GEOTECHNICAL ENGINEERING REPORT
ARLINGTON RETAIL STORE

204th Street Northeast & South Olympic Place
Arlington, Washington

Submitted To:
Baldridge Real Estate, Inc.
11825 Manchester Road
Des Peres, Missouri 63131

WA04-11111-GEO
May 2004

Z-04-049

LSI Adapt, Inc.
615 – 8th Avenue South
Seattle, Washington 98104

Tel (206) 654-7045
Fax (206) 654-7048
www.lsiadapt.com

May 18, 2004
WA04-11111-GEO

Baldridge Real Estate, Inc.
11825 Manchester Road
Des Peres, Missouri 63131

Attention: Mr. C. Allen Kann

Subject: **Geotechnical Engineering Report**
Arlington Retail Development
204th Street Northeast & South Olympic Place
Arlington, Washington

Dear Mr. Kann:

LSI Adapt, Inc. (Adapt) is pleased to submit this report summarizing our geotechnical engineering evaluation for the above-referenced project. The purpose of our evaluation was to derive design conclusions and recommendations concerning site preparation, excavations, foundations, floors, drainage, and structural fill.

As outlined in our proposal letter dated April 9, 2004, our scope of work comprised a field exploration, geotechnical research, geotechnical analyses, and report preparation. We received your written authorization for our evaluation on February 9, 2004. This report has been prepared for the exclusive use of Baldridge Real Estate, MC Squared Engineering, and their agents, in accordance with generally accepted geotechnical engineering practice and for the specific application to this project. Use or reliance upon this report by a third party is at their own risk. Adapt does not make any representation or warranty, express or implied, to such other parties as to the accuracy or completeness of this report or the suitability of its use by such other parties for any purpose, whether known or unknown to Adapt.

We appreciate the opportunity to be of service on this project. Should you have any questions concerning this report or need further assistance, please contact us at (206) 654-7045.

Respectfully Submitted,
LSI Adapt, Inc.

Charles C. Cacek, L.E.G.
Senior Engineering Geologist

Distribution:	Baldridge Real Estate (1)	Attn: Mr. C. Allen Kann
	MC Squared Engineering (3)	Attn: Mr. Greg Seipel

TABLE OF CONTENTS
WA04-11111-GEO

1.0 SUMMARY

Based on our field explorations, research and analyses, the proposed construction appears feasible from a geotechnical standpoint, contingent on the implementation of the recommendations presented in this report. The following summary of project geotechnical considerations is presented for introductory purposes and, as such, should be used only in conjunction with the full text of this report.

- Project Description: Development plans call for constructing a single-story retail building with slab-on-grade floors, adjacent walkways, and asphalt-paved parking to cover the balance of the property.

- Exploratory Methods: We explored subsurface conditions by means of five (5) borings advanced to depths up to about 14-feet below ground surface (bgs) at strategic locations within planned building areas.

- Soil Conditions: The near surface soils underlying the planned building area generally consist of up to 3-feet of black sandy topsoil mantling loose to medium dense sand/silty sand or medium stiff silt/sandy silt to a depth of 7½ to 8 feet depth. These upper soils mantled medium dense to very dense gravelly, fine to coarse sands with fine sand interbeds that extended to the full depth explored.

- Groundwater Conditions: At the time of exploration (April 2004), perched groundwater seepage was encountered at depths of about 5 to 8 feet depth. Significant seepage is therefore not expected within the anticipated near-surface site and building excavations, depending upon the time of year construction occurs. It is possible however, that significant seepage may be encountered in the deeper utility excavations.

- Shallow Spread Foundations: In our opinion, the proposed building can be supported by conventional spread footings, either directly onto the the native, medium stiff or loose to medium dense soils with a relatively low bearing pressure of 1,800 psf, or on a structural fill pad (overexcavated to medium stiff/dense soils) with a moderate bearing pressure of 2,500 psf. These spread footings alternatively, may be designed for a seismic bearing pressure of 1,330 psf and 3,300 psf, respectively. Up to 3 feet of organic-rich soils (topsoil) will need to be removed prior to footing subgrade preparation with either of these shallow foundation options.

- Floors: Typical soil-supported, lightly loaded, slab-on-grade floors are feasible at this site, contingent upon proper subgrade preparation. This will include removal of up to 3 feet of organic-rich soils (topsoil) and replacement with a structural fill pad.

- Seismic Considerations: Based on our literature review and subsurface interpretations, we recommend that the project structural engineer use the following seismic parameters for design of buildings, retaining walls, and other site structures, as appropriate.

Design Parameter	**Value**
Acceleration Coefficient	0.30
Risk Zone (1997 UBC)	3
Soil Profile Type (1997 UBC)	S_C

- Asphaltic Concrete Pavement: In our opinion, a conventional asphaltic pavement section consisting of 2.5 inches asphalt concrete over 4 inches crushed rock base course will generally provide a suitable pavement section atop the native, medium dense subgrade soils or properly compacted structural fill. All pavement subgrade areas should be proof-rolled to verify firm and unyielding soil conditions. A granular subbase layer may be required where soft or wet native subgrade soil conditions are encountered.

- Temporary Excavation Considerations: All temporary soil cuts associated with site regrading or excavations should be adequately sloped back to prevent sloughing and collapse. For medium stiff/dense, near-surface sandy silts and silty sands that will likely be encountered within the anticipated excavation depths, we tentatively recommend a maximum temporary cut slope inclination of 1.5H:1V.

2.0 SITE AND PROJECT DESCRIPTION

The subject site is a vacant parcel located at the northeast corner of the intersection of 204th Street Northeast and South Olympic Place in Arlington, Snohomish County, Washington, as shown on the enclosed *Location/Topographic Map* (Figure 1). The roughly rectangular shaped property is bounded by South Olympic Place to the west, 204th Street Northeast to the south, and by vacant undeveloped land to the north and west. The subject site and adjacent properties to the north and east support low-lying grasses and weeds. A gravel roadway enters the site near the northwest corner of the property. Underground natural gas, water, electrical, sewer, and telephone easements border the site along the south and west property lines. Otherwise, the property appears to be undeveloped.

It is our understanding that the proposed development will include construction of a single-story, slab-on-grade retail store with a footprint of approximately 6,840 square feet. The building will be located in the north-central portion of the parcel, as depicted on the *Site & Exploration Plan* (Figure 2). The west and south portions of the site will support an asphalt-paved parking lot, and a concrete slab is proposed for the area to the northeast of the building. Site access will be obtained from easements off of South Olympic Place and 204th Street Northeast, near the northwest and southeast corners of the property, respectively.

Final site grades were not available at the time of this study, though we anticipate that a limited amount of fill will be required to regrade or re-level the site.

The conclusions and recommendations contained in this report are based on our understanding of the currently proposed utilization of the project site, as derived from layout drawings, written information, and verbal information supplied to us. Consequently, if any changes are made in the currently proposed project, we may need to modify our conclusions and recommendations contained herein to reflect those changes.

3.0 EXPLORATORY METHODS

We explored surface and subsurface conditions at the project site on April 27, 2004. Our exploration and testing program comprised the following elements:

- A visual surface reconnaissance of the site;
- Five borings (designated B-1 to B-5) advanced at a strategic location across the proposed building footprint and parking areas;
- A review of published geologic and seismologic maps and literature.

The following text sections describe our procedures used for performing exploratory borings and any laboratory testing. Figure 2 depicts the approximate relative location of the explorations. The specific number, locations, and depths of our explorations were selected in relation to the existing and proposed site features, under the constraints of surface access, underground utility conflicts, and budget considerations. We estimated the relative location of each exploration by measuring from existing features and scaling these measurements onto a layout plan supplied to us. Then we estimated their elevations by interpolating between elevation contour lines shown on this same plan. Consequently, the locations depicted on Figure 2 should be considered accurate only to the degree permitted by our data sources and implied by our measuring methods.

It should be realized that the explorations performed for this evaluation reveal subsurface conditions only at discrete locations across the project site and that actual conditions in other areas could vary. Furthermore, the nature and extent of any such variations would not become evident until additional explorations are performed or until construction activities have commenced. If significant variations are observed at that time, we may need to modify our conclusions and recommendations contained in this report to reflect the actual site conditions.

<u>3.1 Auger Boring Procedures</u>

Our exploratory borings were advanced with a trailer-mounted drill rig operated by an independent drilling firm working under subcontract to Adapt. An engineering geologist from our firm continuously observed the borings, logged the subsurface conditions, and collected representative soil samples. All samples were stored in watertight containers and later transported to our laboratory for further visual examination and testing. After the borings were completed, the boreholes were backfilled with a mixture of bentonite chips and soil cuttings.

Throughout the drilling operation, soil samples were obtained at 2½- or 5-foot depth intervals by means of the Standard Penetration Test (SPT) per ASTM:D-1586. This testing and sampling procedure consists of driving a standard 2-inch-diameter steel split-spoon sampler 18 inches into the soil with a 140-pound hammer free-falling 30 inches.. The number of blows required to drive the sampler through each 6-inch interval is counted, and the total number of blows struck during the final 12 inches is recorded as the Standard Penetration Resistance, or "SPT blow count." If a total of 50 blows is struck within any 6-inch interval, the driving is stopped and the blow count is recorded as 50 blows for the actual penetration distance. The resulting Standard Penetration Resistance values indicate the relative density of granular soils and the relative consistency of cohesive soils.

The enclosed *Boring Logs* describe the vertical sequence of soils and materials encountered in the borings, based primarily on our field classifications and supported by our subsequent laboratory examination and testing. Where a soil contact was observed to be gradational, our logs indicate the average contact depth. Where a soil type changed between sample intervals, we inferred the contact depth. Our logs also graphically indicate the blow count, sample type, sample number, and approximate depth of each soil sample obtained from the borings. If any groundwater was encountered in a borehole, the approximate groundwater depth is depicted on the boring log. Groundwater depth estimates are typically based on the moisture content of soil samples, the wetted height on the drilling rods, and the water level measured in the borehole after the auger has been extracted. The boring logs also indicate the sample reference and the general results of any laboratory tests performed on the site soils.

4.0 SITE CONDITIONS

The following sections of text present our observations, measurements, findings, and interpretations regarding surface, soil, groundwater, and seismic conditions at the project site.

4.1 Surface Conditions

The subject site is a vacant and undeveloped, relatively flat parcel that supports a low growth of grasses and weeds. We did not observe surface water seepage or ponding at the site during our site visit.

4.2 Soil Conditions

According to published geological maps, the general soil conditions in the site vicinity consist of Vashon Glacial Recessional Outwash. The United States Department of Agriculture Soil Conservation Service's Soil Survey of Snohomish County Area, Washington (Alfonso Debose and Michael W. Klungkland, 1978) showed the subject site to be underlain by "Norma Loam" (Map Unit-#39).

Our on-site exploration generally confirmed the presence of these mapped, native, soil units. Specifically, our boring revealed the near-surface soil conditions to consist of surface grasses and weeds mantling 2½ to 3 feet of moist, black, sandy topsoil. These surficial soils were underlain by about 5 feet of interlayered medium stiff to stiff, fine sandy silt/silt and loose to medium dense silty/gravelly sand, overlying medium dense to very dense, gravelly fine to coarse sand with variable silt that extended to the full depth explored (up to 14 feet bgs).

4.3 Groundwater Conditions

At the time of exploration (April 2004), shallow perched groundwater seepage was observed in the borings at depths ranging from 5 to 8 feet bgs. It should be noted that groundwater levels would likely fluctuate throughout the year in response to changing precipitation patterns, off-site construction activities, and changes in site utilization. Because our explorations were performed during an extended period of wet weather, these observed groundwater levels may closely represent the yearly high levels; somewhat lower levels probably occur during the drier summer and early fall months.

4.4 Seismic Conditions

Based on our analysis of subsurface exploration logs and our review of published geologic maps, we interpret the on-site soil conditions to correspond to seismic soil profile type S_C, as defined by Table 16-J of the 1997 *Uniform Building Code* and Table 1615.1.1 of the 2000 *International Building Code*. This soil profile type is characterized by stiff soils with an average blowcount 50 within the upper 100 feet bgs. Current (1996) *National Seismic Hazard Maps* prepared by the U.S. Geological Survey indicate that a peak bedrock site acceleration coefficient of about 0.30 is appropriate for an earthquake having a 10-percent probability of exceedance in 50 years (corresponding to a return interval of 475 years). According to Figure 16-2 of the 1997 *Uniform Building Code*, the site lies within Seismic Risk Zone 3. For purposes of seismic site characterization, the observed soil conditions were extrapolated below the exploration termination depth, based on a review of geologic maps and our knowledge of regional geology.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Development plans call for the construction of a single-story, slab-on-grade retail building, along with associated walkways, parking lot and easements. Based on our findings and the results of our analyses, the project is considered feasible from a geotechnical standpoint, provided that the recommendations of this report are implemented. The following text sections of this report present our specific geotechnical conclusions and recommendations concerning site preparation, spread footings, drainage systems, asphaltic concrete pavements, and structural fill. WSDOT Standard Specifications and Standard Plans cited herein refer to WSDOT publications M41-10, 2000 *Standard Specifications for Road, Bridge, and Municipal Construction*, and M21-01, 2000 *Standard Plans for Road, Bridge, and Municipal Construction*, respectively.

5.1 Site Preparation

Preparation of the project site should involve temporary drainage, clearing, stripping, cutting, filling, excavations, dewatering, and subgrade compaction. The paragraphs below discuss our geotechnical comments and recommendations concerning site preparation.

Temporary Drainage: We recommend intercepting and diverting any potential sources of surface or near-surface water within the construction zones before stripping begins. Because the selection of an appropriate drainage system will depend on the water quantity, season, weather conditions, construction sequence, and contractor's methods, final decisions regarding drainage systems are best made in the field at the time of construction. Nonetheless, we anticipate that curbs, berms, or ditches placed along the uphill side of the work areas will adequately intercept surface water runoff.

Clearing, Stripping, and Overexcavation: After surface and near-surface water sources have been controlled, the construction areas should be cleared and stripped of all sod and topsoil. In addition, some of the native loose/medium stiff, near surface soils may need to be overexcavated to support typical spread foundation loads, as discussed in the subsequent sections of this report. Such overexcavations are anticipated to be on the order of 3 to 4 feet; however, it should be noted that significant variations may exist between our exploration locations. All overexcavated areas should be backfilled with *Structural Fill* in accordance with the recommendations of this report. Furthermore, it should be realized that if the stripping or overexcavation operation proceeds during wet weather, a generally greater stripping depth might be necessary to remove disturbed, surficial, moisture-sensitive soils; therefore, stripping is best performed during a period of dry weather. A layer of crushed rock or quarry spalls may be required to stabilize the overexcavation base prior to placement of structural fill if soft or wet soil conditions are encountered.

Demolition: As a part of the initial site preparation, any existing structures present within the construction areas should be demolished. Any associated underground structural elements or utilities, such as old footings, stemwalls, and drainpipes, should be exhumed as part of this demolition operation. In general, we do not anticipate such conditions on the property.

Excavations: Site excavations ranging up to about 5-feet deep may be required to accommodate the proposed building foundations. Based on our explorations, we anticipate that these excavations will encounter medium dense sands or medium stiff sandy silt. These soils can likely be cut with conventional earth working equipment such as small dozers and trackhoes. Near-surface, perched groundwater seepage zones may be encountered at various depths within the site soils, depending of the time of year construction proceeds.

Temporary Cut Slopes: All temporary soil cuts associated with site regrading or excavations (greater than 4-feet in vertical height) should be adequately sloped back to prevent sloughing and collapse. For the various soil layers that will likely be encountered in the excavation, we tentatively recommend the following maximum cut slope inclinations:

Footing Depths and Widths: For frost and erosion protection, the bottoms of all exterior footings should penetrate at least 18-inches below lowest adjacent outside grades, whereas the bottoms of interior footings need penetrate only 12-inches below the surrounding slab surface level. For footing option 1, all footings should bear within the loose to medium dense or medium stiff interbedded silts and sands, whereas footings using design option 2 should bear on a structural fill pad. Continuous (wall) and isolated (column) footings should be at least 18 and 24-inches wide, respectively, to act as a true footing element providing the specified bearing capacity.

Footing Overexcavation: If the lower bearing pressure approach (Option 1) will not provide adequate support for the proposed building, the soft to medium stiff soils encountered below the anticipated footing subgrade elevation will need to be locally overexcavated and replaced with a structural fill pad (Option 2). For standard 18 to 24 inch wide, 18 inch deep footings, the overexcavation may be limited 3 to 4-feet, respectively, below the planned footing subgrade level. Any locally deeper zones of organic-rich or loose/soft soils encountered at the base of the overexcavation should be removed and replaced with structural fill. Because foundation stresses are transferred outward as well as downward into the bearing soils, all footing overexcavations also should extend horizontally outward from the footing edge a distance equal to the overexcavation depth for structural backfill. Therefore, an overexcavation that extends 4-feet below the footing base should also extend 4-feet outward from the footing edges (a 1H:1V projected line from the bottom of the footing to the bottom of the fill prism).

Soil Replacement: After the footing overexcavations have been completed, the overexcavated soil should be replaced with either a controlled density fill (CDF) or a properly compacted, approved granular structural fill material, as specified in the structural fill section of this report. If subgrade soils at the base of overexcavations are in a wet condition, a drainage layer of washed rock, crushed rock, or quarry spalls may be required to stabilize the base and allow placement and compaction of structural fill. Alternatively, the new wall foundation elements may be extended lower to bear directly onto the underlying, native, dense soils.

Bearing Subgrades: For the low and moderate bearing pressure options outlined above, the proposed shallow spread footing system is expected to be founded on loose/medium stiff silt, sand or gravelly/silty sand or a structural fill prism placed on native soils, respectively. Before concrete is placed, any localized zones of soft or loose soils encountered in the footing subgrades should be compacted to a firm, unyielding condition, if warranted by soil moisture conditions. Any uncontrolled fill material containing a significant amount of organic or debris/deleterious materials within the basement footprint area will need to be overexcavated and replaced with structural fill, as previously discussed.

Bearing Capacities: Based on the bearing subgrade conditions described above, we recommend that all footings be designed for the following allowable bearing capacities for static and seismic loadings:

Design Parameter	Allowable Design Values Pre-Existing Fill Subgrade (Option 1)	Structural Fill Pad Subgrade (Option 2)
Static Bearing Capacity	1,800 psf	2,500 psf
Seismic Bearing Capacity	2,400 psf	3,300 psf

Subgrade Verification: All footing subgrades should consist of firm, unyielding, medium dense to dense, undisturbed, native soils. Footings should never be cast atop loose, soft, or frozen soil, slough, debris, existing uncontrolled fill, or surfaces covered by standing water. We recommend that the condition of all subgrades be verified by an Adapt representative before any concrete is placed.

Footing Settlements: We estimate that total post-construction settlements of properly designed footings bearing on properly prepared subgrades will not exceed 1 inch. Differential settlements could approach one-half of the actual total settlement between adjacent foundation elements.

Footing and Stemwall Backfill: To provide erosion protection and lateral load resistance, we recommend that all footing excavations be backfilled on both sides of the footings and stemwalls after the concrete has cured. Either imported structural fill or non-organic on-site soils can be used for this purpose, contingent on a suitable moisture content at the time of placement. Regardless of soil type, all footing backfill soil should be compacted to a density of at least 90 percent (based on ASTM:D-1557).

Lateral Resistance: Footings and stemwalls that have been properly backfilled as described above will resist lateral movements by means of passive earth pressure and base friction. Passive pressure acts over the embedded front of the footing (neglecting the upper 1 foot for soil foreslopes) and varies with the foreslope inclination. For site-specific design purposes, we are providing recommended allowable passive pressure values for level foreslopes. The level foreslope condition may be assumed if the ground surface is level within a horizontal distance equal to two times the footing depth. We recommend using the following design values, which incorporate a static safety factor of at least 1.5:

Design Parameter	Allowable Design Values: Pre-Existing Native Soil Subgrade (Option 1)	Structural Fill Prism Subgrade (Option 2)
Static Passive Pressure	250 pcf	250 pcf
Seismic Passive Pressure	330 pcf	330 pcf
Base Friction Coefficient	0.25	0.35

5.3 Slab-on-Grade Floors

In our opinion, soil-supported, lightly loaded, slab-on-grade floors can be used for the proposed building if the subgrades are properly prepared. This will involve overexcavation of up to 3 feet of topsoil and replacement with compacted structural fill pad in accordance with the *Site Preparation* and *Structural Fill* sections of this report. We offer the following comments and recommendations concerning slab-on-grade floors.

Capillary Break: To retard the upward wicking of groundwater beneath the floor slab, we recommend that a capillary break be placed over the subgrade. Ideally, this capillary break would consist of a 4-inch-thick layer of pea gravel or other clean, uniform, well-rounded gravel, such as "Gravel Backfill for Drains" per WSDOT Standard Specification 9-03.12(4).

Vapor Barrier: We recommend that a layer of plastic sheeting (such as Crosstuff, Visqueen or Moistop) be placed directly between the capillary break and the floor slab to prevent ground moisture vapors from migrating upward through the slab. During subsequent casting of the concrete slab, the contractor should exercise care to avoid puncturing this vapor barrier.

Bearing Pad: Properly compacted structural fill placed directly onto the medium stiff or loose to medium dense soils underlying the topsoil will in our opinion provide adequate support for the proposed slab-on-grade floors.

Vertical Deflections: Soil-supported slab-on-grade floors can deflect downward when vertical loads are applied, due to elastic compression of the subgrade. In our opinion, a subgrade reaction modulus of 250 pounds per cubic inch (pci) can be used to estimate such deflections upon a properly prepared in-place soil or structural fill subgrade.

Subgrade Verification: All slab-on-grade floors should bear on firm, unyielding soils or on suitable structural fill soils. We recommend that the conditions of all subgrades and overlying layers be verified by an Adapt representative before any concrete is placed.

5.4 Drainage Systems

We recommend that the proposed building additions be provided with permanent drainage systems to minimize the risk of future moisture problems. We offer the following recommendations and comments for drainage design and construction purposes.

Perimeter Drains: We recommend that the building additions be encircled with a perimeter drain system to collect seepage water. This drain should consist of a perforated pipe within an envelope of pea gravel or washed rock, extending at least 6 inches on all sides of the pipe. The gravel envelope should be wrapped with filter fabric to reduce the migration of fines from the surrounding soils. The drain invert should be installed no more than 4 inches above or below the base of the perimeter footings. All perimeter drains should discharge to a municipal storm drain, sewer system, or other suitable location by gravity flow.

Runoff Water: Roof-runoff and surface-runoff water should *not* discharge into the perimeter drain system. Instead, these sources should discharge into separate tight line pipes and be routed away from the building to a storm drain or other appropriate location.

Grading and Capping: Final site grades should slope downward away from the building so that runoff water will flow by gravity to suitable collection points, rather than ponding near the house. Ideally, the area surrounding the building would be capped with concrete, asphalt, or low-permeability (silty) soils to reduce surface-water infiltration.

5.5 Asphaltic Concrete Pavements

We understand that asphaltic pavement surfacing will be used for driveways and car-parking areas. The following comments and recommendations are given for pavement design and construction purposes.

Subgrade Preparation: Initlally, the existing 2½ to 3 feet of topsoil should be removed from all planned pavement areas exposing native loose to medium dense sands/silty sands or medium stiff silts/sandy silts. These underlying soils should be proof-rolled with a loaded dump truck or heavy compactor to verify a firm and yielding subgrade condition. Any localized zones of yielding subgrade disclosed during this proof-rolling operation should be overexcavated to a maximum depth of 12 inches and replaced with a suitable structural fill material (granular subbase course). Alternately, a suitable geofabric may be used to stabilize the soft subgrade and minimize silt migration into the pavement section, based on a field evaluation of subgrade conditions. Structural fill should then be placed and compacted to raise grades to planned pavement subgrade elevations. All structural fill should be compacted according to our recommendations given in the *Structural Fill* section.

Existing Gravel-Surfaced Areas: In general, existing gravel-surfaced driveway areas serve as a part of the gravel base for the new asphaltic pavement, provided they are proof-rolled and found to be firm and unyielding, may be left in-place to. In addition, a representative of the geotechnical engineer should be allowed to field verify by means of test holes that no topsoil or organic-rich soils are present below these pre-existing gravel-surfaced areas.

Design Criteria: Critical features that govern the durability of a pavement section include the stability of the subgrade; the presence or absence of moisture; free water; and organics; the fines content of the subgrade soils; the traffic volume, and the frequency of use by heavy vehicles. Soil conditions can be defined by a California Bearing Ration (CBR) or Hveem Resistance Value (R-value), and traffic conditions can be defined by a Traffic Index (TI).

Design Values: Based on the observed condition of the near-surface site soils and our previous CBR testing on similar soils, we estimate that the pavement subgrade soils will provide a CBR value on the order of 10 percent. For the purpose of this evaluation, we have assumed a TI of 4.0, which is typical for car driveway and parking areas.

Conventional Sections: A conventional pavement section is typically comprised of an asphalt concrete pavement over a crushed rock base course over a granular subbase course or properly prepared native/structural fill subgrade. Using the estimated design values stated above, we recommend the following conventional pavement sections:

Pavement Course	Minimum Thickness
Asphalt Concrete Pavement	2 ½ inches
Crushed Rock Base Course	4 inches

Pavement Materials: Imported crushed rock, such as "crushed surfacing top course" per WSDOT Standard Specification 9-03.9(3), should be used for the crushed rock base course. Clean, well-graded sand and gravel, such as "ballast" per WSDOT Standard Specification 9-03.9(1), is appropriate for the granular subbase course.

Soil Compaction: All crushed rock base course and granular sub-base material, and any fill placed below the subbase, should be placed and compacted according to our recommendations given in the *Structural Fill* section of this report. Specifically, the upper 2 feet of soils should be compacted to at least 95 percent of the modified Proctor maximum dry density (ASTM:D-1557), and all soils below this 2-foot depth should be compacted to at least 90 percent.

Pavement Subgrade Verification: We recommend that an Adapt representative be retained to verify the condition of the subgrade, granular subbase, and crushed rock base course before each successive layer is placed. For the subbase course, this is best accomplished by means of frequent density testing. For the base course, method observations and hand-probing are sufficient.

Pavement Life and Maintenance: It should be emphasized that no asphaltic pavement is maintenance-free. The above described pavement sections represent our minimum recommendations for an average level of performance during a 20-year design life; therefore, an average level of maintenance will likely be required. The selection of the actual pavement section should be based both on the desired pavement performance and on economic considerations. Thicker asphalt, crushed rock base, and granular subbase courses would offer better long-term performance, but would cost more initially; thinner courses would be more susceptible to "alligator" cracking and other failure modes. As such, pavement design can be considered a compromise between a high initial cost and low maintenance costs versus a low initial cost and higher maintenance costs.

5.6 Structural Fill

The term "structural fill" refers to any material placed under foundations, retaining walls, slab-on-grade floors, sidewalks, pavements, and other such features. Our comments, conclusions, and recommendations concerning structural fill are presented in the following paragraphs.

Materials: Typical structural fill materials include clean sand, granulithic gravel, pea gravel, washed rock, crushed rock, quarry spalls, controlled-density fill (CDF), lean-mix concrete, well-graded mixtures of sand and gravel (commonly called "gravel borrow" or "pit-run"), and miscellaneous mixtures of silt, sand, and gravel. Recycled asphalt, concrete, and glass, which are derived from pulverizing the parent materials, are also potentially useful as structural fill in certain applications. Soils used for structural fill should not contain any organic matter or debris, nor any individual particles greater than about 6 inches in diameter.

Fill Placement: Generally, pea gravel, washed rock, quarry spalls, CDF, and lean-mix concrete do not require special placement and compaction procedures. In contrast, clean sand, granulithic gravel, crushed rock, soil mixtures, and recycled materials should be placed in horizontal lifts not exceeding 8 inches in loose thickness, and each lift should be thoroughly compacted with a mechanical compactor.

On-Site Soils: With the spread footing and slab-on-grade option, up to about 3.0 feet of topsoil or organic rich soil may need to be overexcavated. We anticipate that fill will be needed to backfill footings and retaining walls at the site. The excavation materials are anticipated to consist of sand, gravelly sand or silty/gravelly sand. We offer the following evaluation of these on-site soils in relation to potential use as structural fill.

- *Organic Soils*: Topsoil or organic-rich soil is *not* suitable for use as structural fill under any circumstances, due to their high organic content. Consequently, these materials can be used only for non-structural purposes, such as in landscaping areas.

- *Near Surface Silts, Sandy Silts, and Silty Sands*: The near-surface silty sand/sandy silt soils underlying the topsoil appears to contain a significant amount of fines and are significantly above their optimum moisture condition. We anticipate that these silty/sandy soils may only be reworked and recompacted given favorable weather conditions when they can be aerated to reduce their moisture content, and provided that they are free of organic/deleterious material. These soils would be difficult or impossible to reuse during wet weather, due to their relatively high silt content and in-place moisture condition

- *Underlying Gravelly Sands with Variable Silt*: The gravelly sands have variable silt and moisture contents, but could generally be considered relatively clean soil that could be reused as structural fill. While these soils may be amenable to be reworked and recompacted as structural fill, we do not anticipate that significant volumes of these materials will be available for reuse at the site, given the depth of this soil layer.

Compaction Criteria: Using the Modified Proctor test (ASTM:D-1557) as a standard, we recommend that structural fill used for various on-site applications be compacted to the following minimum densities:

Fill Application	Minimum Compaction
Footing subgrade or bearing pad	90 percent
Footing and retaining wall backfill	90 percent
Slab-on-grade floor subgrade and subbase	90 percent
Roadway embankment (upper 2 feet)	95 percent
Roadway embankment (below 2 feet)	90 percent
Concrete sidewalk subgrade	90 percent

It should be noted that many municipal standards for construction work within right-of-way areas requires 95 percent density, based on the Standard Proctor test (ASTM:D-698). This requirement is generally equivalent to about 90 percent compaction using the more stringent Modified Proctor criteria (ASTM:D-1557).

Subgrade Verification and Compaction Testing: Regardless of material or location, all structural fill should be placed over firm, unyielding subgrades prepared in accordance with the *Site Preparation* section of this report. The condition of all subgrades should be verified by an Adapt representative before filling or construction begins. Also, fill soil compaction should be verified by means of in-place density tests performed during fill placement so that adequacy of soil compaction efforts may be evaluated as earthwork progresses.

CDF Strength Considerations: CDF is normally specified in terms of its compressive strength, which typically ranges from 50 to 200 psi. CDF having a strength of 50 psi (7,200 psf) provides adequate support for most structural applications and can be readily excavated with hand shovels. A strength of 100 psi (14,400 psf) provides additional support for special applications but greatly increases the difficulty of hand-excavation. In general, CDF having a strength greater than about 100 psi requires power equipment to excavate and, as such, should not be used where future hand-excavation might be needed.

6.0 RECOMMENDED ADDITIONAL SERVICES

Because the future performance and integrity of the structural elements will depend largely on proper site preparation, drainage, fill placement, and construction procedures, monitoring and testing by experienced geotechnical personnel should be considered an integral part of the construction process. Consequently, we recommend that Adapt be retained to provide the following post-report services:

- Review all construction plans and specifications to verify that our design criteria presented in this report have been properly integrated into the design;
- Prepare a letter summarizing all review comments (as required by City of Arlington);
- Attend a pre-construction conference with the design team and contractor to discuss important geotechnically related construction issues;
- Observe all exposed subgrades after completion of stripping and overexcavation to confirm that suitable soil conditions have been reached and to determine appropriate subgrade compaction methods;
- Monitor the placement of all structural fill and test the compaction of structural fill soils to verify their conformance with the construction specifications;
- Check all completed subgrades for footings and slab-on-grade floors before concrete is poured, in order to verify their bearing capacity;
- Observe the installation of all perimeter drains, wall drains, and capillary break layers to verify their conformance with the construction plans;
- Prepare a post-construction letter summarizing all field observations, inspections, and test results (as required by City of Arlington).

Upon request, we could submit a proposal for providing some or all of these construction monitoring, inspection, and testing services. Such a proposal is best prepared after the project plans and specifications have been approved for construction.

7.0 CLOSURE

The conclusions and recommendations presented in this report are based, in part, on the explorations that we performed for this study; therefore, if variations in the subgrade conditions are observed at a later time, we may need to modify this report to reflect those changes. Also, because the future performance and integrity of the project elements depend largely on proper initial site preparation, drainage, and construction procedures, monitoring and testing by experienced geotechnical personnel should be considered an integral part of the construction process.

We appreciate the opportunity to be of service on this project. If you have any questions regarding this report or any aspects of the project, please feel free to contact our office.

Respectfully submitted,

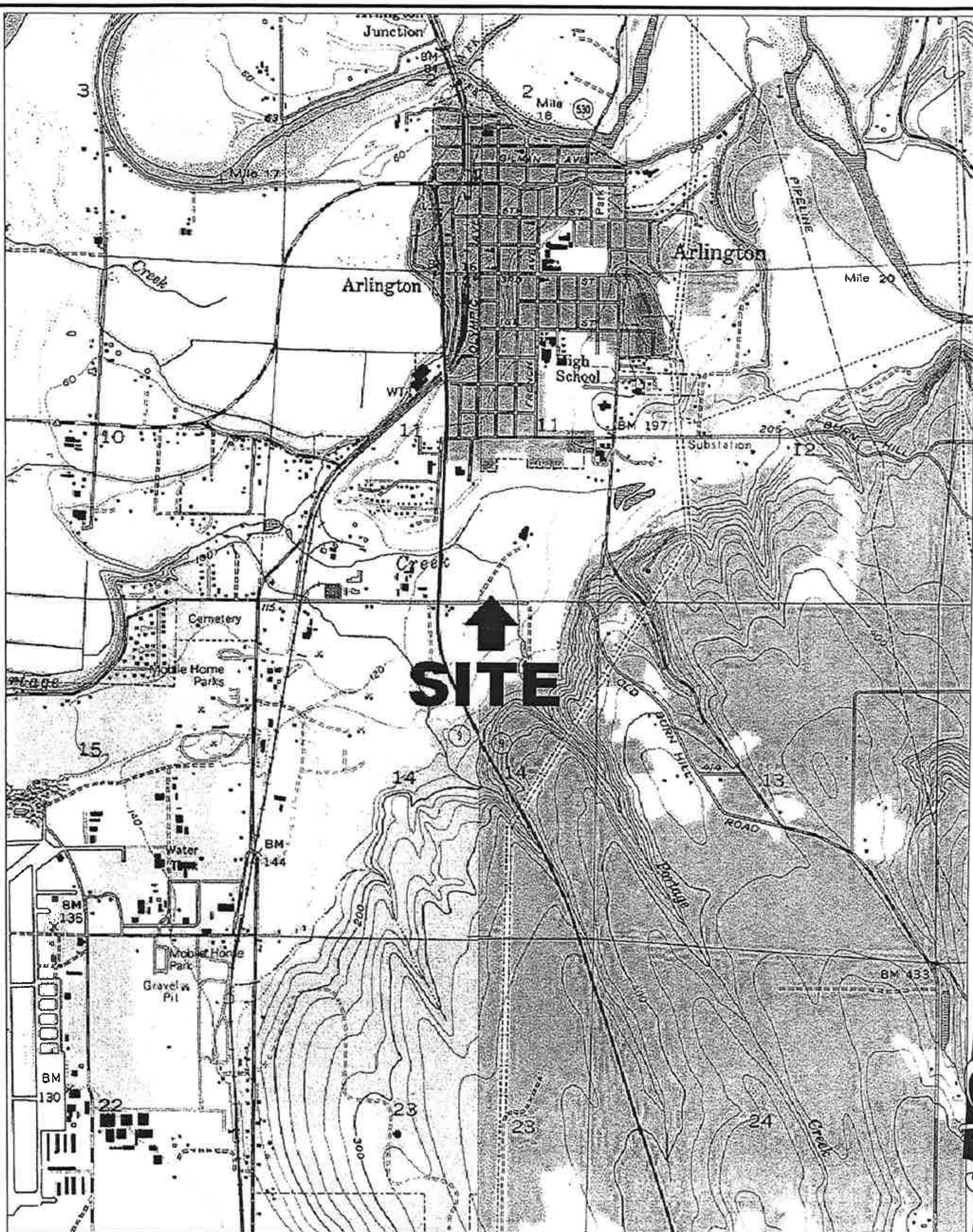
LSI Adapt, Inc.

State of Washington Licensed Geologist
Engineering Geologist
836
CHARLES C. CACEK

Charles C. Cacek, L.E.G.
Licensed Engineering Geologist

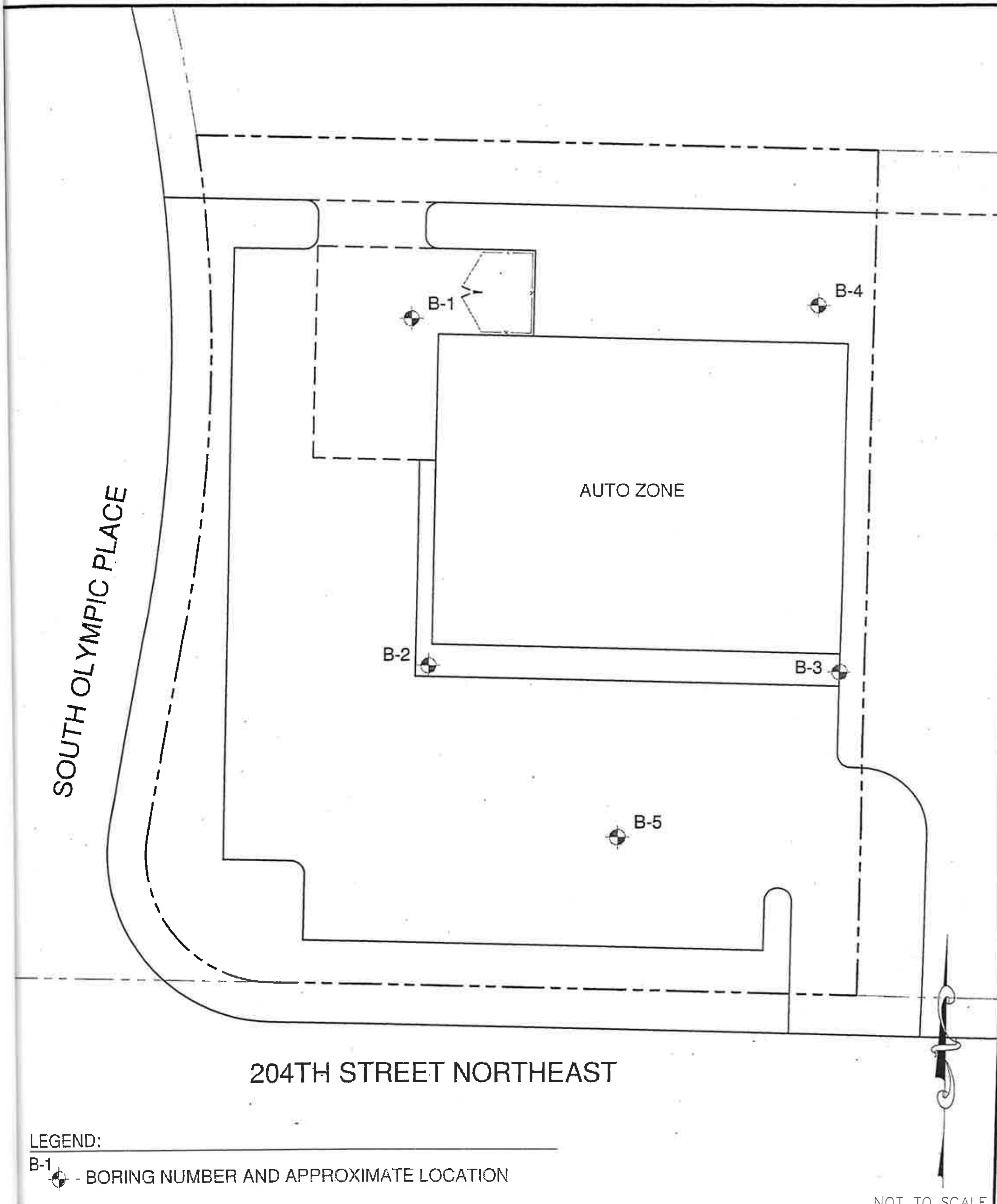
ROLF B. HYLLSETH
STATE OF WASHINGTON
31760
REGISTERED PROFESSIONAL ENGINEER
EXPIRES 6/5/05

Rolf B. Hyllseth, P.E., L.G.
Senior Geotechnical Engineer



Printed from TOPO! ©2000 National Geographic Holdings (www.topo.com)

LSI ADAPT, INC. 615 8th Avenue South Seattle, Washington 98104 Ph : 206.654.7045 Fax : 206.654.7048	FIGURE 1 – Location/Topographic Map Project :Proposed Retail Store Location :204th Street Northeast & South Olympic Place Olympia, Washington 98223 Client : Baldridge Real Estate Date : 05/04/05 Job #S-WA-04-11111-GEO



LSI ADAPT
615 8th Avenue South
Seattle, Washington 98104
Ph : 206.654.7045 Fax : 206.654.7048

FIGURE 2 - Site & Exploration Plan

Project : Proposed Retail Store
Location : 204th Street Northeast & South Olympic Place
Olympia, Washington 98223
Client : Baldridge Real Estate
Date : 05/04/05 **Job #** : S-WA-04-11111-GEO

BORING LOG

LSI ADAPT
615 8th Avenue South
Seattle, Washington 98104
TEL: 206.654.7045 FAX: 206.654.7048

PROJECT : Proposed Retail Store — Job Number : WA04-11111-GEO — Boring No. : B-1
LOCATION : 204th Street Northeast & South Olympic Place
Arlington, Washington 98223 — Baldridge Real Estate

Elevation Reference : N/A — Well Completed : N/A
Ground Surface Elevation : N/A — Casing Elevation : N/A

DEPTH (feet)	Description	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNT	OVM READING	GROUND WATER	AS-BUILT DESIGN	TESTING
0	Surface grass over black sandy TOPSOIL							
	Loose, moist, brown, fine to medium SAND, some silt over dark brown, fine sandy SILT	I	S-1	5 5 3				
5	Medium stiff, moist, tan to dark brown, SILT, some fine SAND	I	S-2	2 2 3		▽	Minor perched groundwater	
	Dense to very dense, moist to wet, dark brown with oxidation, gravelly, fine to coarse SAND	I	S-3	22 38 39				
10		I	S-4	11 18 23				
	with broken gravels	I	S-5	36 50/6"			Blowcounts overstated	
	Boring terminated at 13.5 feet depth							
15								
20								
25								
30								

LEGEND

- 2-inch O. D. Split-Spoon Sample
- 1" Geoprobe
- Sample not Recovered
- DATE — Static Water Level at Drilling
- DATE — Static Water Level
- Perched Groundwater
- Grab Sample
- WTPH-G Ex. 8010 — Type of Analytical Testing Used
- NR — No Recovery
- ATD — At Time of Drilling

Page : 01 of 01

Drilling Start Date : 04/28/04 — Drilling Completion Date : 04/28/04 — Logged By : C.C.C.

File Name : Boring Log.dwg

BORING LOG

LSI ADAPT
615 8th Avenue South
Seattle, Washington 98104
TEL: 206.654.7045 FAX: 206.654.7048

PROJECT : Proposed Retail Store
Job Number : WA04-11111-GEO
Boring No. : B-2
LOCATION : 204th Street Northeast & South Olympic Place
Arlington, Washington 98223
Baldridge Real Estate

Elevation Reference : N/A
Ground Surface Elevation : N/A
Well Completed : N/A
Casing Elevation : N/A

DEPTH (feet)	Description	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNT	OVM READING	GROUND WATER	AS-BUILT DESIGN	TESTING
0	Surface grass over loose, black, sandy TOPSOIL							
	Medium stiff, moist, dark brown with gray, SILT	I	S-1	2 1 3				
5	Loose, moist to wet, oxidized dark brown, gravelly, fine to coarse SAND	I	S-2	3 4 5		Perched groundwater	Very minor perched groundwater	
	Very dense, moist, dark brown with oxidation, gravelly, fine to coarse SAND	I	S-3	8 30 33				
10								
	with broken gravels	I	S-4	50/5"			Blowcount overstated	
	Boring terminated at 13.0 feet depth							
15								
20								
25								
30								

LEGEND

- 2-inch O. D. Split-Spoon Sample
- 1" Geoprobe
- Sample not Recovered
- Static Water Level at Drilling (DATE)
- Static Water Level (DATE)
- Perched Groundwater
- Grab Sample
- Type of Analytical Testing Used (WTPH-D Ext. 8010)
- NR — No Recovery
- ATD — At Time of Drilling

File Name : Boring Log.dwg

Drilling Start Date : 04/28/04
Drilling Completion Date : 04/28/04
Logged By : C.C.C.

BORING LOG

LSI ADAPT
615 8th Avenue South
Seattle, Washington 98104
TEL: 206.654.7045 FAX: 206.654.7048

PROJECT : Proposed Retail Store
Job Number : WA04-11111-GEO
Boring No. : **B-3**
LOCATION : 204th Street Northeast & South Olympic Place
Arlington, Washington 98223
Baldridge Real Estate

Elevation Reference : N/A
Ground Surface Elevation : N/A
Well Completed : N/A
Casing Elevation : N/A

DEPTH (feet)	Description	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNT	OVM READING	GROUND WATER	AS-BUILT DESIGN	TESTING
0	Surface grass over loose, moist, black sandy TOPSOIL							
	Medium stiff, moist to damp, fine sandy SILT		S-1	3 3 4				
5	Medium stiff, wet, brown with orange oxidation, SILT		S-2	1 3 3		Perched groundwater	Minor perched groundwater	
	Medium dense, wet, dark brown, silty fine SAND grading to gravelly SAND		S-3	19 11 13				
10								
	Very dense, wet, brown, gravelly, fine to coarse SAND with broken gravels		S-4	25 50/5"			Blowcounts overstated	
	Boring terminated at 13.5 feet depth							
15								
20								
25								
30								

LEGEND

- 2-inch O. D. Split-Spoon Sample
- 1" Geoprobe
- Sample not Recovered
- DATE — Static Water Level at Drilling
- DATE — Static Water Level
- Perched Groundwater
- Grab Sample
- WTPH-D Ext. 8010 — Type of Analytical Testing Used
- NR — No Recovery
- ATD — At Time of Drilling

Page : 01 of 01

Drilling Start Date : 04/28/04 Drilling Completion Date : 04/28/04 Logged By : C.C.C.

BORING LOG

LSI ADAPT
615 8th Avenue South
Seattle, Washington 98104
TEL: 206.654.7045 FAX: 206.654.7048

PROJECT : Proposed Retail Store
LOCATION : 204th Street Northeast & South Olympic Place
Arlington, Washington 98223

Job Number : WA04-11111-GEO
Boring No. : B-4
Baldridge Real Estate

Elevation Reference : N/A
Ground Surface Elevation : N/A
Well Completed : N/A
Casing Elevation : N/A

DEPTH (feet)	Description	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNT	OVM READING	GROUND WATER	AS-BUILT DESIGN	TESTING
0	Surface grass over loose, black, sandy TOPSOIL							
	Medium dense, moist to wet, gravelly, fine to medium SAND grading to wet, silty fine SAND		S-1	5 7 3				
5	Stiff, wet, dark brown, fine sandy SILT grading to SILT		S-2	3 5 7		Perched groundwater	Minor perched groundwater	
	Medium dense, damp to wet, dark brown, gravelly, silty fine SAND							
	Dense, damp to wet, brown with oxidation, gravelly, silty, fine to coarse SAND with broken gravels		S-3	15 16 22			Blowcounts overstated	
10								
	Medium dense, wet, brown, medium to coarse sandy GRAVEL		S-4	20 19 17				
	Boring terminated at 14.0 feet depth							
15								
20								
25								
30								

LEGEND

- 2-inch O. D. Split-Spoon Sample
- 1" Geoprobe
- Sample not Recovered
- DATE — Static Water Level at Drilling
- DATE — Static Water Level
- Perched Groundwater
- Grab Sample
- WTPH-D Ext. 8010 — Type of Analytical Testing Used
- NR — No Recovery
- ATD — At Time of Drilling

Drilling Start Date : 04/28/04
Drilling Completion Date : 04/28/04

Logged By : C.C.C.

BORING LOG

LSI ADAPT
615 8th Avenue South
Seattle, Washington 98104
TEL: 206.654.7045 FAX: 206.654.7048

PROJECT : Proposed Retail Store Job Number : WA04-11111-GEO Boring No. : B-5
LOCATION : 204th Street Northeast & South Olympic Place
Arlington, Washington 98223
Baldridge Real Estate

Elevation Reference : N/A
Ground Surface Elevation : N/A
Well Completed : N/A
Casing Elevation : N/A

DEPTH (feet)	Description	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNT	OVM READING	GROUND WATER	AS-BUILT DESIGN	TESTING
0	Surface grass over loose, black, sandy TOPSOIL							
	Medium stiff, moist to damp, brown, fine sandy SILT		S-1	3 3 3		▽	Perched groundwater	
5	Medium stiff, wet, tan-brown, sandy SILT grading to SILT		S-2	2 3 4				
	Dense, saturated, brown, fine to coarse sandy GRAVEL with silt-rich zones		S-3	22 18 17		▽		
10								
	Medium dense, dry to moist, tan-brown, fine SAND with some silt		S-4	14 9 8				
15	Boring terminated at 14.0 feet depth Groundwater level measured at a depth of ~10.5-feet bgs within bore hole after removal of augers (interpreted to derive from perched groundwater seepage).							
20								
25								
30								

LEGEND

2-Inch O. D. Split-Spoon Sample	DATE	Static Water Level at Drilling		Grab Sample	
1" Geoprobe	DATE	Static Water Level	WTPH-D Ext. 8010	Type of Analytical Testing Used	
Sample not Recovered		Perched Groundwater	NR	No Recovery	
			ATD	At Time of Drilling	

Drilling Start Date : 04/28/04 Drilling Completion Date : 04/28/04 Logged By : C.C.C.