parking lot (associated with the library) to the south. The site is shown on the Vicinity Map (Figure 1) and the Site Plan (Figure 2).

The purpose of this study is to provide geotechnical engineering conclusions and recommendations for the design and construction of the planned improvements to the library. GeoEngineers' geotechnical engineering services were completed in general accordance with our services agreement executed on October 3, 2012.

PROJECT DESCRIPTION

GeoEngineers' project understanding is based on information provided by The Miller Hull Partnership, LLP, the project architect, and Coughlin Porter Lundeen (CPL), the project structural engineer. The existing library building is constructed similar to a three-span bridge structure with girders spanning between foundations located on the river banks and two interior piers that are located within the river. We understand that KCLS is planning to complete extensive renovation of the existing building including upgrading structural systems for current seismic code requirements, and reconstruction of much of the library structure located above the girders/foundation elements. The renovated building will consist of a single level building with no below grade levels, and will have a similar or smaller footprint as the existing library building.

FIELD EXPLORATIONS AND LABORATORY TESTING

Field Explorations

GeoEngineers evaluated the subsurface conditions at the site by completing two borings, GEI-1 and GEI-2, on October 22, 2012. The borings were completed to depths of 51½ feet below the existing ground surface. The approximate locations of the explorations are shown on the Site Plan, Figure 2. Descriptions of the field exploration program and the boring logs are presented in Appendix A.

Laboratory Testing

Soil samples were obtained from the explorations and were taken to GeoEngineers' laboratory for further evaluation. Selected samples were tested for the determination of fines content, moisture content, and sieve analyses. A description of the laboratory testing and the test results are presented in Appendix B.

SITE CONDITIONS

Surface Conditions

A reinforced concrete/masonry building currently occupies the site. The existing building has an associated paved surface parking lot that occupies the south portion of the site. The site topography slopes steeply down to the Cedar River on both the north and south sides of the building with grades ranging from approximate Elevation 45 feet at the top of the slopes, to Elevation 26 feet at the river bottom. Site grades to the north and south of the building and outside of the river banks are relatively level.

Buried utilities consisting of sanitary sewer, storm drain, fiber optic, telecommunications, water, and others are present in the site vicinity. The site is presently vegetated with ornamental landscaping and lawn areas in the vicinity of the existing structure, and scattered deciduous and coniferous trees/shrubs.

Subsurface Conditions

In general, soil types encountered in the explorations completed in the vicinity of the Liberty Park Library (GEI-1 and GEI-2) consisted of undocumented fill and recent alluvium deposits.

Fill soils were encountered in each of the explorations completed and consisted of loose to medium dense/very soft to soft silty sand/silt with variable gravel and cobble content, and organics. The fill extended to depths of 15 feet below existing grades. Additional fill is anticipated in areas where buried utilities are present. The fill may contain debris, concrete, organics and/or cobbles and boulders.

Recent alluvium deposits were observed below the fill in borings GEI-1 and GEI-2. The alluvium deposits consist of medium dense to very dense silty sand with varying amounts of gravel and medium dense to dense gravel with varying amounts of silt and sand. The recent alluvium deposits extended to the depth explored. Occasional cobbles are anticipated to be present in the alluvium deposits.

Groundwater Conditions

Groundwater was encountered in both of the borings at an approximate depth of 20½ feet below site grades during drilling. Groundwater levels at the site are expected fluctuate in response to water levels in the Cedar River, and will vary as a function of season, precipitation and other factors.

CONCLUSIONS AND RECOMMENDATIONS

General

A summary of the primary geotechnical considerations is provided below. The summary is presented for introductory purposes only and should be used in conjunction with the complete recommendations presented in this report.

- The results of our site investigation and geotechnical analyses indicate that portions of the fill and alluvium deposits present below the groundwater table are potentially liquefiable during a

design level earthquake. The potentially liquefiable soils present a risk to the existing building through loss of foundation support, potential foundation settlement, and lateral deformation of soils towards the Cedar River.

- Due to the presence of potentially liquefiable soils, the use of ground improvement is recommended to meet seismic settlement and building performance tolerances. Through discussions with the project team, the preferred ground improvement option is the use of a ground improvement system comprised of closely spaced augercast piles to mitigate the liquefaction potential at the Cedar River banks on the north and south sides of the building. We understand the augercast piles, in conjunction with a concrete pile cap, will also be used to provide anchorage to the building to help resist seismic lateral forces.
- Because the site is underlain by potentially liquefiable soils, the site is designated as seismic Soil Profile Type F per the 2009 International Building Code (IBC). Given that the planned structure is expected to have a fundamental period of vibration equal to or less than 0.5 seconds, a site response analysis is not required to determine the spectral accelerations and the Site Class can be determined in accordance with Section of 20.3 of ASCE 7. Per ASCE 7, the site is best characterized as Site Class D.
- The near surface soils are soft/loose and have a high silt content. As a result, the near surface soils are anticipated to be highly moisture sensitive and will require specific subgrade preparation in pavement/hardscape areas.

Our specific geotechnical recommendations are presented in the following sections of this report.

Earthquake Engineering

General

GeoEngineers evaluated the site for seismic hazards including liquefaction. Our analyses indicate that the site has a moderate to high risk of liquefaction induced settlement during a design level earthquake. The liquefaction hazard and building code site coefficients are discussed in detail below.

Liquefaction

Liquefaction is a phenomenon where soils experience a rapid loss of internal strength as pore water pressures increase in response to strong ground shaking. The increased pore water pressure may temporarily meet or exceed soil overburden pressures to produce conditions that allow soil and water to flow, deform, or erupt from the ground surface. Ground settlement, lateral spreading and/or sand boils may result from soil liquefaction. Structures, such as buildings, supported on or within liquefied soils may suffer foundation settlement or lateral movement that can be damaging to the buildings.

The evaluation of liquefaction potential is a complex procedure and is dependent on numerous site parameters, including soil grain size, soil density, site geometry, static stresses, and the design ground acceleration. Typically, the liquefaction potential of a site is evaluated by comparing the cyclic shear stress ratio (the ratio of the cyclic shear stress to the initial effective overburden stress) induced by an earthquake to the cyclic shear stress ratio required to cause liquefaction. Estimation of the cyclic shear stress required to initiate liquefaction and the cyclic shear stress

initiated by a design earthquake was completed using empirical methods. The cyclic shear stress ratio required to cause liquefaction at the site was estimated using empirical procedures based on correlations from the standard penetration tests (SPTs). Estimated ground settlement resulting from earthquake-induced liquefaction was analyzed using an empirical procedure that relates settlement to average SPT N-values. This analysis assumes a level ground surface.

In general, soils that are susceptible to liquefaction at this site include very loose to medium dense fill soils and recent alluvium deposits (sands and gravels) that are below the groundwater table. Based on our analyses, the site soils are moderately to highly susceptible to liquefaction under the design earthquake event. Given the slopes located along the banks of the Cedar River, should the soils located in the vicinity of the building foundations bearing on the river banks experience liquefaction and loss strength, both settlement and lateral deformation of these foundation elements (towards the Cedar River) may occur.

Lateral Spreading

Lateral spreading involves lateral displacement of large, surficial blocks of soil as the underlying soil layer liquefies. Lateral spreading can occur on near-level ground as blocks of surface soils are displaced relative to adjacent blocks. Lateral spreading also occurs as blocks of surface soils are displaced toward a nearby slope or free-face by movement of the underlying liquefied soil. The Cedar River banks to the north and south sides of the building represent a free-face condition. In the case of the Liberty Park Library site, lateral spreading could occur during earthquakes resulting in the movement of soil towards the Cedar River and excessive foundation deformation

Surface Fault Rupture

Because of the anticipated infrequent recurrence of earthquake events and the project site's location with respect to the nearest known fault, it is our opinion that the risk of ground rupture at the site resulting from surface faulting is low.

2009 IBC Seismic Design Information

Because the site is underlain by potentially liquefiable soils, the site is designated as seismic Soil Profile Type F per the 2009 IBC. Given that the planned structure is expected to have a fundamental period of vibration equal to or less than 0.5 seconds, a site response analysis is not required to determine the spectral accelerations and the Site Class can be determined in accordance with Section of 20.3 of ASCE 7. Per ASCE 7, the site is best characterized as Site Class D.

We recommend the use of the following 2009 IBC parameters for Site Class, short period spectral response acceleration (S_S), 1-second period spectral response acceleration (S_1) and seismic coefficients for the project site.

2009 IBC Parameter	Recommended Value
Site Class	D
Short Period Spectral Response Acceleration, S_S (percent g)	142.8
1-Second Period Spectral Response Acceleration, S_1 (percent g)	48.8
Seismic Coefficient, F_A	1.0
Seismic Coefficient, F_V	1.51

Foundation Support

General

The existing foundations are considered to have sufficient capacity for static loading conditions; however, given the presence of potentially liquefiable soils, seismic stability and foundation bearing for the foundation located on the river banks are considered to be insufficient. As a result, mitigation of the liquefiable soils is recommended. Through discussions with CPL, the preferred mitigation alternative consists of creating a zone of improved ground immediately outside the building foundations located on each bank of the river. The purpose of the ground improvement is to provide a 'block' of improved soil that will resist seismic lateral earth pressures acting towards the river and to provide improved bearing for the spread footings currently located on the river banks. Our analyses/explorations indicate that the soils located below the river bottom elevation have a low risk of liquefaction, therefore, no additional improvement of the interior piers is considered to be necessary.

Several ground improvement alternatives were explored, such as compaction grouting, driven piles, soil mixing, and stone columns. However, these options were not selected as the preferred ground improvement solution due to the proximity to the river, vibrations, and/or the cost of these methods. Through discussions with CPL, the preferred ground improvement system recommended to mitigate the liquefaction hazard consists of tightly spaced augercast piles connected at the top of pile elevation by a structural slab. This system will be connected to the existing building foundations located on the river banks to provide both lateral and vertical support. More detailed recommendations are presented below for the augercast pile ground improvement system.

Ground Improvement

General

Due to the presence of potentially liquefiable soils in the planned improvements area, the use of ground improvement is recommended to meet seismic settlement and lateral deformation tolerances. For the Liberty Park Library site, the purposes of ground improvement are twofold: the ground improvement will: (1) mitigate potential liquefaction hazards in the immediate vicinity of the foundation elements located on the river banks and (2) provide anchorage to the building to help resist seismic lateral forces. The benefits of ground improvement for this site include:

- Ground improvement will mitigate the liquefaction potential in the improved zone and as a result, will minimize the lateral spreading potential and lateral loading on the structure.
- Ground improvement at the river banks will essentially work as abutments to anchor the building concrete base for resisting seismic forces.

Augercast Piles

Augercast piles extending into the dense/competent soils with a thick concrete pile cap have been selected as the preferred ground improvement technique for the Liberty Park Library site. Preliminary estimates indicate that an 18- to 24-inch-diameter augercast pile embedded 5 to 10 feet into the dense/competent soils should provide sufficient capacity to resist seismic forces, while mitigating the potential for liquefaction. GeoEngineers will develop full design recommendations for augercast piles, the details of which will be presented under separate cover.

Augercast piles are constructed using a continuous flight hollow stem auger attached to a set of leads supported by a crane. The first step in the pile casting process consists of drilling the auger into the ground to the specified tip elevation of the pile. Grout is then pumped through the hollow stem auger upon steady withdrawal of the auger and replaces the soils on the flights of the auger. The final step is to install a steel reinforcing cage and typically a center bar into the column of fresh grout. One benefit of using augercast piles is that the auger provides support for the soils during the pile installation process, thus eliminating the need for temporary casing or drilling fluid.

Detailed recommendations for the augercast piles, including pile capacities, recommended diameter and length, and construction considerations will be provided in GeoEngineers' ground improvement design report, to be provided under separate cover.

Earthwork

Based on the subsurface soil conditions encountered in the borings, we expect the soils at the site may be excavated using conventional heavy duty construction equipment. The materials we encountered include fill and recent alluvium deposits. The fill and alluvium soils often contain cobbles and boulders that may be encountered during excavation. Asphalt, concrete, and debris from the previous development on the site may also be encountered.

The on-site fill soils contain significant fines (material passing the U.S. standard No. 200 sieve) and will be highly moisture-sensitive and susceptible to disturbance, especially when wet. Ideally, earthwork should be undertaken during extended periods of dry weather when the surficial soils will be less susceptible to disturbance and provide better support for construction equipment.

Trafficability on the site may be difficult, even during dry weather conditions, due to the loose, silty fill that will be exposed during excavation activities. If exposed, the soils will be especially susceptible to disturbance from construction equipment during wet weather conditions and pumping and rutting of the exposed soils under equipment loads may occur. The contractor should be prepared to protect the site and prevent subgrade soils from deteriorating in wet weather conditions.

Clearing and Site Preparation

Construction of the proposed improvements will require demolition of existing structures, pavement, and other appurtenant structures. Concrete and asphalt may be recycled and reused as structural fill in limited areas; otherwise it should be removed from the site along with other construction debris. All existing utilities should be removed from the ground improvement areas and rerouted if needed.

Subgrade Preparation

Prior to placing new fills, pavement or hardscape base course materials, subgrade areas should be proof rolled to locate any soft or pumping soils. Proof rolling can be completed using a piece of heavy tire-mounted equipment such as a loaded dump truck. During wet weather, the exposed subgrade areas should be probed to determine the extent of soft soils. If soft or pumping soils are observed, they should be removed and replaced with structural fill meeting the requirements of Mineral Aggregate Type 17, City of Seattle Standard Specification 9-03.16.

Structural Fill

All fill supporting pavement/hardscape, foundations, or placed against retaining walls or in utility trenches should meet the criteria for structural fill presented below. The suitability of soil for use as structural fill depends on its gradation and moisture content.

MATERIALS

Fill placed to support structures, placed behind retaining structures, and placed below pavements and sidewalks will need to be specified as structural fill as described below:

- If structural fill is necessary beneath or adjacent to building foundations, the structural fill should meet the requirements of Mineral Aggregate Type 17 (bank run gravel), City of Seattle Standard Specification 9-03.16.
- Structural fill placed behind retaining walls should meet the requirements of Mineral Aggregate Type 17 (bank run gravel), City of Seattle Standard Specification 9-03.16.
- Structural fill placed within utility trenches and below pavement and sidewalk areas should meet the requirements of Mineral Aggregate Type 17 (bank run gravel), City of Seattle Standard Specification 9-03.16.
- Structural fill placed as crushed surfacing base course below pavements and sidewalks should meet the requirements of Mineral Aggregate Type 2 (1¼-inch minus crushed rock), City of Seattle Standard Specification 9-03.16.

REUSE OF ON-SITE SOILS

The on-site soils are moisture-sensitive and generally have natural moisture contents higher than the anticipated optimum moisture content for compaction. As a result, the on-site soils will likely require moisture conditioning in order to meet the required compaction criteria during dry weather conditions and will not be suitable for reuse during wet weather. Furthermore, most of the fill soils required for the project have specific gradation requirements, and the on-site soils do not meet these gradation requirements. Therefore, imported structural fill meeting the requirements described above should be used where structural fill is necessary.

FILL PLACEMENT AND COMPACTION CRITERIA

Structural fill should be mechanically compacted to a firm, non-yielding condition. Structural fill should be placed in loose lifts not exceeding 1 foot in thickness. Each lift should be conditioned to the proper moisture content and compacted to the specified density before placing subsequent lifts. Structural fill should be compacted to the following criteria:

- Structural fill placed in building areas (around foundations or below slab-on-grade floors) and in pavement and sidewalk areas (including utility trench backfill) should be compacted to at

least 95 percent of the maximum dry density (MDD) estimated in general accordance with ASTM D 1557.

- Structural fill placed against subgrade walls should be compacted to between 90 and 92 percent. Care should be taken when compacting fill against subsurface walls to avoid overcompaction and hence overstressing the walls.

We recommend that GeoEngineers be present during probing of the exposed subgrade soils in building and pavement areas, and during placement of structural fill. We will evaluate the adequacy of the subgrade soils and identify areas needing further work, perform in-place moisture-density tests in the fill to verify compliance with the compaction specifications, and advise on any modifications to the procedures that may be appropriate for the prevailing conditions.

Weather Considerations

During wet weather, some of the exposed soils could become muddy and unstable. If so affected, we recommend that:

- The ground surface in and around the work area should be sloped so that surface water is directed to a sump or discharge location. The ground surface should be graded such that areas of ponded water do not develop.
- Slopes with exposed soils should be covered with plastic sheeting or similar means.
- The site soils should not be left uncompacted and exposed to moisture. Sealing the surficial soils by rolling with a smooth-drum roller prior to periods of precipitation will reduce the extent to which these soils become wet or unstable.
- Construction activities should be scheduled so that the length of time that soils are left exposed to moisture is reduced to the extent practicable.

Temporary Slopes

Temporary slopes may be used around the site to facilitate installation of the augercast piles. We recommend that temporary slopes constructed in the fill and near surface soils be inclined at 1½H:1V (horizontal to vertical). Flatter slopes may be necessary if seepage is present on the face of the cut slopes or if localized sloughing occurs. For open cuts at the site, we recommend that:

- No traffic, construction equipment, stockpiles or building supplies be allowed at the top of the cut slopes within a distance of at least 5 feet from the top of the cut;
- Exposed soil along the slope be protected from surface erosion by using waterproof tarps or plastic sheeting;
- Construction activities be scheduled so that the length of time the temporary cut is left open is reduced to the extent practicable;
- Erosion control measures be implemented as appropriate such that runoff from the site is reduced to the extent practicable;
- Surface water be diverted away from the slope; and
- The general condition of the slopes be observed periodically by the geotechnical engineer to confirm adequate stability.

Because the contractor has control of the construction operations, the contractor should be made responsible for the stability of cut slopes, as well as the safety of the excavations. Shoring and temporary slopes must conform to applicable local, state and federal safety regulations.

Utility Trenches

Trench excavation, pipe bedding, and trench backfilling should be completed using the general procedures described in the 2012 Washington State Department of Transportation (WSDOT) Standard Specifications or other suitable procedures specified by the project civil engineer. The silts and fill soils encountered at the site are generally of low corrosivity based on our experience in the Puget Sound area.

Utility trench backfill should consist of structural fill and should be placed in lifts of 1 foot or less (loose thickness) such that adequate compaction can be achieved throughout the lift. Each lift must be compacted prior to placing the subsequent lift. Prior to compaction, the backfill should be moisture conditioned to within 3 percent of the optimum moisture content, if necessary. The backfill should be compacted in accordance with the criteria discussed above.

Recommended Additional Geotechnical Services

GeoEngineers will submit a ground improvement design report for the recommended ground improvement system under separate cover. Following completion of the structural design, GeoEngineers should be retained to review the project plans and specifications to confirm that our design recommendations have been implemented as intended.

During construction, GeoEngineers should observe the installation of the augercast piles, evaluate the suitability of subgrades, evaluate structural backfill, and provide a summary letter of our construction observation services. The purposes of GeoEngineers construction phase services are to confirm that the subsurface conditions are consistent with those observed in the explorations and other reasons described in Appendix C, Report Limitations and Guidelines for Use.

LIMITATIONS

We have prepared this report for the exclusive use of KCLS, The Miller Hull Partnership, LLP, and CPL for the Liberty Park Library project in Renton, 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.

Any electronic form, facsimile or hard copy of the original document (email, text, table and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

Please refer to Appendix C titled “Report Limitations and Guidelines for Use” for additional information pertaining to use of this report.

We appreciate the opportunity to participate on this project. Should you have any questions concerning this report or if we can be of additional service, please call.

REFERENCES

City of Seattle, 2011, "Standard Specifications for Road, Bridge and Municipal Construction."

International Code Council, 2009, "International Building Code."

Washington State Department of Transportation, 2012, "Standard Specifications for Road, Bridge and Municipal Construction."

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U.S. Geological Survey. (2009) "Earthquake Ground Motion Parameters, Version 5.0.9a-10/21/2009."

FIGURES

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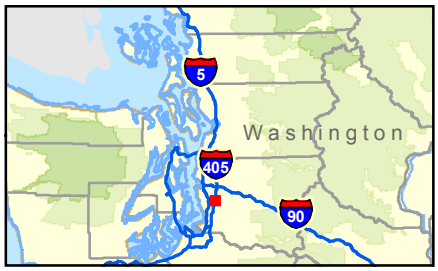

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Feet

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: ESRI Data & Maps

Projection: NAD 1983 StatePlane Washington North FIPS 4601 Feet

Vicinity Map

Liberty Park Library Project
Renton, Washington

GeoEngineers

Figure 1

Map Revised: 19 December 2012 bmagdasy

Path: C:\GIS\1784018_F1.mxd

Office: TAC

Legend

B-1 Boring by GeoEngineers, 2012

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. cannot 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.

Reference: Base drawing "Topographic Survey" by Pacific Geomatic dated 10/29/12.

Site Plan	
Liberty Park Library Renton, Washington	
GeoEngineers	**Figure 2**

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APPENDICES

GeoEngineers

APPENDIX A
Field Explorations

APPENDIX A
FIELD EXPLORATIONS

General

Subsurface conditions were explored at the site by drilling two borings (GEI-1 and GEI-2). The borings were completed to depths of about 51½ feet below the existing ground surface. Subsurface exploration services were provided by Geologic Drill Exploration Inc. on October 22, 2012.

The locations of the explorations were estimated by taping/pacing from existing site features. The approximate exploration locations are shown on the Site Plan, Figure 2.

Borings were completed using trailer-mounted continuous-flight, hollow-stem auger drilling equipment. The borings were continuously monitored by a geotechnical representative from our firm who examined and classified the soils encountered, obtained representative soil samples, observed groundwater conditions and prepared a detailed log of each exploration.

The soils encountered in the borings were generally sampled at 2½- or 5-foot vertical intervals with a 2-inch outside diameter split-barrel standard penetration test (SPT). The samples were obtained by driving the sampler 18 inches into the soil with either a 140-pound hammer hammer with a rope and cathead free-falling 30 inches. The number of blows required for each 6 inches of penetration was recorded. The blow count ("N-value") of the soil was calculated as the number of blows required for the final 12 inches of penetration. This resistance, or N-value, provides a measure of the relative density of granular soils and the relative consistency of cohesive soils. Where very dense soil conditions preclude driving the full 18 inches, the penetration resistance for the partial penetration was entered on the logs. The blow counts are shown on the boring logs at the respective sample depths.

Soils encountered in the borings were visually classified in general accordance with the classification system described in Figure A-1. A key to the boring log symbols is also presented in Figure A-1. The logs of the borings are presented in Figures A-2 and A-3. The boring logs are based on our interpretation of the field and laboratory data and indicate the various types of soils and groundwater conditions encountered. The logs also indicate the depths at which these soils or their characteristics change, although the change may actually be gradual. If the change occurred between samples, it was interpreted. The densities noted on the boring logs are based on the blow count data obtained in the borings and judgment based on the conditions encountered.

Observations of groundwater conditions were made during drilling. The groundwater conditions encountered during drilling are presented on the boring logs. Groundwater conditions observed during drilling represent a short-term condition and may or may not be representative of the long-term groundwater conditions at the site. Groundwater conditions observed during drilling should be considered approximate.

SOIL CLASSIFICATION CHART

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

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

ADDITIONAL MATERIAL SYMBOLS

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

Groundwater Contact

- **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**

Graphic Log Contact

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

Material Description Contact

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

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.

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
PPM	Parts per million
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

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FIGURE A-1

Drilled Start	End	Total Depth (ft)	Logged By / Checked By	Driller	Drilling Method
10/22/2012	10/22/2012	51.5	SCG / HPD	Geologic Drill, Inc.	HSA

Surface Elevation (ft) / Vertical Datum	Hammer Data	Drilling Equipment
45 / NAVD88	Automatic 140 (lbs) / 30 (in) Drop	Diedrich D50

Easting (X) / Northing (Y)	System Datum	Groundwater		
		Date Measured	Depth to Water (ft)	Elevation (ft)
Notes:		10/22/2012	20.5	24.5

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
40	0								SOD	Sod/grass			
			6			1			ML	Brown sandy silt with organics (fine roots) (very soft to soft, moist) (fill)			
			18	2		2							
	5		0	3		3							Gravels at 4.5 feet, per driller
			12	3		4			SM	Gray silty fine to medium sand with occasional fine gravel and oxidation staining (very loose, moist)			
35	10		8	4		5				With occasional organics (fine roots) (very loose to loose, moist)			
			0	19		6							Gravels at 11.5 feet
30	15			15		7			SP-SM	Orange brown fine to medium sand with silt and gravel (medium dense, moist)			
									GP	Brown fine to coarse gravel with sand (medium dense, wet)			
25	20		8	27		8 %F	▼				10		%F = 4
													Gravels at 21.5 feet
20	25		12	29		9 SA				With silt	10		SA; %F = 5
15	30		4	25		10 %F					10		2 feet of heave at 30 feet, added mud %F = 3
10	35												

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

Log of Boring B-1

GeoEngineers

Project: Liberty Park Library
Project Location: Renton, Washington
Project Number: 1784-018-00

Figure A-2
Sheet 1 of 2

Redmond: Date:11/6/12 Path:C:\DOCUMENTS AND SETTINGS\KROBINETTE\DESKTOP\1784018OO.GPJ DBTemplate\LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	FIELD DATA: Blows/foot	FIELD DATA: Collected Sample / Sample Name Testing	FIELD DATA: Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	35	3	29	11							
	40	3	33	12				Becomes dense			
	45	12	114	13				Becomes very dense			
	50	3	60	14							

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

Log of Boring B-1 (continued)

GeoEngineers

Project: Liberty Park Library
Project Location: Renton, Washington
Project Number: 1784-018-00

Figure A-2
Sheet 2 of 2

Redmond: Date:11/6/12 Path:C:\DOCUMENTS AND SETTINGS\KROBINETTE\DESKTOP\1784001800.GPJ DBTemplate\LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Drilled: Start 10/22/2012 End 10/22/2012	Total Depth (ft): 51.5	Logged By: SCG Checked By: HPD	Driller: Geologic Drill, Inc.	Drilling Method: HSA	
Surface Elevation (ft): 45 Vertical Datum: NAVD88		Hammer Data: Automatic 140 (lbs) / 30 (in) Drop		Drilling Equipment: Diedrich D50	
Easting (X): Northing (Y):		System Datum:		Groundwater: Date Measured 10/22/2012; Depth to Water (ft) 20.5; Elevation (ft) 24.5	
Notes:					

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	Blows/foot	Collected Sample: Sample Name / Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	0						AC	3 inches asphalt concrete pavement			
		6		1			SP-SM	Gray fine to medium sand with silt and gravel (medium dense, moist) (fill)			
		3	8	2			SP-SM	Orange brown fine to coarse sand with silt and gravel (loose, moist)			
40	5	8	5	3							
		12	28	4			SP-SM	Black fine to coarse sand with silt and gravel (medium dense, moist) (old topsoil)			
35	10	12	10	5				Grades to gray with concrete fragments			
			18	6							
30	15	3	21	7			GP	Gray sandy fine to coarse gravel (medium dense, moist)			
		12	30	8 SA	▼		GP-GM	Brown poorly graded gravel with silt and sand (medium dense to dense, wet)	6		SA; %F = 7
25	20						SP	Brown fine to coarse sand with gravel (medium dense, wet)			
	25	8	21	9 %F					8		Added mud after driving sampler %F = 4
20	30	8	24	10 %F			GP	Brown fine to coarse gravel with sand (medium dense, wet)	7		%F = 1
15	35										

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

Log of Boring B-2

GeoEngineers

Project: Liberty Park Library
Project Location: Renton, Washington
Project Number: 1784-018-00

Figure A-3
Sheet 1 of 2

Redmond: Date:11/6/12 Path:C:\DOCUMENTS AND SETTINGS\KROBINETTE\DESKTOP\1784018OO.GPJ DBTemplate\LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered (in)	Blows/foot	Collected Sample: Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content, %	Dry Density, (pcf)	REMARKS
	35	8	27	11 %F					7		%F = 4
5	40	2	49	12			GM	Brown silty fine to coarse gravel with sand (dense, wet)			
5	45	6	58	13							
5	50	3	66	14							

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

Log of Boring B-2 (continued)

GeoEngineers

Project: Liberty Park Library
Project Location: Renton, Washington
Project Number: 1784-018-00

Figure A-3
Sheet 2 of 2

Redmond: Date:11/6/12 Path:C:\DOCUMENTS AND SETTINGS\KROBINETTE\DESKTOP\1784001800.GPJ DBTemplate\LibTemplate:GEOENGINEERS8.GDT/GEI8_GEOTECH_STANDARD

APPENDIX B
Laboratory Testing

APPENDIX B
LABORATORY TESTING

Soil samples obtained from the explorations were transported to GeoEngineers' laboratory and evaluated to confirm or modify field classifications, as well as to evaluate engineering properties of the soil samples. Representative samples were selected for laboratory testing to determine the moisture content and percent fines (material passing the U.S. No. 200 sieve). The tests were performed in general accordance with test methods of ASTM International (ASTM) or other applicable procedures.

The results of the moisture content and percent fines determinations are presented at the respective sample depths on the exploration logs in Appendix A.

Moisture Content

Moisture content tests were completed in general accordance with ASTM D 2216 for representative samples obtained from the explorations. The results of these tests are presented on the exploration logs in Appendix A at the depths at which the samples were obtained.

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

Sieve Analyses

Sieve analyses were performed on selected samples in general accordance with ASTM D 422 to determine the sample grain size distribution. The wet sieve analysis method was used to determine the percentage of soil greater than the U.S. No. 200 mesh sieve. The results of the sieve analyses were plotted, were classified in general accordance with the Unified Soil Classification System (USCS) and are presented in Figure B-1.

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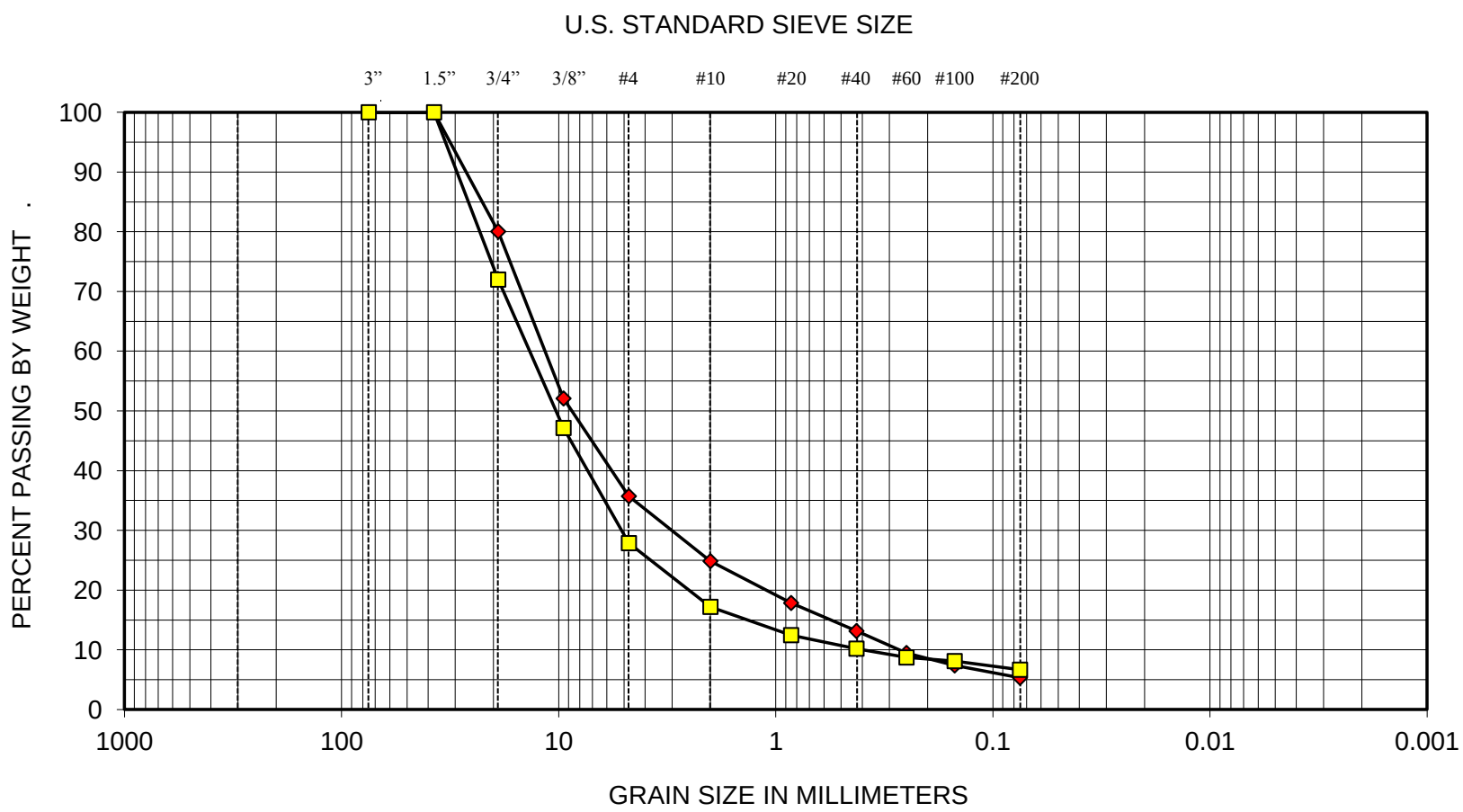
FIGURE B-1

SIEVE ANALYSIS RESULTS



BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

SYMBOL	EXPLORATION NUMBER	DEPTH (ft)	SOIL CLASSIFICATION
◆	B-1	25	Well-graded gravel with silt and sand (GW-GM)
■	B-2	20	Poorly graded gravel with silt and sand (GP-GM)

APPENDIX C
Report Limitations and Guidelines for Use

APPENDIX C
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

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 King County Library System and other project team members for the Liberty Park Library project. 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 Liberty Park Library project in Renton, 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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[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; 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 groundwater fluctuations. Always contact GeoEngineers before applying a report to determine if it remains applicable.

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. Accordingly, this report does not include any interpretations, recommendations, findings, or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants and no conclusions or inferences should be drawn regarding Biological Pollutants, as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria, and viruses, and/or any of their byproducts.

If Client desires these specialized services, they should be obtained from a consultant who offers services in this specialized field.

Have we delivered World Class Client Service?
Please let us know by visiting **www. geoengineers.com/feedback**.

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