741988

Geotechnical Studies
Lake City Civic Center
Parking Garage and Plaza
Seattle, Washington

August 4, 2003

12501 - 28th Ave NE

SHANNON & WILSON, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

At Shannon & Wilson, our mission is to be a progressive, well-managed professional consulting firm in the fields of engineering and applied earth sciences. Our goal is to perform our services with the highest degree of professionalism with due consideration to the best interests of the public, our clients, and our employees.

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GEOTECHNICAL STUDIES
LAKE CITY CIVIC CENTER PARKING GARAGE AND PLAZA
SEATTLE, WASHINGTON

1.0 INTRODUCTION

This report presents the results of our geotechnical studies for the proposed Lake City Civic Center Parking Garage and Plaza in Seattle, Washington. The purpose of our work was to evaluate subsurface soil and groundwater conditions at the site and to provide geotechnical recommendations for design and construction of the proposed structures and development of the site. The scope of our work included drilling four exploratory borings, performing laboratory testing, developing design recommendations, and preparing this report. Two of the four borings were completed to evaluate soil infiltration potential.

This work was accomplished in general accordance with our proposal letter dated July 30, 2002.

2.0 SITE AND PROJECT DESCRIPTION

The site of the proposed project is located at 12501 28th Avenue NE in Seattle as shown on the Vicinity Map, Figure 1. The existing Lake City Branch Library, consisting of a single-story, at-grade structure, occupies the southern portion of the property. An asphalt-paved parking lot is located on the northern portion of the site. Portions of Albert Davis Park south and west of the existing Civic Center will be included in the proposed new parking garage and possibly a storm water infiltration system. The Site and Exploration Plan, Figure 2, shows the approximate locations of the proposed parking garage and plaza and possible storm water infiltration system in Albert Davis Park.

We understand that the proposed project will include constructing a below grade parking garage. Proposed excavations will vary from 13 feet deep adjacent to the south building wall of the Lake City Community Center and 19 feet in the southwest corner near the existing library building. Excavation for proposed storm water detention tanks will be about 9 feet below the Parking Garage lowest slab-on-grade level. The proposed garage floor elevation is 185 feet, whereas the storm water infiltration tanks could be near elevation 176 feet. An addition to the Lake City Branch library about 50 by 75 feet in plan dimension is planned to occupy the south portion of the garage site. We understand the library addition will be constructed on top of the top floor of the parking garage at the existing ground surface elevation. The approximate locations of the proposed parking garage, limits of excavation, and the library addition are shown on the Site and Exploration Plan, Figure 2.

3.0 FIELD EXPLORATIONS

The subsurface conditions at the site were evaluated by drilling four exploratory borings. The borings, designated B-101 through B-104, were drilled on December 17 and 18, 2002. In addition to these explorations, four soil borings, designated B-1 through B-4, were made for our geotechnical report for the Seattle Public Library Lake City Branch proposed addition dated June 2001.

The approximate locations of the borings located within the proposed project area are shown on the Site and Exploration Plan, Figure 2. The current borings, B-101 and B-104, were drilled in the proposed parking garage excavation area and B-102 and B-103 were drilled at a potential location in Albert Davis Park for a storm water infiltration system. The borings were drilled to a maximum depth of 30.9 feet for the parking garage excavation and 15.4 feet for the infiltration system. No observation wells were installed. The locations of the borings were determined by taping from existing features and should be considered approximate. The logs for the borings are presented in Appendix A, Field Explorations, as Figures A-2 through A-9. Figure A-1 presents a key to our classification system and boring log symbols. A description of the field methods and procedures used during drilling and sampling are included in Appendix A.

4.0 GEOTECHNICAL LABORATORY TESTING

Geotechnical laboratory tests were performed on selected samples retrieved from the borings to determine soil index and engineering properties encountered at the site. The tests were performed in the Shannon & Wilson soils laboratory by an experienced technician or engineer. The soil tests included visual classification and natural water contents. Descriptions of the test methods are presented in Appendix B, Geotechnical Laboratory Testing. The natural water contents are also shown on the boring logs in Appendix A.

5.0 SUBSURFACE CONDITIONS

The explorations indicate that the site is underlain by dense glacial soils at a relatively shallow depth. Detailed soil descriptions at each of the boring locations are shown in Figures A-2 through A-9.

Underlying the proposed Parking Garage and Plaza site, a layer of sand ranging from 16 feet thick at the southwest to 25 feet thick at the northeast corners was encountered. This soil consists of loose (in the upper 3 to 6 feet) grading to medium dense to very dense, brown, slightly silty, gravelly sand and fine sand. A 2-foot-thick layer of gravelly sand and crushed rock fill soil was encountered beneath the asphalt pavement at boring B104 and 5 feet of sand and topsoil fill was encountered in boring B-3. Very dense glacial till was encountered beneath the sand at a depth of 16 feet in boring B-101 and 25 feet in B-104. Glacial till consists of very dense, gray, gravelly, silty sand. This material has been overridden by the weight of an ice sheet during the latest glacial advance about 13,000 years ago.

The location for the proposed storm water infiltration system was explored with borings B-102 and B-103. The borings encountered fill soil 2 to 3 feet thick consisting of loose to medium dense, slightly gravelly, silty sand mixed with fine roots and fragments of brick. Underlying the fill, medium dense to dense, gray, gravelly slightly silty to silty sand was encountered to a depth of 9.5 to 13.2 feet. Glacial till-like soil consisting of very dense, gray, gravelly, silty sand and fine sandy silt was found below the sand and extended to the depth of the borings (15.4 feet).

Wet soil conditions were observed in borings B-101 and B-104 at the time of drilling at about 27.5 and 25 feet, respectively. At boring B-104, groundwater appears to be perched on top of the glacial till; however, in boring B-101 wet soil conditions were encountered within the glacial till, indicating groundwater could be contained inside gravelly, sandy lenses within the glacial till. Generally, the upper sand layer is pervious and allows surface and groundwater to infiltrate and flow through it and glacial till is relatively impervious to groundwater flow and normally contains a limited volume of water.

6.0 ENGINEERING CONCLUSIONS AND RECOMMENDATIONS

Based on the subsurface conditions encountered in the field explorations and our understanding of the project, engineering studies were performed to develop conclusions and recommendations regarding the following:

- Seismic design criteria and seismically-induced geologic hazards
- Shallow foundation recommendations for the proposed parking garage
- Lateral earth pressure and resistance recommendations
- Slabs-on-grade
- Temporary excavation shoring
- Site grading, excavation, and temporary cut slopes
- Groundwater and surface water drainage and control
- Backfill material, placement, and compaction
- Wet weather earthwork
- Construction observation

A discussion of our studies, conclusions, and design recommendations is presented in the following sections.

7.0 RECOMMENDATIONS

7.1 Earthquake Engineering

7.1.1 Ground Motions

The project is located in a moderately active seismic region. While the region has historically experienced moderate to large earthquakes (such as the April 13, 1949, magnitude 7.1 Olympia Earthquake; April 29, 1965, magnitude 6.5 Seattle-Tacoma Earthquake; and February 28, 2001, magnitude 6.8 Nisqually Earthquake), geologic evidence suggests that larger earthquakes have occurred in the recent past and will continue to occur in the future (for example, magnitude 8½ to 9 Cascadia Subduction Zone Interplate events, magnitude 7½ Seattle Fault events). We understand that the project will be designed in accordance with the 1997 Uniform Building Code (UBC) (1997). The UBC requires that the seismicity of the region be considered by requiring structures be designed for earthquake ground motions with a 10 percent chance of being exceeded in 50 years (500-year recurrence). Accordingly, the UBC indicates that the project site is located in Seismic Zone 3 (peak ground acceleration on rock of approximately 0.3g).

In addition to seismicity, the UBC also requires that the response of the subsurface soils at the site be considered in developing design earthquake ground motions. The soil profile coefficient (S-factor), which is based on the subsurface geological conditions at the site, is used to represent the soil conditions at the site. Because the project site is generally underlain by medium dense to very dense soils, which are anticipated to extend to a depth of several hundred feet, we recommend that the soils at this site be characterized as a UBC Soil Profile Type S_C. The corresponding seismic coefficients C_a and C_v have values of 0.33 and 0.45, respectively. A seismic zone factor, Z, of 0.30 is recommended.

7.1.2 Earthquake Hazards

Earthquake-induced geologic hazards that may affect a given site include landsliding, fault rupture, and liquefaction and associated effects (such as loss of shear strength, bearing capacity failures, loss of lateral support, ground oscillation, and lateral spreading). Because of the relatively flat topography at the site, the risk of landsliding is low. The potential for fault rupture at the site should be considered relatively low because of the large distance from known faults. Because a static groundwater level was not observed in the borings and because of the very dense nature of the underlying soils, liquefaction and related effects also do not appear to pose a significant earthquake-induced geologic hazard at the site.

7.2 Conventional Spread Footings

We recommend that the proposed structure be founded upon column or continuous wall footings bearing in the undisturbed, competent native soils or on compacted structural fill that has been placed over the undisturbed, competent native soils. Footings founded upon the medium dense or denser native soils could be designed for an allowable soil bearing pressure of 8 kips per square foot (ksf). A soil pressure of 4 ksf may be used for footings founded upon structural fill compacted as recommended in the fill placement and compaction section of this report. Minimum footing widths should be 24 inches for individual square footings and 18 inches for continuous footings. Footings should be founded at least 2 feet below the lowest adjacent grade and set back behind a 1 Vertical to 1 Horizontal (1V:1H) projection from adjacent excavations such as the detention tanks. If footings are supported by structural fill, the fill should extend beyond the outer edges of footings a minimum distance equal to the thickness of the fill beneath the footing. Based on the results of our explorations, it is anticipated that the top of the bearing layer (medium dense or denser) will be encountered between roughly 3 to 6 feet below the existing ground surface.

The allowable bearing pressures given could be increased by one-third for wind or earthquake loads.

Footing excavations should be cleaned of all loose soil, leveled, and protected from water. The site soils contain a sufficient quantity of fines to become soft and spongy when subjected to water and disturbance. If construction is to take place during wet conditions, we recommend that a thin layer (2 to 3 inches thick) of lean concrete or compacted clean crushed rock be placed immediately after excavating to suitable foundation soils to serve as a working surface. Footing excavations should be kept free of water at all times.

Each footing excavation should be evaluated by a qualified geotechnical engineer to confirm suitable bearing conditions and to determine that all loose materials have been removed. This should be accomplished prior to placement of concrete or the working surface.

Assuming compliance with the above recommendations, we expect settlements to be less than ¾ inch, with differential settlements (between adjacent footings or over a 20-foot span of continuous footing) less than ½ inch.

7.3 Lateral Earth Pressures

Lateral earth pressures may act on buried portions of the building walls. For buried building walls that are allowed to move at least 0.001 times the wall height, we recommend that a static, active, lateral earth pressure be used. For buried building walls that are not allowed to move 0.001 times the wall height (a braced condition), static, at-rest, lateral earth pressures should be used. The equivalent fluid weights for both the active and at-rest conditions are 35 and 55 pounds per cubic foot (pcf), respectively. These values are based on the assumption that proper drainage is provided, and that no buildup of hydrostatic pressure occurs.

The total earth pressures should be analyzed for seismic loading conditions using a dynamic load increment equal to a percentage of the static, active and at-rest earth forces. The percentage increases for both the active and at-rest earth pressure conditions are 25 and 20 percent, respectively. This percent load increment should be applied as a uniform load to the wall, with the resultant force acting at the midpoint of the wall height. A percentage load increase for seismic conditions is consistent with a pseudostatic analysis using the Mononobe-Okabe equation for lateral earth pressures and a horizontal seismic coefficient of 0.15g. The seismic coefficient is not necessarily equivalent to the site peak ground acceleration. The magnitude of this coefficient accounts for the fact that the peak ground acceleration of 0.30g is experienced only a few times within the record of earthquake shaking, and the actual earthquake ground motion is cyclic in nature, as opposed to a static force. Values of the seismic coefficient are typically one-third to one-half the value of the peak ground acceleration that may be experienced at the site. These pressures assume drained conditions and a horizontal ground surface.

It may be found that the increase in lateral earth pressures during earthquake loading can be accommodated by the 33 percent capacity increase that is allowed in the strength of structural members by the UBC. Therefore, walls that are adequately designed for static loads may be capable of withstanding the combined effects of static and earthquake loading during the design earthquake.

7.4 Lateral Resistance

For structures founded on footings, lateral loads may be resisted by a combination of base friction and passive pressure against the footings and buried portions of building walls. We recommend that the base sliding resistance be determined based on an allowable coefficient of friction of 0.40 for dense, silty sand or densely compacted structural fill. We recommend an allowable passive pressure of 350 pcf. These passive pressures are for soil above the groundwater table. Both the coefficient and passive pressure values above include a factor-of-safety (FS) of 1.5.

7.5 Slabs-on-grade

We understand that the proposed building will have a slab-on-grade basement parking level floor. For a rigid concrete slab built on a subgrade that is prepared as described subsequently, we recommend using a modulus of subgrade reaction, k, of 200 pounds per cubic foot (pci). Site soils are suitable for slab support and, in our opinion, slab settlements should be within acceptable limits (less than ½ inch) if the subgrade is prepared as recommended.

As a capillary break, we recommend that a minimum 6-inch-thick layer of washed pea gravel (⅜-inch to No. 8 sieve size) or clean, ⅝-inch minus crushed rock (less than 3 percent passing the No. 200 sieve) and a vapor barrier consisting of plastic sheeting be placed beneath floor slabs, as shown on Figure 6. City of Seattle Type 22 would provide a suitable capillary break material. If pea gravel is used, a 2-inch layer of clean crushed rock can be placed over a 4-inch minimum layer of washed pea gravel to provide a firmer working surface on which to place the reinforcement. If used, the crushed rock should be compacted with at least three complete coverages of a vibrating plate compactor. The vapor barrier should be placed on top of the capillary break materials. A layer of damp sand may be placed above the vapor barrier as an option to aid in curing the concrete. Prior to placing pea gravel and/or crushed rock, the exposed subgrade surface should be compacted as needed to achieve a dense, unyielding condition.

7.6 Temporary Excavation Shoring

We understand that most of the site will be excavated using temporary shoring because of space limitations and adjacent structures; however, there may be open cuts along 28th Avenue NE and the portions of the west side excavation. We anticipate that temporary shoring would be soil nailing along the north wall because of dense soil conditions, or possibly a cantilevered or single row tieback anchor soldier pile wall in other areas of the site due to looser soil conditions. The site shoring would be temporary, with the final building wall cast against the shoring face. Soil nailing has been used successfully in the Seattle area and is more economical than conventional soldier pile walls. Shannon & Wilson has successfully designed temporary, permanent, and "top-down" soil nail shoring walls. We could provide a cost estimate for "permit ready" shoring plans, specifications, and calculations.

General recommendations for soldier piles and lagging are given in the following sections. Following the general recommendations are discussions of the temporary shoring design and drainage.

7.6.1 Soldier Piles

Vertical members for the soldier pile shoring system consist of steel sections placed into predrilled holes. Penetration depth below the final excavation level should be adequate for kick-out resistance. We recommend that soldier piles penetrate at least 8 feet below the bottom of the excavation.

The actual performance of the walls should be monitored during construction. The top of every other soldier pile should be surveyed on a weekly basis for horizontal and vertical movements until the walls for the new structure reach street level or adjacent floor level. We recommend that a preconstruction crack survey of adjacent structures, streets, and facilities be completed prior to any excavation or shoring.

7.6.2 Lagging

We recommend that lagging be installed between soldier piles. Lagging should be installed as the excavation proceeds, and not more than 4 feet (measured vertically) of unsupported excavation should be exposed at any one time. The actual height of vertical, unsupported excavation may vary depending on the soils encountered; however, it should be no more than 4 feet.

The Contractor should provide means, such as weep holes, to prevent the buildup of hydrostatic pressures behind shoring walls. Voids behind the lagging should be filled with concrete sand or drainage sand and gravel or locally with a weak control density fill.

Because of soil arching between soldier piles, a reduced lateral earth pressure is recommended for design of lagging. Recommended pressures for temporary lagging design are presented in Figure 3.

7.6.3 Temporary Shoring Wall Design Pressures

Recommended lateral earth pressures for temporary cantilever and single-row tieback wall designs are given on Figure 3. These included active, at-rest, and passive pressures and distributions. Also included on Figure 3 are recommendations for traffic and/or construction surcharge loads of 250 to 600 pounds per square foot (psf).

For active conditions, lateral wall movements could range from 0.10 to 0.15 percent of the excavation depth. In general, settlements of the same order of magnitude could occur behind the wall for a distance of half the height of the excavation, decreasing linearly to zero at a distance of approximately 1.5 to 2 times the excavation height. The above-mentioned deflections and settlements are estimates only and are, in part, affected by the method and care used during excavation and shoring wall installation. If these deflections and settlements are objectionable, at-rest earth pressures should be utilized.

Additional surcharge loading and conditions are presented on Figure 4. These include adjacent foundations, slabs, and slopes. Earth pressure coefficients K of 0.30 and 0.50 are recommended for active and at-rest conditions.

7.6.4 Shoring Wall Drainage

Drainage recommendations for soldier pile shoring walls are presented in Figure 5. In our opinion, the care taken in construction of the weep drains at the base of the walls is critical. A positive connection with the drainage mat must be provided, and concrete contamination and plugging must be avoided; otherwise, in our opinion, the basement walls will leak. Close quality control during construction is very important.

7.7 Site Grading, Excavation, and Temporary Cut Slopes

7.7.1 Slab-on-grade Preparation

For the building, we recommend the following subgrade preparation for rigid concrete slabs-on-grade:

- Remove material from the building footprint as needed to establish the required subgrade elevation.
- Compact the exposed subgrade soil to at least 95 percent of the Modified Proctor maximum dry density (American Society for Testing and Materials [ASTM] D 1557) unless dense subgrade soils are encountered based on evaluation by geotechnical engineer.
- Remove any soft/loose zones noted during compaction and replace those areas with structural fill material constructed in accordance with the recommendations presented subsequently.
- Place densely compacted, free-draining, well-graded, imported, clean, crushed gravel or rockfill to provide a capillary break and drainage layer.
- Install a vapor barrier capable of resisting puncture and/or tearing due to the underlying capillary break material.

The design civil engineer should determine if sand for concrete curing is required between the vapor barrier and the concrete slab. We recommend that the external grade be sloped away from the structure.

7.7.2 Excavation and Temporary Groundwater Control

Throughout any excavated areas, the on-site soil contains enough fine-grained material to make it moisture sensitive; therefore, control of surface and groundwater will be necessary to maintain the integrity of the exposed material and a firm working platform. Lean concrete (minimum 1½ sacks of cement per cubic yard) may be placed beneath proposed footings to provide a stable working surface or as backfill to replace unsuitable exposed soil.

The Contractor should be responsible for the control of ground and surface water within the contract limits. In this regard, sloping, slope protection, ditching, sumps, dewatering, and other measures should direct water away from the structure to prevent ponding of water next to the facility.

We do not anticipate that the basement excavations would be below the groundwater table; however, perched groundwater may be encountered. Wet weather or wet conditions may require the use of sumps or wells to control the surface and/or groundwater and allow for an accessible excavation.

7.7.3 General Excavation and Temporary Cut Slopes

For safe working conditions and prevention of ground loss, excavation slopes should be the responsibility of the Contractor because he/she will be at the job site to observe and control the work. All current and applicable safety regulations regarding excavation slopes and shoring should be followed.

Excavations can be accomplished with conventional excavating equipment, such as a dozer, front-end loader, or backhoe. The very dense material may be difficult to excavate. For planning purposes, we recommend that temporary, unsupported, open-cut slopes in the glacially overridden native soil be no steeper than 1H:1V. Where existing fill is encountered, we recommend that cut slopes be no steeper than 1.5H:1V. Flatter cut slopes may be required where loose soils or seepage zones are encountered during excavation. We recommend that all exposed cut slopes be protected with a waterproof covering during periods of wet weather to reduce sloughing and erosion.

All traffic and/or construction equipment loads should be set back from the edge of the cut slopes by a minimum of 2 feet. Excavated material (or stockpiles of construction materials or equipment) should not be placed closer to the edge of any excavation than the depth of the excavation, unless the excavation is shored and such materials are accounted for as a surcharge load on the shoring system.

7.8 Permanent Groundwater and Surface Water Drainage and Control

To remove surface storm water from the site, we understand detention tanks may be installed below the slab-on-grade. A suggested alternate or supplement to detention tanks is a storm water infiltration system consisting of perforated pipes located along the western border of Albert Davis Park. Regardless of the storm water disposal system selected, we make the following recommendations regarding site drainage.

Perimeter foundation drains should be installed at the parking garage site in order to control perched groundwater and higher groundwater table conditions (which are possible during wet winter months). The underslab drainage/capillary break layer shown on Figure 6 could be hydraulically connected to the perimeter drains to reduce the potential for hydrostatic pressure below the slab.

To control surface water, provisions should be made to direct it away from structures and prevent it from seeping into the ground adjacent to the structures or excavations. The ground surface should be sloped away, and surface and downspout water should not be introduced into site backfill. Surface water should be collected in catch basins and, along with downspout water, should be conveyed in a nonperforated pipe (tightline) into an approved discharge point.

7.9 Backfill Material, Placement, and Compaction

All fill placed beneath areas to be paved or against below grade walls or other foundation elements should consist of structural fill. Structural fill should be placed on subgrade material that has been proof-rolled to a dense, unyielding condition or evaluated and probed by an experienced geotechnical engineer.

Structural fill should meet the Washington State Department of Transportation specification for Gravel Borrow (Section 9-03.14 [1]) but should have a maximum particle size of about 3 inches or Gravel Backfill for Walls (Section 9-03.12[2]), City of Seattle Type 17 material. During wet weather or wet conditions, it should not contain more than about 5 percent fines (material passing the No. 200 mesh sieve) by weight, based on the minus ¾-inch soil fraction. Structural fill should not contain organics or deleterious material. It should be placed in horizontal lifts and compacted to at least 95 percent of its Modified Proctor maximum dry density (ASTM D 1557, Method C or D) and to a dense and unyielding condition. The thickness of loose lifts should not exceed 8 inches for heavy equipment compactors and 4 inches for hand-operated compactors. In landscaping areas, the backfill should be compacted to at least 90 percent of the Modified Proctor maximum dry density.

All utility trenches beneath pavements or floor slabs should also be backfilled with Gravel Borrow or Type 17; however, it should have a maximum diameter of 2 inches and should not have more than 5 percent passing the No. 200 sieve (wet sieve analysis, ASTM D 1140). Any fines should be nonplastic. The trench backfill should be placed in lifts not exceeding 4 inches if compacted with hand-operated equipment, or 8 inches if compacted with heavy equipment. Each lift should be compacted to a dense, unyielding condition and to at least 92 percent of the maximum dry density (ASTM D 1557) 12 inches or more below the pavement subgrade, and to

95 percent within 12 inches of the pavement subgrade. We recommend a minimum cover over utilities of 2 feet from the crown of the pipes or conduits to the top of the pavement subgrade. Catch basins, utility vaults, detention tanks, and other structures installed flush with the pavement or slab should be designed and constructed to transfer wheel loads to the base of the structure.

We recommend that basement walls constructed in open excavations be backfilled with free-draining soils that are connected hydraulically to perimeter drains. The ground surface should be sloped away from the buildings to prevent ponding against them. Our recommendations for drainage behind permanent basement walls are presented in Figure 6. These recommendations include compaction criteria and gradation requirements of drainage materials.

In our opinion, the on-site soils are not suitable for reuse as structural fill.

7.10 Wet Weather Earthwork

In this area, wet weather generally begins in October and continues through about May, although rainy periods may occur at any time of the year. Earthwork performed during the wet weather months will cost more and take longer to complete. Groundwater levels will also be higher during the rainy season. Groundwater and surface water runoff could enter into site excavations and would need to be intercepted by drainage ditches, or trench drains, or be otherwise removed. The soils at the site generally contain sufficient silt to produce an unstable mixture when wet. Such soils are susceptible to softening when wet. Standing water on the soil surface, along with construction activity, will result in disturbance and an unacceptable bearing surface requiring overexcavation.

The following recommendations are applicable for general excavation, floor slabs, or pavements:

- The ground surface in the construction area should be sloped and sealed with a smooth-drum roller to promote rapid runoff of precipitation, to prevent surface water from flowing into excavations, and to prevent ponding of water.

- Construction should be observed on a full-time basis by Shannon & Wilson personnel to determine that all unsuitable materials are removed, suitable drainage is achieved, and an appropriate bearing surface results.

- Covering work areas with plastic and/or sloping, ditching, pumping from sumps, and other dewatering measures should be employed as necessary to permit proper completion of the work.

- Refer to Section 6.10 for type of structural fill to use during wet weather.

The above recommendations apply for all weather conditions, but are most important for wet weather or wet conditions earthwork. They should be incorporated into the contract specifications for foundation construction.

8.0 CONSTRUCTION CONSIDERATIONS

8.1 Footings

The recommended allowable bearing capacities presented previously in this report are contingent upon the following construction considerations:

- Footing subgrade excavations should be cleaned of all fill, debris, and loose, soft, wet, or disturbed soil prior to placing the reinforced concrete.

- If construction is to take place in wet weather, we recommend that a thin layer (2 to 4 inches thick) of lean concrete, also know as a "rat slab" or "mud slab," be placed immediately after excavating to serve as a working surface. Footing excavations should be kept free of water at all times. If groundwater is encountered, it should be lowered to at least 2 feet below the bottom of footing excavations.

- Structural fill placed around the footings should be accomplished in accordance with the recommendations given in this report.

- All excavations for spread footing foundations should be observed by a geotechnical engineer to evaluate the adequacy of the bearing stratum and to confirm that subsurface conditions at and below the bearing elevation are suitable for the design bearing values provided.

8.2 Soldier Pile Installation and Monitoring

The shoring contractor should anticipate drilling boreholes for the installation of soldier piles through water-bearing sand and gravel layers (perched groundwater), as well as the obstructions discussed in this report.

The actual performance of the wall should be monitored during construction. The top of every other soldier pile should be surveyed on a weekly basis for horizontal and vertical movements until the walls for the new structure reach street level.

8.3 Obstructions

Although not encountered in the explorations, cobbles and boulders are commonly found in glacial soils and should be anticipated at the site. The Contractor should be prepared to encounter cobbles and boulders during soldier pile and tieback installations and site excavation.

8.4 Plans and Specifications Review and Construction Observation

We recommend that Shannon & Wilson be retained to review those portions of the plans and specifications that pertain to foundations and earthwork to determine if they are consistent with our recommendations. We also recommend that we be retained to observe the geotechnical aspects of construction, particularly the temporary shoring and foundation installation, slab-on-grade subgrade preparation, drainage, and backfill. This observation would allow us to confirm the subsurface conditions as they are exposed during construction, and to determine that the work is accomplished in accordance with our recommendations

9.0 LIMITATIONS

The analyses, conclusions, and recommendations contained in this report are based upon site conditions as they presently exist, and further assume that the explorations are representative of the subsurface conditions at the proposed Parking Garage site; that is, the subsurface conditions everywhere are not significantly different from those disclosed by the explorations. Within the limitations of the scope, schedule, and budget, the analyses, conclusions, and recommendations presented in this report were prepared in accordance with generally accepted professional geotechnical engineering principles and practice in this area at the time this report was prepared. We make no other warranty, either express or implied. Our conclusions and recommendations are based on our understanding of the project as described in this report and the site conditions as interpreted from the explorations.

If, during final design and construction, subsurface conditions different from those encountered in the field explorations are observed or appear to be present, we should be advised at once so that we can review these conditions and reconsider our recommendations where necessary. If there is substantial lapse of time between the submission of the final design report and the start of work at the site, or if conditions have changed because of natural forces or construction operations at or adjacent to the site, we recommend that this report be reviewed to determine the applicability of the conclusions and recommendations concerning the changed conditions or the time lapse.

This report was prepared for the exclusive use of Hewitt Architects. It should be made available to prospective contractors for information on factual data only, and not as a warranty of subsurface conditions such as those interpreted from the exploration logs and presented in the discussions of subsurface conditions included in this report.

Unanticipated soil conditions are commonly encountered and cannot fully be determined by merely taking soil samples from test borings. Such unexpected conditions frequently require that additional expenditures be made to attain properly constructed projects. Therefore, some contingency fund is recommended to accommodate such potential extra costs. The scope of our geotechnical services did not include any environmental assessment or evaluation regarding the presence or absence of hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below the site, or for evaluation of disposal of contaminated soils or groundwater, should any be encountered, except as noted in this report.

Shannon & Wilson, Inc. has prepared a document, "Important Information About Your Geotechnical Report," to assist you and others in understanding the use and limitations of our report. This document is included as Appendix C.

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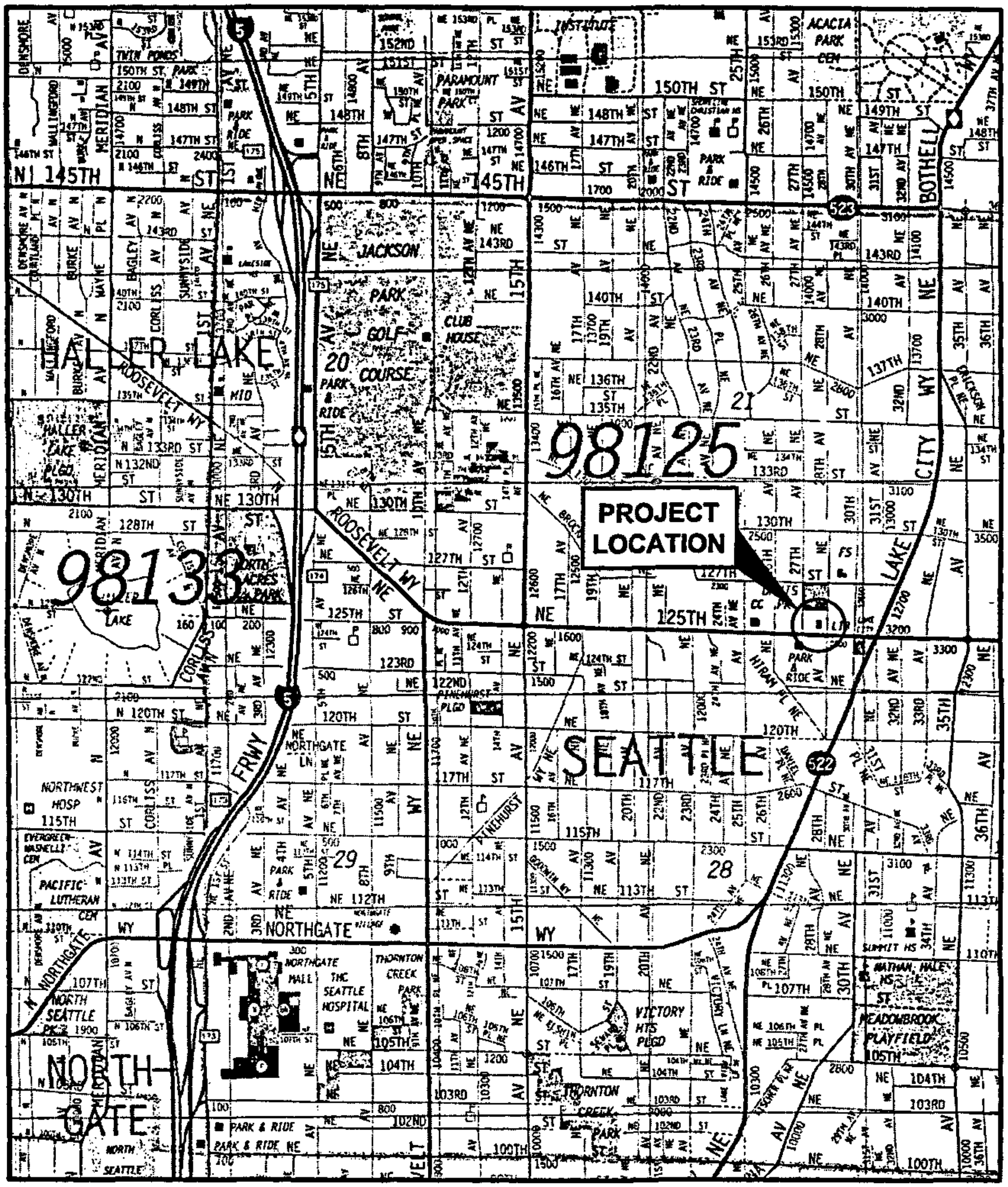

0 1/4 1/2 1

Scale in Miles

NOTE

Lake City Civic Center
Parking Garage and Plaza
Seattle, Washington

VICINITY MAP

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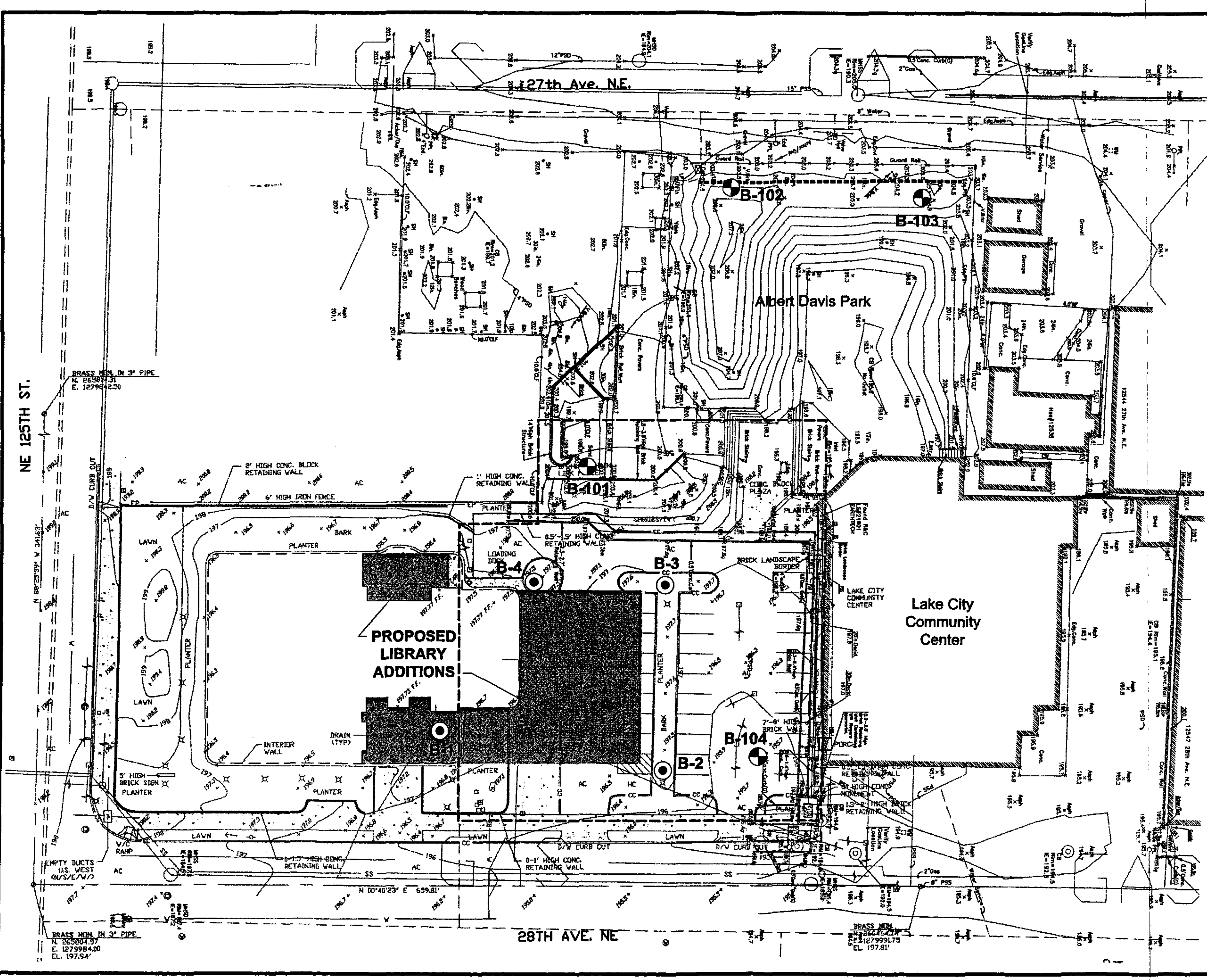
SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 1

File: I:\Drafting\211\09409-002\21-1-09409-002 FIG 1.dwg Date: 01-02-2003 Author: SAC



Lake City Civic Center
Parking Garage and Plaza
Seattle, Washington

SITE AND EXPLORATION PLAN

January 2003 | 21-1-09409-002

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FIG. 2

File: I:\Drafting\21\109409-002\21-1-09409-002 FIG 2.dwg Date: 01-07-2003 Author: SAC

File: I:\Drafting\211\09409-002\21-1-09409-002 FIG 3.dwg Date: 01-07-2003 Author: SAC

Figure A. Recommended Earth Pressures for Cantilever and Single Tieback Wall

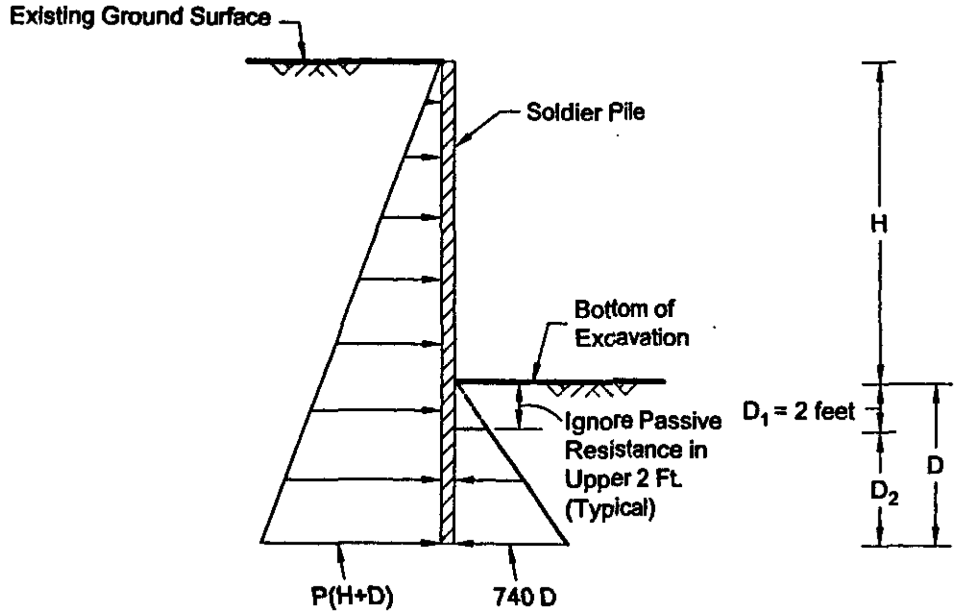
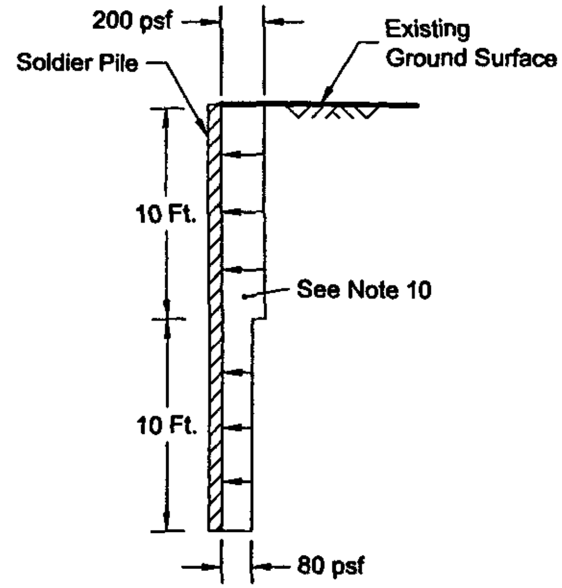


Figure B. Heavy Traffic & Construction Equipment Surcharge



NOTES

1. All Earth Pressures are in units of pounds per square foot.
2. Wall Embedment (D) should consider kickout resistance. Embedment should be determined by satisfying horizontal static equilibrium about the bottom of the pile. Minimum recommended embedment is 8 feet.
3. Total design pressure should be the sum of the above earth pressures and the traffic/construction surcharge. If cut slopes are made above the soldier pile walls, a slope surcharge should be added to the total design pressure; see Figure 4.
4. The recommended pressure diagrams are based on a continuous wall system. If soldier piles with laggings are used, apply active pressure over the width of the soldier piles below the bottom of the excavation and apply passive resistances over twice the width of the piles or the spacing of the piles, whichever is smaller.
5. Free drainage assumed behind the wall.
6. Use 80% of the design pressures for computing moment in piles.
7. For temporary lagging design, use 30% of the design pressures.
8. Allowable vertical pile capacity:
   Temporary Skin Friction = 1 ksf
   Temporary End Bearing = 8 ksf
9. Lateral pressures in Figure B are based on an assumed vertical traffic surface surcharge of 250 to 600 psf acting over a limited influence area. More severe construction equipment loading requires special analysis.

LEGEND

H = Wall Heights (Ft.)

D, D_1, D_2 = Embedment Depths (Ft.)

P = 30 pcf, Active Condition
= 50 pcf, At-Rest Condition

Lake City Civic Center
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Seattle, Washington

CANTILEVER AND SINGLE TIEBACK ANCHOR SOLDIER PILE WALL DESIGN CRITERIA

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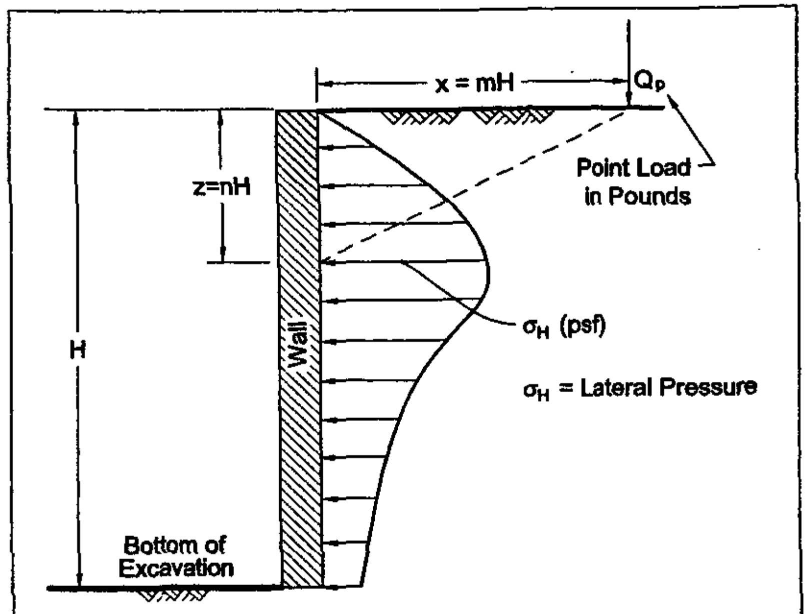
FIG. 3

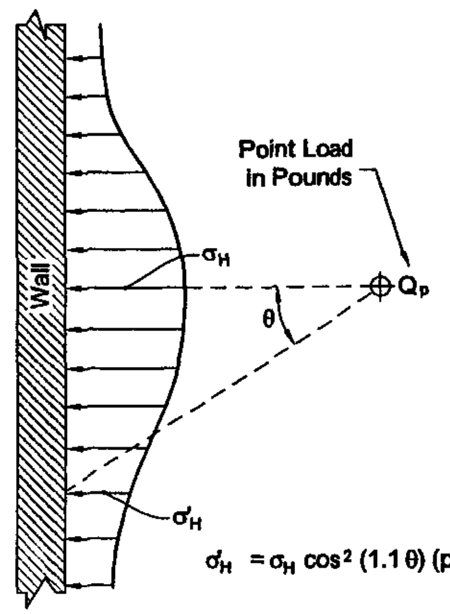
FIG. 3



ELEVATION VIEW

For $m \leq 0.4$: $\sigma_H = 0.28 \dfrac{Q_p}{H^2} \dfrac{n^2}{(0.16 + n^2)^3}$ (psf)

For $m > 0.4$: $\sigma_H = 1.77 \dfrac{Q_p}{H^2} \dfrac{m^2\, n^2}{(m^2 + n^2)^3}$ (psf)

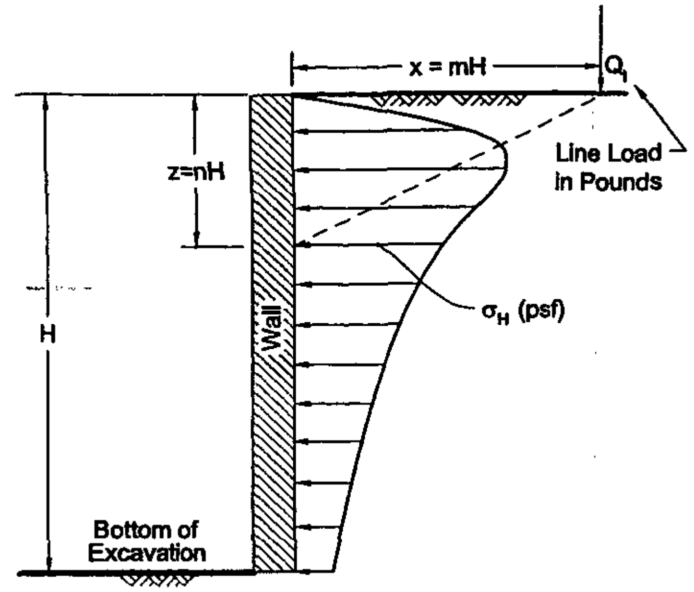


$\sigma'_H = \sigma_H \cos^2(1.1\,\theta)$ (psf)

PLAN VIEW

A) LATERAL PRESSURE DUE TO POINT LOAD i.e. SMALL ISOLATED FOOTING OR WHEEL LOAD

(NAVFAC DM 7.2, 1986)



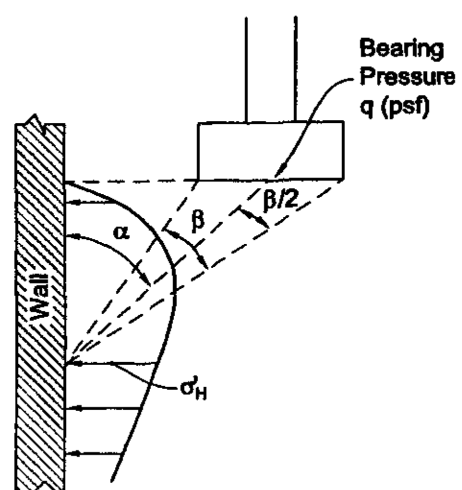
ELEVATION VIEW

For $m \leq 0.4$: $\sigma_H = 0.20 \dfrac{Q_l}{H} \dfrac{n^2}{(0.16 + n^2)^2}$ (psf)

For $m > 0.4$: $\sigma_H = 1.28 \dfrac{Q_l}{H} \dfrac{m^2\, n}{(m^2 + n^2)^2}$ (psf)

B) LATERAL PRESSURE DUE TO LINE LOAD i.e. NARROW CONTINUOUS FOOTING PARALLEL TO WALL

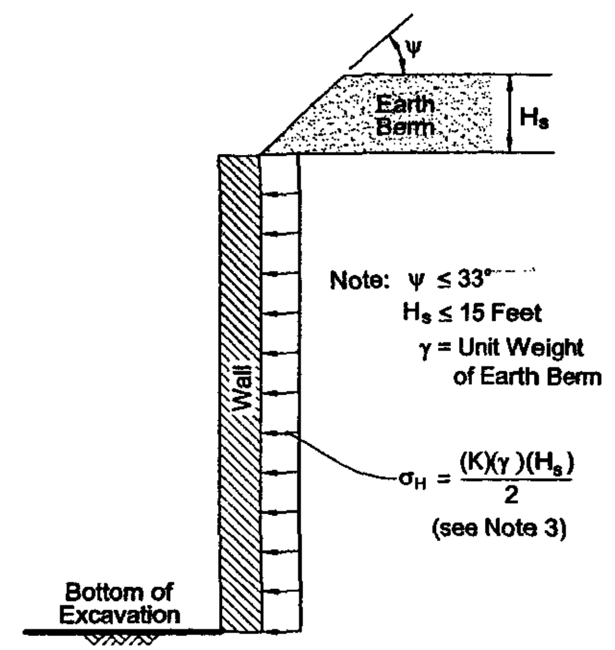
(NAVFAC DM 7.2, 1986)



$\sigma_H = \dfrac{2q}{\pi}(\beta - \sin\beta\cos 2\alpha)$ (psf) (β in radians)

C) LATERAL PRESSURE DUE TO STRIP LOAD

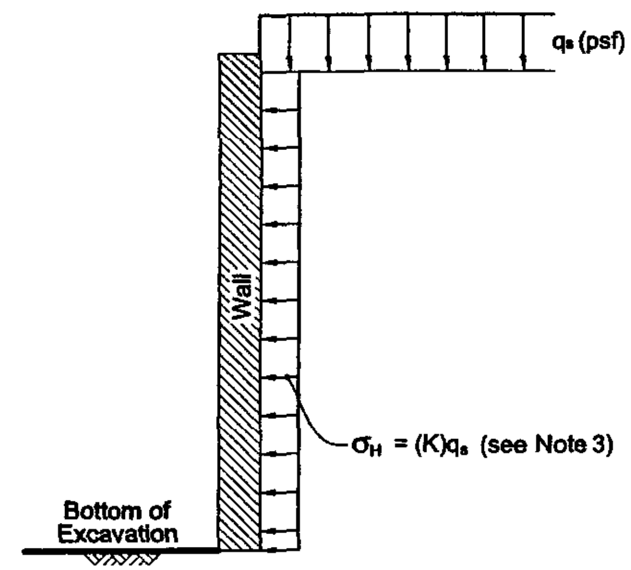
(derived from Fang, *Foundation Engineering Handbook*, 1991)



Note: $\psi \leq 33°$
$H_s \leq 15$ Feet
γ = Unit Weight of Earth Berm

$\sigma_H = \dfrac{(K)(\gamma)(H_s)}{2}$ (see Note 3)

EARTH BERM

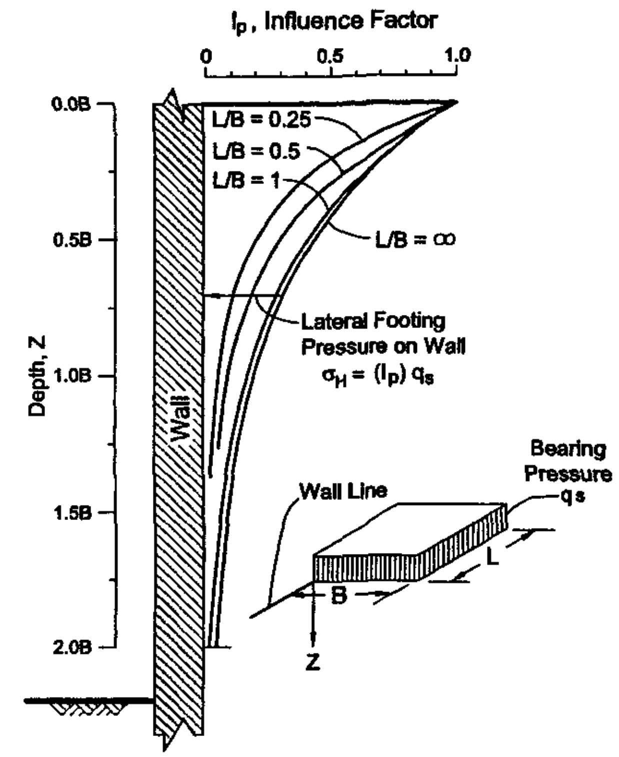


$\sigma_H = (K)q_s$ (see Note 3)

UNIFORM SURCHARGE

D) LATERAL PRESSURE DUE TO EARTH BERM OR UNIFORM SURCHARGE

(derived from Poulous and Davis, *Elastic Solutions for Soil and Rock Mechanics*, 1974; and Terzaghi and Peck, *Soil Mechanics in Engineering Practice*, 1967)



E) LATERAL PRESSURE DUE TO ADJACENT FOOTING

(derived from NAVFAC DM 7.2, 1986; and Sandhu, *Earth Pressure on Walls Due to Surcharge*, 1974)

NOTES

1. Figures are not drawn to scale.
2. Applicable surcharge pressures should be added to appropriate permanent wall lateral earth and water pressure.
3. See text for recommended K values.

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Parking Garage and Plaza
Seattle, Washington

RECOMMENDED SURCHARGE LOADING FOR TEMPORARY AND PERMANENT WALLS

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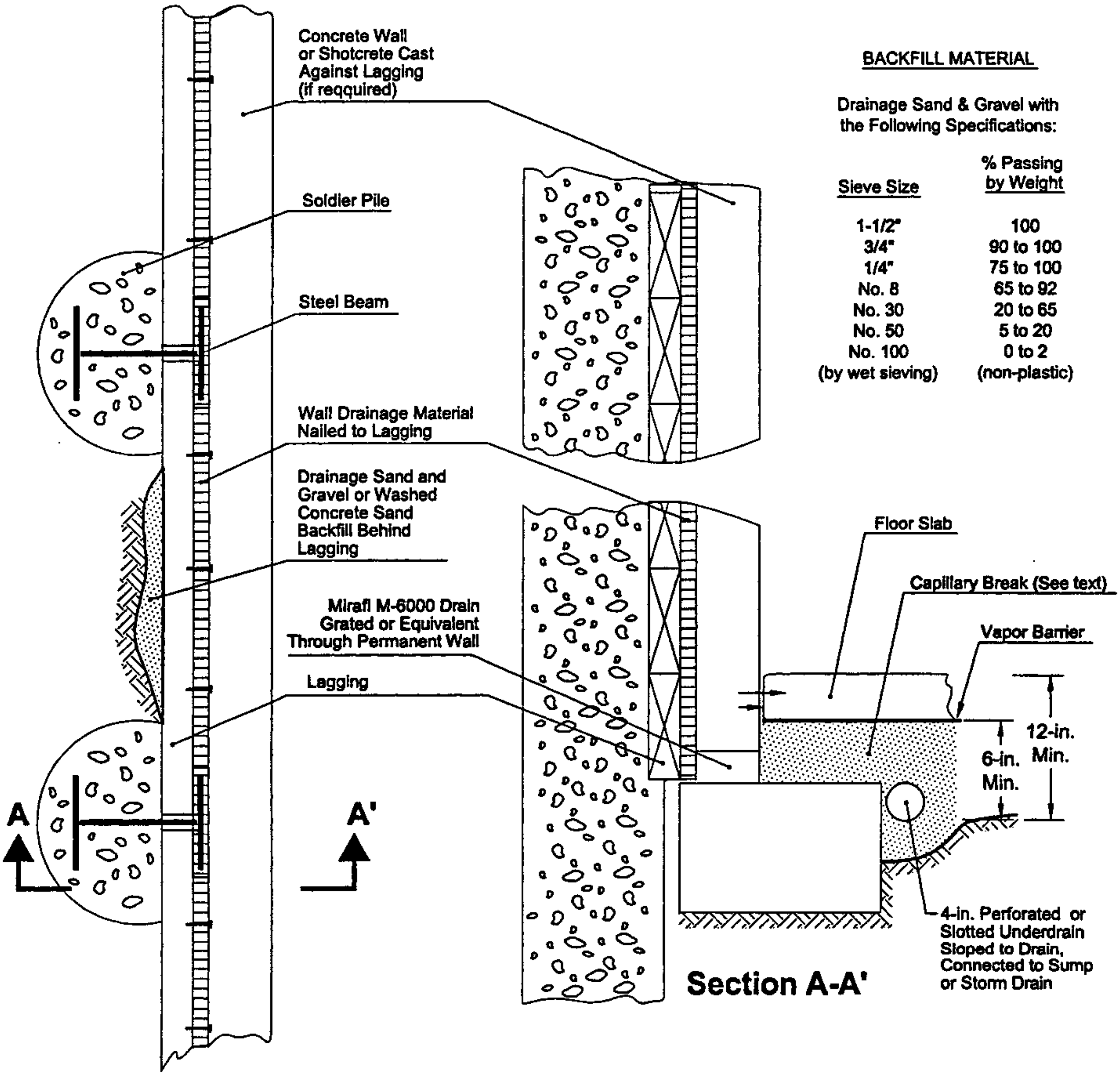
SHANNON & WILSON, INC. Geotechnical and Environmental Consultants | **FIG. 4**

File: I:\Drafting\21\109409-002\21-1-09409-002 FIG 4.dwg Date: 01-07-2003 Author: SAC



BACKFILL MATERIAL

Drainage Sand & Gravel with the Following Specifications:

Sieve Size	% Passing by Weight
1-1/2"	100
3/4"	90 to 100
1/4"	75 to 100
No. 8	65 to 92
No. 30	20 to 65
No. 50	5 to 20
No. 100 (by wet sieving)	0 to 2 (non-plastic)

Not to Scale

NOTES

1. Wall drainage material: Miradrain 6000 or equivalent.
2. Clean-outs should be provided in the underdrain system.
3. Slotted pipe to have 1/8-inch maximum width slots.
4. Weep holes should be provided through lagging if concrete or steel panels are used.

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SHORING WALL AND FLOOR SLAB DRAINAGE RECOMMENDATIONS

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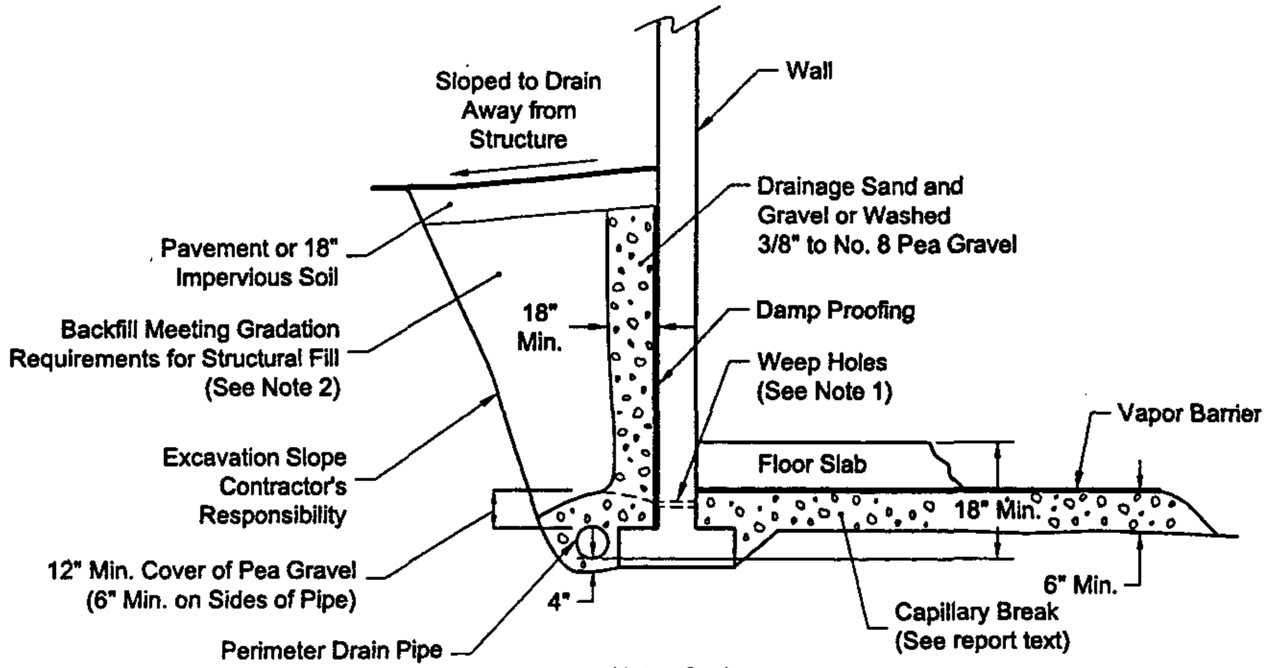
FIG. 5

File: I:\Drafting\211\09409-002\21-1-09409-002 FIG 5.dwg Date: 01-07-2003 Author: SAC



Not to Scale

MATERIALS

Drainage Sand & Gravel with the Following Specifications:

Sieve Size	% Passing by Weight
1-1/2"	100
3/4"	90 to 100
1/4"	75 to 100
No. 8	65 to 92
No. 30	20 to 65
No. 50	5 to 20
No. 100	0 to 2
(by wet sieving)	(non-plastic)

PERIMETER DRAIN PIPE

4" minimum diameter perforated or slotted pipe; tight joints; sloped to drain (6"/100' min. slope); provide clean-outs.

Perforated pipe holes (3/16" to 3/8" dia.) to be in lower half of the pipe with lower quarter segment unperforated for water flow.

Slotted pipe to have 1/8" maximum width slots.

NOTES

1. Capillary break beneath floor slab could be hydraulically connected to perimeter drain pipe. Use of 1-inch diameter weep holes as shown is one applicable method.

2. Structural fill should meet WSDOT Gravel Borrow Specification 9-03.14(1) but should have a maximum size of 3 inches, and during wet conditions or wet weather should not have more than 5% fines (by weight based on minus 3/4" portion) passing No. 200 sieve (by weight sieving) with no plastic fines.

3. Backfill within 18" of wall should be compacted with hand-operated equipment. Heavy equipment should not be used for backfill, as such equipment operated near the wall could increase lateral earth pressures and possibly damage the wall.

4. All backfill should be placed in layers not exceeding 4" loose thickness for light equipment and 8" for heavy equipment and densely compacted. Beneath floor slabs, paved or sidewalk areas, compact to at least 95% Modified Proctor maximum dry density (ASTM: D1557, Method C or D). Otherwise compact to 90% minimum.

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TYPICAL BASEMENT WALL PERIMETER DRAIN AND BACKFILL

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FIG. 6

File: I:\Drafting\211\09409-002\21-1-09409-002 FIG 6.dwg Date: 01-07-2003 Author: SAC

APPENDIX A

FIELD EXPLORATIONS

APPENDIX A

FIELD EXPLORATIONS

TABLE OF CONTENTS

LIST OF FIGURES

Shannon & Wilson, Inc. (S&W), uses a soil classification system modified from the Unified Soil Classification System (USCS). Elements of the USCS and other definitions are provided on this and the following page. Soil descriptions are based on visual-manual procedures (ASTM D 2488-93) unless otherwise noted.

S&W CLASSIFICATION OF SOIL CONSTITUENTS

- MAJOR constituents compose more than 40 percent, by weight, of the soil. Major consituents are capitalized (i.e., SAND).
- Minor constituents compose 12 to 50 percent of the soil and precede the major constituents (i.e., silty SAND). Minor constituents preceded by "slightly" compose 5 to 12 percent of the soil (i.e., slightly silty SAND).
- Trace constituents compose 0 to 5 percent of the soil (i.e., slightly silty SAND, trace of gravel).

MOISTURE CONTENT DEFINITIONS

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, from below water table

ABBREVIATIONS

ATD	At Time of Drilling
Elev.	Elevation
ft	feet
FeO	Iron Oxide
HSA	Hollow Stem Auger
ID	Inside Diameter
in	inches
lbs	pounds
Mon.	Monument cover
N	Blows for last two 6-inch increments
NA	Not applicable or not available
NP	Non plastic
OD	Outside diameter
OVA	Organic vapor analyzer
PID	Photo-ionization detector
ppm	parts per million
PVC	Polyvinyl Chloride
SS	Split spoon sampler
SPT	Standard penetration test
USC	Unified soil classification
WLI	Water level indicator

GRAIN SIZE DEFINITION

DESCRIPTION	SIEVE NUMBER AND/OR SIZE
FINES	< #200 (0.8 mm)
SAND*	
- Fine	#200 to #40 (0.8 to 0.4 mm)
- Medium	#40 to #10 (0.4 to 2 mm)
- Coarse	#10 to #4 (2 to 5 mm)
GRAVEL*	
- Fine	#4 to 3/4 inch (5 to 19 mm)
- Coarse	3/4 to 3 inches (19 to 76 mm)
COBBLES	3 to 12 inches (76 to 305 mm)
BOULDERS	> 12 inches (305 mm)

* Unless otherwise noted, sands and gravels, when present, range from fine to coarse in grain size.

RELATIVE DENSITY / CONSISTENCY

COARSE-GRAINED SOILS		FINE-GRAINED SOILS	
N, SPT, BLOWS/FT.	RELATIVE DENSITY	N, SPT, BLOWS/FT.	RELATIVE CONSISTENCY
0 - 4	Very loose	Under 2	Very soft
4 - 10	Loose	2 - 4	Soft
10 - 30	Medium dense	4 - 8	Medium stiff
30 - 50	Dense	8 - 15	Stiff
Over 50	Very dense	15 - 30	Very stiff
		Over 30	Hard

WELL AND OTHER SYMBOLS

Cement/Concrete
Bentonite Grout
Bentonite Seal
Silica Sand
PVC Screen
Vibrating Wire
Asphalt or Cap
Slough
Ash
Bedrock

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SOIL CLASSIFICATION AND LOG KEY

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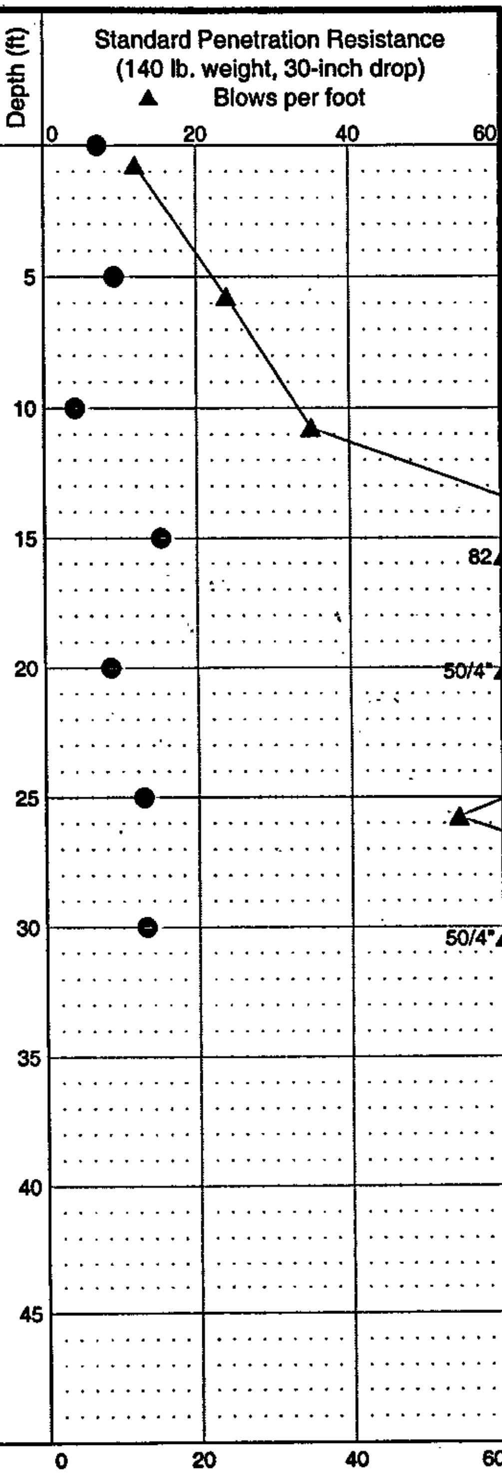
FIG. A-1

SOIL DESCRIPTION Surface Elevation: Approx. 200 Ft.	Depth (ft)	Symbol	Samples	Ground Water
Medium dense, brown and gray, slightly silty, fine to medium SAND; moist; laminated; SM-SP.			1, 2, 3	
Very dense, gray, slightly gravelly to gravelly, silty, fine SAND grading to fine sandy SILT; moist; wet at 28 feet; (Glacial Till) SM/ML.	16.0		4, 5, 6, 7	During Drilling
BOTTOM OF BORING COMPLETED 12/17/2002	30.9			



LEGEND

- * Sample Not Recovered
- Ꮖ 2-inch O.D. Split Spoon Sample
- Ⅱ 3-inch O.D. Shelby Tube Sample
- ∇ Ground Water Level ATD

● % Water Content

Plastic Limit ├──●──┤ Liquid Limit
Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
3. Groundwater level, if indicated above, is for the date specified and may vary.
4. Refer to KEY for explanation of "Symbols" and definitions.
5. USCS designation is based on visual-manual classification and selected laboratory index testing.

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LOG OF BORING B-101

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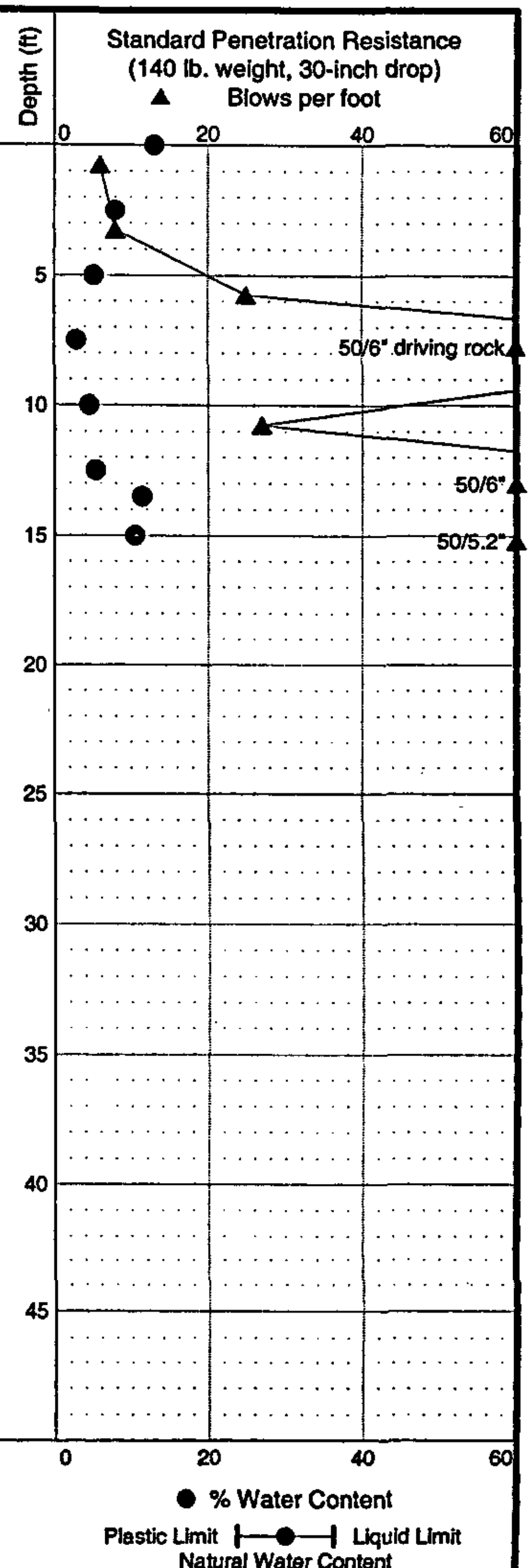
FIG. A-2

MASTER_LOG 21-09409.GPJ OLD 2001 SHANWIL TEMPLATE.GDT 1/7/03 Log: BMR Rev: TMG Typ: LKD

SOIL DESCRIPTION Surface Elevation: Approx. 205 Ft.	Depth (ft)	Samples	Ground Water
Loose, brown, silty, fine SAND; moist; mottled with fine roots; (Fill) SM.	2.0	1	None Observed During Drilling
Medium dense to very dense, gray, gravelly, fine to coarse SAND; moist; SP.	9.0	2, 3, 4	
Medium dense, gray, slightly silty, fine SAND; moist; SM.	13.2	5, 6	
Very dense, gray-brown, gravelly, silty SAND grading to gravelly fine sandy SILT; moist; (till-like) SM/ML.	15.4	7	

BOTTOM OF BORING
COMPLETED 12/17/2002



LEGEND

- * Sample Not Recovered
- 2-inch O.D. Split Spoon Sample
- 3-inch O.D. Shelby Tube Sample
- Ground Water Level ATD

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
3. Groundwater level, if indicated above, is for the date specified and may vary.
4. Refer to KEY for explanation of "Symbols" and definitions.
5. USCS designation is based on visual-manual classification and selected laboratory index testing.

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LOG OF BORING B-102

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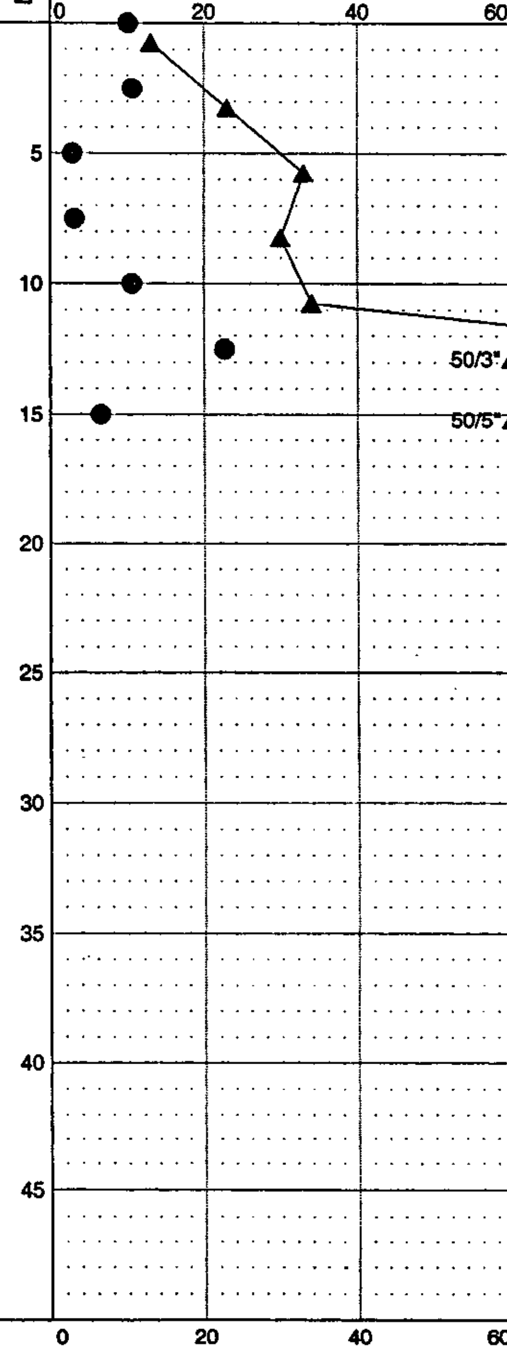
FIG. A-3

MASTER_LOG 21-09409.GPJ OLD 2001 SHANWIL TEMPLATE.GDT 1/7/03 Log: BMR Rev: TMG Typ: LKD

SOIL DESCRIPTION Surface Elevation: Approx. 205 Ft.	Depth (ft)	Symbol	Samples	Ground Water
Medium dense, slightly gravelly, silty SAND; moist; with fine roots and brick fragments; (Fill) SM.	3.0		1, 2	None Observed During Drilling
Medium dense to dense, gray-brown, gravelly, slightly silty to silty, fine to medium SAND; moist; SP-SM.	9.5		3, 4	
Very dense, gray, gravelly, silty SAND; moist; (till-like) SM.	15.4		5, 6, 7	
BOTTOM OF BORING COMPLETED 12/17/2002				

Standard Penetration Resistance
(140 lb. weight, 30-inch drop)
▲ Blows per foot



● % Water Content

Plastic Limit |—●—| Liquid Limit
Natural Water Content

LEGEND

- * Sample Not Recovered
- 2-inch O.D. Split Spoon Sample
- 3-inch O.D. Shelby Tube Sample
- ▽ Ground Water Level ATD

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
3. Groundwater level, if indicated above, is for the date specified and may vary.
4. Refer to KEY for explanation of "Symbols" and definitions.
5. USCS designation is based on visual-manual classification and selected laboratory index testing.

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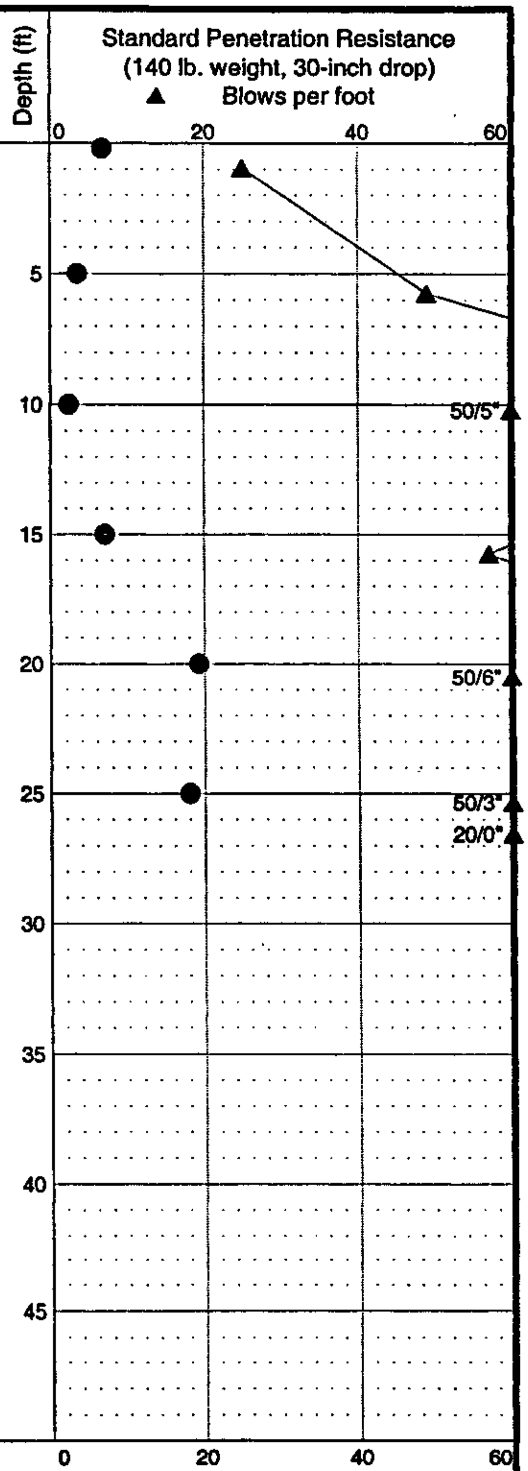
FIG. A-4

MASTER LOG 21-09409.GPJ OLD 2001 SHANWIL TEMPLATE.GDT 1/7/03 Log: BMR Rev: TMG Typ: LKD

SOIL DESCRIPTION

Surface Elevation: Approx. 195.7 Ft.

Soil Description	Depth (ft)	Samples	Ground Water
Asphalt Pavement.	0.2	1	
Medium dense, brown, silty, gravelly SAND; moist; (crushed gravel base course) (Fill) SM.	2.0		
Dense to very dense, orange-brown, slightly silty, gravelly, fine to coarse SAND; moist; SM-SP.		2, 3	
Very dense, light brown to gray, slightly silty to silty, fine SAND; moist to wet at 25 feet; SM.	12.0	4, 5	
Very dense, gray, gravelly, silty SAND; moist; (Glacial Till) SM.	25.0	6, 7*	During Drilling ∇
BOTTOM OF BORING COMPLETED 12/18/2002	26.6		



LEGEND

- * Sample Not Recovered
- 2-inch O.D. Split Spoon Sample
- 3-inch O.D. Shelby Tube Sample
- ∇ Ground Water Level ATD

● % Water Content

Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
3. Groundwater level, if indicated above, is for the date specified and may vary.
4. Refer to KEY for explanation of "Symbols" and definitions.
5. USCS designation is based on visual-manual classification and selected laboratory index testing.

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LOG OF BORING B-104

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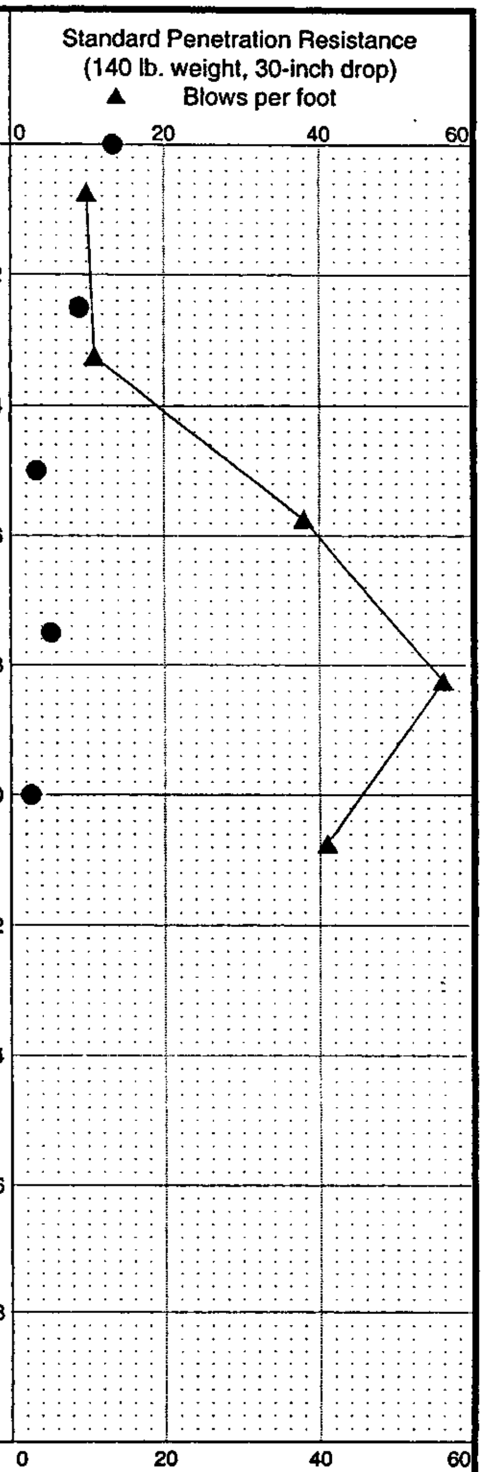
FIG. A-5

MASTER_LOG 21-09409.GPJ OLD 2001 SHANWIL_TEMPLATE.GDT 1/7/03 Log: BMR Rev: TMG Typ: LKD

SOIL DESCRIPTION Surface Elevation: Approx. 198 Ft.	Depth (ft)	Symbol	Samples	Ground Water
Loose, dark brown organic SILT; moist; with numerous organics; (Topsoil) PT.	0.5		1	None observed during drilling
Loose to medium dense, brown, slightly silty, fine SAND with organics and cobbles; moist; SP.	4.0		2	
Dense to very dense, brown, fine to medium SAND; moist; with trace of silt and scattered gravel; SW.	11.5		3, 4, 5	
BOTTOM OF BORING COMPLETED ON 05/25/2001				



LEGEND

- * Sample Not Recovered
- I 2-inch O.D. Split Spoon Sample
- II 3-inch O.D. Shelby Tube Sample
- ⊻ Ground Water Level ATD

● % Water Content

Plastic Limit |—●—| Liquid Limit
Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
3. Groundwater level, if indicated above, is for the date specified and may vary.
4. Refer to KEY for explanation of "Symbols" and definitions.
5. USCS designation is based on visual-manual classification and selected laboratory index testing.

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LOG OF BORING B-1

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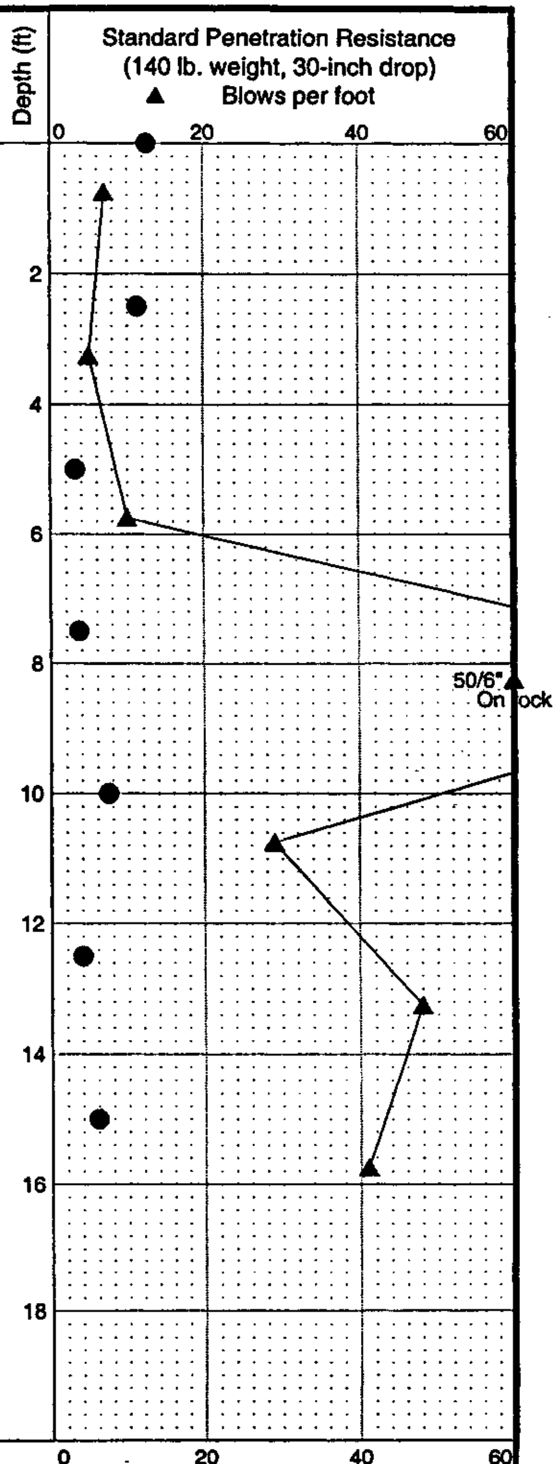
FIG. A-6

SOIL DESCRIPTION Surface Elevation: Approx. 198 Ft.	Depth (ft)	Symbol	Samples	Ground Water
Loose, dark brown, organic SILT; moist; (Topsoil) PT.	0.5			
Loose, brown, silty fine SAND; moist; with scattered organics; SM.	5.0		1, 2	
Loose to medium dense, brown, fine to medium SAND; moist; with trace of silt and scattered gravel; SW.	7.0		3	None observed during drilling
Medium dense to dense, gray-brown, slightly silty, fine SAND; moist; with scattered gravel; SW-SM.	16.5		4, 5, 6, 7	
BOTTOM OF BORING COMPLETED ON 05/25/2001				



LEGEND

- * Sample Not Recovered
- ⌶ 2-inch O.D. Split Spoon Sample
- Ⅱ 3-inch O.D. Shelby Tube Sample
- ⊽ Ground Water Level ATD

● % Water Content

Plastic Limit |—●—| Liquid Limit
Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
3. Groundwater level, if indicated above, is for the date specified and may vary.
4. Refer to KEY for explanation of "Symbols" and definitions.
5. USCS designation is based on visual-manual classification and selected laboratory index testing.

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LOG OF BORING B-2

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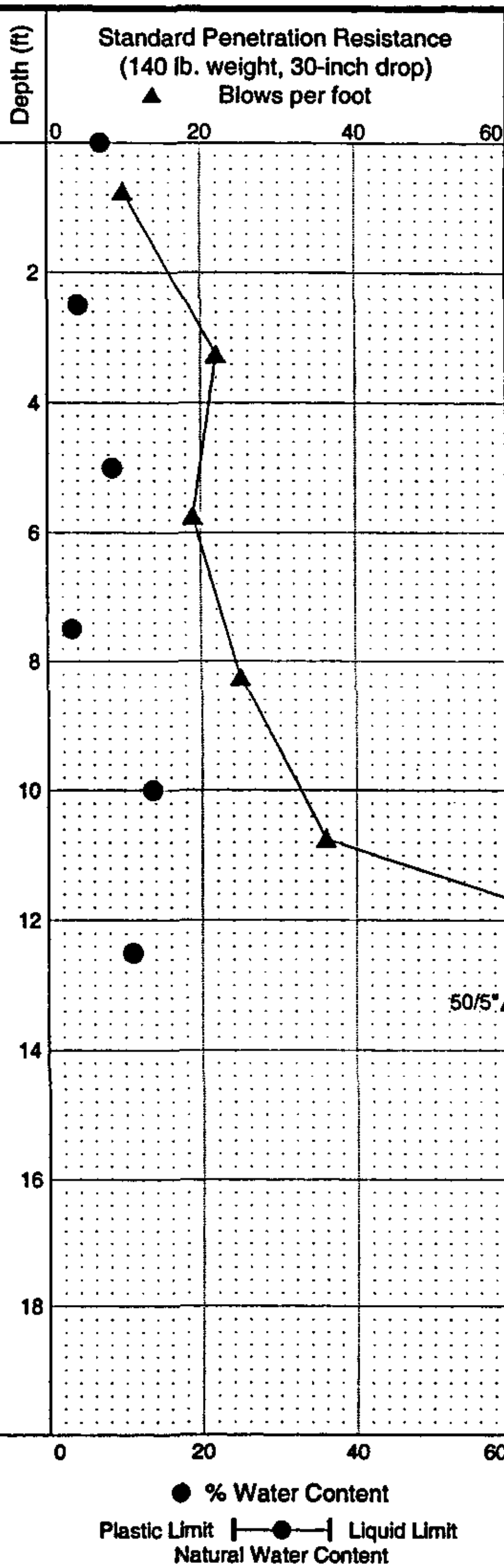
FIG. A-7

MASTER LOG 21-09409.GPJ OLD 2001 SHANWIL TEMPLATE.GDT 1/7/03 Log: DMR Rev: Typ: MGI

SOIL DESCRIPTION Surface Elevation: Approx. 198 Ft.	Depth (ft)	Symbol	Samples	Ground Water
Loose, brown, organic SILT; (Topsoil) PT.	0.5			
Loose to medium dense, brown, silty fine SAND with trace gravel; moist; with topsoil mixed in (Fill?) SM.	5.0		1, 2	None observed during drilling
Medium dense to dense, brown, slightly silty to silty, fine SAND; SW-SM.	11.5		3, 4, 5	
Very dense, mottled brown-gray, slightly silty, fine SAND; moist; SM.	14.0		6	
BOTTOM OF BORING COMPLETED ON 05/25/2001				



LEGEND

- * Sample Not Recovered
- Ɪ 2-inch O.D. Split Spoon Sample
- ꟾꟾ 3-inch O.D. Shelby Tube Sample
- ⊻ Ground Water Level ATD

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
3. Groundwater level, if indicated above, is for the date specified and may vary.
4. Refer to KEY for explanation of "Symbols" and definitions.
5. USCS designation is based on visual-manual classification and selected laboratory index testing.

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LOG OF BORING B-3

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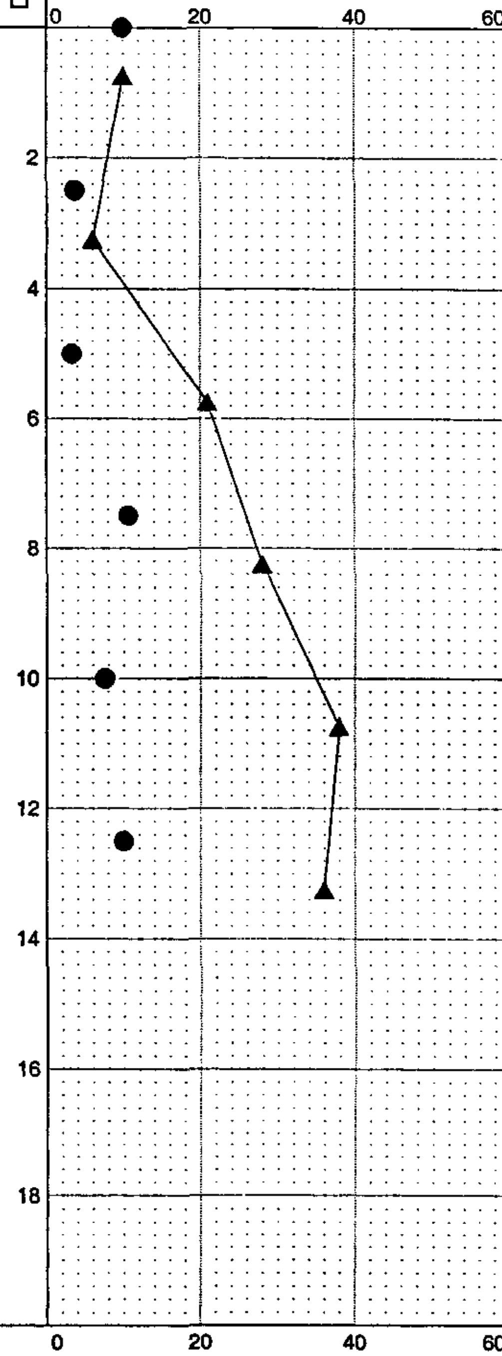
FIG. A-8

MASTER LOG 21-09409.GPJ OLD 2001 SHANWIL TEMPLATE.GDT 1/7/03 Log: DMR Rev: Typ: MGI

SOIL DESCRIPTION Surface Elevation: Approx. 198 Ft.	Depth (ft)	Symbol	Samples	Ground Water
Loose, dark brown, organic SILT; moist; (Topsoil) PT.			1	None observed during drilling
Loose to medium dense, brown, fine to medium SAND; moist; with trace of gravel; SW.	1.5		2, 3	
Medium dense to dense, gray-brown, silty fine SAND; moist; with iron oxide staining from 8.0 to 8.1 feet; SM.	6.5		4, 5, 6	
BOTTOM OF BORING COMPLETED ON 05/25/2001	14.0			

Standard Penetration Resistance
(140 lb. weight, 30-inch drop)
▲ Blows per foot



● % Water Content

Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

LEGEND

- * Sample Not Recovered
- 2-inch O.D. Split Spoon Sample
- 3-inch O.D. Shelby Tube Sample
- Ground Water Level ATD

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of the subsurface materials.
3. Groundwater level, if indicated above, is for the date specified and may vary.
4. Refer to KEY for explanation of "Symbols" and definitions.
5. USCS designation is based on visual-manual classification and selected laboratory index testing.

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Seattle, Washington

LOG OF BORING B-4

December 2002 21-1-09409-001

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Geotechnical and Environmental Consultants

FIG. A-9

MASTER LOG 21-09409.GPJ OLD 2001 SHANWIL TEMPLATE.GDT 1/7/03 Log: DMR Rev: Typ: MGI

APPENDIX B

GEOTECHNICAL LABORATORY TESTING

APPENDIX B

GEOTECHNICAL LABORATORY TESTING

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APPENDIX B

GEOTECHNICAL LABORATORY TESTING

B.1 INTRODUCTION

This appendix contains descriptions of the procedures and the results of geotechnical laboratory tests performed on the soil samples obtained from the field explorations for Lake City Civic Center Parking Garage and Plaza project in Seattle, Washington. The samples were tested to determine the basic index properties and the engineering characteristics of the site soils.

Laboratory testing was performed at the Shannon & Wilson, Inc. laboratory in Seattle, Washington, during January 2003.

B.2 VISUAL CLASSIFICATION

Soil samples obtained from the explorations were visually classified in the laboratory using a system based on American Society for Testing and Materials (ASTM) D 2487, Standard Test Method for Classification of Soil for Engineering Purposes, and ASTM D 2488, Standard Recommended Practice for Description of Soils (Visual-Manual Procedure).[1] This visual classification allows for convenient and consistent comparison of soils from widespread geographical areas.

The sample classifications have been incorporated into the soil descriptions on the exploration logs presented in Appendix A.

B.3 WATER CONTENT DETERMINATION

Moisture content determinations were performed in general accordance with ASTM D 2216, Standard Method of Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures, on all of the soil samples. Water contents are plotted on the boring logs presented in Appendix A.

[1] American Society for Testing and Materials (ASTM), 2001, Annual book of standards, Construction, v. 4.08, Soil and rock (I): D 420 - D 4914: West Conshohocken, Pa.

APPENDIX C

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL REPORT

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include: the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used: (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors which were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the
ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland