Insight Engineering

STORM DRAINAGE STUDY
For
CENTER POINTE NORTH
173XX SMOKEY POINT DRIVE
ARLINGTON, WA 98273

Insight Project: 05-0270
Issue date: August 11, 2005

PREPARED BY:
Santhosh J. Moolayil, BSCE

REVIEWED BY:
Brian R. Kalab, P.E.

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STATE OF WASHINGTON
36499
REGISTERED
PROFESSIONAL ENGINEER

8-11-05

EXPIRES 11/30/2006

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1. PROJECT OVERVIEW

The proposed project is located at 173xx Smokey Point Drive in the City of Arlington, Washington. More generally, the site is located within Section 20, Township 31N, Range 5E, of the Willamette Meridian, Washington. Refer to the vicinity map attached in the next page for more details.

The property is currently undeveloped and exists as grass. The parcel is bounded on the north, south and east by commercial developments and on the west by Smokey Point Drive. No critical areas were found on the site.

The project site contains approximately 0.65 Acres. The proposal is to construct a two story building and parking with associated utilities.

Porous pavers are used for retention and water quality.

VICINITY MAP

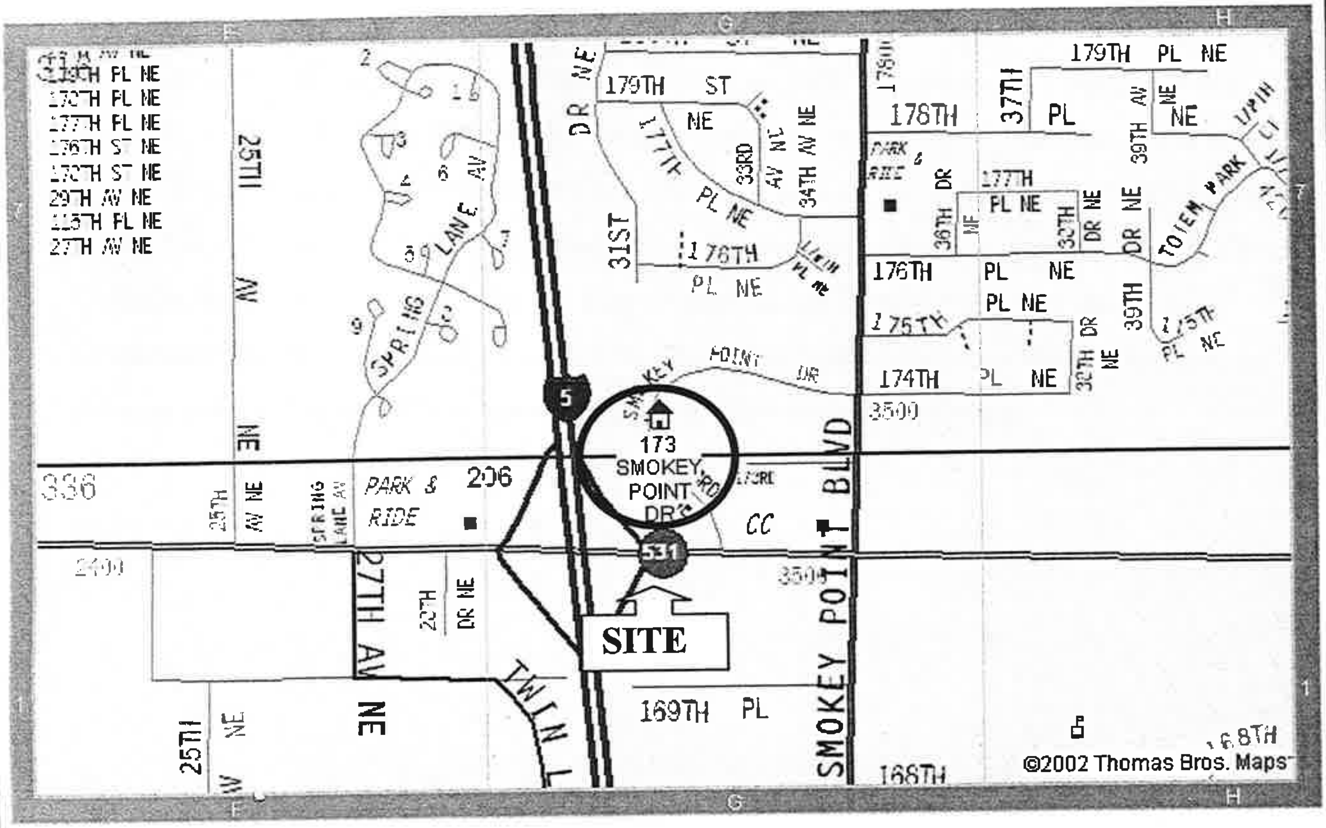

PHOTO TAKEN FROM THE 2002 THOMAS BROTHERS® GUIDE CD-ROM

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FIGURE 1. VICINITY MAP
CHAPMAN ENGINEERING
ARLINGTON, WA 98270

SCALE: 1" = 1,222'	DATE: 8/11/05	JOB #: 05-0270
BY: BRK	FILE NAME: 05-0270/doc/VICINITYMAP	

2. EXISTING CONDITIONS

The property is currently undeveloped and exists as grass. The parcel is bounded on the north, south and east by commercial developments and on the west by Smokey Point Drive. No critical areas were found on the site. The site is nearly flat. No runoff currently leaves the site and no surface water was observed on the site during the site visit on July 12, 2005. From the Soil Conservation Service Map of Snohomish County, the site is shown to contain Ragnar fine sandy loam, 0 to 8 %. The infiltration calculations for this site assume a conservative rate of 1" per hour. Refer to the plans for test pit results.

3. DEVELOPED CONDITIONS

The project site contains approximately 0.65 Acres. The proposal is to construct a two story building and parking with associated utilities.

The on-site soil is slightly finer than the requirement for soil for a sand filter. Therefore the soil will be adequate to provide water quality treatment as well as retention. It is proposed that porous pavers be used that allow the runoff to be directly infiltrated into ground (WSDOE BMP T5, 42). The pavers are set in a surfacing top course that is underlain by coarser gravel surfacing that provides pre-settling of the runoff to reduce sediments reaching the native sand. Additionally, there is a layer of filter fabric that will trap sediments prior to their reaching the native sub-grade. The coarse gravel and the filter fabric provide pre-treatment (settling) for the runoff. Maintenance of the system includes vacuuming the parking lot to remove accumulated sediments. If the system becomes clogged, the pavers can be reinstalled after removing the sediments.

Refer to the construction plans for more details. Refer to the flowing pages for drainage calculations.

4. DRAINAGE CALCULATIONS

Infiltration Trench Sizing for OnSite:

Impervious area included in the analysis includes building, the driveway and the parking lot = 0.16 + 0.35 = 0.51 Acres

Infiltration rate = 1 in/hr

Weighted Void ratio = 20%

Appended on: 14:36:33 Friday, July 29, 2005

LPOOLCOMPUTE [LevelPool] SUMMARY using Puls

Start of live storage: 100.0000 ft

Event	Match Q (cfs)	Peak Q (cfs)	Peak Stg (ft)	Vol (cf)	Vol (acft)	Time to Empty
100 year	0.0000	0.3509	100.3182	954.53	0.0219	25.50

Running R:\\Jobs\\05-0270 Chapman Engineering\\Stormshed\\LevelPool Report.pgm on Friday, July 29, 2005

Summary Report of all Detention Pond Data

Event	Precip (in)
100 year	3.5000

BASLIST2

[Developed] Using [TYPE1A] As [100 year]

LSTEND

BasinID	Event	Peak Q (cfs)	Peak T (hrs)	Peak Vol (ac-cf)	Area (ac)	Method/Loss	Raintype
Developed	100 year	0.7533	8.00	0.2586	1.00	SBUH/SCS	TYPE1A

BASLIST [TYPE1A] AS [100 year] DETAILED

[Developed]

LSTEND

Record Id: Developed

Design Method	SBUH	**Rainfall type**	TYPE1A
Hyd Intv	10.00 min	**Peaking Factor**	484.00
		Abstraction Coeff	0.20
Pervious Area (AMC 2)	0.14 ac	**DCIA**	0.86 ac
Pervious CN	86.00	**DC CN**	98.00
Pervious TC	6.00 min	**DC TC**	6.00 min

Pervious CN Calc

Description	SubArea	Sub cn
Open spaces, lawns,parks (>75% grass)	0.14 ac	86.00
Pervious Composited CN (AMC 2)		86.00

Pervious TC Calc

Type	Description	Length	Slope	Coeff	Misc	TT

Fixed	Minimum Tc		6.00 min
Pervious TC			6.00 min

Directly Connected CN Calc		
Description	SubArea	Sub cn
Impervious surfaces (pavements, roofs, etc)	0.86 ac	98.00
DC Composited CN (AMC 2)		98.00

Directly Connected TC Calc						
Type	Description	Length	Slope	Coeff	Misc	TT
Fixed	Minimum Tc					6.00 min
Directly Connected TC						6.00min

HYDLIST SUMMARY
[100 year out]
LSTEND

HydID	Peak Q (cfs)	Peak T (hrs)	Peak Vol (ac-ft)	Cont Area (ac)
100 year out	0.3509	8.50	0.2586	1.0000

STORLIST
[Pavers]
LSTEND

Record Id: Pavers

Descrip:	Prototype Record	Increment	0.10 ft
Start El.	100.0000 ft	Max El.	102.0000 ft
Length	150.0000 ft	Width	100.0000 ft
Catch	20.0000		

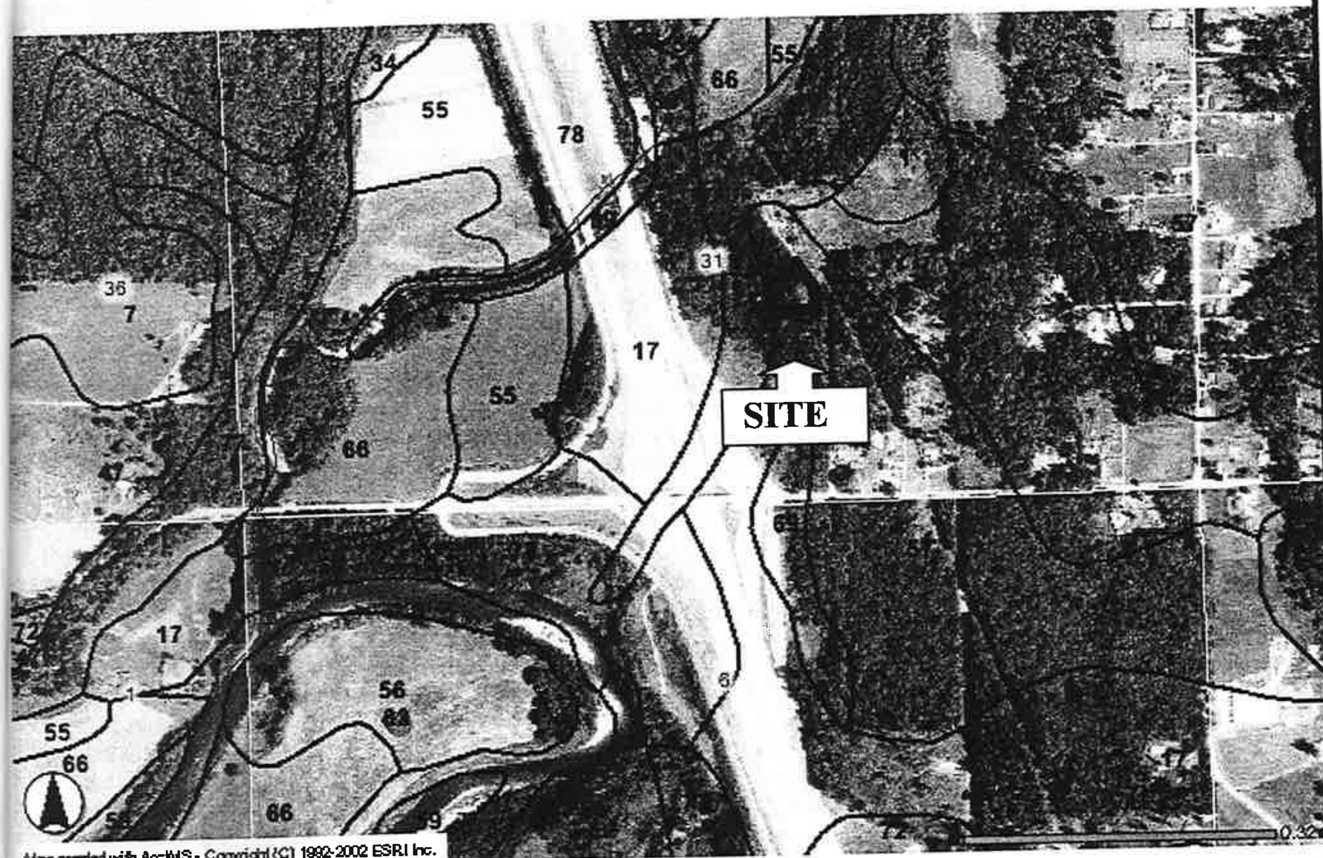
DISCHLIST
[Infiltration]
LSTEND

Record Id: Infiltration

Descrip:	Prototype Structure	Increment	0.10 ft
Start El.	100.0000 ft	Max El.	102.0000 ft
Infiltration rate	1.0000 in/hr	WP Multiplier	1.00

APPENDIX

SOIL MAP



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SOIL MAP
CHAPMAN ENGINEERING
ARLINGTON, WA 98223

SCALE: NONE	**DATE:** 8/11/05	**JOB #:** 05-0270
BY: BRK	**FILE NAME:** 05-0270\docs\SOILMAP	

This map unit is in capability subclass IIs.

57—Ragnar fine sandy loam, 0 to 8 percent slopes. This very deep, well drained soil is on outwash plains. It formed in glacial outwash. Areas are 10 to 40 acres in size. The native vegetation is mainly conifers. Elevation is 300 to 1,000 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 200 days.

Typically, the surface is covered with a mat of partially decomposed leaves, needles, and twigs about 2 inches thick. The surface layer is dark brown fine sandy loam about 2 inches thick. The subsoil is dark brown and brown sandy loam about 22 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown and dark gray loamy sand and sand. In some areas the surface layer is loamy, the subsoil is gravelly, and the substratum is very gravelly.

Included in this unit are areas of Everett, Indianola, Pastik, and Winston soils on terraces and outwash plains. Included areas make up about 15 percent of the total acreage.

Permeability of this Ragnar soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is 60 inches or more. Runoff is slow, and the hazard of water erosion is slight.

This unit is used mainly for homesite development. It is also used as cropland, hay and pasture, and woodland.

Douglas-fir and western hemlock are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 165 for Douglas-fir and 159 for western hemlock. On the basis of a 50-year site curve, the mean site index is 125 for Douglas-fir and 112 for western hemlock. The mean annual increment at culmination (CMAI) is 176 cubic feet per acre for Douglas-fir at age 60 and 252 cubic feet per acre for western hemlock at age 50. Among the trees of limited extent are red alder and western redcedar. Among the common forest understory plants are western swordfern, brackenfern, Oregon-grape, salal, and huckleberry.

This unit is well suited to year-round logging; however, logging roads require suitable surfacing for year-round use.

Seedling establishment is the main concern in the production of timber. Reforestation can be accomplished by planting Douglas-fir seedlings. If seed trees are present, natural reforestation of cutover areas by Douglas- fir and red alder occurs readily. When openings are made in the canopy, invading brushy plants, if not controlled, can delay the establishment of seedlings. The droughtiness of the surface layer reduces the survival of seedlings.

This unit is suited to hay and pasture. The main limitation is moderate available water capacity. Use of proper stocking rates, pasture rotation, and restricted grazing during wet periods helps to keep the pasture in good condition. Periodic mowing and spreading of droppings help to maintain uniform growth and discourage selective grazing. Proper grazing practices, weed control, and fertilizer are needed for maximum quality of forage. In some years supplemental irrigation is needed. Legumes benefit from applications of agricultural lime.

This unit is suited to use as cropland. A suitable cropping system is strawberries, sweet corn, or peas for 3 or 4 years and grasses and legumes for 3 to 5 years. Returning all crop residue to the soil and using a cropping system that includes grasses, legumes, or grass-legume mixtures help to maintain fertility and tilth. Grain and grasses respond to nitrogen; legumes respond to phosphorous, boron, sulfur and lime; and vegetables and berries respond to nitrogen, phosphorus, and potassium. Fall tillage or seeding should be across the slope or on the contour.

This unit has few limitations for homesites. The main limitation for septic tank absorption fields is seepage in the substratum. If the density of housing is moderate to high, community sewage systems may be needed to prevent contamination of water supplies as a result of seepage from onsite sewage disposal systems. Cutbanks are not stable and are subject to caving in.

This map unit is in capability subclass IIIe.

58—Ragnar fine sandy loam, 8 to 15 percent slopes. This very deep, well drained soil is on outwash plains. It formed in glacial outwash. Areas are 10 to 40 acres in size. The native vegetation is mainly conifers. Elevation is 300 to 1,000 feet. The average annual precipitation is about 45 inches, the average annual air temperature is about 50 degrees F, and the average frost-free season is 180 to 200 days.

Typically, the surface is covered with a mat of partially decomposed leaves, needles, and twigs about 2 inches thick. The surface layer is dark brown fine sandy loam about 2 inches thick. The subsoil is dark brown and brown sandy loam about 22 inches thick. The substratum to a depth of 60 inches or more is dark yellowish brown and dark gray loamy sand and sand.

Included in this unit are small areas of soils that have a loamy sand surface layer, a gravelly subsoil, and a very gravelly substratum. Also included are areas of Everett, Indianola, Pastik, and Winston soils on terraces. Included areas make up about 15 percent of the total acreage.

Permeability of this Ragnar soil is moderately rapid. Available water capacity is low. Effective rooting depth is 60 inches or more. Runoff is medium, and the hazard of water erosion is moderate.

This unit is used mainly as woodland. It is also used for hay and pasture and for homesite development.

Douglas-fir and western hemlock are the main woodland species on this unit. On the basis of a 100-year site curve, the mean site index is 165 for Douglas-fir and 159 for western hemlock. On the basis of a 50-year

Gary A. Flowers, PLLC
Geological & Geotechnical Consulting
19532 12th Avenue NE
Shoreline, WA 98155-1106

April 5, 2005
Project No. GF05028

T. F. Borseth Architects
624 Beach Avenue
Marysville, WA 98270

Attention: Todd Borseth
Principal Architect

Subject: Geological/Geotechnical Assessment
Proposed Chapman Office Building
Smokey Point Drive – Parcel No. 00645300000501
Arlington Park, Arlington, Washington

Dear Mr. Borseth:

This report presents the results of our geological/geotechnical evaluation of the approximate .65 acre property located on Smokey Point Drive about 800 feet north of its intersection with 172nd Street NE, in the Arlington Park area of Arlington, Washington. It is our understanding that the property will be developed into a two story, 6,000 sf office building. The structure will be located on the western portion of the parcel. The remainder of the parcel will be asphalt parking/driveway and landscaping. See Figure 1, Site and Exploration Plan.

The purpose of our site evaluation was to document existing shallow soil and ground water conditions on the property, and to provide geotechnical design recommendations for construction of the proposed improvements. An undated site plan, by T.J. Borseth Architects, was used as a reference for this study.

SITE CONDITIONS

The subject parcel is irregular in shape with a radius along Smokey Point Drive on the west, an angled property line along the south and straight sides only along the east and north sides. The parcel is bounded on the north, east and south by commercial development and on the west by Smokey Point Drive and retail development across the street. The property is currently undeveloped although several storm water lines run through it. Vegetation on the subject parcel is entirely lawn grass. Topographically the subject parcel is nearly flat.

Subsurface Soil and Ground Water Conditions

In order to characterize the shallow subsurface soil and ground water conditions on the property a total of four subsurface exploration pits, EP-1 through EP-4, were excavated on the site on March 22, 2005. The exploration pits were excavated at the approximate locations shown on Figure 1, Site & Exploration Plan. Logs of the pits are as follows:

EP-1

0-16"	Sod/Topsoil
16-42"	Medium dense becoming dense with depth, moist to very moist with depth, brown, fine sand with some silt. Mottling to within 16" of ground surface.
42"-6'	Medium dense, gray, very moist to saturated, medium sand with some gravel and trace silt.

BOH – 6', Ground water at 60" – very rapid seepage, Moderate caving near water table
6" pvc pipe (perforated) within washed rock encountered along west side of pit. Washed rock was about 2 feet wide by 1 foot deep.

EP-2

0-9"	Sod/Topsoil
9" – 42"	Medium dense becoming dense with depth, moist to very moist with depth, brown, fine sand with some silt. Mottling to within 16" of ground surface.
42"- 6'	Medium dense, gray, very moist to saturated, medium sand with some gravel and trace silt.

BOH – 6', Ground water at 58" – very rapid seepage, Moderate caving near water table

EP-3

0-10"	Sod/Topsoil
10" – 44"	Dense to very dense, moist to very moist with depth, brown, fine sand with some silt. Heavy iron staining. Below 33" becomes dense with less iron staining.
42"- 6'	Medium dense, gray, very moist to saturated, medium sand with some gravel and trace silt.

BOH – 6', Ground water at 56" – very rapid seepage, Moderate caving near water table

EP-4

0-6"	Sod/Topsoil
6"-3'	Medium dense becoming dense with depth, moist to very moist with depth, brown, fine sand with some silt. Mottling to within 16" of ground surface.

BOH – 3', No ground water, No caving

All of the exploration pits encountered a sod and organic topsoil layer that varied from 6 inches to 16 inches in thickness. In EP-1, near the southwest corner of the site, drain rock from a storm water infiltration system was encountered. The drain rock appeared to be about 2 feet wide by 1 foot deep with a 6 inch diameter, perforated, PVC pipe near the top of the rock. The pipe was located at a depth of approximately 2 feet below existing ground surface. The test pit at this location was extended deeper after moving slightly away from the drain rock.

In all of the exploration pits, beneath the organic layer, medium dense becoming dense with depth, brown, fine sand with some silt was encountered. This sand was heavily mottled up to a depth of about 16 to 20 inches below ground surface. In EP-3 the upper approximate 2 feet of this unit was very dense and had significant iron staining.

Beneath the brown, fine sand, beginning at a depth of 42 to 44 inches below existing grade, medium dense, gray, medium sand, with trace silt and some gravel was encountered.

The sediments were moist to a depth of about 36 inches, then became very moist and then wet at a depth of about 48 inches. Ground water was encountered in exploration pits EP-1, EP-2 and EP-3 at depths of 60 inches, 58 inches and 56 inches respectively. Pit EP-4 was only extended to a depth of 3 feet.

Moderate caving was observed in the wet soils above water table. Major caving can be expected below water table but will extend well above water table.

This material is interpreted to be the Marysville sand member of the Vashon age recessional outwash sediments. This material was deposited by meltwater flowing south from the stagnating and receding Vashon ice sheet. As such, this soil has not been consolidated by glacial ice. The Marysville sand member is typically greater than 50 feet thick.

According to the United States Department of the Interior, Geological Survey, Open File Report 80-461, "Distribution and Description of the Geologic Units in the Arlington West Quadrangle, Washington", by James P. Minard, the subject site has been mapped as the Marysville sand member. Our interpretation is in agreement with the geology map of the area.

Hydrology

No indication of standing or flowing water was present on the property at the time of our field work. There was no evidence of erosion anywhere on the parcel. Ground water was encountered in the exploration pits at the time of our field work. Seepage was very rapid and appeared to stabilize at a depth of about 5 ½ to 6 feet. We anticipate this depth represents the regional water table in this area. Soils above the water table were very wet beginning at a depth of about 1 foot above water table. The depth to water table may be somewhat shallower during the winter and spring months of the year. The mottling/oxidation of the upper sands indicate that ground water impacts during very wet years may be expected to within about 1 ½ feet of existing ground surface.

Seismic Hazards

Earthquakes occur in the Puget Lowland with great regularity. The vast majorities of these events are small and are usually not felt by people. However, large earthquakes do occur as evidenced by the 1949, 7.2-magnitude event, the 1965, 6.5-magnitude event, and the February 2001 magnitude 6.8 Nisqually earthquake. The 1949 earthquake appears to have been the largest in this region during recorded history and was centered in the Olympia area. Evaluation of earthquake return rates indicates that an earthquake of the magnitude between 5.5 and 6.0, similar to the 1996, 5.4 earthquake centered near Duvall, Washington, is likely within a given 20-year time interval.

Generally, there are four types of potential geologic hazards associated with large seismic events: 1) surficial ground rupture; 2) seismically induced landslides; 3) liquefaction; and 4) ground motion. The potential for each of these to impact the site is discussed below.

No surficial faulting or earth rupture has been documented, to date, in the Arlington area.

Due to the lack of steep slopes the potential risk of damage to the proposed structures, by seismically induced landsliding, is negligible.

Liquefaction is the result of the loss of shear strength in soils when they are subjected to saturated conditions and seismic shaking. Typical soils that are susceptible are those that are saturated, poorly graded (all one size), relatively fine-grained and in a loose condition. During a seismic event, severe shaking may cause liquefaction to occur and differential settlement may result. The Marysville sands are typically medium dense with depth and are well graded. Therefore, it is our opinion that the risk of liquefaction is low to moderate.

Structural design of the building should follow the 2003 *International Building Code* (IBC) standards for Site Class D (Table 1615.1.1), S_S = 120% (Figure 1516[1]) and S_1 = 36% (Figure 1516[2])

CONCLUSIONS AND RECOMMENDATIONS

On the basis of our geologic research and field explorations, the existing sand soils, either when undisturbed or when recompacted if disturbed, will provide suitable support for the proposed structure and pavement. A reduced allowable soil bearing pressure is necessary due to the potential for a high water table. The on-site soils can be reused as compacted fill for grading of the property, if required.

Site Grading

The site should be cleared of all grass sod and the organic topsoil layer that is not required as part of the landscape plan. These materials should be removed from the site. Grading plans were not available to us at the time of this study; however, since the site is extremely flat, we anticipate little to no grading to be necessary other than for foundation excavation and utilities.

Structural fill is defined as non-organic soil, acceptable to the geotechnical engineer or engineering geologist, placed in maximum 8-inch loose lifts with each lift being compacted to at least 95 percent of the modified Proctor maximum density using ASTM:D 1557 as the standard. Prior to placing any structural fill the exposed soils must first be compacted to a dense, nonyielding condition and approved for structural fill placement. These recommendations should apply wherever structural fill is to be placed except for roadway and utility trench backfill. In the case of roadway and utility trench backfill, the structural fill should be placed and compacted in accordance with current local or county codes and standards. The top of all compacted fill should extend horizontally outward a minimum distance of 3 feet beyond the location of perimeter footings or pavement edges before sloping down at a maximum angle of 2H:1V. Structural fill placed in foundation excavations must extend a minimum distance of 2 feet beyond the edges of the footings.

All areas to be paved should be crowned to direct storm water flow to the edges of the roadway and parking areas. The subgrade should then be compacted to a dense and nonyielding condition (minimum 95 percent of the modified Proctor maximum density). Following the compaction effort the areas to be paved should be proofrolled with a fully loaded, tandem axle dump truck. Any soft or yielding areas identified during proofrolling should be overexcavated and backfilled with structural fill. Both the compaction of the subgrade and the proofroll should be witnessed and documented by a representative of this firm.

Foundation Recommendations

Shallow foundations may be used for support of the planned structures when placed on recompacted, outwash sand or approved structural fill placed atop these materials. An allowable soil bearing value of 1,200 psf should be used in the design of these footings, including both dead and live loads. An increase of one-third may be used for short-term wind or seismic loading. Perimeter footings for the proposed structures should be buried a minimum of 18 inches into the surrounding soil for frost protection. Settlement of footings placed as detailed herein should be less than ¾ inch. However, foundations placed on disturbed soil may result in increased settlement. All foundation excavations should be inspected by a representative of this firm, prior to concrete placement, to verify that the design bearing capacity of the soils has been attained and that construction conforms to the recommendations contained in this report. The governing municipality may require such inspections.

Lateral loads can be resisted by friction between the foundation and the supporting soils, and/or by passive earth pressure acting on the buried portions of the foundations. The foundations must be backfilled with structural fill compacted to at least 95 percent of ASTM:D 1557 to achieve the passive resistance provided below. The structural fill must extend horizontally outward from the embedded portion of the foundation a distance equal to at least three times the embedment depth over which the passive resistance is applied. We recommend the following design parameters.

- Passive equivalent fluid = 250 pcf
- Coefficient of friction = 0.35

The above values are allowable and include a factor of safety of at least 2.0.

Floor Support Recommendations

For the slab-on-grade floors, we recommend that the upper twelve (12) inches of natural soil beneath the slab be recompacted to a firm, unyielding condition with a density of at least 92 percent of the modified Proctor maximum density using ASTM:D 1557 as the standard. Any yielding areas should be overexcavated and filled with approved structural fill.

A capillary break layer consisting of 4 inches of washed pea gravel and a minimum 10 mil thick, polyethylene plastic vapor barrier should be provided under any floor slabs where moisture intrusion is a concern. Based on American Concrete Institute recommendations, we also recommend placing a 2- to 3-inch layer of sand or pea gravel over the vapor barrier to protect it, and to allow some moisture loss through the bottom of the slab to aid in the curing process. The sand or pea gravel will also aid in the fine-grading process of the subgrade to provide uniform support under the slab.

Site Drainage

It is our understanding that storm water from the new structures and paved areas of the site will be infiltrated on the site. Based on our field study, ground water was observed at a depth of about 56 to 60 inches below existing grade. Wet to saturated soil conditions were observed up to a depth of about 48 inches below existing grade. Based on observed soil conditions (mottling) we anticipate that during very wet years ground water may approach to within 16 to 20 inches of existing ground surface.

In order to determine an approximate infiltration rate for the receptor soils, we utilized both the USDA Textural Triangle and gradation testing. Use of both methods allows correlation and a higher degree of confidence in the findings. Both of these methods are approved by Washington State Department of Ecology (Ecology) in their 2001 Manual. The design engineer should decide which method is most applicable for this project. The design engineer must also consider the depth to water table in the design as that will likely be the controlling factor.

Based on laboratory analyses, and the USDA Textural Triangle, the receptor soils (to a depth of about 44 inches) are classified as sand with a short-term infiltration rate, as per Table 3.7, of 8 inches/hour. The receptor soils were relatively homogenous in EP-1, EP-2 and EP-4. EP-3 was different and had a very dense layer to a depth of 33 inches which must be considered. As such, as per Table 3.7, a minimum correction factor of 4 should be used, thus providing a long-term infiltration rate of 2 inches/hour. For actual design purposes, the design engineer should apply a further correction factor, if appropriate and must consider the depth to water table.

Based on the ASTM gradation testing method, the D_{10} size for the sand sample tested was .075. As per Table 3.8, the estimated long-term infiltration rate for the receptor soils would be about 1.2 inches/hour. However, mottling was observed to within about 16 inches of the surface. Based on the DOE manual, the presence of mottling indicates soil conditions that reduce the infiltration rate for homogeneous conditions by a factor of 3 to 4. This would reduce the long term infiltration rate to .3 to .4 inches per hour.

Should a higher infiltration rate be important for design purposes, field infiltration testing would be necessary to determine the actual infiltration capacity of the receptor soils. A copy of the sieve analysis is attached.

It is also important to understand that the infiltration rate may be compromised if the contractor is not careful to avoid compaction or siltation of the receptor soils. Should either of these conditions occur, the receptor soils must be overexcavated and loosened and/or the upper 2 to 3 feet overexcavated and replaced to remove unwanted silt that has washed into the area. The infiltration rate can also be compromised if adequate pretreatment of the influent is not provided or if the facility is not properly maintained to remove any siltation or biomass buildup.

The design engineer may want to consider the use of pavers or permeable concrete and asphalt on this project since the water table is high and infiltration rate is low. Use of these methodologies will allow for storage in the crushed rock base materials and slow infiltration into the underlying receptor soils while staying as high as possible above potential high water table. The design engineer must determine the appropriate thickness of crushed rock base materials to meet storage requirements for the site.

Foundation Drains

The perimeter footing walls for the convenience store should be provided with a drain at the footing level. Drains should consist of rigid, perforated, PVC pipe surrounded by washed pea gravel. The level of the perforations in the pipe should be set approximately 2 inches below the bottom of the footing and the drains should be constructed with sufficient gradient to allow gravity discharge away from the buildings. Roof and surface runoff should not discharge into the footing drain system, but should be handled by a separate, rigid, tightline drain that discharges into an approved storm water conveyance system. In planning, exterior grades adjacent to walls should be sloped downward away from the structure to achieve surface drainage.

Erosion Protection

Due to the extreme flatness of the site, and the presence of sand soils, the site has little potential for erosion and sediment transport off site. Areas stripped of vegetation during construction should be replanted, or otherwise protected, as soon as possible. Construction entrances should be rocked to minimize off-site soil transport.

SUMMARY

Based on our site reconnaissance and subsurface explorations the site appears to be suitable for the proposed development provided the recommendations provided herein are properly implemented.

We recommend that we be retained to review those portions of the plans and specifications that pertain to grading or foundation and paving installations to determine that they are consistent with the recommendations of this report. Construction monitoring and consultation services should also be provided to verify that subsurface conditions are as expected. Should conditions be revealed during construction that differs from the anticipated subsurface profile, we will evaluate those conditions and provide alternative recommendations where appropriate.

Field construction monitoring and observation services should be considered an extension of this initial geotechnical evaluation, and are essential to the determination of compliance with the project drawings and specifications. Such activities would include site clearing and grading, roadway, parking and sidewalk construction, utilities, subsurface drainage, foundations and fill placement and compaction.

Our findings and recommendations provided in this report were prepared in accordance with generally accepted principles of engineering geology and geotechnical engineering as practiced in the Puget Sound area at the time this report was submitted. We make no other warranty, either express or implied.

Sincerely,

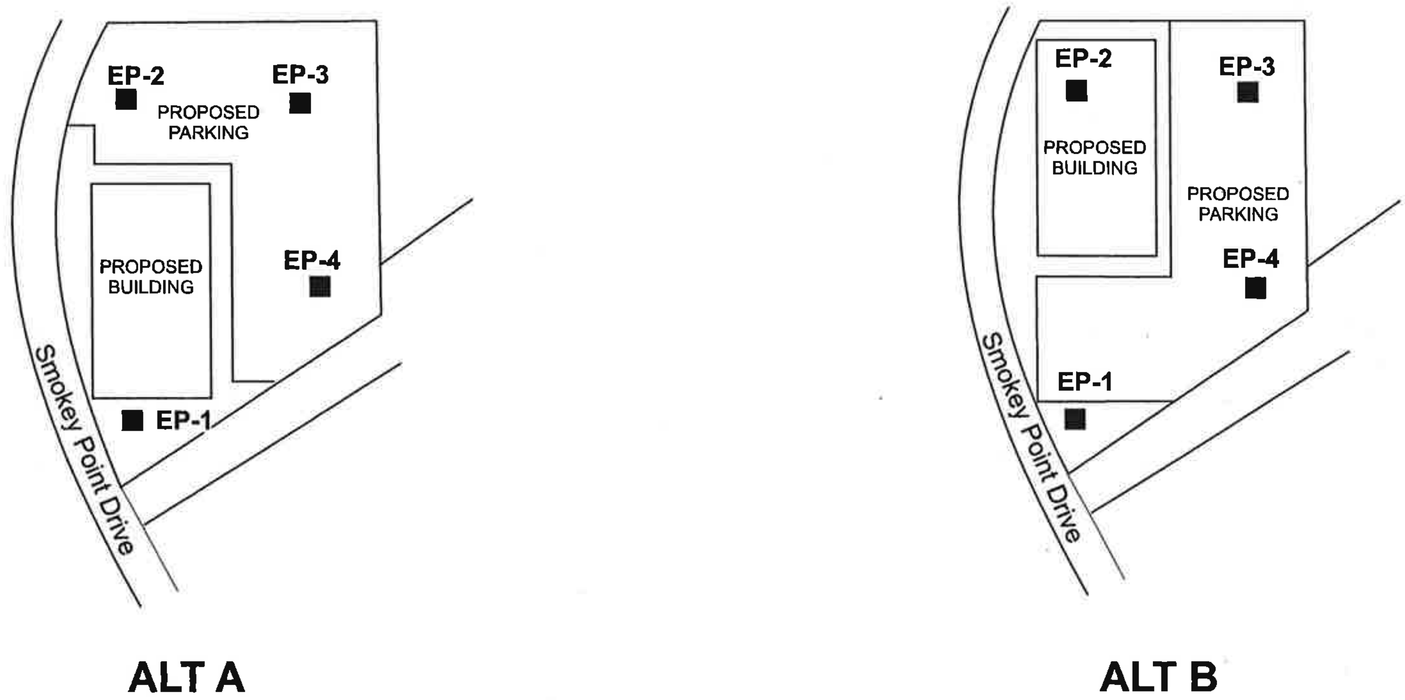
State of Washington Licensed Geologist Engineering Geologist 1056
Gary A. Flowers

Gary A. Flowers, P.G., P.E.G.
Principal Engineering Geologist

Robert M. Pride State of Washington 16271 Registered Professional Engineer
EXPIRES 7-20-06

Robert M. Pride, P.E.
Geotechnical Engineer

Attachments: Site and Exploration Plan
Sieve Analysis



REFERENCE: T.F. BORSETH ARCHITECTS, 3-15-05

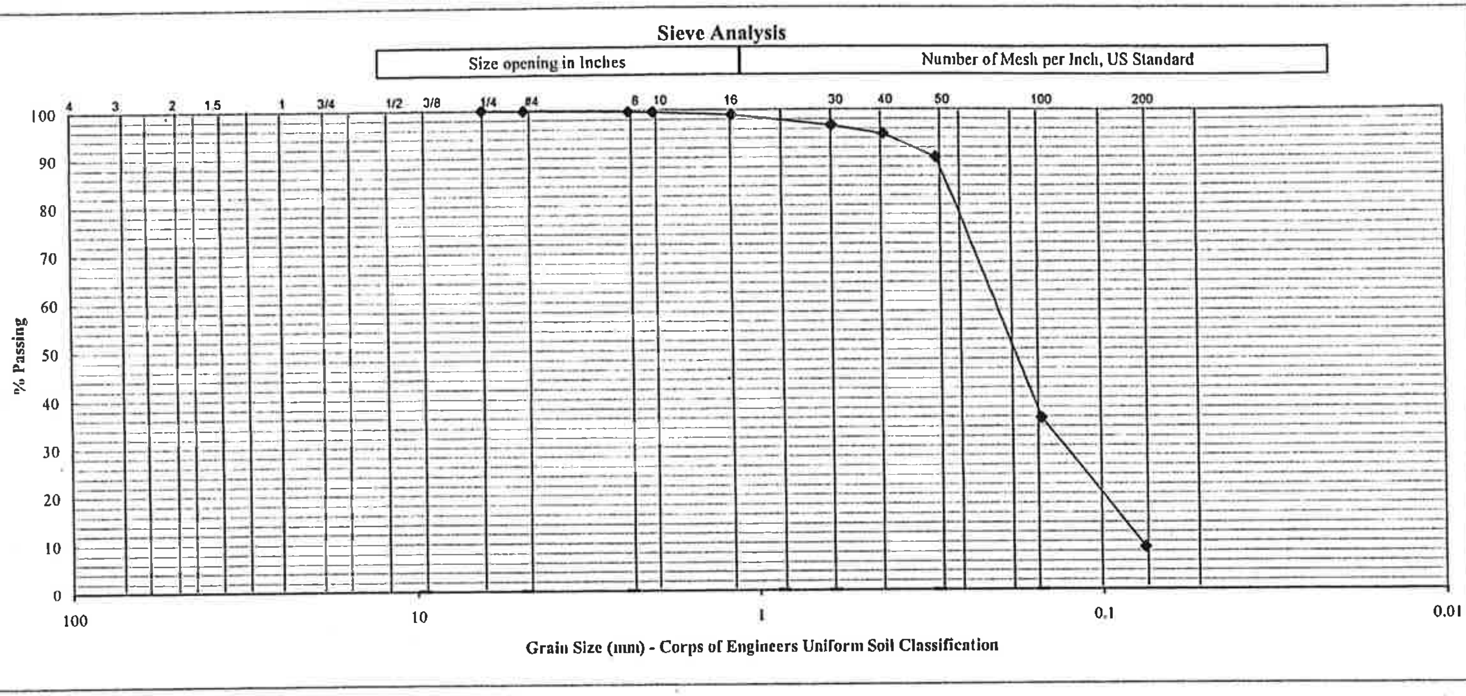
LEGEND

EP-4 ■ Approximate location of exploration pit

N

NOT TO SCALE

GARY A. FLOWERS, PLLC	**SITE AND EXPLORATION PLAN** CHAPMAN OFFICE BUILDING ARLINGTON PARK ARLINGTON, WASHINGTON	FIGURE 1 DATE 4/05 PROJECT NO. GF05028



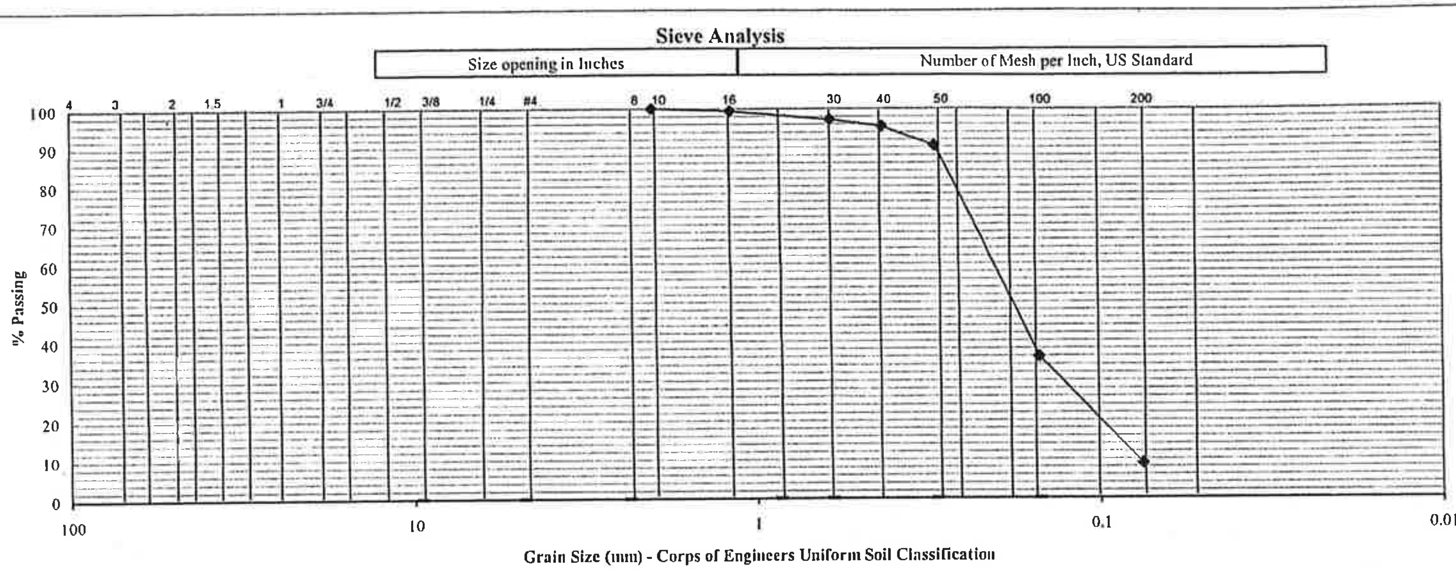
Sieve Analysis

Sieve Size	% Passing	Specs * min	Specs * max
1/4"	100		
#4	100		
#8	100		
#10	99		
#16	99		
#30	97		
#40	95		
#50	90		
#100	36		
#200	8.8		

Material:	Brown sandy silt
Source:	EP-3, 30-36"
Project:	QC - Chapman Office Building
Project #:	Q4025
Date Rec'd:	3/22/2005

Sample Number	Depth (ft)	Classification	Nat. W.C.	L.L.		P.I.
9230						

Reviewed by:



Sieve Analysis

Sieve Size	% Passing	Specs * min	max
#10	100		
#16	99		
#30	97		
#40	95		
#50	90		
#100	36		
#200	8.8		

Gradation based on #10 minus material only.

Sample Number	Depth (ft)	Classification	Nat. W.C.	L.L.		P.I.
9230A						

Material:	Brown sandy silt
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Reviewed by: