Encompass
ENGINEERING & SURVEYING

TECHNICAL INFORMATION REPORT

For

Lakeview 34
3803 NE 155th Street
Lake Forest Park, WA 98155

Original submittal: September 17, 2015
Revised Submittal: November 3, 2016

Encompass Engineering Job No. 15620

Prepared

For

AML Construction & Development LLC
12055 Lakeside Place NE
Seattle, WA 98125

Western Washington Division
165 NE Juniper St., Ste 201, Issaquah, WA 98027
Phone: (425) 392-0250 Fax: (425) 391-3055

Eastern Washington Division
407 Swiftwater Blvd. , Cle Elum, WA 98922
Phone: (509) 674-7433 Fax: (509) 674-7419

www.EncompassES.net

TABLE OF CONTENTS

SECION 1 - PROJECT OVERVIEW

FIGURE 1
TIR Worksheet
FIGURE 2
Site Location
FIGURE 3
Drainage Basins, Sub-Basins & Site Characteristics

SECTION 2 - CONDITIONS AND REQUIREMENT SUMMARY

SECTION 3 – OFFSITE ANALYSIS

SCOPE OF ANALYSIS
Task 1 – Study Area Definition & Maps
Task 2 – Resource Review
Task 3 – Field Inspection
Task 4 – Drainage System Description & Problems
Task 5 – Mitigation of Existing or Potential Problems
Figure 4
Downstream Photos

SECTION 4 – FLOW CONTROL & WATER QUALITY ANALYSIS

EXISTING SITE HYDROLOGY - PART A
DEVELOPED SITE HYDROLOGY - PART B
PERFORMANCE STANDARDS - PART C
FLOW CONTROL SYSTEM - PART D
WATER QUALITY SYSTEM - PART E

SECTION 5 – CONVEYANCE SYSTEM ANALYSIS & DESIGN

SECTION 6 – SPECIAL REPORTS & STUDIES

SECTION 7 – OTHER PERMITS

SECTION 8 – CSWPPP ANALYSIS & DESIGN

ESC PLAN ANALYSIS & DESIGN – PART A
SWPPS PLAN DESIGN – PART B

SECTION 9 – BOND QUANTITIES, FAC. SUMMARY & DEC. OF COVENANT

SECTION 10 – OPERATIONS & MAINTENANCE MANUAL

APPENDIX A – GEOTECHNICAL ENGINEERING REPORT

APPENDIX B – OPERATIONS & MAINTENANCE MANUAL

APPENDIX C – KCRTS DRAINAGE CALCULATIONS

I. PROJECT OVERVIEW

General:

This commercially zoned project proposes to develop a 0.70-acre parcel into a 4-story, 14-unit condominium building including one parking garage level. The building will have an underground detention system to contain runoff from all new impervious surface areas. The residential structure will attach to utilities provided by the City and utility districts in the area.

Project Location:

The project site address is 3803 NE 155th Street, Lake Forest Park, WA 98155 and is located east of SR 522. More generally, the site is located within Section 15, Township 26 North, Range 4 East, W.M., King County, Washington.

Existing and Proposed Project Site Characteristics.

The parcel is currently developed with a single family residential building (with an office and other internal use rooms) with a couple significant trees and much overgrown vegetation on most of the site. The region of the site to be developed generally slopes down from northwest to southeast at an average slope of approximately 14%±. The steeper portion of the site, which will not be developed, contains slopes in excess of 60%. Most of the site was cleared in 2014 and plastic sheeting installed over the steep slopes. Large areas of invasive species have taken hold on the slopes and around the paved parking area in 2015.

The proposal is to develop the parcel into a 4-story condominium structure including one parking garage level with below-grade detention vault. The project will have frontage improvements including adding landscaping, sidewalks and driveway entrances.

Critical Areas.

The property does contain Environmentally Sensitive Areas. Steep slopes are present on the southern portion of the site. The sensitive area types include soil erosion (due to steep slopes with loose fills), and steep slope and landslide hazard areas (due to slopes steeper than 40% and higher than 10 feet). The site also contains a buffer for an existing creek located offsite. This creek is located within 50 feet from the southern property line. The buffers for the creek are well down the slope away from the proposed construction and building area. The proposed development will be located entirely outside of the steep slope hazard area and corresponding buffer area. Stormwater released from the onsite stormwater detention facility will also be conveyed to existing storm sewer, located along the south side of SE 155th Street, with a tightline to avoid water seepage into the surrounding soils.

Soils.

Refer to attached geotechnical report prepared by Geo Group Northwest, Inc.

Proposed Stormwater Controls.

The storm drainage system has been designed according to the standards set forth by the 2009 King County Surface Water Design Manual (KCSWDM). KCRTS was used to size the required detention only system.

Refer to Section IV of this TIR for additional information regarding the Flow Control and Water Quality BMPs.

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 1 PROJECT OWNER AND PROJECT ENGINEER

Project Owner AML Construction & Developement

Phone 206-850-4586

Address 12055 Lakeside Place NE
Seattle, WA 98125

Project Engineer Chad Allen, PE

Company Encompass Engineering & Surveying

Phone 425-392-0250

Part 2 PROJECT LOCATION AND DESCRIPTION

Project Name Lakeview 34

DDES Permit #

Location Township 26N

Range 4E

Section 15

Site Address 3803 NE 155th Street
Lake Forest Park, Wa. 98155

Part 3 TYPE OF PERMIT APPLICATION

- ☐ Landuse Services
  Subdivison / Short Subd. / UPD
- ☒ Building Services
  M/F / Commerical / SFR
- ☒ Clearing and Grading
- ☐ Right-of-Way Use
- ☐ Other

Part 4 OTHER REVIEWS AND PERMITS

- ☐ DFW HPA
- ☐ COE 404
- ☐ DOE Dam Safety
- ☐ FEMA Floodplain
- ☐ COE Wetlands
- ☐ Other
- ☐ Shoreline Management
- ☒ Structural Rockery/Vault/
- ☐ ESA Section 7

Part 5 PLAN AND REPORT INFORMATION

Technical Information Report		Site Improvement Plan (Engr. Plans)	
Type of Drainage Review (circle):	Full / Targeted / Large Site	Type (circle one):	Full / Modified / Small Site
Date (include revision dates):	08-22-2016	Date (include revision dates):	08-22-2016
Date of Final:		Date of Final:	

Part 6 ADJUSTMENT APPROVALS

Type (circle one): Standard / Complex / Preapplication / Experimental / Blanket

Description: (include conditions in TIR Section 2)

Date of Approval:

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 7 MONITORING REQUIREMENTS

Monitoring Required: Yes / No

Start Date: N/A

Completion Date: _____

Describe: _____

Part 8 SITE COMMUNITY AND DRAINAGE BASIN

Community Plan : Shoreline

Special District Overlays: N/A

Drainage Basin: West Lake Washington - Lake Forest Park

Stormwater Requirements: _____

Part 9 ONSITE AND ADJACENT SENSITIVE AREAS

- ☐ River/Stream _____
- ☐ Lake _____
- ☐ Wetlands _____
- ☐ Closed Depression _____
- ☐ Floodplain _____
- ☐ Other _____

- ☒ Steep Slope _____
- ☒ Erosion Hazard _____
- ☒ Landslide Hazard _____
- ☐ Coal Mine Hazard _____
- ☐ Seismic Hazard _____
- ☐ Habitat Protection _____
- ☐ _____

Part 10 SOILS

Soil Type	Slopes	Erosion Potential
Qvt, Qcu, Qg	9-100%	Moderate

- ☐ High Groundwater Table (within 5 feet)
- ☒ Other Fill
- ☐ Sole Source Aquifer
- ☐ Seeps/Springs

☐ Additional Sheets Attached

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 11 DRAINAGE DESIGN LIMITATIONS	
REFERENCE	LIMITATION / SITE CONSTRAINT
☒ Core 2 – Offsite Analysis	
☒ Sensitive/Critical Areas	
☐ SEPA	
☒ Other	Downstream Flooding Complaint
☐	
☐ Additional Sheets Attached	

Part 12 TIR SUMMARY SHEET (provide one TIR Summary Sheet per Threshold Discharge Area)	
Threshold Discharge Area: (name or description)	TDA-1
Core Requirements (all 8 apply)	
Discharge at Natural Location	Number of Natural Discharge Locations: 1
Offsite Analysis	Level: 1 / 2 / 3 dated:
Flow Control (incl. facility summary sheet)	Level: 1 / 2 / 3 or Exemption Number Small Site BMPs
Conveyance System	Spill containment located at: Sediment Pond
Erosion and Sediment Control	ESC Site Supervisor: TBD Contact Phone: After Hours Phone:
Maintenance and Operation	Responsibility: Private / Public If Private, Maintenance Log Required: Yes / No
Financial Guarantees and Liability	Provided: Yes / No By Owner
Water Quality (include facility summary sheet)	Type: Basic / Sens. Lake / Enhanced Basicm / Bog or Exemption No. Landscape Management Plan: Yes / No
Special Requirements (as applicable)	
Area Specific Drainage Requirements	Type: CDA / SDO / MDP / BP / LMP / Shared Fac. / None Name: N/A
Floodplain/Floodway Delineation	Type: Major / Minor / Exemption / None 100-year Base Flood Elevation (or range): N/A Datum:
Flood Protection Facilities	Describe: N/A
Source Control (comm./industrial landuse)	Describe landuse: N/A Describe any structural controls:

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Oil Control	High-use Site: Yes / No Treatment BMP: N/A Maintenance Agreement: Yes / No with whom?
Other Drainage Structures	
Describe:	

Part 13 EROSION AND SEDIMENT CONTROL REQUIREMENTS

MINIMUM ESC REQUIREMENTS DURING CONSTRUCTION	MINIMUM ESC REQUIREMENTS AFTER CONSTRUCTION
☒ Clearing Limits	☒ Stabilize Exposed Surfaces
☒ Cover Measures	☒ Remove and Restore Temporary ESC Facilities
☒ Perimeter Protection	☒ Clean and Remove All Silt and Debris, Ensure Operation of Permanent Facilities
☐ Traffic Area Stabilization	☐ Flag Limits of SAO and open space preservation areas
☒ Sediment Retention	☐ Other
☐ Surface Water Collection	
☐ Dewatering Control	
☐ Dust Control	
☐ Flow Control	

Part 14 STORMWATER FACILITY DESCRIPTIONS (Note: Include Facility Summary and Sketch)

Flow Control	Type/Description	Water Quality	Type/Description
☒ Detention	vault	☐ Biofiltration	
☐ Infiltration		☐ Wetpool	
☐ Regional Facility		☐ Media Filtration	
☐ Shared Facility		☐ Oil Control	
☐ Flow Control BMPs		☐ Spill Control	
☐ Other		☐ Flow Control BMPs	
		☐ Other	

TECHNICAL INFORMATION REPORT (TIR) WORKSHEET

Part 15 EASEMENTS/TRACTS		Part 16 STRUCTURAL ANALYSIS
☐ Drainage Easement		☒ Cast in Place Vault
☐ Covenant		☐ Retaining Wall
☐ Native Growth Protection Covenant		☐ Rockery > 4' High
☐ Tract		☐ Structural on Steep Slope
☐ Other		☐ Other

Part 17 SIGNATURE OF PROFESSIONAL ENGINEER

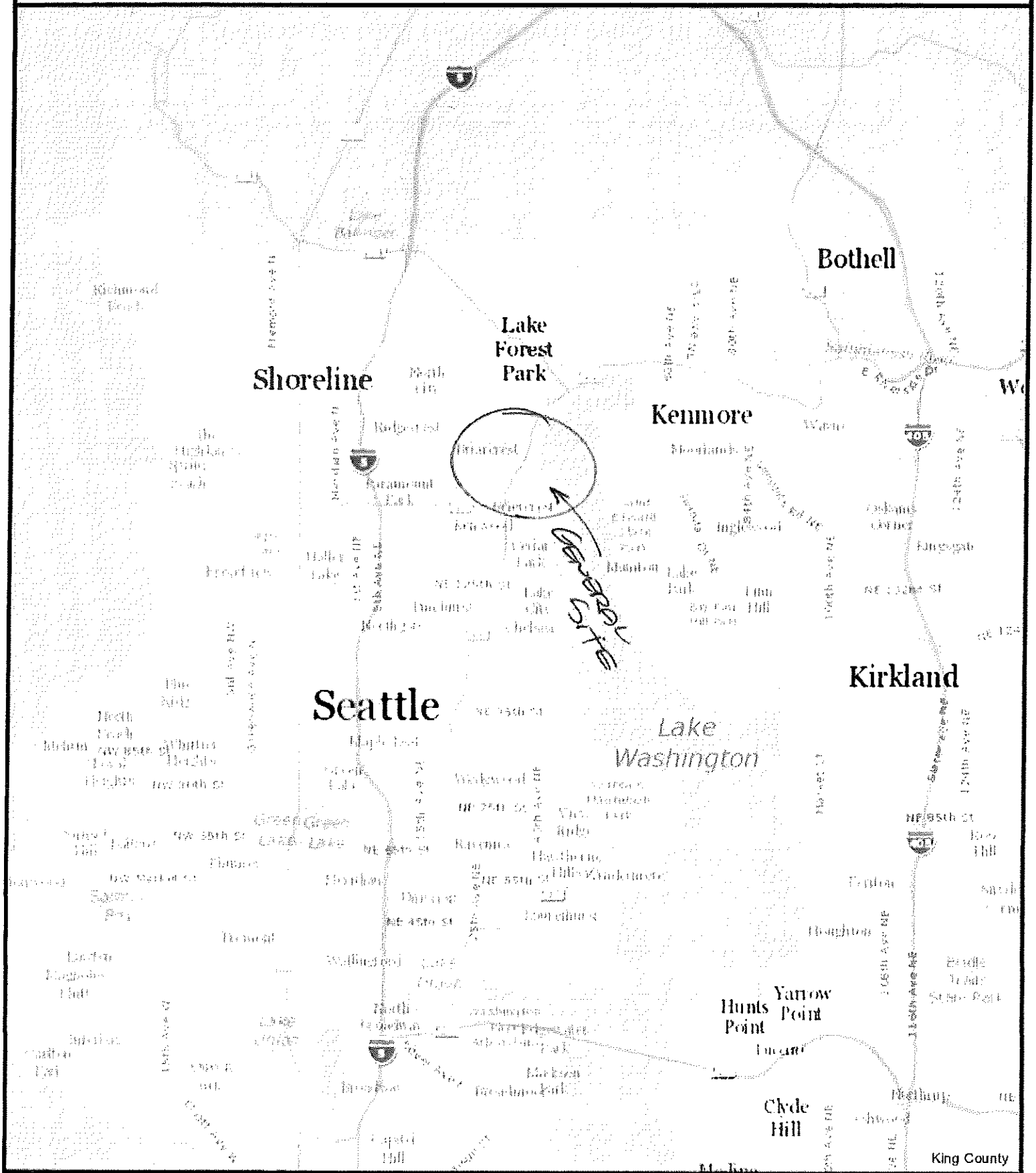
I, or a civil engineer under my supervision, have visited the site. Actual site conditions as observed were incorporated into this worksheet and the attached Technical Information Report. To the best of my knowledge the information provided here is accurate.

Chad Tamura 8-22-16

Signed/Date

King County iMap

FIGURE 2-A

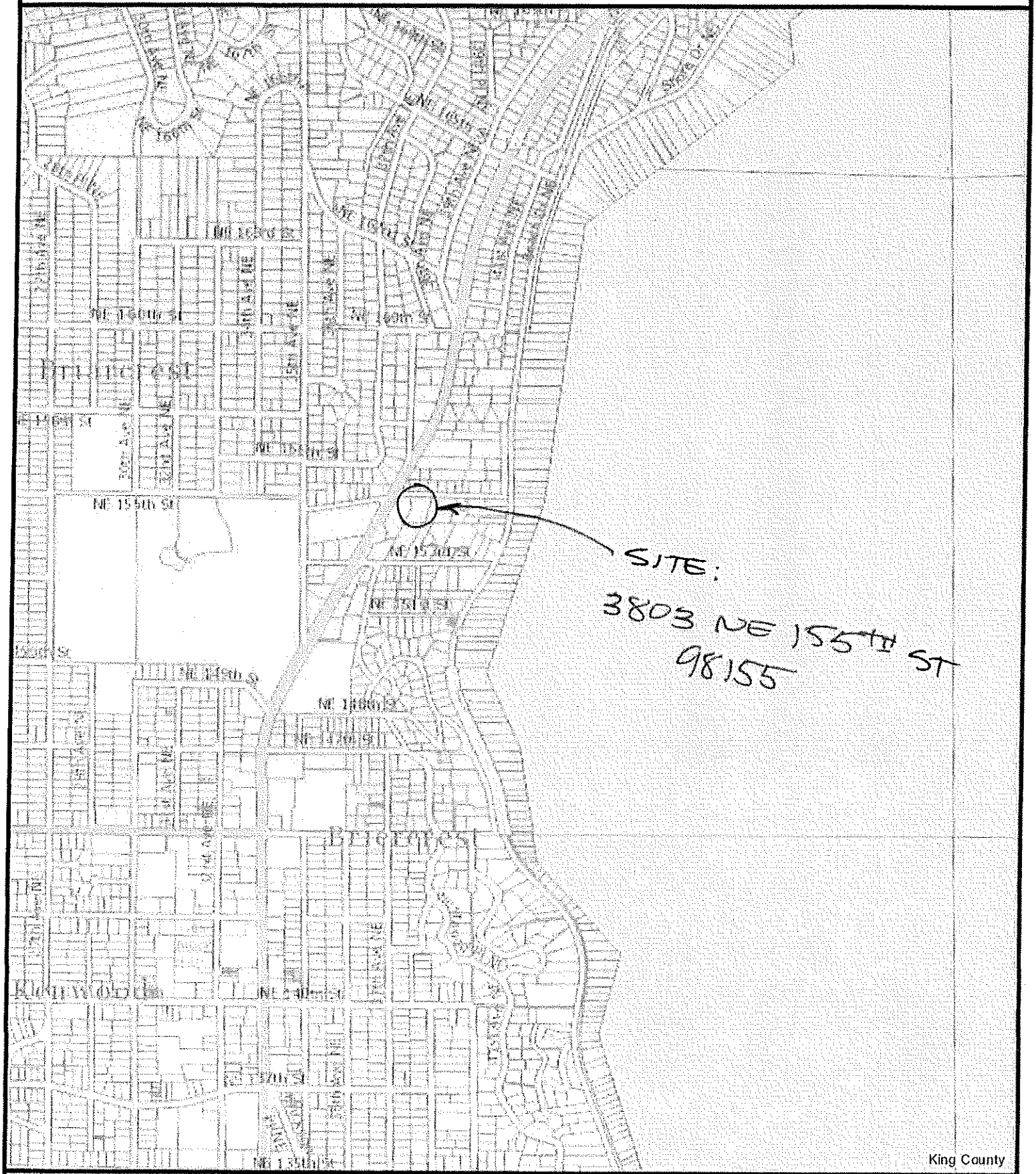


Date: 10/8/2015 Notes:

King County GIS Center

King County iMap

FIGURE-2-B



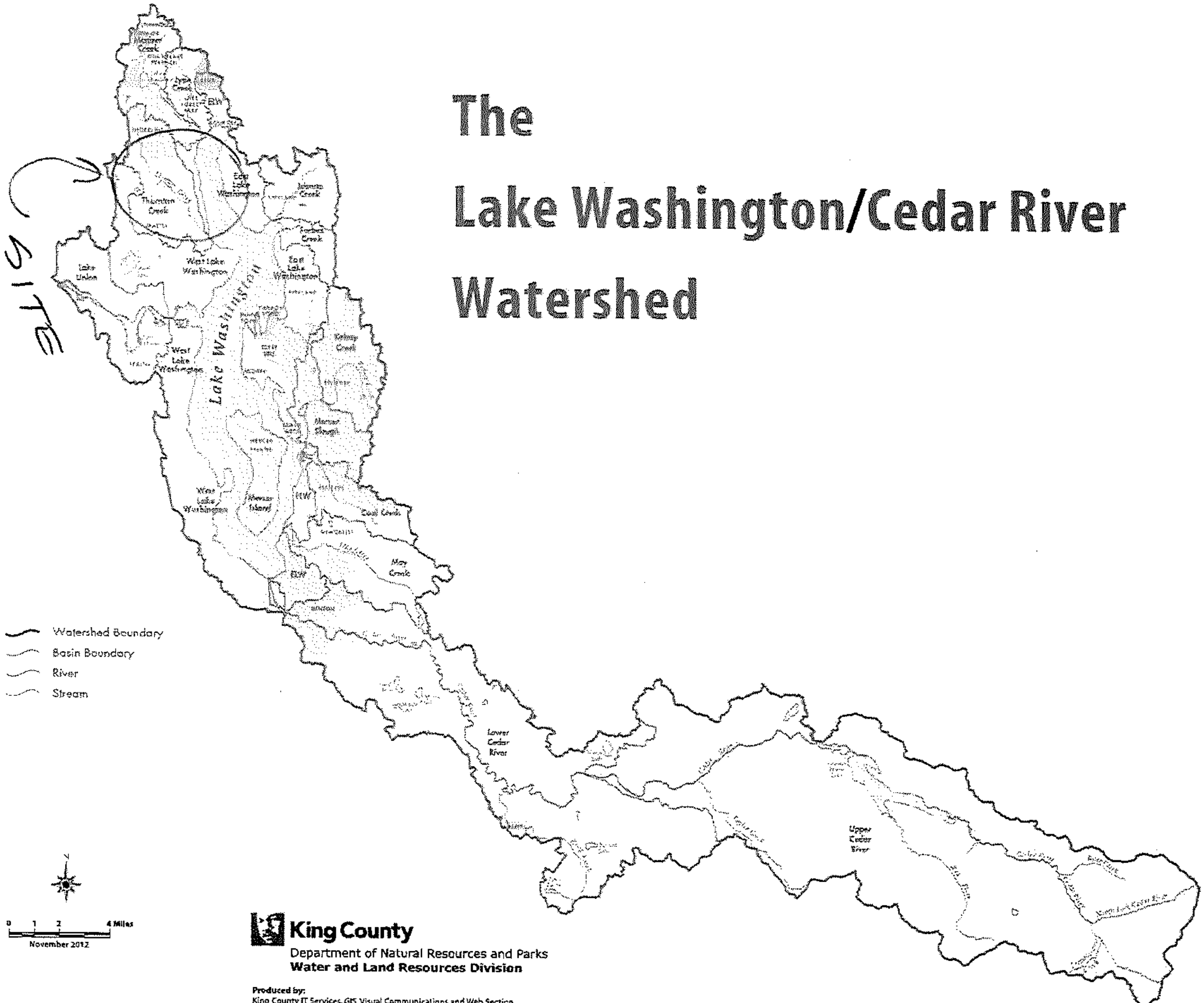
Date: 10/8/2015 Notes:

N

King County GIS Center

FIGURE 3-A

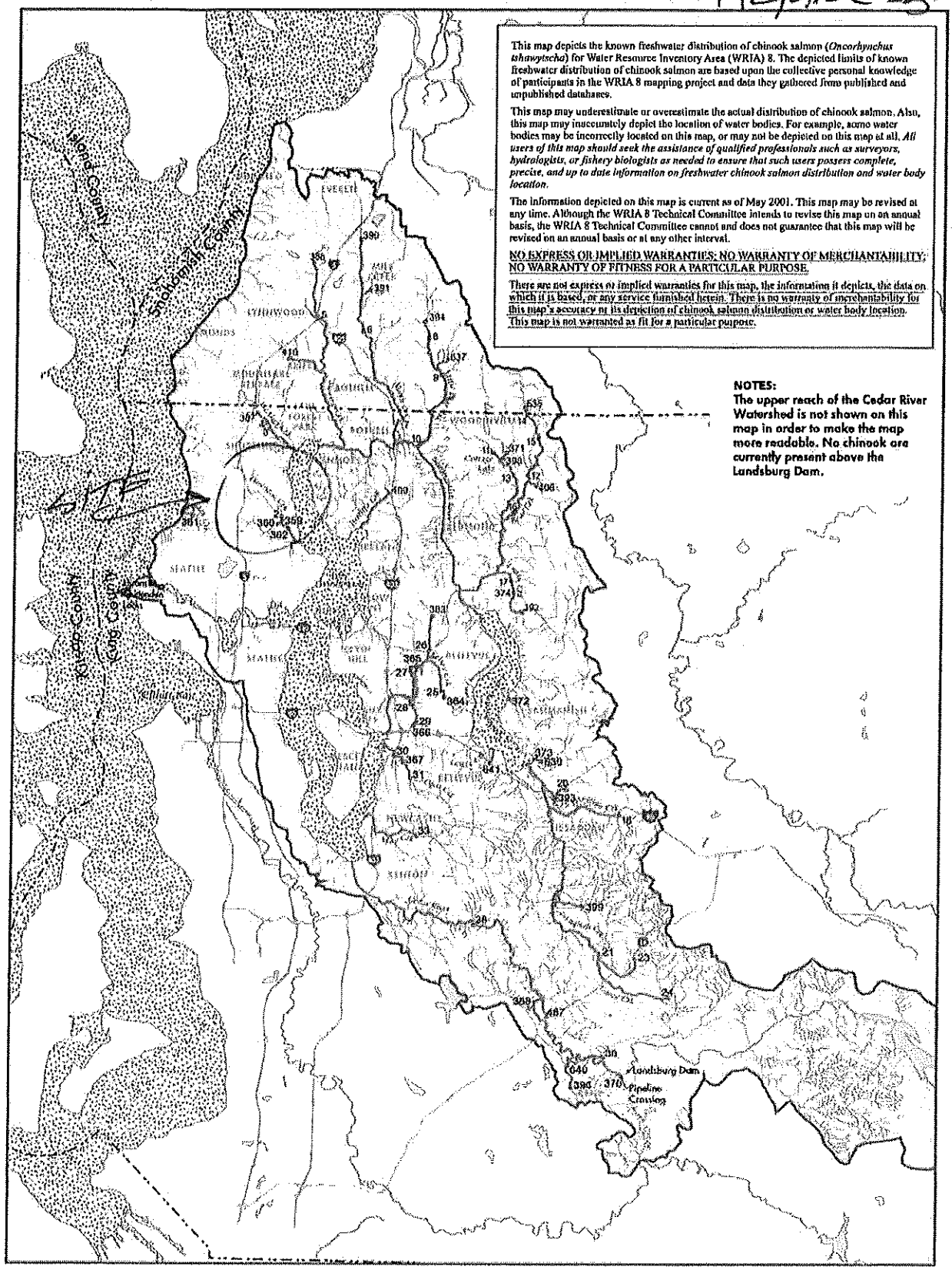
The Lake Washington/Cedar River Watershed



King County
Department of Natural Resources and Parks
Water and Land Resources Division

Produced by:
King County IT Services, GIS, Visual Communications and Web Section
File Name: 1211_2650_CedarLkWashMap.ai skrau

FIGURE 2-B



Known Freshwater Distribution of Chinook Salmon for Water Resource Inventory Area (WRIA) 8

Chinook Distribution - Streams

- Present - First Hand Information
- Present - Second Hand Information

Chinook Distribution - Lakes

- Present

- Data Point and Number (CLICK HERE to see data table for a description of each point.)
- WRIA 8 Boundary
- River
- Stream
- Major Road

N

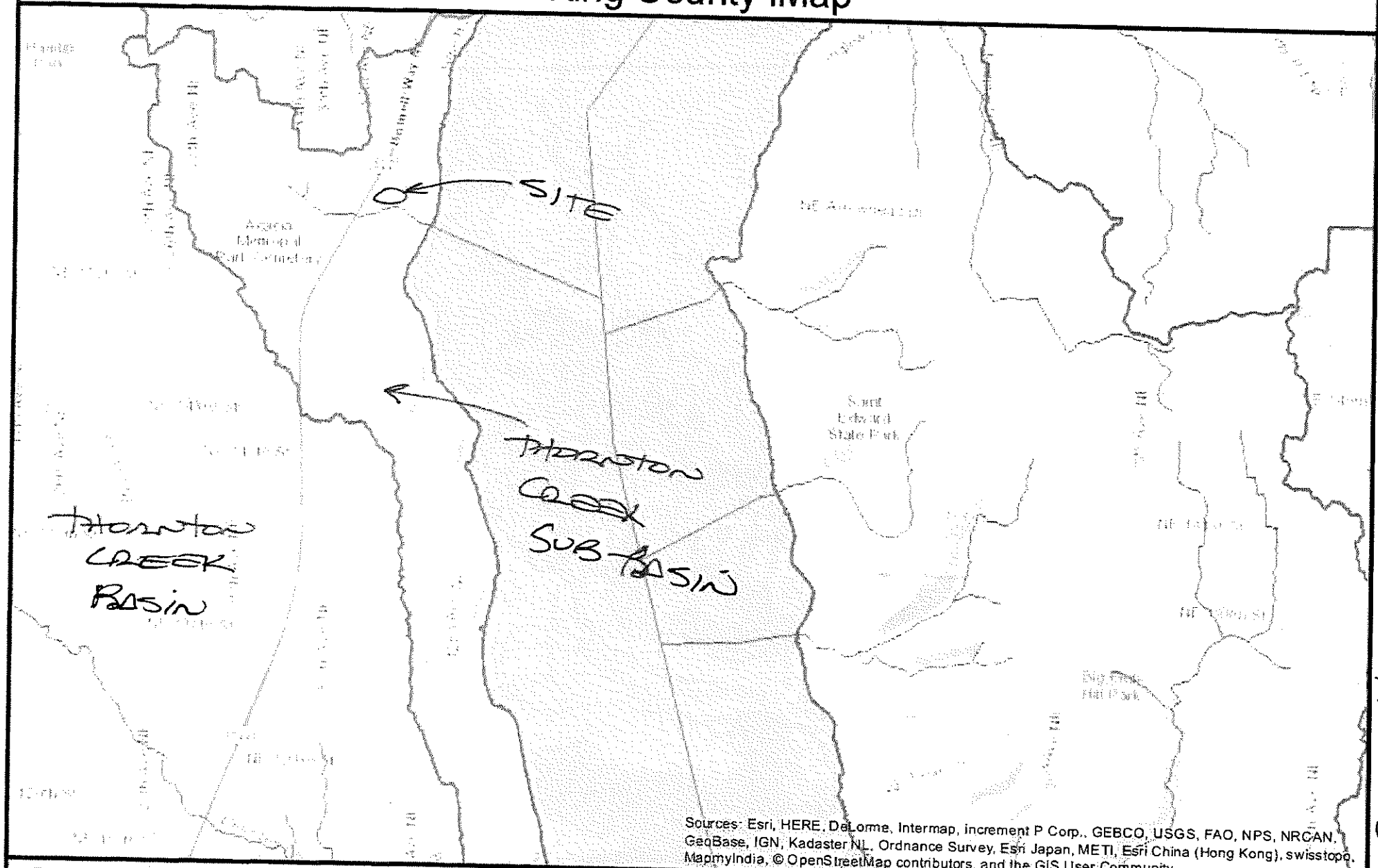
0 2 4 6 Miles

Revised May 2001

KING COUNTY

Map Produced by:
GIS & Visual Communications Unit, WLR
File Name: 010SChinookDistMap.eps md,lp,sk

King County iMap



Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

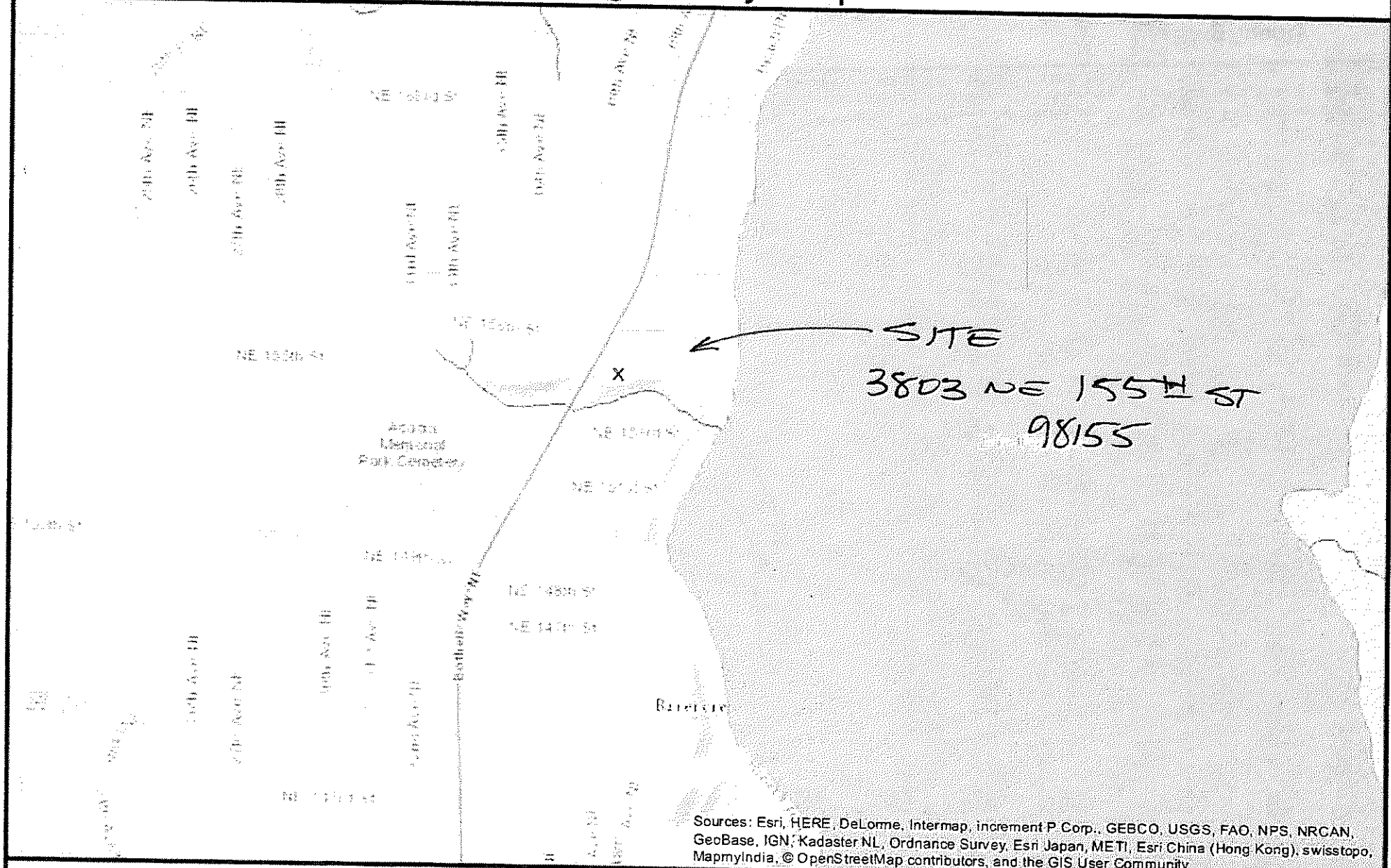
Date: 10/8/2015 Notes:

N

King County GIS Center

FIGURE 3-C

King County iMap



Date: 10/8/2015 Notes:

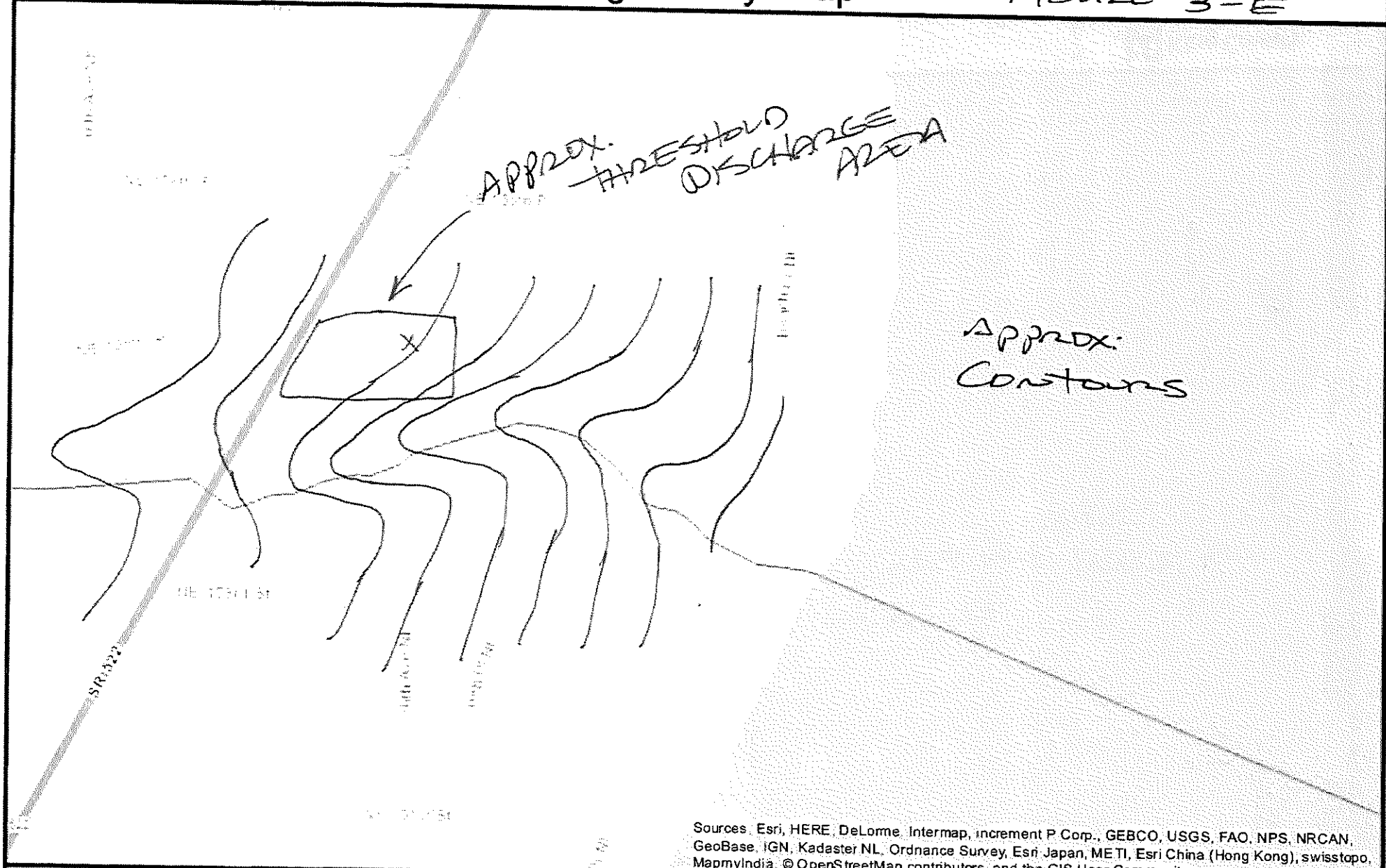
N

King County GIS Center

FIGURE 3-D

King County iMap

FIGURE 3-E



Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Date: 10/8/2015 Notes:

N

King County GIS Center

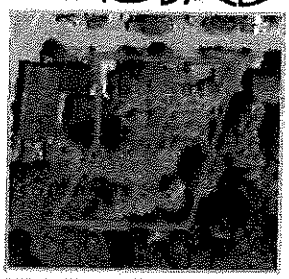
FIGURE 3-E

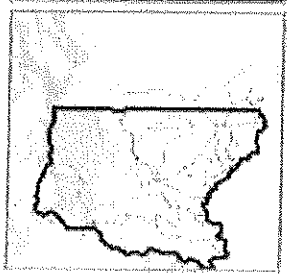
King County Districts and Development Conditions for parcel 6744701588

print

FIGURE 4

Parcel number	**6744701588**	Drainage Basin	**West Lake Washington - Lake Forest Park**
Address	**3803 NE 155TH ST**	Watershed	Cedar River / Lake Washington
Jurisdiction	**Lake Forest Park**	WRIA	Cedar-Sammamish (8)
Zipcode	**98155**	PLSS	**SW - 15 - 26 - 4**
Kroll Map page	**217**	Latitude	**47.74058**
Thomas Guide page	**505**	Longitude	**-122.28728**





Electoral Districts

Voting district	**LFP 46-0003**	Fire district	**King County Fire Protection District No. 16**
King County Council district	**District 1, Rod Dembowski (206) 477-1001**	Water district	**does not apply**
		Sewer district	**does not apply**
		Water & Sewer district	**does not apply**
Congressional district	**7**		
Legislative district	**46**	Parks & Recreation district	**Shoreline Park & Recreation District**
School district	**Shoreline #412**	Hospital district	**does not apply**
Seattle school board district	**does not apply (not in Seattle)**	Rural library district	**Rural King County Library**

King County planning and critical areas designations

King County zoning	**NA, check with jurisdiction**	Potential annexation area	**does not apply**
		Rural town?	**No**
Development conditions	**None**	Water service planning area	**does not apply**
Comprehensive Plan	**does not apply**	Roads MPS zone	**175**
		Transportation Concurrency Management	**does not apply**
Urban Growth Area	**Urban**		
Community Service Area	**does not apply**	Forest Production district?	**No**
		Agricultural Production district?	**No**
Community Planning Area	**Shoreline**	Critical aquifer recharge area?	**None mapped**
Coal mine hazards?	**None mapped**	100-year flood plain?	**None mapped**
		Wetlands at this parcel?	**None mapped**
Erosion hazards?	**None mapped**	Within the Tacoma Smelter Plume?	**Non-Detect to 20.0 ppm**

Related resources

King County Assessor: eReal Property Report
King County Assessor: Quarter Section Map (PDF format requires Acrobat)
King County DPER: **Permit Applications Report** (for unincorporated areas only)
King County Treasury Operations: Property Tax Information for this property
King County Recorders Office: Scanned images of plats.
King County Recorders Office: Scanned images of surveys and other map documents.
Seattle/King County Public Health: Septic system as-built documents.
Open iMAP to this property
Open Parcel Viewer to this property

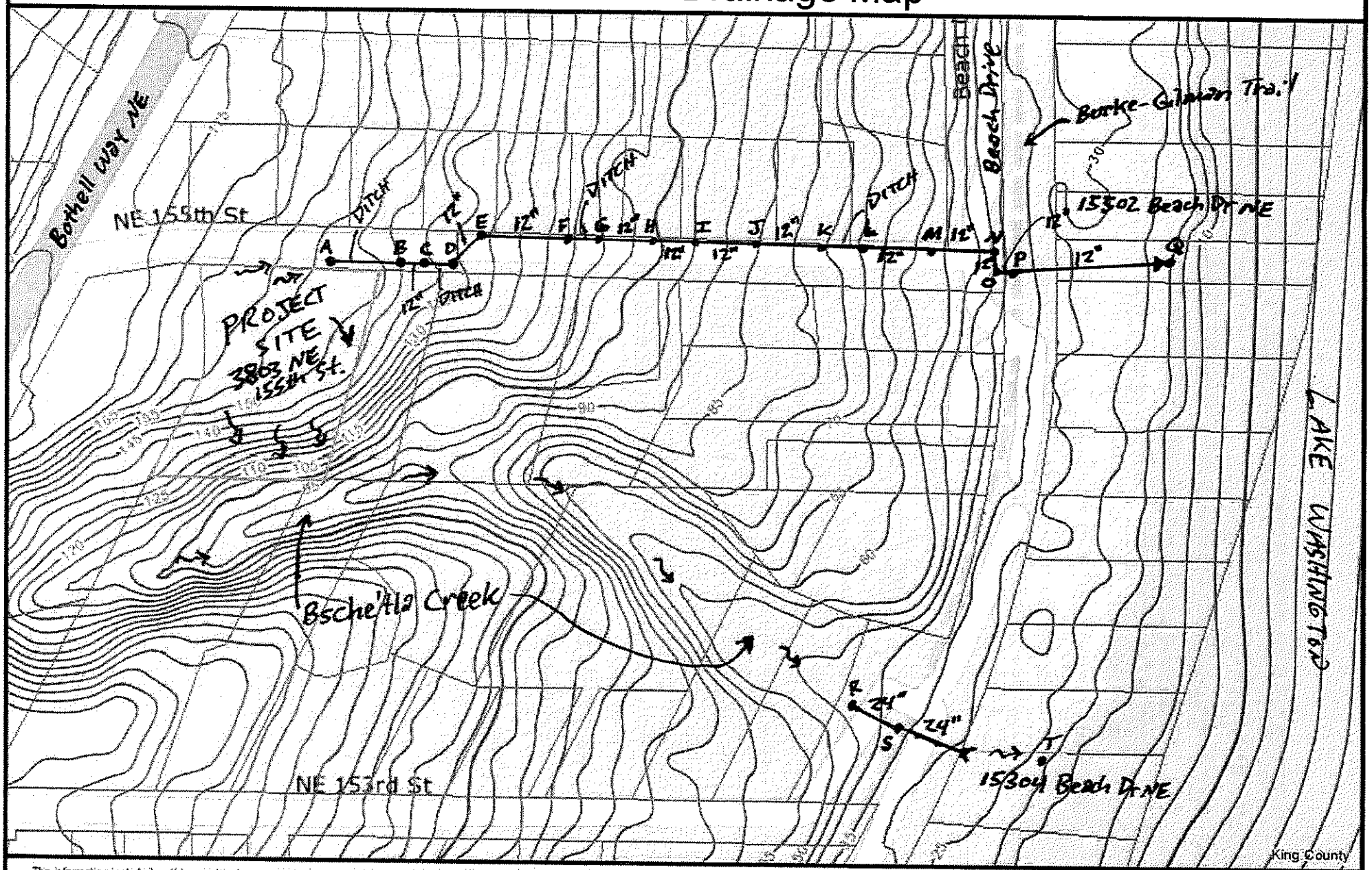
Search

Address or parcel number: Search Reset

☐ search by condo name

example address: 201 S Jackson St | example parcel number: 0942000860

Downstream Drainage Map



Date: 6/14/2016 Parcel: 6744701588

N

King County GIS Center

FIGURE 5

II. CONDITIONS AND REQUIREMENTS SUMMARY

CORE REQUIREMENTS

Core Requirement #1: Discharge at the natural Location

Runoff generally sheet flows across the site from northwest to southeast. Refer to the Level 1 Downstream Analysis in Section III for a complete description of the existing drainage path.

Core Requirement #2: Offsite Analysis

An offsite drainage analysis is provided in Section III of this TIR. Level 1 Drainage Analysis has been prepared and a drainage problem was identified along the proposed downstream flowpath. Refer to section IV for a complete description.

Core Requirement #3: Flow Control

The KCRTS analysis was performed and Level 3 Flow Control is being provided to mitigate downstream drainage issues. A Level 3 flow control detention facility is being provided for flow control. The vault will discharge into an existing pipe located beneath NE 155th Street which will convey the flow to the north side of NE 155th Street. Refer to section IV of this TIR for additional information. The detention facility was designed by matching developed discharge durations to predeveloped durations for the range of predeveloped discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow and also matching developed peak discharge rates to predeveloped peak discharge rates for the 2-year, 10-year 100-year return periods. Historic site conditions were assumed as the predeveloped condition.

Core Requirement #4: Conveyance System

Conveyance system analysis and design will be provided in the Final TIR.

Core Requirement #5: Erosion and Sediment Control

A temporary erosion and sediment control (TESC) plan provides BMPs to be implemented during construction. These consist of a silt fence at the clearing limits, and interceptor trench with check dams that direct runoff into a sediment pond (located on the eastern edge of the property. All released storm drainage will be directed into an existing drainage system along NE 155th Street and conveyed to Lake Washington, the release point.

Core Requirement #6: Maintenance and Operations

Refer to section X of this TIR for Maintenance and Operations.

Core Requirement #7: Financial Guarantees and Liability

The owner will arrange for any financial guarantees and liabilities required by the permit.

Core Requirement #8: Water Quality

Water Quality Control is not required for this project.

SPECIAL REQUIREMENTS

Special Requirement #1: Other Adopted Area-Specific Requirements

Critical Drainage Area – N/A

Master Drainage Plan – N/A

Basin Plan – This site is located within the Lake Washington drainage basin

Lake management Plan – N/A

Shared Facility Drainage Plan – N/A

Special Requirement #2: Floodplain/Floodway Delineation

N/A

Special Requirement #3: Flood Protection Facilities

N/A

Special Requirement #4: Source controls

N/A

Special Requirement #5: Oil Control

N/A

III. LEVEL I DOWNSTREAM ANALYSIS

Task 1 – Define and map the study area

The proposed site is located at 3803 NE 155th Street, Lake Forest Park, WA 98155. Information provided by the City indicate that the entire City of LFP is in a conservation zone (which requires flow control). See Figures 3A to 3F for drainage basin maps.

Task 2 – Review all available information on the study area

Regarding this parcel No. 6744701588, see attached districts and development conditions report from King County

Task 3 & 4 – Field inspect the study area – Describe the drainage system, and its existing and predicted drainage and water quality problems.

A site visit was conducted on September 14, 2015 (and also on June 14, 2016) to verify the existing stormwater flowpath. At the time of the site visit, the weather was cloudy with occasional sun and it was about 72 degrees. There was no construction or clearing at the site. At one time, it may have been clear of vegetation, however, today it was impassable due to overgrown Himalayan Blackberry and other invasive species covering the site except as shown in the photos.

The stormwater leaving the site reaches Lake Washington via two separate flow paths, which are described below.

Flow path #1:

Runoff from the northern portion of the site enters into a roadside drainage ditch at point A, which is along NE 155th Street, and travels to the east for approximately 65 feet and then enters into a 12" RCP culvert pipe at Point B. The 12" RCP culvert pipe is approximately 20 feet long drains into a ditch at point C. This ditch is approximately 5' wide, 3' deep and 38' long. The flow then enters into a 12" CMP storm sewer at point D and is conveyed northeast for approximately 32 feet until it enters into a Catch Basin at point E, located on the north side of SE 155th Street. From here, the flow is conveyed eastward by a 12" RCP storm sewer for approximately 91 feet and then enters into a ditch at point F. The flow is conveyed the 5' wide, 2' deep ditch for approximately 19 feet and then enters into a 12" CPP storm sewer at point G. The flow is conveyed through this pipe for approximately 45 feet and then enters a Catch Basin at point H. From this point, the flow enters into a 12" CPP storm sewer, which is approximately 56' in length, that drains into a Catch Basin located at point I. From here, the flow travels eastward through a 12" RCP storm sewer, approximately 53 feet in length, and then enters into a Catch Basin at point J. From here, the flow travels through a 12" CMP storm sewer for approximately 70 feet and discharges into a 5' wide, 2' deep paved ditch at point K. This paved ditch is approximately 38' in length and conveys the flow to point L, where it enters into a 12" RCP storm sewer. The flow is conveyed through this pipe for 83 feet to a Catch Basin at point M. From here, the flow continues traveling

eastward via a 12" PVC pipe for approximately 34' until it enters a Catch Basin at point N. The flow is then conveyed southeast to a Catch Basin at point O by a 12" CPP storm sewer, approximately 25' in length. From there, the flow is conveyed eastward down a steep slope into a Catch Basin at point P by a 12" RCP pipe which is approximately 23' in length. The flow is then conveyed to an outfall location at point Q near the edge of Lake Washington via a 12" PVC storm sewer that is approximately 151 feet in length (see photos 3-5). Pipe and ditch slopes along NE 155th Street (from the project site to Beach Dr NE) range from approximately 8 to 20 percent based on King County GIS information. The City was consulted about drainage complaints in this neighborhood and it was determined that an existing drainage problem exists along the downstream flowpath for NE 155th Street (Flow Path #1). The drainage problem exists at 15502 Beach Dr NE, where ponding of water is occurring in a paved parking area. Storm water is also entering a paved walkway along the south side of the home during larger storm events. Information regarding this drainage problem were verified from Mr. Frank Zenk, who the Public Works Operations Director for Lake Forest Park, and from Mr. Lane Ruud, who is the homeowner of the property with the existing drainage problem.

Flow Path #2:

Most of the project site drains down a steeply sloped region located on the south side of the property (see photo 2). At the bottom of the steep slope is Bsche'tla Creek that drains from the west side of Bothell Way NE (a major north-south roadway) to Lake Washington. The creek conveys the flow to point R, near NE 153rd Street where it enters into a 24" CMP storm sewer which conveys the flow under NE 153rd Street to a Catch Basin located at Point S. From here, the flow is conveyed beneath Beach Drive NE and the Burke-Gilman Trail via another 24" CMP storm sewer which discharges the flow into a channel draining into Lake Washington near the northern property line of 15304 Beach Dr NE. The channel then discharges the flow into Lake Washington at point T.

During the site visit, there were no obvious signs of drainage problems along Flow Path #2 but some erosion along the downstream end of Bsche'tla Creek (near 153rd Street) was evident and can be seen in photo 8. The Creek appears to be washing out soil material from beneath the existing ground surface along the edge of the creek.

Task 5 – Mitigation of Existing or Potential Problems

No onsite drainage problems were identified but a downstream drainage problem does exist at 15502 Beach Dr NE, where ponding of water is occurring in a paved parking area. Storm water is also entering a paved walkway along the south side of the home during larger storm events. This drainage problem exists along the flowpath for NE 155th Street (Flow Path #1). Much of the site currently flows toward a Bsche'tla Creek to the south of the property but we have been directed by the City of Lake Forest Park to direct all storm water runoff down NE 155th Street (along Flow Path #1). To minimize the impact of the proposed development on the existing drainage system along NE

155th Street and the drainage problem for the home located at 15502 Beach Dr. NE, Level III flow control was used for the design of the stormwater detention vault. Level III flow control requires matching the developed discharge durations to predeveloped durations for the range of predeveloped discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow and also matching developed peak discharge rates to predeveloped peak discharge rates for the 2-year, 10-year 100-year return periods. Historic site conditions were assumed as the predeveloped condition.

Photo 1

In Photo 1 above, the road clearly slopes down to the left (east) and the far portion of the property in front of the car slopes down to the southeast (Photo 2 below). A ditch starts near the mailboxes and flows down to the left (east). No significant drainage enters the property from the west. A small market is located on the corner and runoff flows to the south and east into Bsche'tla Creek.

Photo 2

Photo 3

In Photo 3, we see a view down NE 155th Street with Lake Washington in the distance.

Photo 4

In photo 4, we see NE 155th Street which conveys drainage toward Lake Washington through a series of ditches, culverts & catch basins/storm sewer pipe.

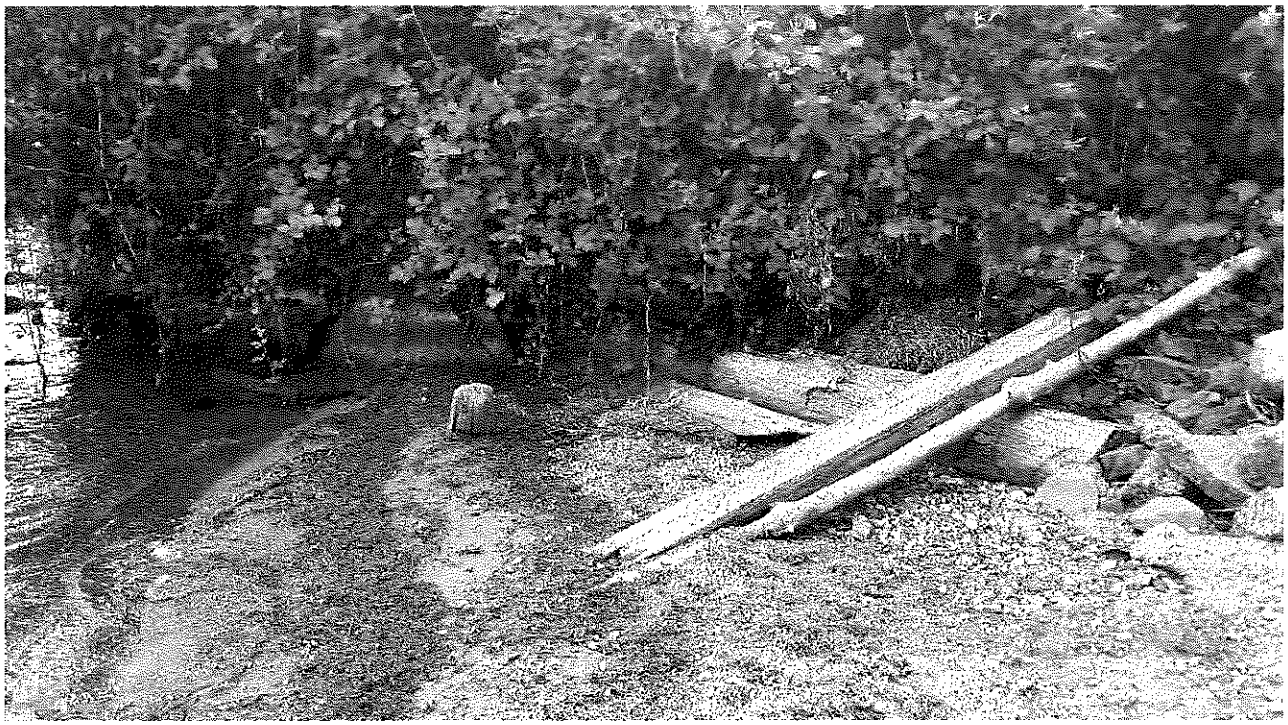
Photo 5

In photo 5, we see a catch basin located in the Burke Gilman trail which is part of the storm water conveyance system that drains the flow from NE 155th Street to Lake Washington.

Photo 6

Photo 6 shows a public tract of land located between two residences (15502 Beach Dr NE & 15348 Beach Dr NE). The flow from NE 155th Street is conveyed to Lake Washington via an underground storm sewer running beneath this tract and discharges into the lake near the shoreline.

Photo 7

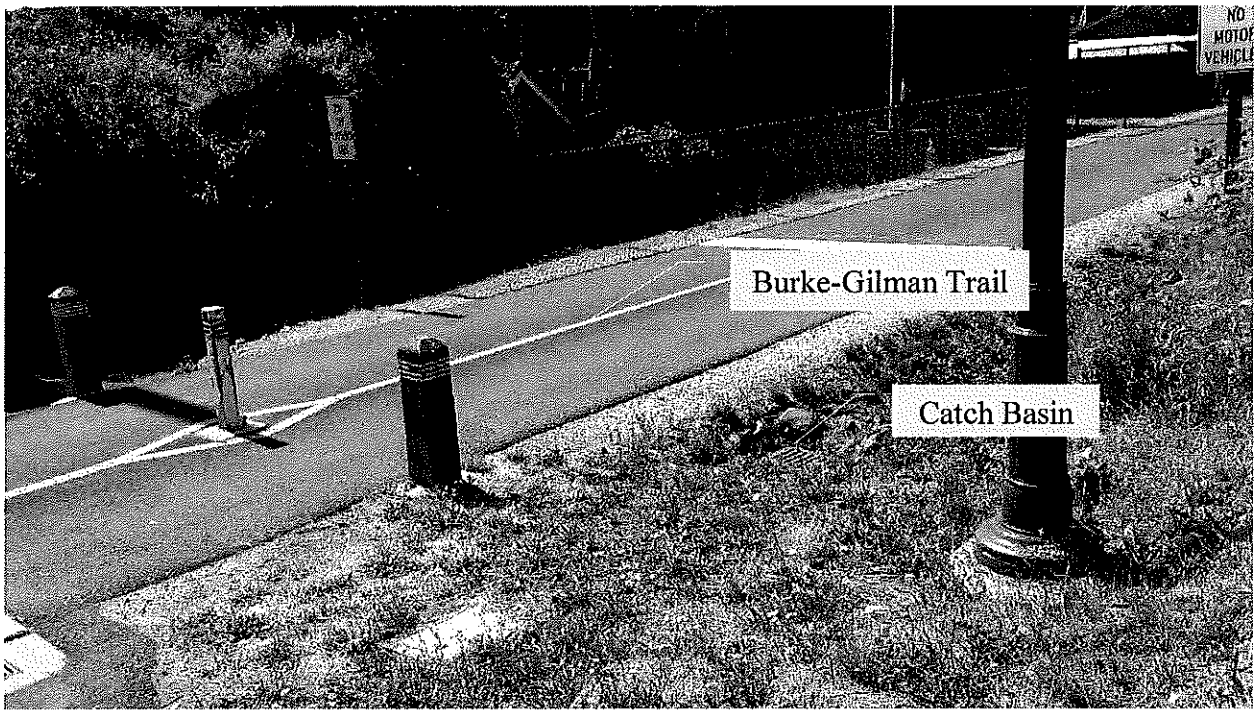


The outlet is hidden under overhanging vegetation and Lake Washington is on the left

Photo 8

Bsche'tla Creek near NE 153rd Street.

Photo 9



Bsche'tla Creek drains into the Catch Basin shown above via a 24" CMP pipe and drains east to Lake Washington via a 24" CMP pipe.

Photo 10

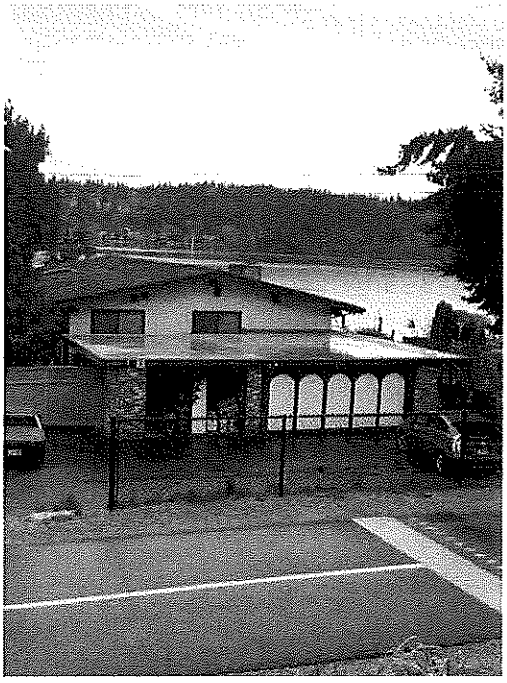


Photo 10 shows the house located at 15502 Beach Dr NE 98155 where an existing drainage problem exists. This drainage issue is along the flow path for NE 155th Street (Flow Path #1)

IV. FLOW CONTROL AND WATER QUALITY FACILITY ANALYSIS AND DESIGN

Existing Site Hydrology

Two existing wooden structures and an asphalt parking area currently exist on the property. The existing structures have rooftop downspouts which release stormwater directly onto the ground surface. Most of the runoff from the site currently flows to the southeast and eventually enters Bsche'tla Creek at the bottom of a steep slope. The rest of the runoff enters into a roadside ditch along NE 155th Street and is conveyed to Lake Washington by a series of existing culverts, ditches, and storm sewer.

Developed Site Hydrology and Performance Standards

The site storm drainage system has been designed according to the standards set forth by the 2009 King County Surface Water Design Manual 2009 (KCSWDM). The project proposes to develop a portion of the 0.70-acre parcel into a 14-unit condominium building. The building is proposed to consist of 3 floors of residential condominium units over one parking garage level with on-grade concrete slab. The proposed development will also include street frontage improvements including new sidewalk, landscaping and driveway entrances.

For conceptual drainage design, a KCRTS stormwater analysis was performed for sizing of the stormwater detention facility and a level 3 flow control standard was utilized to mitigate a downstream drainage issue. The level 3 flow control standard is the most stringent flow control standard shown in the King County Stormwater Design Manual and requires that the detention facility be designed by matching flow durations between 50 percent of the 2-year flow and the 50-year flows and matching the 100-year annual peak outflow to the predeveloped level. See attached Conceptual Drainage Site plan and KCRTS calculations.

Flow Control BMPs

A level 3 flow control detention facility will be constructed to provide the flow control for this project. Runoff from the rooftop area (0.21 ac.) will be conveyed to the detention vault which will discharge into the public storm drainage system via a water-tight storm sewer system. The release location is a proposed catch basin located on the south side of the NE 155th St which will connect to an existing storm sewer pipe.

Water Quality

This project will create less than 5,000 sq-ft of pollution generating surfaces (rooftop area); therefore, water quality BMP's are not required.

V. CONVEYANCE SYSTEM ANALYSIS AND DESIGN

The stormwater runoff from the roof will enter into multiple downspouts and piped to a level 3 flow control detention facility located beneath the building. Discharge from the detention facility into the public storm sewer system along NE 155th Street will have

minimal impact as the release rate from the level 3 flow control facility would be only 0.016 cfs during a 100-year storm event.

VI. SPECIAL REPORTS AND STUDIES

Geo Group Northwest, Inc. has provided a geotechnical engineering report and recommendations dated July 9th, 2015. The report also includes previous soil boring logs and soil study performed by Cascade Geotechnical, Inc. dated July 20, 1990. The investigation performed by Cascade Geotechnical, Inc. had utilized a rubber tire backhoe which did not excavate through the fill and into the native soils. Reviewing this report resulted in use of a boring machine to reach through to the native soils and the resulting recommendations are for auger-cast concrete pile installations to properly support the structure. Both Geotechnical reports are included in Appendix A.

VII. OTHER PERMITS

Building permits will be required.

VIII. TESC ANALYSIS AND DESIGN

The potential for erosion within the site will be mitigated by use of erosion control measures during clearing, grading, and site development activities. The BMP's will consist of a sediment pond with outlet riser, interceptor trench (sloped from the west to the east with integral check dams). The sediment pond will outlet into an existing ditch on the south side of NE 155th Street. The flow path down the street is the same as is shown in the downstream analysis.

Silt fences will be installed along the downhill perimeter (clearing limit) of the site to protect adjacent properties from the possibility of sediment-laden water. A rocked construction entrance will be installed at the entrance to the site to protect mud from entering the paved roadway. Due to the very constricted nature of this site (very little room for a contractor lay-down area), much of the initial site excavation will remove soils immediately to an approved disposal site.

Stockpiles and exposed disturbed areas will be covered to protect from erosion and sediment runoff. Erosion and sediment control will be continually monitored by a Certified Erosion and sediment control lead. We consider the erosion and sediment portion of this project to be continually upgraded as required.

IX. BOND QUANTITIES and DECLARATION of COVENANT

Will be provided with the final design.

X. OPERATION AND MAINTENANCE MANUAL

See Appendix B.

APPENDIX A

Geotechnical Engineering Report

GEOTECHNICAL ENGINEERING STUDY
PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

Project No. G-2239-1

Prepared for

Mr. Adam Lundberg
AML Construction & Development, LLC
12055 Lakeside Pl. NE
Seattle, Washington 98125

July 9, 2015

GEO GROUP NORTHWEST, INC.
13240 NE 20TH STREET, SUITE 10
BELLEVUE, WASHINGTON 98005
PHONE (425) 649-8757 / FAX (425) 649-8758

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists
& Environmental Scientists

July 9, 2015

G-2239-1

Mr. Adam Lundberg
AML Construction & Development, LLC
12055 Lakeside Pl. NE
Seattle, Washington 98125

Subject: Geotechnical Engineering Study
Proposed Residential Building
3803 NE 155th Street
Lake Forest Park, Washington

Dear Mr. Lundberg:

GEO Group Northwest, Inc. is pleased to present its geotechnical engineering study report for the above-subject property in Lake Forest Park, Washington. This geotechnical engineering report summarizes our activities and presents our findings and conclusions regarding the site conditions and geotechnical aspects of the proposed redevelopment of the site with a multi-story residential building.

Due to the presence of loose fills and soils to depths of up to approximately 27 feet below existing grades the site, we recommend that the proposed building be supported on a system of augered concrete piles with interconnected grade beams and structurally supported floors. Building support and other geotechnical issues are discussed in the enclosed report.

We appreciate this opportunity to provide you with geotechnical engineering services. Should you have any questions regarding this report or need additional consultation during the design and construction phases, please feel welcome to contact us.

13240 NE 20th Street, Suite 10 · Bellevue, Washington 98005
Phone 425/649-8757 · Fax 425/649-8758

Sincerely,

GEO Group Northwest, Inc.

William Chang

William Chang, P.E.
Principal

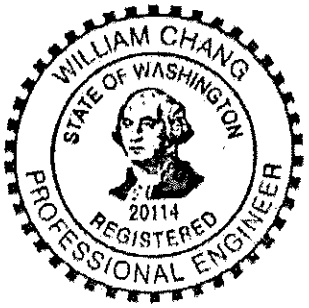


TABLE OF CONTENTS
Project No. G-2239-1

		Page
1	**INTRODUCTION**	1
2	**SCOPE OF SERVICES**	1
3	**SITE CONDITIONS**	1
3.1	Site Description	1
3.2	Adjacent Properties	2
3.3	Proposed Development	2
3.4	Geologic Overview	2
3.5	Environmentally Sensitive Areas Review	3
4	**SITE INVESTIGATION**	3
4.1	Subsurface Exploration by GEO Group Northwest	3
4.2	Previous Geotechnical Investigation by Others	5
4.3	Summary of Exploration Findings	6
5	**SITE SEISMICITY AND SOIL LIQUEFACTION EVALUATION**	7
4.1	Seismicity History	7
4.2	Site Seismic Design Classification	8
4.3	Soil Liquefaction Potential	8
6	**SITE STABILITY EVALUATION**	9
6.1	Previous Landsliding	9
6.2	Evaluation of Soil Stability	9
7	**CONCLUSIONS AND RECOMMENDATIONS**	11
7.1	Grading and Earthwork	12
7.2	Building Support	13
7.3	Excavation Support	15
7.4	Conventional Basement Walls and Retaining Walls	17
7.5	Underground Utilities	18
7.6	Site Drainage	19
7.7	Pavement Section Support and Design	19
8	**LIMITATIONS**	20

TABLE OF CONTENTS (cont.)
Project No. G-2239-1

		Page
9	**ADDITIONAL SERVICES**	20
10	**CLOSING**	21

PLATES

Plate 1 – Site Location Map
Plate 2 – Site Plan
Plate 3 – Geologic Map
Plate 4A – Profile A – A'
Plate 4B – Profile B – B'
Plate 5 – Lateral Earth Pressure Diagram
Plate 6 – Typical Shoring Wall Drainage
Plate 7 – Typical Basement Wall Drainage
Plate 8 – Typical Retaining Wall Drainage
Plate 9 – Typical Footing Drain

APPENDICES

Appendix A – Boring Logs
Appendix B – Previous Geotechnical Investigation and Test Pit Logs

GEOTECHNICAL ENGINEERING STUDY
PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

Project No. G-2239-1

1 INTRODUCTION

GEO Group Northwest, Inc. has completed a geotechnical engineering study of the property located at 3803 NE 155th Street in Lake Forest Park, Washington, and prepared this report of findings, conclusions, and recommendations. This study was completed for Mr. Adam Lundberg of AML Construction & Development, LLC, for a proposed redevelopment of the property with a multi-unit residential building having 5 or 6 stories.

2 SCOPE OF SERVICES

The scope of the work for this geotechnical engineering study consisted of the following tasks, as outlined in our proposal dated April 28, 2015:

- Performing a subsurface exploration of the site, consisting of drilling three soil borings in the proposed building location to supplement three borings that were drilled in 2006 for a previously proposed development of the site;

- Performing engineering evaluation and analysis regarding foundation design parameters, site grading (including structural fill specifications), soil liquefaction potential, and subgrade preparation of the site prior to construction; and

- Preparing this report of our findings, conclusions, and recommendations regarding geotechnical aspects of the proposed development of the site.

3 SITE CONDITIONS

3.1 SITE DESCRIPTION

The site is located on the south side of the 3800 block of NE 155th Street in a mixed small commercial and residential area of Lake Forest Park, Washington, as illustrated in Plate 1 - Site

Location Map. The site property consists of an irregular-shaped lot that comprises 0.7 acres of land. The north part of the site is occupied by a two-story residence that has been converted to an office and a by a detached garage west of the residence. An asphalt paved parking area is located east of the existing building. The area behind (south of) the existing buildings and parking lot is vacant land that is mostly covered with heavy-gauge black plastic sheeting. Vegetation mostly consisting of blackberry vines and knotweed has penetrated though the sheeting in several locations.

The site has a steep slope along its south and east sides. The slope faces toward the south and southeast and has a height typically ranging between approximately 40 and 50 feet. The slope has inclinations typically ranging up to approximately 80 percent grade. The site topography and existing features are illustrated in Plate 2 - Site Plan.

3.2 ADJACENT PROPERTIES

The adjacent property to the east (3829 NE 155th Street) is occupied by a single-family residence. This residence is located approximately 5 feet from the site boundary and has a floor elevation of approximately 139 feet.

A two-story apartment building is located on the adjacent property to the west. This building is located approximately 5 feet away from the site boundary and appears to have a floor elevation of about 152 or 154 feet.

3.3 PROPOSED DEVELOPMENT

We understand that the proposed development of the site is generally envisioned to involve the construction of a multi-unit residential building. The building is proposed to be located on the northern part of the site, as illustrated in Plate 2 – Site Plan. The building is proposed to have two floors of parking below five floors of residences. The bottom floor of the building will have an elevation of 140 feet. An exterior parking lot is proposed along the south side of the building.

3.4 GEOLOGIC OVERVIEW

According to the geologic literature for the vicinity of the project site, surficial soils at the site consist of Quaternary-age glacial deposits associated with the Vashon Stade of the Fraser

Glaciation and older non-glacial deposits[1]. In order of relative age, youngest to oldest, these deposits are identified as 1) Vashon glacial till, 2) Upper Clay, and 3) Unnamed Gravel. Mapped surface exposure of these units in the site vicinity is illustrated in Plate 3 - Geologic Map.

Vashon glacial till deposits (Qvt in the geologic map) typically consist of very dense, unsorted mixtures of silt, sand, gravel, and occasional cobbles which were deposited by and then overridden by the Puget Lobe glacier approximately 12,000 years ago. The silt and clay deposits of the Upper Clay unit (Qcu in the geologic map) typically consist of very dense layers of lacustrine (lake environment) sediments that were deposited before or during the early stages of the Vashon glacial advance. The Unnamed Gravel unit (Qg in the geologic map) consists of oxidized gravel and sand interpreted to have been deposited in an older non-glacial environment.

3.5 Environmentally Sensitive Areas Review

A review of the Environmentally Sensitive Areas map on the City of Lake Forest Park internet site indicates that the middle and southern portion of the site is located within an environmentally sensitive area. This area includes the steep slope on the southern part of the site. The sensitive area types which are present on the site include soil erosion (due to the presence of slopes with loose fills), and steep slope and landslide hazard areas (due to the presence of slopes steeper than 40 percent and higher than 10 feet).

4 SITE INVESTIGATION

4.1 Subsurface Exploration by GEO Group Northwest

A GEO Group Northwest, Inc. geologist supervised the drilling of three exploratory soil borings (B-1, B-2, and B-3) at the site on April 25, 2006, and an additional three borings (B-4, B-5, and B-6) on June 10, 2015. The boring locations are illustrated in Plate 2 – Site Plan. The boring locations were estimated by using a measuring tape and by visually estimating property line locations relative to existing features. The borings were terminated in dense, native soils at depths ranging between approximately 20 and 55 feet below the ground surface. Soil samples

[1] B.A. Liesch, et al., 1963, Geology and Ground-Water Resources of Northwestern King County, Washington. U.S. Geological Survey Water Supply Bulletin No. 20.

were collected from the borings and were tested for moisture content. Copies of the logs for the boring are provided in Appendix A.

Soil samples were collected during drilling by using a 2-inch outside-diameter split-spoon sampler. Standard Penetration Test (SPT) data was recorded while sampling by driving the sampling tube using a 140-pound hammer with a 30-inch drop. The soil samples were reviewed in our office to verify the field classifications, and moisture content testing of the samples was performed. The moisture content data are included on the boring logs.

The soils encountered in the borings typically consisted of a layer of loose fills underlain with a relatively thin layer of loose to medium dense soils (apparent old topsoil or alluvium), all underlain with medium dense to dense native soils. Boring B-6 was the only boring where the fills were limited to a thin layer of pavement base course. The fills typically consisted of heterogeneous mixtures of silty sand, sandy silt, and silt, commonly with trace or minor amounts of wood fragments and lesser fine organics. Substantial amounts of wood were encountered at a depth of about 12 feet in boring B-3 and at 27 to 30 feet in boring B-4. Fill thicknesses ranged between approximately 7 and 27 feet, with the greatest thicknesses (over 20 feet) found in borings B-1, B-3, and B-4.

The fills were observed to typically be underlain with relatively thin layer of loose to medium dense, wet, grayish brown sand, dark gray silty sand, and black sandy silt, commonly containing organics and mottling. These soils are interpreted to be variety of old topsoil, colluvium, and stream alluvium and muck.

Dense native soils that were encountered in the borings typically consisted of layers of fine-grained sand, silty sand, and silt. Depths to these soils ranged between approximately 27 and 40 feet, except at boring B-2 where the depth to dense soils was found to be approximately 15 feet. Occasional medium dense layers of fine sand were found within these soils in borings B-4, B-5, and B-6.

Groundwater was encountered in each of the borings except for B-2 at depths ranging between approximately 17 and 22 feet. No groundwater was encountered in boring B-2, but the soils at the bottom of the boring (at approximately 20 feet deep) were rather moist. The groundwater elevations typically ranged between approximately 122 and 126 feet, except in boring B-6 where is it was encountered at approximately 132 feet. The top of the groundwater commonly was

encountered a few feet above the base of the fills, but groundwater also was noted within many of the native soil layers.

4.2 PREVIOUS GEOTECHNICAL INVESTIGATION BY OTHERS

Cascade Geotechnical, Inc., in Kirkland, Washington, completed a preliminary subsurface soils investigation of the site in 1990. GEO Group Northwest, Inc., reviewed a copy of the report from this investigation, dated July 20, 1990, which was prepared for Norbrook Construction. A copy of the report is provided in Appendix B.

According to the report, four exploratory test pits were excavated on the site by using a backhoe. The test pits were completed to depths ranging between 11.5 and 17 feet below the ground surface. Approximate locations of these test pits, identified as TP1-1 through TP1-4, are illustrated in Plate 2 – Site Plan. The locations of these test pits are based solely on the information provided in the 1990 geotechnical report and have not been field-verified.

Subsurface soil conditions in the test pits were reported to consist of fills composed of loose silty sand and sandy silt with trace amounts of debris. The thicknesses of the fills were reported to range from 2.5 to 15 feet. Native soils under the fills consisted of medium dense or dense silty sand and silt in test pits TP1-2 and TP1-4. In test pit TP1-1, the encountered native soils consisted of very stiff silty clay and very dense sandy silt. In test pit TP1-3, the encountered native soils consisted of soft to medium stiff clay and silt to the bottom of the test pit at 17 feet.

A site sketch and a written log that documented the excavation of an additional four test pits on the northeast part of the site in 1996 was appended to the 1990 report. These four test pits were excavated to depths ranging between 4.5 and 21 feet below the ground surface, and the approximate locations of these test pits, identified as TP2-1 through TP2-4, as indicated in the sketch are noted in Plate 2 – Site Plan. The locations of these test pits have not been field-verified.

The fills encountered in these test pits were reported to have thicknesses ranging between 2.5 and 18 feet and to have consisted of loose mixtures of silt, sand, and gravel, occasionally with organic matter and pea gravel. Relatively dense native soils reportedly encountered in test pits TP2-2, TP2-3, and TP2-4 at depths of about 2.5, 18, and 5 feet, respectively, consisted of silty gravelly sand (TP2-2) or sand and silty sand(TP2-3 and TP2-4). Dense native soils were not reported to be encountered in test pit TP2-1 which was terminated at a depth of 16.5 feet.

Groundwater seepage was reported encountered at a depth of 16 feet (two feet above the base of the fill) in test pit TP2-3. Groundwater is not noted in the logs for the other test pits.

4.3 SUMMARY OF EXPLORATION FINDINGS

Based on the findings from the test pits and soil borings, the thickness of the fills and loose to medium dense native soils varies by up to 23 feet across the northern part of the site (i.e., from 4 feet at test pit TP1-1 to 27 feet at boring B-4).

A summary of the exploration elevations, fill thickness and dense soil elevations for the test pits and borings is presented in the table below. This information was used to create two cross sections to interpret and illustrate the subsurface conditions of the site. These cross sections are presented in Plate 4A – Profile A-A' and Plate 4B – Profile B-B'. Soil and groundwater conditions depicted beyond the exploration locations in the sections are inferred and may vary from those shown.

SUMMARY OF SUBSURFACE EXPLORATION DATA

Exploration ID	Surface Elevation	Fill Thickness	Depth to Dense Soil	Elevation of Top of Dense Soil	Elevation of Bottom of Boring/ Test Pit	Depth to Groundwater	Groundwater Elevation
Borings							
B-1	143	20	30	113	106.5	17	126
B-2	147	7	15	132	125.5	NE	NE
B-3	145	22	27	118	108.5	20	125
B-4	141	27	40	101	84.5	19	122
B-5	142	8	30	2	95.5	18	124
B-6	154	< 2.5	30	124	112.5	22	132

Notes: All data are in units of feet. NE = Not encountered.

SUMMARY OF SUBSURFACE EXPLORATION DATA (CONT'D)

Exploration ID	Surface Elevation	Fill Thickness	Depth to Dense Soil	Elevation of Top of Dense Soil	Elevation of Bottom of Boring/ Test Pit	Depth to Groundwater	Groundwater Elevation
Test Pits							
TP1-1	149.5	2.5	4	140	138	NE	NE
TP1-2	149	8	10.5	137.5	136.5	NE	NE
TP1-3	143	15	NE (>17)	NE (<126)	126	NE	NE
TP1-4	143	8.5	NE (>14)	NE (<129)	129	NE	NE
TP2-1	136	16.5	NE (>16.5)	NE (<119.5)	119.5	NE	NE
TP2-2	142	2.5	4.5	137.5	137.5	NE	NE
TP2-3	138	18	18	120	117	16	122
TP2-4	142	5	6.5	135.5	135.5	NE	NE

Notes: All data are in units of feet. NE = Not encountered.

The native soils encountered in borings B-1, B-2, B-3, B-4, and B-5 are generally similar to the Upper Clay deposits described in the referenced geologic literature, but also commonly contain some fine-grained sandy layers. The soils encountered in boring B-6 at the northwest corner (and highest portion) of the site are interpreted to be similar to weathered glacial till soils to a depth of about 10 feet overlying other older Vashon-age glacial deposits that are generally sandy but contain appreciable silty layers. Soils with the characteristics described for the Unnamed Gravel deposit do not appear to have been encountered in the borings.

5 SITE SEISMICITY AND SOIL LIQUEFACTION EVALUATION

5.1 SEISMICITY HISTORY

The greater Puget Sound region has experienced a number of small to moderate earthquakes and occasionally strong shocks during the period of historical record in the Pacific Northwest.

Historical records for the region indicate that the Olympia earthquake of April 13, 1949, with a Richter magnitude of 7.1, produced ground-shaking of intensity VIII on the Modified Mercalli Scale near its epicenter; and the Seattle-Tacoma earthquake of April 29, 1965, with a Richter magnitude of 6.5, produced a ground-shaking of intensity IV to VIII near its epicenter. More recently, the Nisqually earthquake of February 28, 2001, with a Richter magnitude of 6.8, produced ground shaking at intensities up to VIII near its epicenter and at scattered locations in King County, including the Duwamish River valley area of Kent. These levels of ground-shaking are estimated to be the maximum that have occurred in the local region during the period of historic record keeping that goes back to approximately the 1850s.

5.2 Site Seismic Design Classification

Per the 2012 edition of the International Building Code (IBC), the project site meets Site Class E (Soft Soil Profile), as outlined in Section 1613 in the code. This site class determination is based on the observed presence of a thickness of more than 10 feet of loose or soft soils and fills that have apparent shear strengths of less than 500 pounds per square foot (psf).

5.3 Soil Liquefaction Potential

Liquefaction is a phenomenon where soil below the water table temporarily loses strength and behaves as a liquid due to strong shaking, such as from earthquakes. The results of soil liquefaction can include ground settlement, sand boils, and lateral soil spreading. Loose, saturated, medium- to fine-grained sands are the soil types which typically are most susceptible to liquefaction.

Soils encountered in boring B-1 at depths of approximately 20 to 25 feet and in boring B-4 at a depth of approximately 30 feet consisted of saturated, loose to medium dense, fine-grained sand and slightly silty sand. The thicknesses of these layers were found to be less than 5 feet. Other loose, saturated soils encountered in the borings typically consisted of silty sand with appreciable proportions of fines and are expected to have low susceptibility to liquefaction.

Based on the soil conditions found in the borings drilled for this study, we conclude that the site has a low susceptibility to liquefaction from seismic shaking of the intensity, duration, and location which have characterized past events in the region. If future events of greater severity at the site occur, however, the susceptibility of these soils to liquefaction may be higher. The risk of potential damage to the proposed redevelopment due to soil liquefaction can be mitigated by

supporting the building on a deep foundation system that is embedded into dense, native soils which are not susceptible to seismically-induced liquefaction.

6 SITE STABILITY EVALUATION

6.1 RECORD OF PREVIOUS LANDSLIDING

During our subsurface investigation work in 2006, we were told by the occupant of the existing buildings that a landslide had occurred on the steep slope on the site about 15 years ago. The black plastic sheeting that covers much of the southern part of the site was placed following the landslide, and the sheeting also covered part of the steep slope. The landslide apparently was located on or in proximity to the eastern edge of the project site, and abutted the adjacent residence to the east. During our subsurface investigation work on site in 2015, neighboring residents told us that a landslide had occurred on the steep slope many years ago. The extent of the landslide reportedly reached the south side of the house on the adjacent property to the east. Details about the date, extent, or cause of the landslide have not been provided to us.

During our visits to the site we have observed no evidence of recent, fresh landslides. However, much of the eastern and southern portions of the site have been obscured by thick overgrown vegetation, and much of the ground surface has been covered with black plastic sheeting. Some apparent cracks were observed on the ground surface between the locations of borings B-4 and B-5 during our exploration work in 2015.

6.2 EVALUATION OF SOIL STABILITY

Based on 1) the findings from our subsurface investigation, 2) the local geologic conditions reported in the literature we reviewed, 3) the findings reported in the previous soil investigation report for the site by Cascade Geotechnical, 4) the surface conditions as depicted in the topographic survey for the site, and 5) the anecdotal information we received about a past landslide on site, we have developed the following comments and conclusions.

- The eastern and southern portions of the site are marginally stable in their present condition, in our opinion. This is due to multiple factors, chiefly that 1) the fills are loose and are thick in proximity to the slope, the slope inclination approaches the typical angle of repose for relatively loose soils (independent of the effects of rooted vegetation,

surface hardening/compacting, and the like), and the base of the fills and underlying loose soil zone are wet.

- The northern portion of the site in the vicinity of the existing buildings appears to be relatively stable, in our opinion. These soils have higher densities, the extent of the loose fills is less, and slope conditions are much gentler.

- In our opinion, the proposed building can be constructed in a manner that will not adversely affect the stability of the site or of the adjacent property to the east provided that it is supported on a pile and structural beam foundation system. Resistance of lateral forces against pile caps and grade beams can be provided by compacting the existing subgrade soils to a firm condition.

- In addition to compacting the subgrade below the proposed building, we also recommend that the fills beyond the south and east limits of the proposed building be improved by compacting them to a firm condition. This improvement to the exterior fills will supplement the building's resistance against lateral forces and will improve the stability of the fills and slope.

- It should be understood that post-construction settlement of the fills can be expected. Compaction of the surficial portion of the fills likely will reduce the magnitude of such settlement but will not eliminate it. This settlement may result in visible settlement of structures and pavements which are supported on these materials.

- We understand that the proposed office building will be located at least 40 feet away from the top of the steep slope (25 feet steep slope buffer plus 15 feet building setback). In our opinion, this proposed distance of the proposed building from the top of the steep slope is sufficient to avoid adverse impact to the slope and the proposed building, provided that the development is designed and constructed in conformance with the recommendations in this report.

- We understand that a parking lot may be planned next to the south side of the proposed building and may abut the top of the steep slope. We understand that the parking lot will not extend into the 25 feet wide steep slope buffer. In our opinion, the proposed parking lot will be susceptible to gradual settlement if it will rely on the underlying subgrade for support, due to the presence of loose fills across much of the area. The degree of

potential settlement can be reduced by compacting the subgrade below the parking lot, or by constructing it as a structurally supported concrete slab on augered concrete piles that are embedded in the deeper dense native soils, or both.

- The site has a potential for significant soil erosion due to the loose condition of the fills and steepness of the slope area. Stormwater generated during construction should be controlled so that it does not accumulate in proximity to the steep slope or flow onto the steep slope. Post-construction stormwater also should be controlled to avoid its accumulation near the steep slope or flow onto the slope, and preferably should be tightlined to the local stormwater utility system.

7 CONCLUSIONS AND RECOMMENDATIONS

Based on the results from our subsurface investigation, it is our opinion that the main geotechnical issues to be considered for the proposed development include building support, site stability, excavations and slopes, excavation support, basement and retaining walls, and subsurface drainage.

The presence of loose fills with thicknesses of up to about 27 feet and the saturated condition of the lower portion of these fills and of the underlying soils lead us to recommend that a pile foundation system be used to support the proposed building. In our opinion, the preferred piling alternative for the project is auger-cast concrete piles that are embedded into the dense native soils. We anticipate that installing piles by using 'open-hole' methods may encounter difficulties at maintaining open boreholes and with groundwater accumulation in the boreholes. We anticipate that similar difficulties would be encountered with installing aggregate piers at the site.

In our opinion, the steep slope on site appears to be marginally stable based on the loose condition of the fills, the steepness of the slope, and the presence of saturated soils and fills at the bottom of the fill section. Improvement to the stability of the site can be achieved by compacting the surface of the loose fills below the proposed building location and beyond the building toward the top of the steep slope.

Our recommendations regarding these and other geotechnically-related aspects of the proposed site development are presented in the following sections of this report.

7.1 GRADING AND EARTHWORK

7.1.1 Site Clearing and Grubbing

The construction area should be cleared and grubbed of vegetation, organics, debris, and other deleterious materials if present. Silt fencing should be installed around areas to be disturbed by construction activity to prevent sediment being carried off site.

7.1.2 Excavations and Slopes

We recommend that temporary excavation slopes not exceed the limits specified in local, state and federal government safety regulations. We recommend that temporary cuts greater than 4 feet in height be sloped at an inclination no steeper than 1.5H:1V (Horizontal:Vertical) in the fills due to their variable and uncontrolled composition, and to no steeper than 1H:1V in the native soils. If groundwater seepage is encountered during excavation, the excavation work should be halted, and the stability of the excavation and issues regarding slope stability and potential need for engineered support should be evaluated on site by the geotechnical engineer. We recommend that permanent slopes be graded to no steeper than 3H:1V.

7.1.3 Subgrade Preparation

Loose fills were encountered during the exploration work we performed on the site. These fills typically consisted of loose silty sand and silt with occasional wood debris. These soils are susceptible to deep rutting and pumping from construction traffic during wet weather conditions. Therefore, we recommend that the subgrade be stabilized by compacting it to a firm condition by using a full-size vibratory roller at the start of construction. A layer of clean crushed rock also can be placed over the subgrade for additional protection to the subgrade due to construction activity.

7.1.4 Structural Fill

Fills placed to achieve design site elevations below building, pavement, patio, or sidewalk areas should meet the requirements for structural fill in situations where the fills will provide support to these improvements.

The on-site soils have moisture contents and in some instances also have relatively high silt contents. For these reasons, these soils are unlikely to be suitable for use as structural fill. We recommend that an imported granular soil or aggregate material be used as structural fill; this material should have a moisture content that is at or near its optimum value for attaining compaction density requirements. This material should be free of organic or other deleterious substances and should contain no particles larger than three inches in diameter. During wet weather, however, we recommend that this material not contain more than 5 percent fines (silt and clay-size particles passing the No. 200 mesh sieve), so that it can more readily be compacted to the required standards.

Structural fill material should be placed at or near its optimum moisture content. The optimum moisture content is the water content in soil that enables the soil to be compacted to the highest dry density for a given compaction effort.

Structural fill should be placed in horizontal lifts no greater than 10 inches in loose thickness. Structural fill under parking lots, driveways, patios and sidewalks should be compacted to at least 90 percent of maximum density, with the exception of the upper 12 inches. The top 12 inches should be compacted to at least 95 percent maximum dry density, as determined by ASTM Test Designation D-1557-91 (Modified Proctor).

We recommend that GEO Group Northwest, Inc. be retained to 1) evaluate the suitability of material that is proposed for use as structural fill, and 2) to monitor the placement and compaction of structural fill for quality assurance of the earthwork.

7.2 BUILDING SUPPORT

The proposed building can be supported on auger-cast concrete piles that penetrate through the fills and loose to medium dense soils and are embedded into the underlying native, dense soils. We recommend that the piles have a minimum diameter of 18 inches and a minimum embedment of 20 feet into the native, dense soils. Allowable bearing capacities for a selection of pile sizes and embedment lengths are presented in the table

Allowable Axial Pile Capacities

Pile Diameter (inches)	Pile Embedment (feet)	Allowable Capacity (tons)	Uplift Capacity (tons)
18	20	45	22
18	25	58	29
18	30	73	36
24	20	75	37
24	25	98	49
24	30	121	60
30	20	115	57
30	25	148	74
30	30	182	91
36	20	163	81
36	25	208	104
36	30	256	128

A safety factor of 3.0 is included in the tabulated capacities. The capacities were calculated based on the soil conditions encountered in the soil borings completed for this study. These capacities are based on skin friction and end bearing resistance in the medium dense to dense soils that were found below depths of approximately 30 to 40 feet. Negative skin friction resistance (also referred to as "down-drag") associated with potential settlement of the upper loose fills and soils are not anticipated to significantly affect the pile capacities, as these materials have low relative densities and minimal cohesiveness that would generate down-drag.

No reduction in pile capacity is required if the pile spacing is at least three times the pile diameter. A one-third increase in the above allowable pile capacities can be used when considering short-term transitory wind or seismic loads. We estimate that the maximum total post-construction settlement should be one-quarter (1/4) inch or less, and the differential settlement across building width should be one-quarter (1/4) inch or less.

Lateral forces against the foundation system can be resisted by passive earth pressure and friction of an improved subgrade against the pile caps and grade beams. The subgrade should be improved by thoroughly compacting it to a firm condition. The improved subgrade can be assigned a passive soil pressure of 250 pcf (pounds per cubic foot) equivalent fluid weight. A

coefficient of friction of 0.35 may be used between the improved subgrade and the foundation elements. Alternatively, lateral forces can be resisted by using battered augered piles or inclined helical anchors.

The performance of piles depends on how and into what bearing stratum the piles are installed. It is critical that judgment and experience be used as a basis for determining the embedment length and acceptability of a pile. Therefore, we recommend that GEO Group Northwest, Inc. be retained to monitor the pile installation operation, collect and interpret installation data, and verify suitable bearing stratum. We also suggest that the contractor's equipment and installation procedure be reviewed by GEO Group Northwest, Inc. prior to pile installation to help mitigate problems which may delay work progress.

7.3 EXCAVATION SUPPORT

We understand that construction of the proposed building will require temporary excavation reaching depths of up to approximately 9 to 15 feet in depth in proximity to the north and west property lines, and will therefore require shoring. Cantilever soldier pile shoring with timber lagging can be used to support portions of the excavation where open cut slopes are not feasible.

Active Earth Pressures

We recommend that the cantilever soldier pile and lagging shoring for level backslope conditions be designed to resist an active pressure distribution of 35 pounds per cubic foot (pcf). The active soil pressure should be considered to act on a width of one pile-spacing above the excavation line and of one pile-diameter below the excavation line.

Backslope Considerations

Backslopes which extend a height approximately equal to or greater than the excavation height should be considered as "infinite" slopes for purposes of engineering design. For "infinite" backslopes of approximately 1H:1V, an active pressure of 50 pcf should be used for design.

Smaller backslopes that have inclinations of approximately 1H:1V, however, can be considered as surcharge loads having a value equivalent to the soil weight of one-half the height of the backslope using a unit weight of 125 pounds per square foot (psf). For example, a 4-feet high backslope can be considered equivalent to a surcharge load of 250 psf.

Other Surcharge Pressure

We recommend that surcharge pressure associated with construction equipment operating in proximity to the shoring be accounted for in the shoring design as equivalent to an additional 2 feet of soil height against the shoring.

Seismic Earth Pressure

If the shoring is to provide permanent support, a rectangular pressure of 8H pounds per square foot (psf), where H is the wall height in feet, should be added to active pressure distribution account for seismic pressure on the wall.

Passive Earth Pressure

The shoring can be designed using a passive soil pressure of 350 pcf, equivalent fluid weight. The passive pressure zone should start at one foot below the lowest level of excavation or soil disturbance. The passive pressure can be considered to act on a width of one pile-spacing or two pile-diameters, whichever is less. Mobilization of the full passive pressure assumes that the grade in front of the wall relatively level for a distance of four times the pile embedment. These recommended pressures apply to drained soil conditions.

The distribution of the above-described earth pressures acting on the shoring wall is schematically illustrated in Plate 5 - Lateral Earth Pressure Diagram.

Wall Lagging

Due to soil arching effects in the soil, timber lagging for the shoring system can consist of either pressure-treated or untreated lumber designed to resist 50 percent of the apparent lateral soil pressure for pile spacing up to four times the pile diameter. In order for this soil arching effect to occur, the pile holes should be backfilled with grout approximately to soil grade behind the wall.

Excavation work to install the lagging should be performed in lifts approximately 4 to 5 feet in depth, or to less depth as appropriate to avoid significant sloughing of soils from beyond the property line. Void areas behind the lagging should be backfilled with a granular material that contains no more than five percent fines (i.e., material passing a U.S. #200 sieve).

Performance Monitoring

Select points on off-site structures, driveways, or sidewalks located in proximity to the shoring should be surveyed or documented before the start of construction to record their baseline conditions. Existing cracks, sags, or other damage to the adjacent buildings, retaining walls, pavements, and sidewalks also should be documented prior to the start of construction.

The off-site points and selected points along the top of the shoring should then be monitored for movement (vertical and horizontal) following construction. We recommend that every other pile along the shoring wall be monitored. The points should be surveyed on a weekly basis and the information provided to the geotechnical engineer and the structural engineer for review until the shoring has been structurally restrained or has been backfilled.

7.4 Conventional Basement Walls and Retaining Walls

The following recommendations regarding conventional concrete basement walls and non-basement retaining walls are provided for use if these features are planned to be included in development of the site. These recommendations apply only to fully-drained wall systems. If hydrostatic pressures may be exerted on such walls, due to groundwater or other periodic or occasional un-drained conditions, these recommendations should be re-evaluated to incorporate the added hydrostatic pressures. Similarly, if other nearby structures may impose surcharge loads against such walls, these recommendations should be re-evaluated to address those factors.

Retaining walls which are restrained horizontally on top (such as basement walls) are considered unyielding and should be designed for a lateral soil pressure under the at-rest condition. Retaining walls which are free to rotate on top by 0.002 times their height or more should be designed for a lateral soil pressure under the active condition.

Active Earth Pressure: 35pcf (equivalent fluid pressure), for level ground behind the wall;

At-Rest Earth Pressure: 45pcf (equivalent fluid pressure), for level ground behind the wall;

Passive Earth Pressure: 175 pcf (as equivalent fluid pressure) for unimproved soil; 350 pcf for compacted granular fill having a depth of at least 3 feet below and horizontal distance of 10 feet beyond the edge of the wall footing;

Seismic Loading Pressure: 8H psf, where H is the height of the wall in feet;

Base Coefficient of Friction: 0.35 for compacted granular fill or competent soil

To prevent buildup of hydrostatic pressure behind conventional concrete basement or retaining walls, we recommend that a vertical drain mat be used to facilitate drainage behind the walls. The drain mat core should be placed against the wall with the filter fabric side of the mat facing toward the backfill. The drain mat should extend from near the finished surface grade down to the base of the wall, where it should be directed to discharge to a drainage system to be conveyed to an appropriate discharge facility. For long-term drainage ability, a prism at least 18 inches wide of free draining backfill material also should be placed against the wall after the drain mat has been installed. The free-draining backfill should extend downward to the base of the drain mat. We also recommend that a waterproofing layer be applied to basement and retaining walls to prevent moisture intrusion through the wall.

The top 12 inches of backfill behind retaining or basement walls should consist of compacted and relatively impermeable soil. This cap material can be separated from the underlying more granular drainage material by a geotextile fabric, if desired. Alternatively, the surface can be sealed with asphalt or concrete paving. The ground surface should be sloped to drain away from the wall.

GEO Group Northwest, Inc. recommends that backfill material which will support structures or improvements (such as patios, sidewalks, driveways, etc.) behind permanent concrete retaining walls and basement walls be placed and compacted consistent with the structural fill recommendations presented in this report.

7.5 Underground Utilities

Underground utilities that are installed in the loose fills at the site should be supported on a layer of at least 6 to 12 inches of granular bedding material to provide support to rigid conduits. It may be necessary to line the bottom portion of the utility trench with geotextile fabric to confine

the bedding material if conditions are particularly soft. We recommend that a granular material that requires minimal compaction effort to achieve a supporting condition be used for backfill.

7.6 SITE DRAINAGE

7.6.1 Surface Water Drainage during and after Construction

Water should not be allowed to stand in areas where foundations, slabs or pavements are to be constructed. During wet weather, these areas should be protected when idle by compacting the surface or covering the surface with plastic sheeting and directing the water away from the areas. Final site grades should direct drainage away from the building.

7.6.2 Subsurface and Roof Drain Lines

Roof downspout drain lines should be tightlined separately from subsurface drainage systems (such as retaining wall, basement wall, or foundation drainage systems) to their point of discharge into a storm water handling system. We recommend that sufficient cleanouts be installed at strategic locations to allow for periodic maintenance of the roof downspout drainage system.

7.7 PAVEMENT SECTION SUPPORT AND DESIGN

We recommend that parking and driveway areas on site be supported on a layer of structural fill that is at least 12 inches in thickness. We recommend that fill be underlain with a layer of durable woven geotextile fabric, such as Mirafi 500X or similar so that separation of the fill from the underlying soils is maintained. The acceptability of the structural fill layer should be checked by performing a proof-rolling of the surface by using a fully loaded dump truck or other heavy construction vehicle. If areas of soft or unstable subgrade soils are discovered during proof-rolling, they should be excavated and replaced with structural fill or crushed rock.

We recommend that parking and driveway areas on site have a pavement section that consists of at least 3 inches of asphalt over 6 inches of crushed rock base course above the structural fill layer.

8 LIMITATIONS

This report has been prepared for the specific application to this site for the exclusive use of Mr. Adam Lundberg, AML Construction & Development, LLC, and his authorized representatives or agents. We recommend that this report be included in its entirety in the project contract documents for the information of project designers and contractors.

Our findings and recommendations stated herein are based on the field observations, our experience and judgment. The recommendations are our professional opinion derived in a manner consistent with the level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area and within the budget constraints. No warranty is expressed or implied. In the event soil conditions vary from those described herein, during site excavation or construction, GEO Group Northwest, Inc. should be notified, and the above recommendations should be reviewed and, where appropriate, be revised.

9 ADDITIONAL SERVICES

We recommend the GEO Group Northwest, Inc. be retained to perform a general review of the final design and specifications of the proposed development to verify that the earthwork and foundation recommendations have been properly interpreted and implemented in the project documents. We also recommend that GEO Group Northwest, Inc. be retained to provide monitoring and testing service for geotechnically-related work during construction. Work that should be monitored or verified by the geotechnical engineer typically includes the following:

- Preparation of soil subgrade in building and pavement areas;
- Structural fill selection, placement, and compaction;
- Placement and compaction of utility trench backfill

The purposes of this monitoring are to comply with construction permit requirements, where applicable, and to provide independent quality control engineering services. Construction monitoring services also can involve reviewing unanticipated conditions and providing consultation and recommendations that may involve changes to project design or methods.

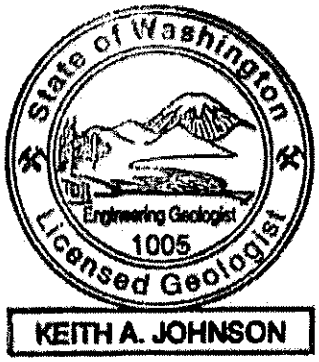
10 CLOSING

We appreciate this opportunity to provide you with geotechnical engineering services. Please feel welcome to contact us if you have any questions regarding this report or need additional consultation.

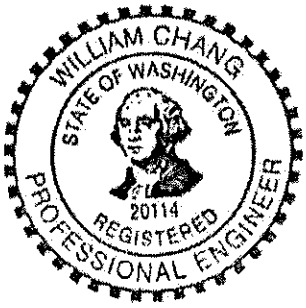
Sincerely,

GEO GROUP NORTHWEST, INC.

Keith Johnson
Project Geologist

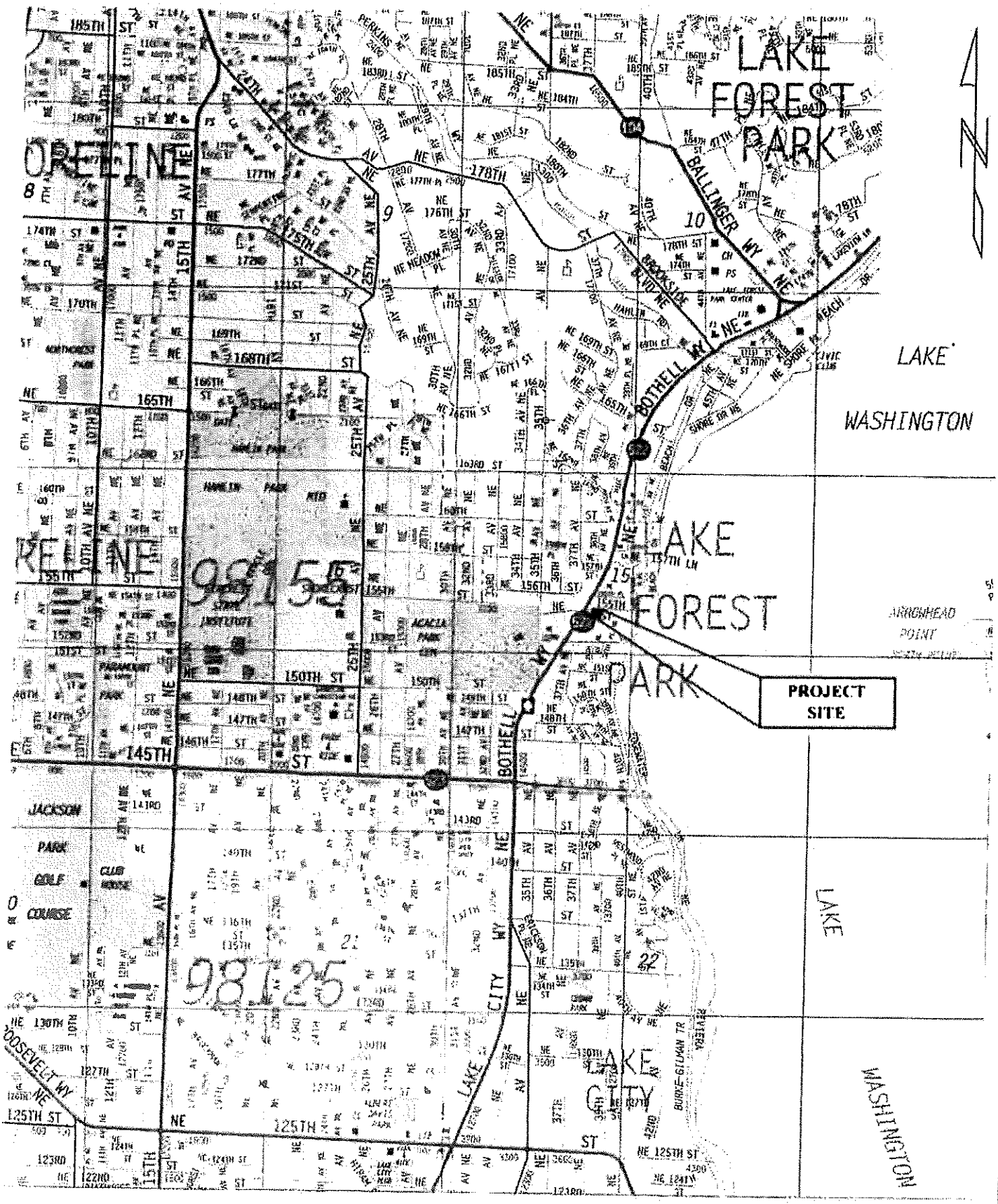


William Chang, P.E.
Principal



PLATES

G-2239-1



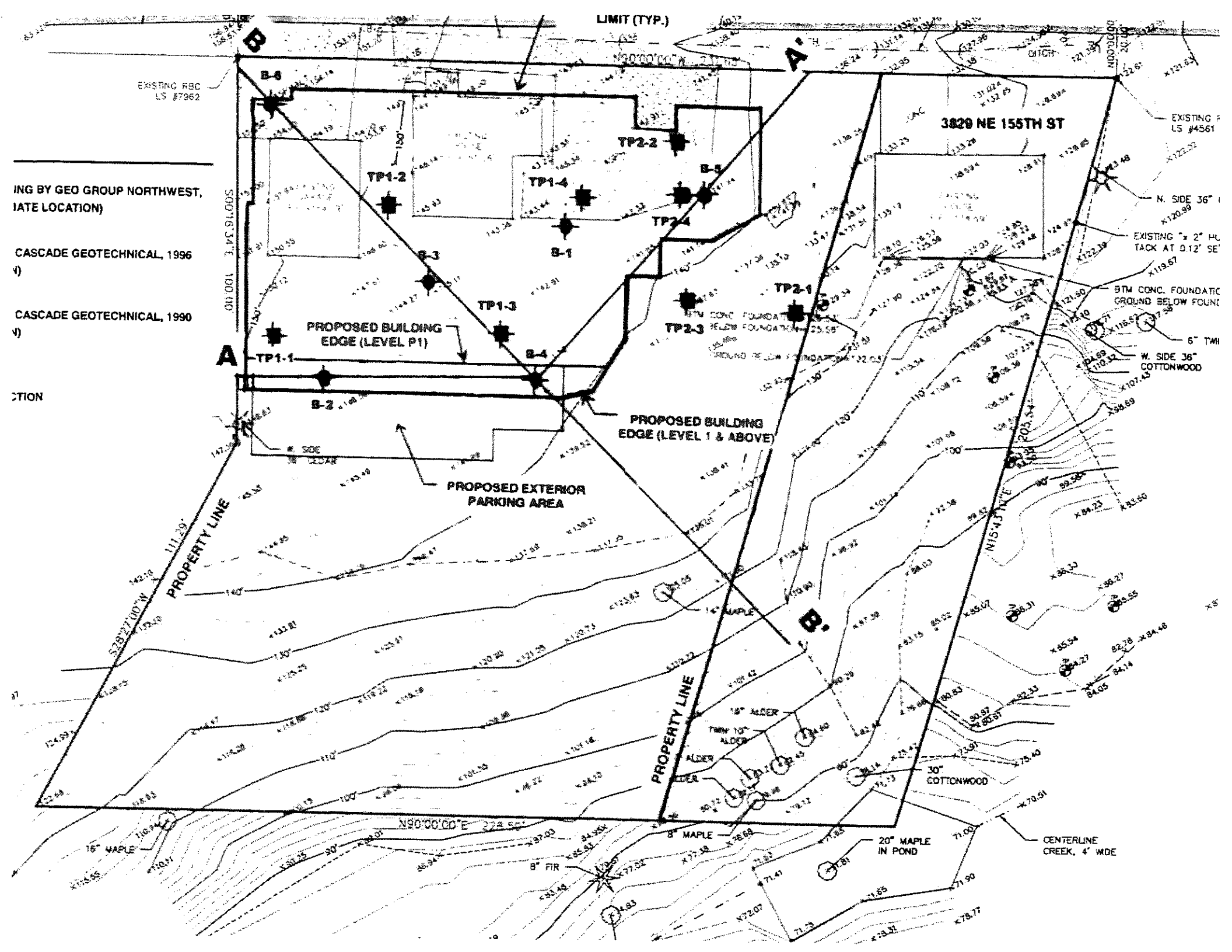
GEO Group Northwest, Inc.

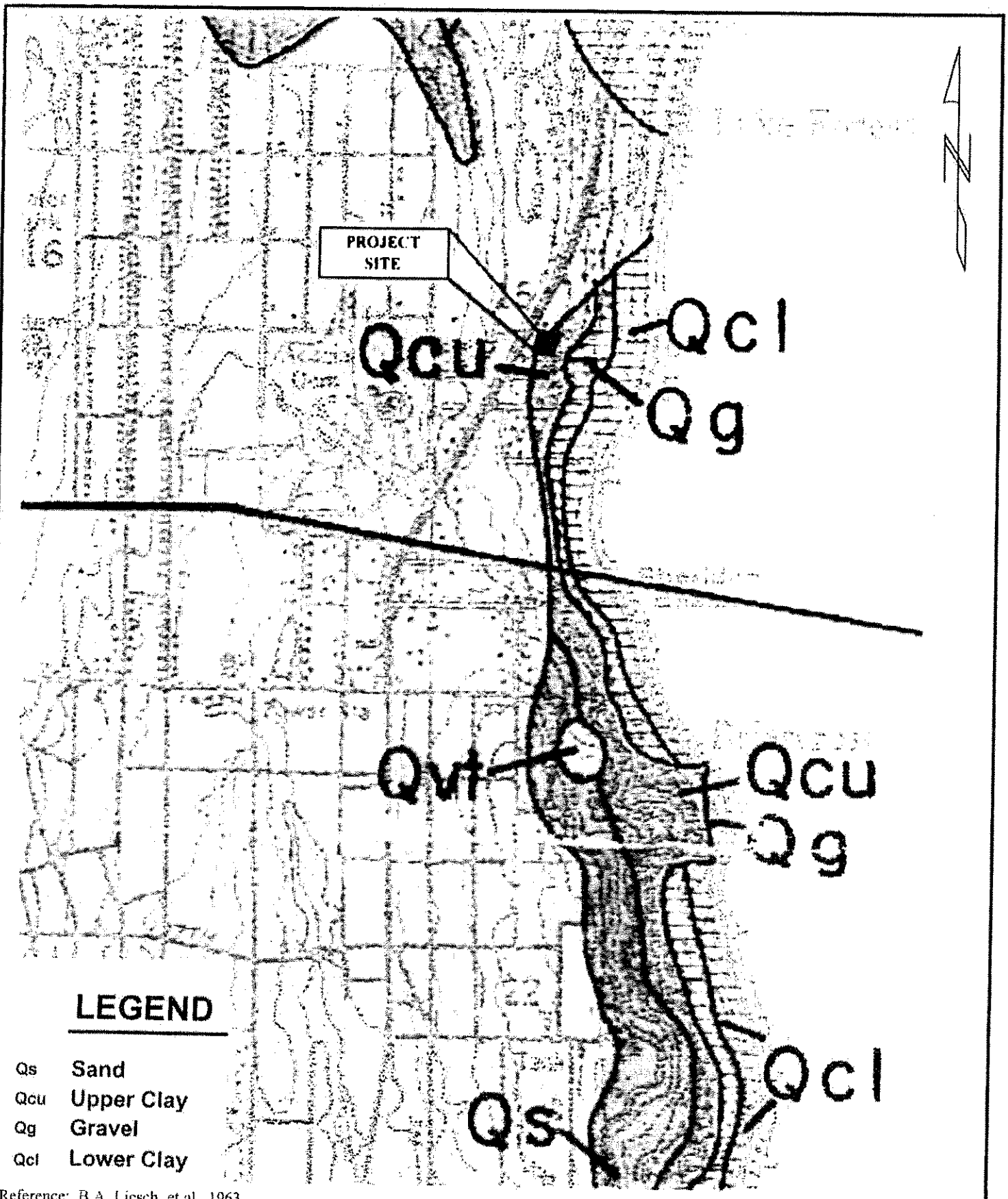
Geotechnical Engineers, Geologists, & Environmental Scientists

SITE LOCATION MAP

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

SCALE:	1" = 2000'	DATE:	5/1/06	MADE:	KJ	CHKD:	WC	JOB NO:	G-2239	PLATE	1


LIMIT (TYP.)
B
A'
B-6
EXISTING RBC
LS #7962
3829 NE 155TH ST
EXISTING
LS #4561
TP2-2
TP1-2
TP1-4
B-5
TP2-4
B-3
B-1
TP2-1
TP1-3
PROPOSED BUILDING
EDGE (LEVEL P1)
TP2-3
A
TP1-1
B-4
B-2
PROPOSED BUILDING
EDGE (LEVEL 1 & ABOVE)
PROPOSED EXTERIOR
PARKING AREA
PROPERTY LINE
PROPERTY LINE
B'
N. SIDE 36"
EXISTING
TACK AT 0.12' SE
BTM CONC. FOUNDATIC
GROUND BELOW FOUND
5" TWI
W. SIDE 36"
COTTONWOOD
14" MAPLE
18" ALDER
TWIN 10"
ALDER
ALDER
ALDER
30"
COTTONWOOD
16" MAPLE
8" FIR
8" MAPLE
20" MAPLE
IN POND
CENTERLINE
CREEK, 4' WIDE
DITCH
N90°00'00"E 328.50'
S38°27'00"W
111.29'
S89°16'34"E
100.00'
N15°43'51"E
205.34'
ING BY GEO GROUP NORTHWEST,
IATE LOCATION)
CASCADE GEOTECHNICAL, 1996
CASCADE GEOTECHNICAL, 1990
CTION



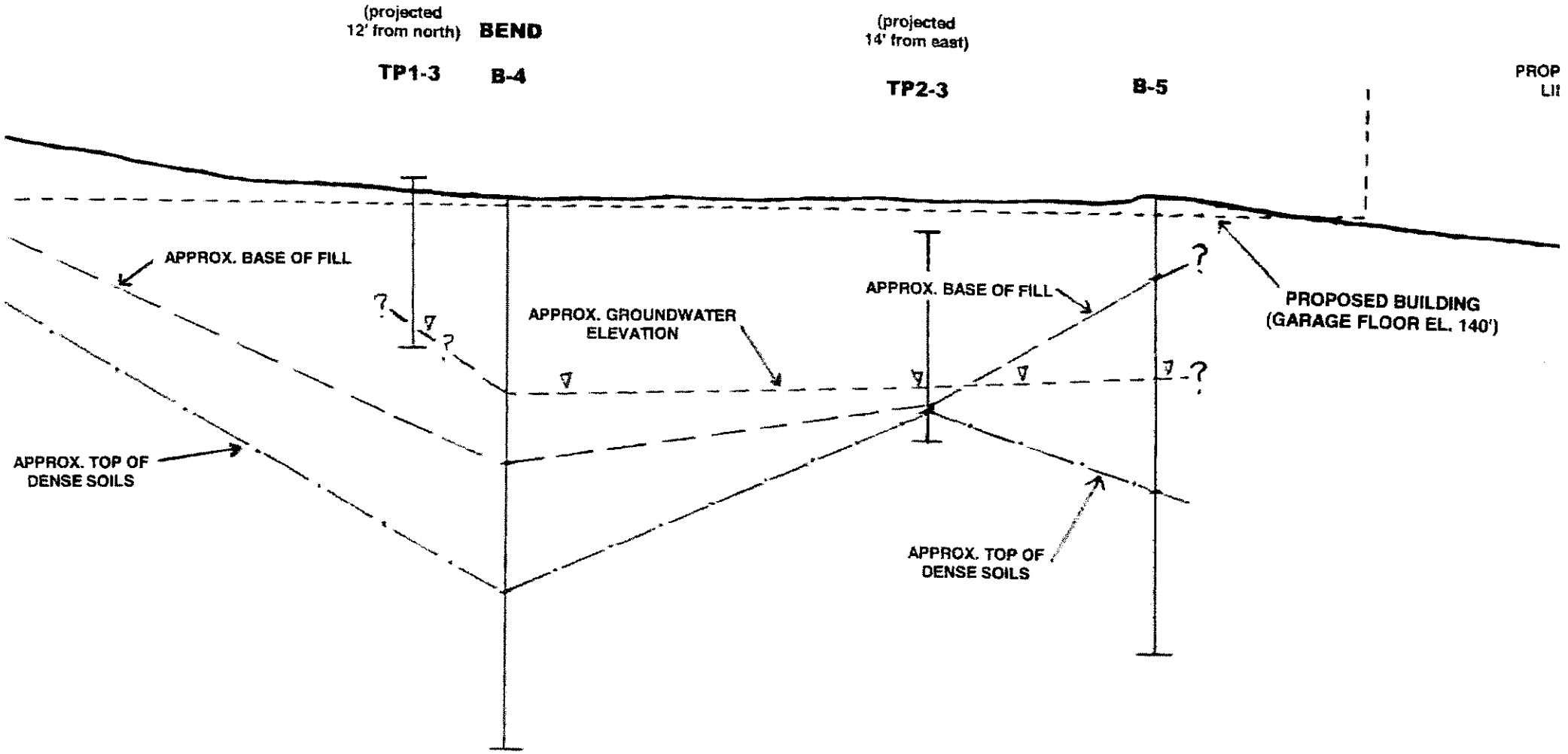
Reference: B.A. Liesch, et al., 1963.

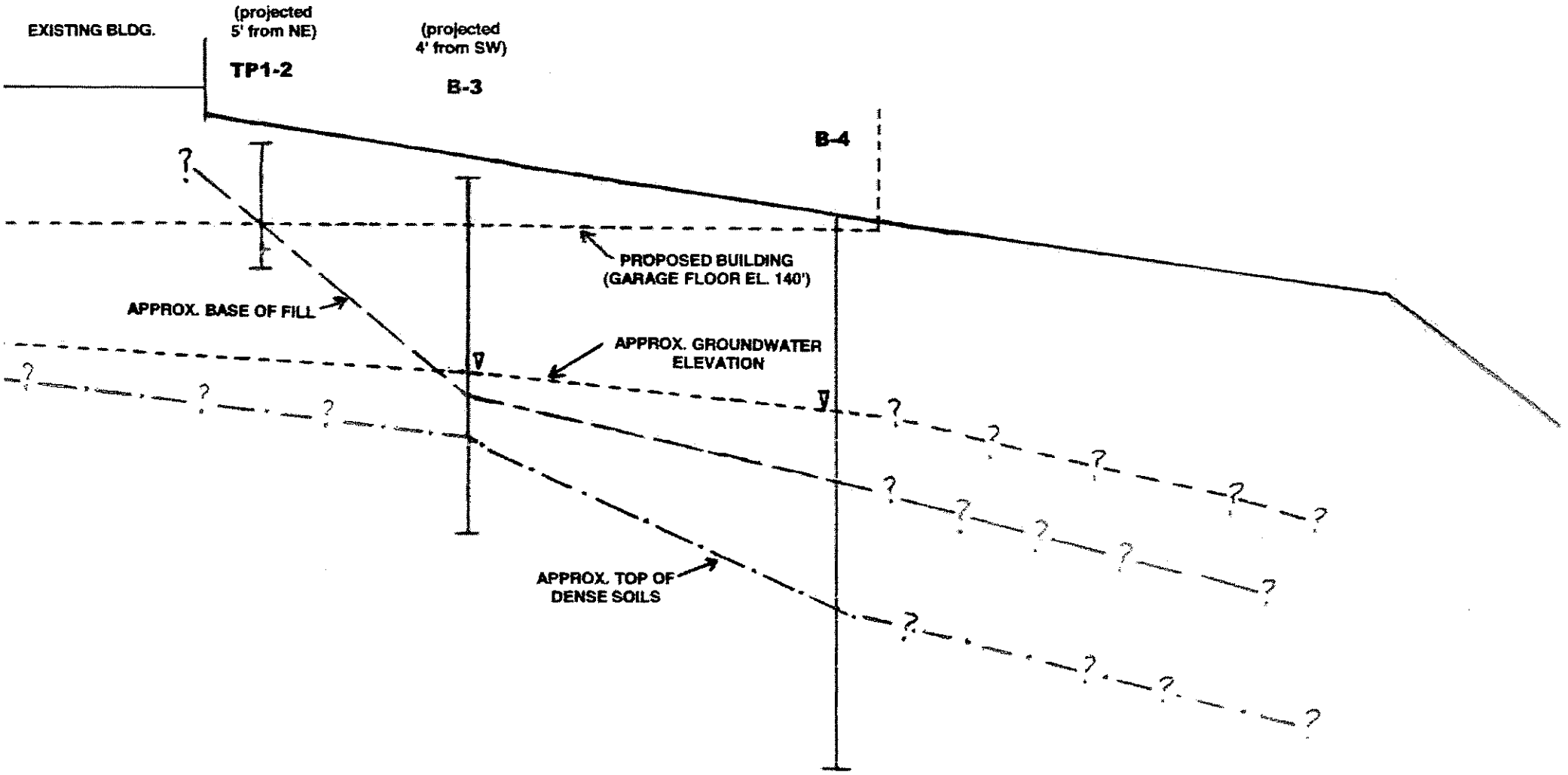
GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

GEOLOGIC MAP

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

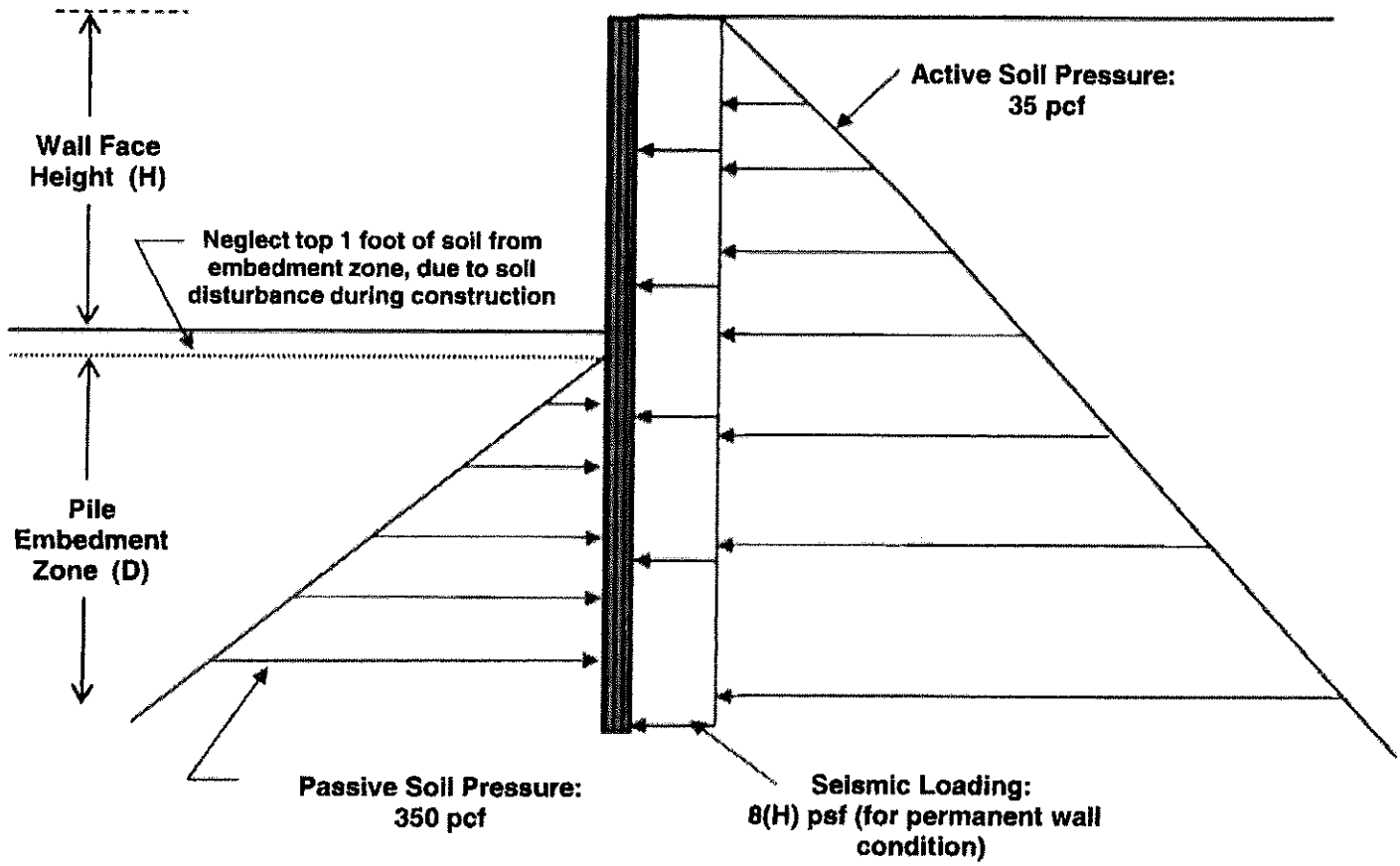
SCALE:	DATE:	MADE:	CHKD:	JOB NO:	PLATE
1" = 1000'	5/1/06	KJ	WC	G-2239	3


(projected
12' from north)
BEND
TP1-3
B-4
(projected
14' from east)
TP2-3
B-5
PROP
LI
APPROX. BASE OF FILL
APPROX. GROUNDWATER
ELEVATION
APPROX. BASE OF FILL
PROPOSED BUILDING
(GARAGE FLOOR EL. 140')
APPROX. TOP OF
DENSE SOILS
APPROX. TOP OF
DENSE SOILS


EXISTING BLDG.
(projected 5' from NE)
TP1-2
(projected 4' from SW)
B-3
B-4
PROPOSED BUILDING (GARAGE FLOOR EL. 140')
APPROX. BASE OF FILL
APPROX. GROUNDWATER ELEVATION
APPROX. TOP OF DENSE SOILS

LATERAL EARTH PRESSURE DIAGRAM

CANTILEVER SOLDIER PILE AND LAGGING SHORING



NOT TO SCALE

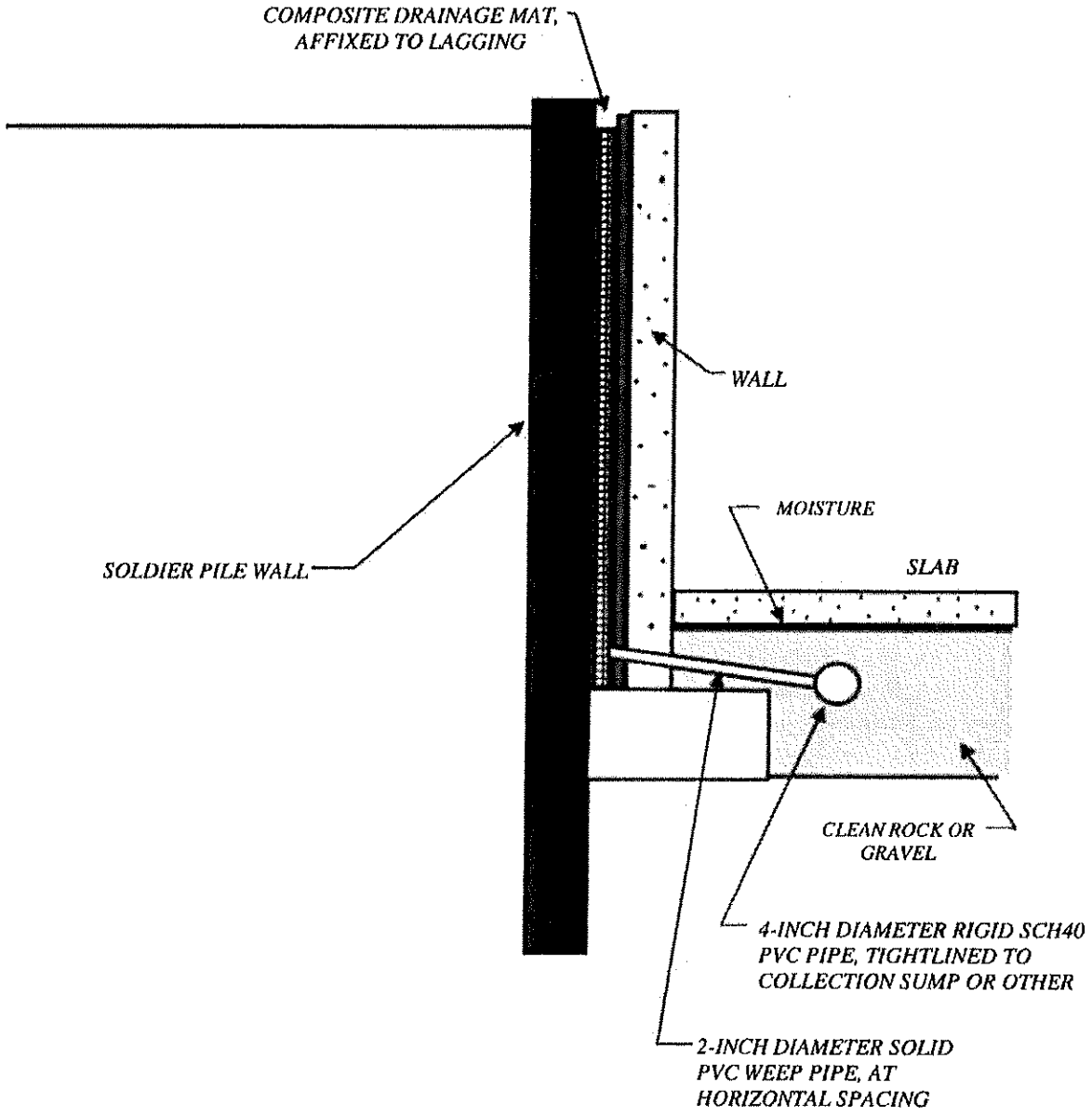
NOTES:

1. Active and passive soil pressures noted above are fluid-equivalent pressures.
2. The active soil pressures act on one pile spacing behind the wall and on the pile width below the wall.
3. The passive soil pressure acts on two pile diameters or one pile spacing, whichever is smaller.
4. The wall is assumed to be fully drained; no hydrostatic pressures act on the wall.
5. Surcharge loads from nearby traffic, buildings, or backslopes are not considered in this diagram, but should be evaluated and included in the design of the shoring.

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

LATERAL EARTH PRESSURE DIAGRAM
PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

SCALE	NONE	DATE	6/24/2015	MADE	KJ	CHKD	WC	JOB NO.	G-2239-1	PLATE	5



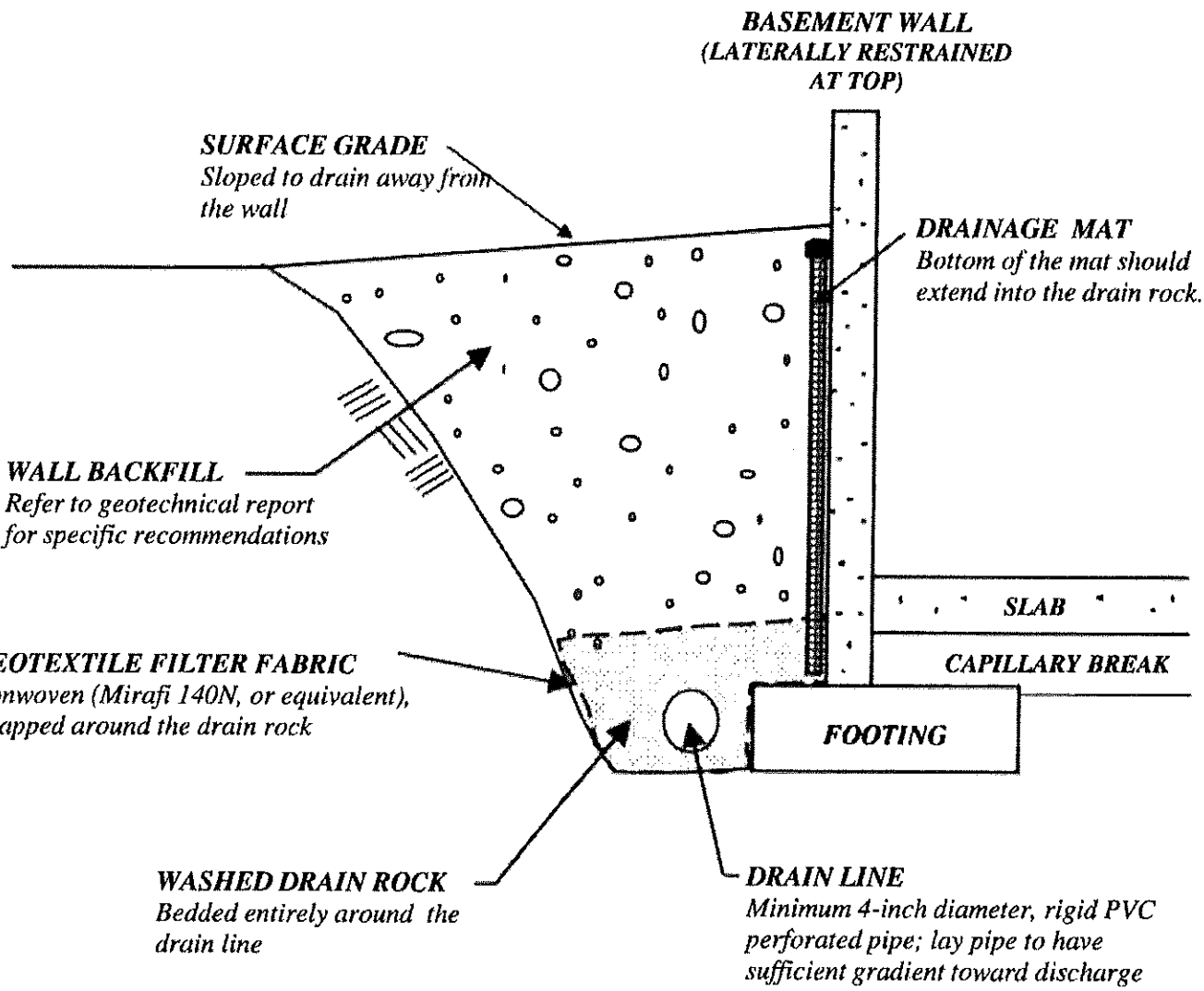
NOT TO SCALE

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

TYPICAL SHORING WALL DRAINAGE

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

SCALE NONE	DATE 6/15/2015	MADE KJ	CHKD WC	JOB NO. G-2239-1	PLATE 6



NOT TO SCALE

NOTES:

1.) Do not replace rigid PVC pipe with flexible corrugated plastic pipe.

2.) Perforated PVC pipe should be tight jointed, laid with perforations facing downward, and sloped toward discharge location(s).

3.) The geotextile filter fabric should be wrapped around the drain rock that surrounds the pipe, not wrapped directly around the pipe.

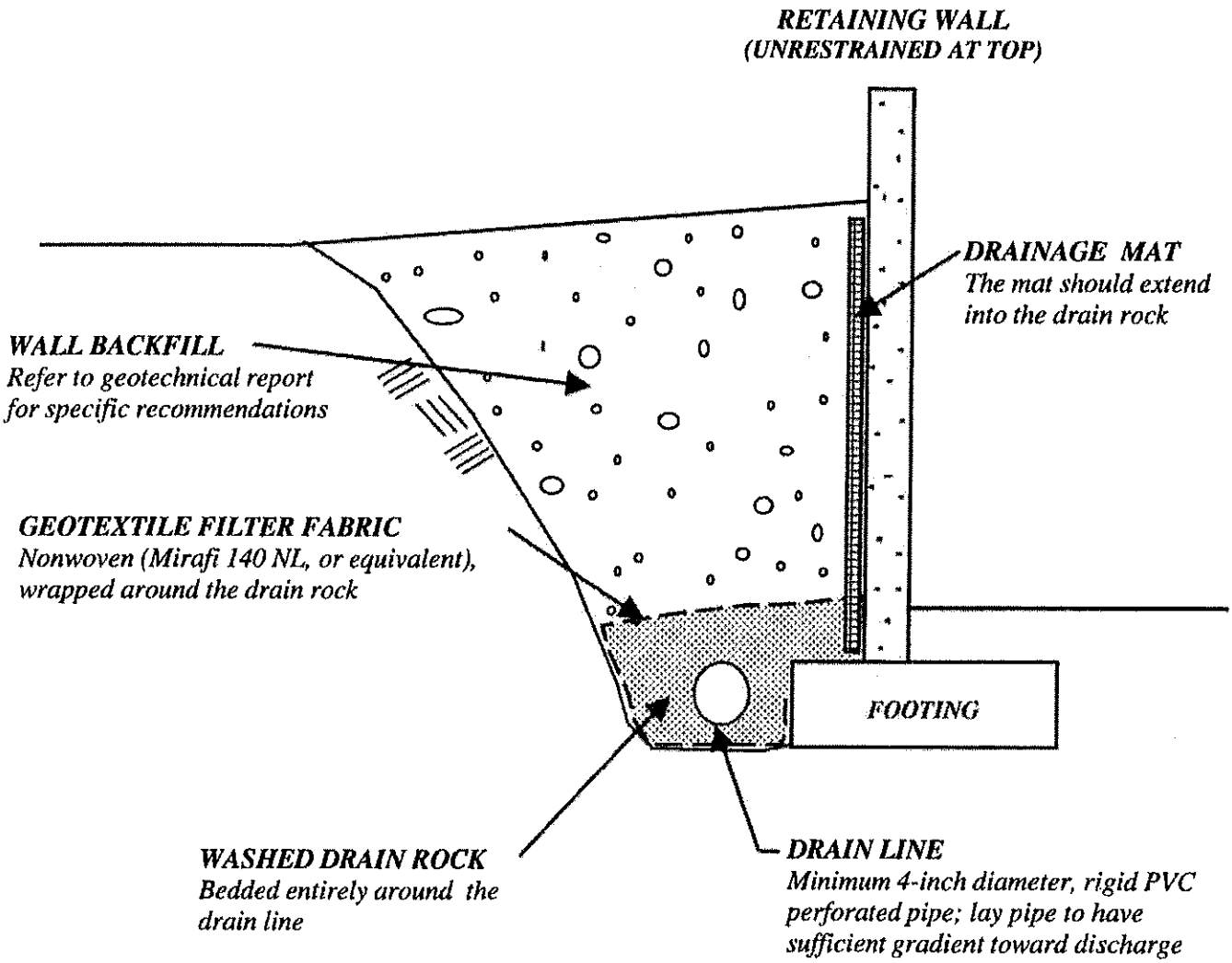
4.) Wall backfill should meet structural fill specifications if it will support pavements, slabs, or structures. Refer to the geotechnical report for structural fill recommendations and specifications.

5.) Surface grade above the backfill can be covered with a layer of relatively impermeable topsoil or pavement or slab to reduce infiltration of surface water into the backfill and drainage system.

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

TYPICAL BASEMENT WALL DRAINAGE
PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

SCALE: NONE	DATE: 6/12/2015	MADE: KJ	CHKD: WC	JOB NO. G-2239-1	PLATE 7



NOT TO SCALE

NOTES:

1.) These recommendations are intended for walls 4 feet or greater in height, but can also be used for walls of lesser height, where desired.

2.) Do not replace rigid PVC pipe with flexible corrugated plastic pipe.

3.) Perforated PVC pipe should be tight jointed and laid with perforations oriented downward. The pipe should be gently sloped to provide flow toward the tightline or discharge location.

4.) Do not connect other drain lines into the footing drain system.

5.) Backfill should meet structural fill specifications if it will support driveways, sidewalks, patios, or other structures. Refer to the geotechnical engineering report for structural fill recommendations.

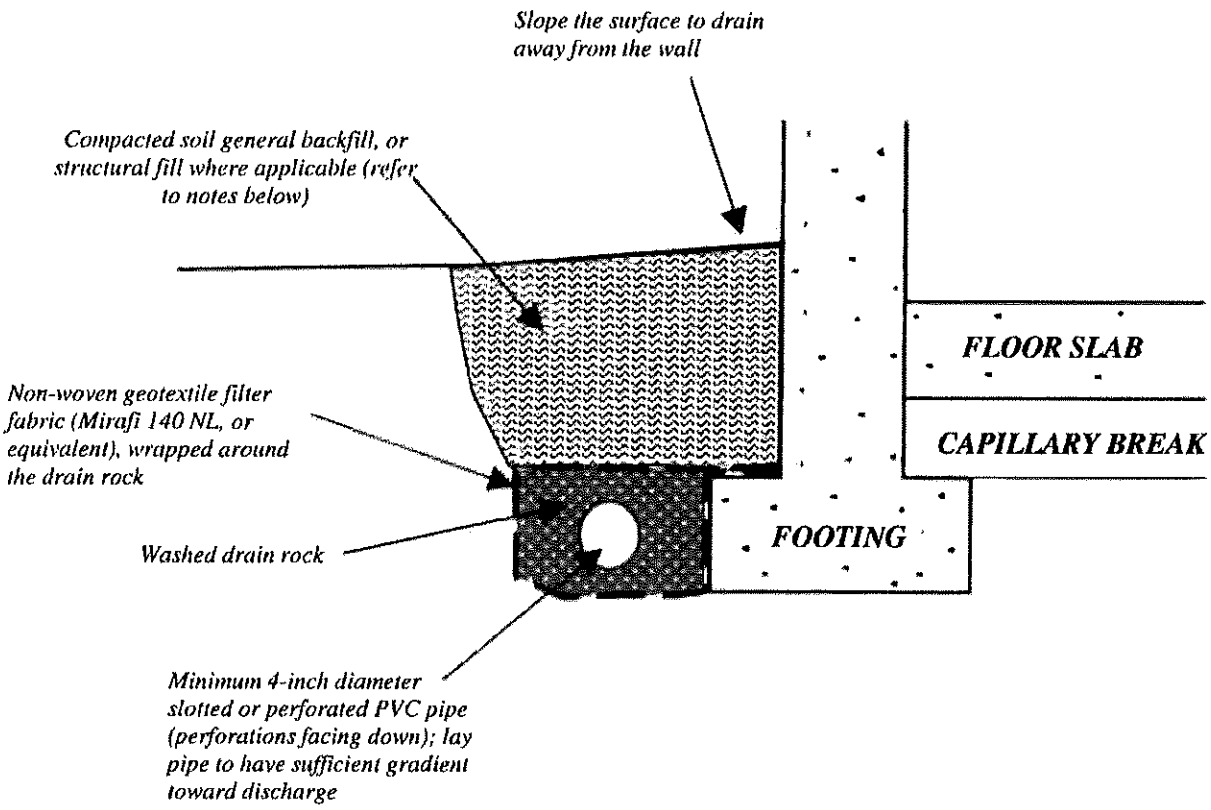
GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

TYPICAL RETAINING WALL DRAINAGE

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

SCALE	DATE	MADE	CHKD	JOB NO.	PLATE
NONE	6/12/2015	KJ	WC	G-2239-1	8

TYPICAL FOOTING DRAIN



NOT TO SCALE

NOTES:

1.) Perforated or slotted rigid PVC pipe should be tight jointed and laid with perforations or slots down, and with positive gradient toward discharge location(s). The pipe should be placed at or slightly above the elevation of the bottom of the footing. Do not replace rigid PVC pipe with flexible corrugated plastic pipe.

2.) Do not connect other drainage lines to the footing drain lines. Drain line cleanouts should be installed at appropriate locations to allow periodic inspection and maintenance of the lines after construction.

3.) If the backfill will support sidewalks, driveways, patios, or other structures, it should meet the recommendations for structural fill provided in the geotechnical report.

4.) The geotextile filter fabric should be placed around the drain rock as shown, and not wrapped directly around the pipe.

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

TYPICAL FOOTING DRAIN
PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

SCALE: NONE	DATE: 3/12/2015	MADE: KJ	CHKD: WC	JOB NO. G-2239-1	PLATE 9

APPENDIX A

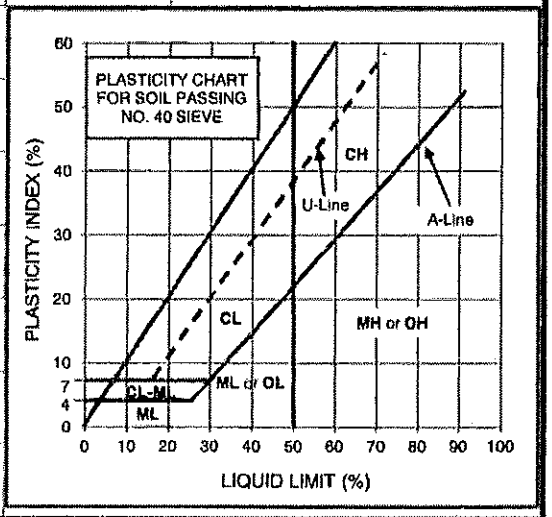
G-2239-1

BORING LOGS

SOIL CLASSIFICATION & PENETRATION TEST DATA EXPLANATION

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE-GRAINED SOILS (More Than Half by Weight Larger Than No. 200 Sieve)	GRAVELS (More Than Half Coarse Fraction is Larger Than No. 4 Sieve)	CLEAN GRAVELS (little or no fines)	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURE, LITTLE OR NO FINES	CONTENT OF FINES BELOW 5%	Cu = (D60 / D10) greater than 4 Cc = $(D30)^2$ / (D10 * D60) between 1 and 3
			GP	POORLY GRADED GRAVELS, AND GRAVEL-SAND MIXTURES LITTLE OR NO FINES		CLEAN GRAVELS NOT MEETING ABOVE REQUIREMENTS
		DIRTY GRAVELS (with some fines)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	GM: ATTERBERG LIMITS BELOW "A" LINE. or P.I. LESS THAN 4
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		GC: ATTERBERG LIMITS ABOVE "A" LINE. or P.I. MORE THAN 7
	SANDS (More Than Half Coarse Fraction is Smaller Than No. 4 Sieve)	CLEAN SANDS (little or no fines)	SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	CONTENT OF FINES BELOW 5%	Cu = (D60 / D10) greater than 6 Cc = $(D30)^2$ / (D10 * D60) between 1 and 3
			SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES		CLEAN SANDS NOT MEETING ABOVE REQUIREMENTS
		DIRTY SANDS (with some fines)	SM	SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW "A" LINE with P.I. LESS THAN 4
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE with P.I. MORE THAN 7
FINE-GRAINED SOILS (Less Than Half by Weight Larger Than No. 200 Sieve)	SILTS (Below A-Line on Plasticity Chart, Negligible Organics)	Liquid Limit < 50%	ML	INORGANIC SILTS, ROCK FLOUR, SANDY SILTS OF SLIGHT PLASTICITY		
		Liquid Limit > 50%	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOIL		
	CLAYS (Above A-Line on Plasticity Chart, Negligible Organics)	Liquid Limit < 50%	CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, CLEAN CLAYS		
		Liquid Limit > 50%	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
	ORGANIC SILTS & CLAYS (Below A-Line on Plasticity Chart)	Liquid Limit < 50%	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY		
		Liquid Limit > 50%	OH	ORGANIC CLAYS OF HIGH PLASTICITY		
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS		



SOIL PARTICLE SIZE

FRACTION	U.S. STANDARD SIEVE Passing Sieve	Passing Size (mm)	Retained Sieve	Retained Size (mm)
SILT / CLAY	#200	0.075		
SAND				
FINE	#40	0.425	#200	0.075
MEDIUM	#10	2.00	#40	0.425
COARSE	#4	4.75	#10	2.00
GRAVEL				
FINE	0.75"	19	#4	4.75
COARSE	3"	76	0.75"	19
COBBLES	76 mm to 203 mm			
BOULDERS	> 203 mm			
ROCK FRAGMENTS	> 76 mm			
ROCK	>0.76 cubic meter in volume			

GENERAL GUIDANCE FOR ENGINEERING PROPERTIES OF SOILS, BASED ON STANDARD PENETRATION TEST (SPT) DATA

SANDY SOILS				SILTY & CLAYEY SOILS		
Blow Counts N	Relative Density, %	Friction Angle ϕ, degrees	Description	Blow Counts N	Unconfined Strength q_u, tsf	Description
0 - 4	0 -15		Very Loose	< 2	< 0.25	Very soft
4 - 10	15 - 35	26 - 30	Loose	2 - 4	0.25 - 0.50	Soft
10 - 30	35 - 65	28 - 35	Medium Dense	4 - 8	0.50 - 1.00	Medium Stiff
30 - 50	65 - 85	35 - 42	Dense	8 - 15	1.00 - 2.00	Stiff
> 50	85 - 100	38 - 46	Very Dense	15 - 30	2.00 - 4.00	Very Stiff
				> 30	> 4.00	Hard

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists
13240 NE 20th Street, Suite 10 Bellevue, WA 98005
Phone (425) 649-8757 Fax (425) 649-8758

PLATE A1

BORING NO. B-1

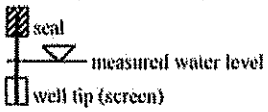
Logged By: KJ Date Drilled: 4/25/2006 Surface Elev. 143 feet +/-

Depth ft.	USCS Code	Description	Sample Type	Sample No.	Blow Count per 6 inches	Water Content %	Other Tests & Comments
	SM-ML	Brown SILTY SAND to SANDY SILT, damp, loose, mottled (FILL).	I	S1	2,2,3 (N=5)	14.4	
5	SM-ML	As above.	I	S2	2,2,2 (N=4)	21.6	
	SM-	As above.	I	S3	2,3,4 (N=7)	18.6	
	SM	Gray SILTY SAND, moist, loose, has visible voids (FILL).	I	S4	2,2,2 (N=4)	12.9	
10	SM	As above, some brownish blotches.	I	S5	2,2,3 (N=5)	22.1	
	SM/OL	Gray SILTY SAND and dark brown SILTY MUCK, heterogeneous, moist, loose, silty sand is as above.	I	S6	5,3,2 (N=5)	16.0	
15	SM	Brown-gray SILTY SAND and WOOD, moist to wet, loose.	I	S7	4,3,5 (N=8)	51.8	
	SM-	Gray SANDY SILT to SILTY SAND, moist, loose.	I	S8	4,3,3 (N=6)	17.9	
20	SP	Gray SAND, wet, loose, some fine black organics, speckled with brown medium sand grains (SUSPECT NATIVE SOIL).	I	S9	1,2,2 (N=4)	11.8	
	SP-SM	Grayish brown SAND, wet, medium dense, damp brown silt lens at bottom of sample (NATIVE SOIL).	I	S10	1,4,8 (N=12)	28.9	
25	SP/	Brownish gray SAND and olive SILTY SAND and SILT, wet, medium dense, gradationally becomes finer toward bottom of sample, silt is damp.	I	S11	9,9,14 (N=23)	36.4	
30	ML	Brown SILT, damp, medium dense to dense, grades to gray very fine sandy silt toward bottom of sample.	I	S12	5,15,14 (N=29)	36.1	
35	ML	Gray SILT, damp, dense.	I	S13	7,11,20 (N=31)	37.5	
40		Bottom of boring: 36.5 feet. Drilling Method: Hollow-stem auger. Sampling Method: 2-inch-O.D. sampler and 140 lb. hammer. Groundwater encountered at 20 feet during drilling, measured at 17 feet after drilling was completed.					

LEGEND:

- I — 2" O.D. Split-Spoon Sampler
- II — 3" O.D. Shelby Tube Sampler
- III — 3" O.D. Dames & Moore Sampler

GROUNDWATER OBSERVATION WELL:



GEO Group Northwest, Inc.

Geotechnical Engineers, Geologists, & Environmental Scientists

BORING LOG

PROPOSED OFFICE BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

JOB NO. G-2239	DATE 5/4/2006	PLATE A2

BORING NO. B-2

Logged By: KJ Date Drilled: 4/25/2006 Surface Elev. 147 feet +/-

Depth ft.	USCS Code	Description	Sample Type	Sample No.	Blow Count per 6 inches	Water Content %	Other Tests & Comments
	SM	Brown SILTY SAND, dry to damp, loose, mostly fine and medium grained with minor gravel (FILL).	I	S1	3,2,3 (N=5)	11.5	
	SM	As above, with mottling, medium dense, no gravel.	I	S2	7,8,9 (N=17)	19.9	
5	SM	As above, dry, with much wood and sawdust.	I	S3	3,2,7 (N=9)	- -	
	ML	Pale gray-brown SANDY SILT, dry to damp, medium dense, with wood waste as above (DISTURBED NATIVE SOIL).	I	S4	5,5,7 (N=12)	20.8	
10	ML	Grayish brown SANDY SILT, damp, medium dense, some very fine grained sand, deep red oxidation (NATIVE SOIL).	I	S5	4,10,12 (N=22)	16.2	
	ML-SM	Brown and gray SILTY SAND to SANDY SILT, damp, medium dense, deep red oxidation blotches and bands.	I	S6	6,10,13 (N=23)	22.6	
15	ML/SM	Gray SILT and brown GRAVELLY SILTY SAND, interbedded, damp, dense, strong red oxidation in sandy layers.	I	S7	7,20,25 (N=45)	13.4	
20	ML/SM	As above, gravelly sand in bottom of sample is moist.	I	S8	5,22,22 (N=44)	20.9	
25		Bottom of boring: 21.5 feet. Drilling Method: Hollow-stem auger. Sampling Method: 2-inch-O.D. sampler and 140 lb. hammer. Groundwater not encountered.					
30							
35							
40							

LEGEND: I 2" O.D. Split-Spoon Sampler; II 3" O.D. Shelby Tube Sampler; III 3" O.D. Dames & Moore Sampler

GROUNDWATER OBSERVATION WELL: seal; measured water level; well tip (screen)

GEO Group Northwest, Inc.

Geotechnical Engineers, Geologists, & Environmental Scientists

BORING LOG

PROPOSED OFFICE BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

JOB NO. G-2239 DATE 5/4/2006 PLATE A3

BORING NO. B-3

Logged By: KJ Date Drilled: 4/25/2006 Surface Elev. 145 feet +/-

Depth ft.	USCS Code	Description	Sample Type	Sample No.	Blow Count per 6 inches	Water Content %	Other Tests & Comments
	SM	Brown SILTY SAND, damp, medium dense, trace gravel (FILL).	I	S1	5,7,9 (N=16)	11.1	
	SM	As above, loose.	I	S2	4,5,5 (N=10)	13.8	Some rock or concrete below surface.
5	SM	Brown SILTY SAND, damp, loose, some red oxidation staining, brown/black silty sand with fine organics at bottom of sample, moist.	I	S3	3,4,5 (N=9)	21.3	
	SM	Dark gray and brown SILTY SAND, damp, loose, trace charcoal.	I	S4	2,1,2 (N=3)	15.3	
10	SM	As above.	I	S5	1,2,2 (N=4)	21.7	
	SM	As above, with wood as most of sample, moist to wet.	I	S6	1,45,11 (N=56)	19.9	Blow count affected by wood waste.
15	SM	As above, very loose, damp to moist.	I	S7	2,1,1 (N=2)	22.8	
	SM	As above, very mottled, loose, moist.	I	S8	2,1,3 (N=4)	17.1	
20	SM	Gray SILTY SAND, wet, loose, minor gravel, brown at bottom.	I	S9	1,2,2 (N=4)	16.7	
	ML/ SM/ SP	Gray SAND and SILTY SAND and black SANDY SILT to SILTY SAND, wet, very loose, fine organics in black soil.	I	S10	0,1,2 (N=3)	23.7	
25	SM-	Dark gray SAND to SILTY SAND, wet, loose, trace rootlets, some brownish lenses (SUSPECT NATIVE SOIL).	I	S11	0,2,5 (N=7)	25.8	
	ML	Dark olive SILT to SANDY SILT, wet to damp, dense, sand is very fine, grades finer and damp and brown toward bottom of sample (NATIVE SOIL).	I	S12	10,15,20 (N=35)	24.1	
30	ML	Brown and gray SILT and SANDY SILT, damp to moist, dense, wet gray sand at bottom of sample.	I	S13	8,18,24 (N=42)	27.7	
35	ML	Gray SILT, damp, dense to very dense.	I	S14	14,17,33 (N=50)	33.5	
40		Bottom of boring: 36.5 feet. Drilling Method: Hollow-stem auger. Sampling Method: 2-inch-O.D. sampler and 140 lb. hammer. Groundwater encountered at 20 feet during drilling, measured at 17 feet after drilling was completed.					

LEGEND: I 2" O.D. Split-Spoon Sampler; II 3" O.D. Shelby Tube Sampler; III 3" O.D. Dames & Moore Sampler

GROUNDWATER OBSERVATION WELL: seal; measured water level; well tip (screen)

▽ = at time of drilling

▼ = later measurement

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

BORING LOG

PROPOSED OFFICE BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

JOB NO. G-2239 DATE 5/4/2006 PLATE A4

BORING NO. B - 4

Logged By: KJ Date Drilled: 6/10/2015 Surface Elev. 141' (±)

Drilled By: Geologic Drill

Depth ft.	Elevation	USCS Code	Description	Sample Loc.	Sample No.	SPT Blow Counts	Water Content %	Other Tests/ Comments
			Cut back blackberry vines and knotweed on bare ground.					
		SM	SILTY SAND, dark grayish brown, dry, loose, sand is mostly fine grained, some organics mixed in (FILL).			2,3,3 (N=6)	8.1	
5		SM/ML	SILTY SAND and SILT, dark grayish brown and olive gray, damp, loose, mixed/hetergenous texture (FILL).			2,2,1 (N=3)	33.1	
		ML	SILT, olive gray, moist, loose, lesser very dark gray sand, mottled, heterogeneous texture (FILL).			3,2,3 (N=5)	20.6	
10		ML/SM	SILT and SILTY SAND, very dark grayish brown and dark gray, moist, loose, mixed/heterogeneous texture, occasional wood and finer organics (FILL).			2,3,3 (N=6)	32.5	
		ML	SANDY SILT and SILT, dark brown and dark gray, moist, very loose, hetergenous/mixed texture, some wood and other fibrous organics, mottled (FILL).			2,1,2 (N=3)	24.0	
15		ML	As above, moist to wet, loose, mottled coloring.			1,3,3 (N=6)	29.6	
▽		ML	As above, damp to moist, loose to medium dense.			2,4,6 (N=10)	26.0	
20		SM	SILTY SAND, gray with some brown, wet, loose to medium dense, sand is mostly fine grained, trace gravel,			8,7,3 (N=10)	12.1	poor sample recovery (may include slough)
		SM	SILTY SAND, dark brown, wet, loose, contains wood, very silty (APPARENT FILL).			2,1,5 (N=6)	35.9	
25								

LEGEND: 2" O.D. SPT Sampler; 3" O.D. California Sampler; ▽ Water Level noted during drilling; ▼ Water Level measured at later time, as noted

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

BORING LOG

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

JOB NO. G-2239-1 **DATE** 3/4/2015 **PLATE** A5

BORING NO. B - 4

Logged By: KJ Date Drilled: 6/10/2015 Surface Elev. 141' (±)

Drilled By: Geologic Drill

Depth ft.	Elevation	USCS Code	Description	Sample Loc.	Sample No.	SPT Blow Counts	Water Content %	Other Tests/ Comments
		SP-SM SM-ML	SAND to SILTY SAND, gray, wet, loose, sand is fine grained, trace gravel. Occasional SANDY SILT to SILTY SAND strata that are brown and contain wood			3,3,4 (N=7)	24.3	
		SM	SILTY SAND, greenish gray, wet, loose in sampler, sand is fine grained (APPARENT NATIVE SOIL).			2,16,50-5" (N=50+)*	13.9	* Note: Blow counts affected by log encountered in boring.
30		SP-SM	SAND to SILTY SAND, dark gray, wet, medium dense, fine grained, some wood in sample (APPARENT NATIVE SOIL).			13,7,5 (N=12)	32.7	
		SM/ML	SILTY SAND and SILT, interlayered, dark gray and dark brownish gray, moist, medium dense, some fine blackish organics, sand is fine grained (NATIVE SOIL).			13,6,6 (N=12)	21.6	
35		SM/ML	SILTY SAND and SILT, dark gray and bluish gray, moist (ML) to wet (SM), sand is fine grained, minor fine gravel in SM.			4,8,5 (N=13)	23.8	
40		SP-SM	SAND to SILTY SAND, dark gray, moist to wet, dense, sand is very fine grained, coarsens downward (but remains fine), occasional rootlets/organics, finely stratified.			40,17,23 (N=40)	26.8	
45		SP-SM	As above, gray.			5,13,23 (N=36)	30.7	
50								

LEGEND: 2" O.D. SPT Sampler; 3" O.D. California Sampler; Water Level noted during drilling; Water Level measured at later time, as noted

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

BORING LOG

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

JOB NO. G-2239-1 **DATE** 3/4/2015 **PLATE** A6

BORING NO. B - 4

Logged By: KJ Date Drilled: 6/10/2015 Surface Elev. 141' (±)

Drilled By: Geologic Drill

Depth ft.	Elevation	USCS Code	Description	Sample Loc.	Sample No.	SPT Blow Counts	Water Content %	Other Tests/ Comments
		SP	SAND, dark gray, wet, medium dense, fine grained, no fines.			1,4,9 (N=13)	26.1	
55		SM-ML	SILTY SAND to SILT, gray, damp to moist, dense, sand is very fine grained, finely stratified.			10,15,20 (N=35)	28.4	
			Depth of boring: 56.5 feet. Drilling Method: Hollow-stem auger. Sampling Method: 2-inch-O.D. standard penetration sampler driven using a 140 lb. hammer with a 30-inch drop. Groundwater seepage encountered at approximately 19 feet below ground surface during drilling.					
60								
65								
70								
75								

LEGEND: 2" O.D. SPT Sampler; 3" O.D. California Sampler; Water Level noted during drilling; Water Level measured at later time, as noted

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

BORING LOG

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

JOB NO. G-2239-1 **DATE** 3/4/2015 **PLATE** A7

BORING NO. B - 5

Logged By: KJ Date Drilled: 6/10/2015 Surface Elev. 142' (±)

Drilled By: Geologic Drill

Depth ft.	Elevation	USCS Code	Description	Sample Loc.	Sample No.	SPT Blow Counts	Water Content %	Other Tests/ Comments
			Asphalt pavement over thin layer of base course.					
		SM	SILTY SAND, dark brown-gray, dry to damp, loose, sand is mostly fine to medium grained, little gravel (FILL).	I		5,4,4 (N=8)	9.9	
5		SM	SILTY SAND with gravel, brown, damp, loose, sand is mostly fine to medium grained, mottled (FILL).	I		4,3,4 (N=7)	16.8	
		SM	As above, moist, oxidized.	I		9,13,15 (N=28)	9.9	
		SM	SILTY SAND, olive brown, damp, medium dense, some oxide staining, sand is fine grained, minor gravel (APPARENT NATIVE SOIL).					
10		SM	SILTY SAND with gravel, brown, damp to moist, medium dense, some oxide staining, sand is mostly fine to medium grained (NATIVE SOIL).	I		8,11,14 (N=25)	10.4	
15		SM	As above, but poor sample recovery, moist to very moist, mottled.	I		11,8,8 (N=16)	14.6	poor sample recovery
▽								
20		SP-SM	SAND, brown, wet, medium dense, fine grained, 5-10% fines (NATIVE SOIL).	I		9,10,10 (N=20)	28.8	
25								

LEGEND: I 2" O.D. SPT Sampler; II 3" O.D. California Sampler; ▽ Water Level noted during drilling; ▼ Water Level measured at later time, as noted

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

BORING LOG

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

JOB NO. G-2239-1 **DATE** 3/4/2015 **PLATE** A8

BORING NO. B - 5

Logged By: KJ Date Drilled: 6/10/2015 Surface Elev. 142' (±)

Drilled By: Geologic Drill

Depth ft.	Elevation	USCS Code	Description	Sample Loc.	Sample No.	SPT Blow Counts	Water Content %	Other Tests/ Comments
		SP-SM / ML	SILT to SANDY SILT, brown, damp to moist, medium dense, weakly stratified, some oxide staining near top.			9,10,14 (N=24)	26.0	
30		SP/ML	SAND and SILT, interbedded, brown to olive brown, damp (ML) to moist (SM), medium dense to dense, sand is fine grained.			9,15,15 (N=30)	20.3 28.0	sand silt
35		SP/SM	SAND and SILTY SAND, interbedded, olive brown to light olive gray, moist (SM) to wet (SP), dense, has some strongly oxidized bands, sand is fine grained			10,15,20 (N=35)	25.5	
40		SM	SILTY SAND, olive brown, wet, medium dense, 10-15% fines, sand is fine grained.			6,13,13 (N=26)	19.1	
45		SM-ML	SILTY SAND to SILT, bluish gray, damp, dense, sand is very fine grained, weakly stratified to massive texture.			11,13,30 (N=43)	32.9	
50			Depth of boring: 46.5 feet. Drilling Method: Hollow-stem auger. Sampling Method: 2-inch-O.D. standard penetration sampler driven using a 140 lb. hammer with a 30-inch drop. Groundwater encountered at approximately 18 feet below ground surface during drilling.					

LEGEND: 2" O.D. SPT Sampler; 3" O.D. California Sampler; Water Level noted during drilling; Water Level measured at later time, as noted

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

BORING LOG

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

JOB NO. G-2239-1 **DATE** 3/4/2015 **PLATE** A9

BORING NO. B - 6

Logged By: KJ Date Drilled: 6/10/2015 Surface Elev. 154' (±)

Drilled By: Geologic Drill

Depth ft.	Elevation	USCS Code	Description	Sample Loc.	Sample No.	SPT Blow Counts	Water Content %	Other Tests/ Comments
			Parking area asphalt pavement over base course.					
		SM	SILTY SAND with gravel, brown, damp to moist, mottled, some blackish organics and oxide staining, massive texture (APPARENT NATIVE SOIL).			7,10,15 (N=25)	10.2	
5		SP/SM	SAND and SILTY SAND, brown and grayish brown, damp to moist, medium dense, little gravel, some oxide stain, sand is mostly fine to medium grained (NATIVE SOIL).			5,6,6 (N=12)	14.6	
		SP/SM	As above, moist.			4,5,7 (N=12)	15.2	
10		SM	SILTY SAND, brown, moist, loose to medium dense, sand is somewhat graded, minor gravel.			3,5,5 (N=10)	13.2	
		SM	SILTY SAND, brown and gray, moist, medium dense, sand is mostly fine grained, mottled, very silty.			7,8,10 (N=18)	15.1	
15		SM	SILTY SAND, olive brown, moist medium dense, sand is fine to medium grained, little gravel, some oxide staining.			5,7,11 (N=18)	23.1	
20		ML	SANDY SILT and SILT, olive brown / olive gray, moist, medium dense, trace gravel, contains occasional wet lenses of clean fine sand			4,4,8 (N=12)	19.6	
▽								
25								

LEGEND: 2" O.D. SPT Sampler; 3" O.D. California Sampler; ▽ Water Level noted during drilling; ▼ Water Level measured at later time, as noted

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

BORING LOG

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

JOB NO. G-2239-1 **DATE** 3/4/2015 **PLATE** A10

BORING NO. B - 6

Logged By: KJ Date Drilled: 6/10/2015 Surface Elev. 154' (±)

Drilled By: Geologic Drill

Depth ft.	Elevation	USCS Code	Description	Sample Loc.	Sample No.	SPT Blow Counts	Water Content %	Other Tests/ Comments
		ML-SM	SANDY SILT to SILTY SAND, dark gray, moist, medium dense, sand is fine to medium grained.			7,11,12 (N=23)	22.1	
		SP	SAND, dark gray, wet, medium dense, fine grained.					
30		SM	SILTY SAND, olive brown, moist, dense, occasional lenses of wet clean fine sand.			10,17,25 (N=42)	20.1	
35		SP	SAND, olive brown, wet, medium dense, fine grained, 5% fines.			8,9,12 (N=21)	25.4	
40		SP-SM	SAND to SILTY SAND, olive gray, wet, dense, fine grained, 5-10% fines.			14,23,20 (N=43)	26.0	
45			Depth of boring: 41.5 feet. Drilling Method: Hollow-stem auger. Sampling Method: 2-inch-O.D. standard penetration sampler driven using a 140 lb. hammer with a 30-inch drop. Groundwater encountered at approximately 22 feet during drilling.					
50								

LEGEND: 2" O.D. SPT Sampler; 3" O.D. California Sampler; Water Level noted during drilling; Water Level measured at later time, as noted

GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists, & Environmental Scientists

BORING LOG

PROPOSED RESIDENTIAL BUILDING
3803 NE 155TH STREET
LAKE FOREST PARK, WASHINGTON

JOB NO. G-2239-1 **DATE** 3/4/2015 **PLATE** A11

APPENDIX B

G-2239-1

PREVIOUS GEOTECHNICAL INVESTIGATION AND TEST PIT LOGS

Copy

NORBROOK OFFICE SITE

3803 N.E. 155th STREET

KING COUNTY, WASHINGTOn

JOB NO. 9006-26G

TABLE OF CONTENTS

Scope	Page 1
Project Description	Page 2
Site Description	Page 2
Subsurface Soil Conditions	Page 3
Ground Water	Page 5
Conclusions and Recommendations	Page 5
Site Preparation	Page 6
Foundation Design (Spread Footings)	Page 7
Structural Fill	Page 8
Drainage	Page 8
General	Page 9
Appendix A	Test Pit Location Map
Appendix B	Test Pit Logs
Appendix C	Unified Soils Classification System

CASCADE GEOTECHNICAL, INC.
12919 N.E. 126TH PLACE (206) 821-5080
KIRKLAND, WASHINGTON 98034 FAX: (206) 823-2203

July 20, 1990
Job No. 9006-26G

Norbrook Construction
P.O. Box 27205
Seattle, Washington 98125

Attention: Mike Sorenson

Reference: Norbrook Office Site
3803 N.E. 155th Street
King County, Washington

Dear Mr. Sorenson:

At your request, we have completed our preliminary subsurface soils investigation for the above site. The following report presents the results of our findings and offers preliminary conclusions and recommendations for the proposed office building in King County, Washington.

SCOPE

The scope of our study was to investigate the subsurface soil and ground water conditions in order to formulate preliminary conclusions and recommendations for construction and development of the site. A Cascade Geotechnical representative visited the above site on July 2, 1990 to view the site and to investigate the subsurface soil and ground water conditions.

The site investigation was based on a surface reconnaissance of the site, a review of available the geologic maps and four (4) backhoe test pits. This report offers conclusions and recommendations for site preparation, foundation design parameters, drainage and slope stability.

PROJECT DESCRIPTION

We understand that the proposed project is to consist of the short platting of an existing lot, removing the existing buildings and constructing a two (2) story office building on the northwest corner of the proposed western lot. No topographic or building plans have been provided to us. A previously completed soil survey of the ground near the slope break was not provided to us for review. We should be engaged to review the site and building plans to see that our recommendations are properly interpreted.

A plat map prepared by Reid, Middleton and Associates, Inc. and dated August 8, 1986 has been provided to us.

SITE DESCRIPTION

The site is an irregular, 42,846 square foot property which is located at the top of a south and southeastern sloping hillside approximately 1000 feet east of Lake Washington in northwestern King County, Washington. The property is bounded by office and residential buildings to the west, N.E. 155th Street to the north and a residence to the south.

Two (2) older, wood-framed buildings are located on the proposed building site, located on the northwest corner of the property. The buildings have slab-on-grade basement floors which were observed to have cracks with one (1) to two (2) inches of vertical displacement.

As determined from our visual observations on July 2, 1990, the ground is relatively flat on a one-hundred (100) foot wide terrace directly adjacent to N.E. 155th Street. The ground slopes down towards the south and east on the southern half and eastern end

at approximately twenty-five (25) to thirty (30) degrees, respectively.

The property was relatively clear in the areas adjacent to the existing buildings. The remaining portions of the property were covered with dense blackberry bushes and grasses.

SUBSURFACE SOIL CONDITIONS

Site subsurface conditions were determined by excavating four (4) backhoe test pits on July 2, 1990. The test pit locations were selected by an engineering geologist from our office and located in or near the proposed building site by pacing relative to property lines and other identifiable landmarks.

The Test Pit Location Map is presented in Appendix A. Depths referred to in this report are relative to the existing ground surface at the time of our investigation. For detailed test pit logs and soil descriptions see Appendix B. All soils were classified according to the Unified Soils Classification System. A copy of this classification is contained in Appendix C.

Up to eight (8) and one-half (8 1/2) feet of uncontrolled fill was observed in the south and northwest sections of the proposed building area. Under the southwest section, approximately two and one-half (2 1/2) feet of uncontrolled fill was observed in Test Pit #1. The uncontrolled fill was observed to thicken towards the south and approximately thirty (30) feet south of the southeast corner of the existing east building, fifteen (15) feet of uncontrolled fill material was observed in Test Pit #3. The uncontrolled fill was observed to consist of gray and brown loose silty sand and sandy silt.

A soft to medium stiff sandy silt was encountered under the uncontrolled fill in Test Pit #3. Test Pit #3 was terminated within this soil at seventeen (17) feet below the surface.

Underlying the uncontrolled fill in Test Pit #1, a loose sand approximately one and one-half (1 1/2) feet thick was observed overlying a dense silty sand. A one (1) foot thick layer of a blue-gray to grayish brown, very stiff clayey silt was found underlying the silty sand at nine and one-half (9 1/2) feet below the surface. This soil was observed to grade into a mottled, grayish-brown, very dense sandy silt. Test Pit #1 was terminated in the very dense sandy silt at a depth of eleven and one-half (11 1/2) feet.

Below the uncontrolled fill in Test Pit #2, a gray, loose to medium silty sand was found at a depth of eight (8) feet. This soil was found to overlie a dense silty sand which was encountered at ten and one-half (10 1/2) feet. The dense silty sand was found to the termination depth of twelve and one-half (12 1/2) feet.

In Test Pit #4, a medium dense gravelly sand with some cobbles and very thin silt layers was found to underlie the uncontrolled fill below eight and one-half (8 1/2) feet. The contact between the uncontrolled fill and the gravelly sand was observed to slope towards the south at approximately twenty-five (25) degrees. A two (2) inch metal pipe was found to slope down with the gravelly sand contact. Test Pit #4 was terminated within the gravelly sand at fourteen (14) feet.

The property lies within an area that has been geologically mapped as the contact between the Vashon glacial till and the older clay as shown on the "Preliminary Geologic Map of Seattle and Vicinity" (USGS Map I-354, Waldron et al, 1962). The property has been

extensively filled, especially towards the south. Overconsolidated material was observed in Test Pits #1 and #2 on the relatively higher sections of the property but no glacially consolidated soils were encountered in Test Pits #3 and #4. The gravelly sand found at depth in Test Pit #4 may be a recessional outwash which had previously been deposited in a gully eroded into the older glacial materials then covered with the fill material.

GROUND WATER

No ground water seepage was observed in the test pits. Wet silty sand was encountered immediately below uncontrolled fill in Test Pit #2 and mottling was observed in the native silty sand and sandy silt in Test Pits #1 and #2. We would expect ground water seepage above the relatively impermeable, dense soils in the wetter, winter months.

CONCLUSIONS AND RECOMMENDATIONS

The building site is located in an area where up to eight and one-half (8 1/2) feet of uncontrolled fill has been placed on a pre-existing slope. However, no evidence of slope movement was noted on the property. Due the considerable set-back from the existing fill slope, we expect that the construction of the proposed office building will not decrease the stability of the site, if our recommendations are closely followed. The owner should be aware that the potential for slope movement on the southern portion of the property will continue to exist.

Based upon the test pit data, development and use of the building site will require that the proposed building foundation bear on the underlying medium dense to dense silty sand and medium dense gravelly sand. A spread and strip footing foundation may bear on

adequately placed and compacted structural fill placed on horizontal surfaces cut well into the native soil. The fill should be limited to a thickness no greater than four (4) feet. Specific and detailed recommendations regarding structural fill placement in the eastern half of the proposed building area are provided below. The amounts of uncontrolled fill to be excavated and structural fill to be placed in the eastern section of the proposed building area will be large for such a constricted site, so a relatively long term earthwork construction schedule should be anticipated.

If the proposed floor elevations on the eastern half of the proposed building area are situated where a spread footing foundation cannot be economically used, an alternate option would be to use a deep foundation to limit settlement. The deep foundation may consist of drilled piers. If you decide to proceed with this option, we can provide the specific design parameters.

If the proposed building utilizes a slab-on-grade floor in conjunction with spread footings, structural fill which is placed and adequately compacted according to our recommendations should be placed under the slab area to prevent excessive settlement. If a deep foundation is placed and structural support for the slab-on-grade is not provided, some differential settlement can be expected in. If no significant settlement can be tolerated, pier support for the slab will be necessary.

Site Preparation

The native soils on the site are moisture sensitive due to the high amount of fine grained material. We therefore recommend performing site preparation and excavation work during an extended period of

dry weather to avoid excess costs and construction problems associated with soil deterioration.

We recommend adjusting site grades to provide proper drainage throughout the site. All excess soil should be removed from the site. During construction, the site slopes should be disturbed as little as possible to avoid erosion and soil saturation. Care should be taken so that no excavated soil is placed on the southern slope. We recommend that any excavation cuts deeper than four (4) feet should be no steeper than a 1.5(H):1(V) slope for temporary construction purposes.

Foundation Design (Spread Footings)

In the western portion of the proposed building area, conventional spread or strip footings which bear on a horizontal, firm, undisturbed surface of the native medium dense to dense silty sand or medium dense gravelly sand are suitable for design loads up to 2000 psf maximum safe bearing value. This native bearing soil should be free of organic material, water or loose soils and should not become wet prior to concrete placement. A one-third ($^1/_3$) increase of the bearing value may be used for the calculation of wind and seismic loading. The bearing surface should be cut at least eighteen (18) inches into the suitable soil. Spread footings should have a minimum width as determined by local building codes and be placed at least eighteen (18) inches below final grade for frost protection.

Since the uncontrolled fill is of unknown stability, building and foundation design should take the possibility of downhill movement of the fill into account.

Structural Fill

Structural fill should be used to support the eastern portion of the foundation where grades require it. Fill should be placed directly on a firm, horizontal subgrade of native bearing soil. The structural fill may consist of an imported free-draining material which meets the following gradation:

Sieve Size	Percent Passing
4 inch	100
#4	25-75
#200	5 maximum, based on the fraction passing the #4 sieve.

Fill should be placed in twelve (12) inch, loose lifts and compacted to at least 95 percent of the ASTM D-1557 maximum dry density. The fill should be limited to a thickness no greater than four (4) feet and should extend out from the outside edge of the footing a distance at least equal to the fill thickness. Fill should be placed under dry conditions.

Drainage

Strict control of all drainage will be necessary. All drainage should be designed so as not to direct surface and subsurface water flows onto the slope.

Footing drains should be placed at the base of all footings and tightlined to the storm sewer system. We suggest using a four (4) inch diameter, rigid, perforated pipe bedded and backfilled with at least twelve (12) inches of pea gravel.

Roof drains should be tightlined to the storm sewer system. These drains should be separate from the footing drains.

Parking areas should be tightlined to the storm sewer system with the surface graded to direct the water away from the slope and the edges curbed to avoid ponding of water. These drains should be separate from the footing drains.

General

We recommend that we be engaged to review the final grades and building plans as they become available. If you decide to proceed with a deep foundation in the eastern half of the building area, we should be engaged to provide additional recommendations. We should be retained to observe the excavation of all uncontrolled fill and the placement and compaction of any structural fill.

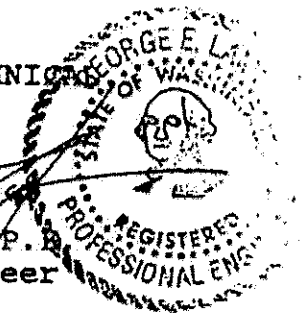
We expect the on site soil conditions to reflect our findings; however, some variations may occur. Should soil conditions be encountered that cause concern and/or are not discussed herein, Cascade Geotechnical should be contacted immediately to determine if additional or alternate recommendations are required.

This report has been prepared for the exclusive use of Norbrook Construction for specific application to the proposed office building at 3803 N.E. 155th Street, King County, Washington, in accordance with generally accepted soils engineering practices. No other warranty, expressed or implied, is made.

Thank you for this opportunity to assist you with this project. Should you have any questions, please feel free to contact us at any time.

Sincerely,

CASCADE GEOTECHNICAL



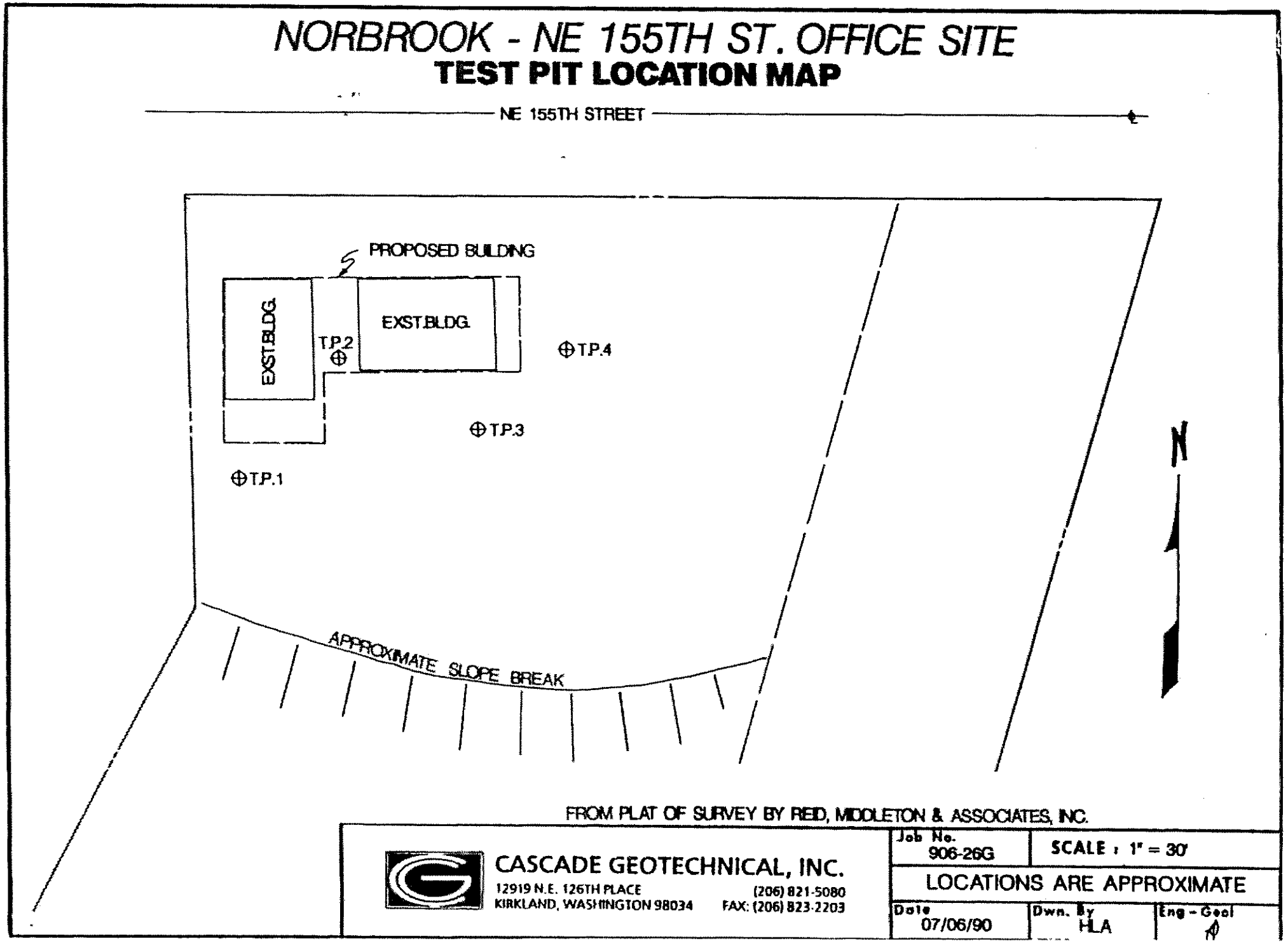
George E. Lamb P.E.
Principal Engineer

Jason Olsson
Engineering Geologist

JO:pg

NORBROOK - NE 155TH ST. OFFICE SITE

TEST PIT LOCATION MAP

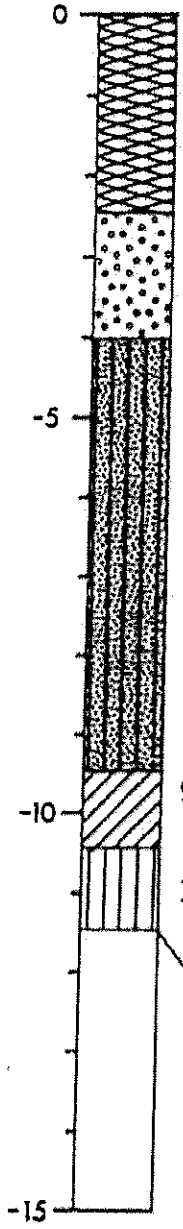


FROM PLAT OF SURVEY BY REID, MIDDLETON & ASSOCIATES, INC.

CASCADE GEOTECHNICAL, INC.
12919 N.E. 126TH PLACE
KIRKLAND, WASHINGTON 98034
(206) 821-5080
FAX: (206) 823-2203

Job No. 906-26G	SCALE : 1" = 30'
LOCATIONS ARE APPROXIMATE	
Date 07/06/90	Dwn. By HLA	Eng - Geol

T.P.- 1	Soil Description & Classification



0 -2.5' UNCONTROLLED FILL; DEBRIS AND LOOSE SILTY SAND.

2.5'-4' SAND; TAN-BROWN, WITH PLANT DEBRIS, LOOSE, MOIST. (SW)

4'-9.5' SILTY SAND; MOTTLED LIGHT GRAY, WITH SOME GRAVEL, DENSE, MOIST, BECOMING SILTIER WITH DEPTH (SM)

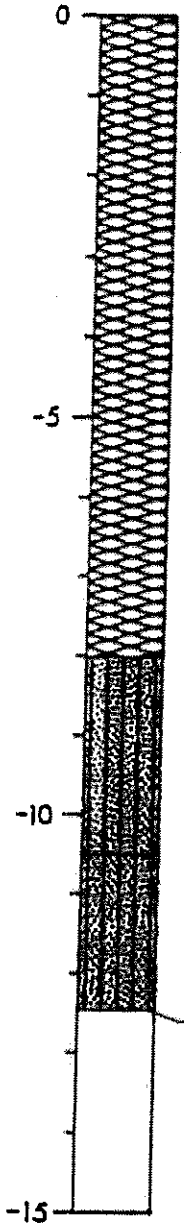
9.5'-10.5' SILTY CLAY; BLUE-GRAY TO GRAYISH BROWN, VERY STIFF, MOIST. (CL)

10.5'-11.5' SANDY SILT; MOTTLED GRAYISH-BROWN, VERY DENSE, MOIST. (ML)

T.D. = 11.5'

Notes: NO GROUND WATER SEEPAGE.

T.P.- 2	Soil Description & Classification



0 -8' UNCONTROLLED FILL; BROWN, LOOSE, SILTY SAND WITH BURIED TREES AND A LARGE ROOT SYSTEM BETWEEN 3.5' AND 7.5'; LOOSE, BROWNISH-GRAY SILTY SAND AT BASE.

8'-10.5' SILTY SAND; GRAY, WITH TRACE ORGANICS AND ROOTS THROUGHOUT, MEDIUM DENSE, WET. (SM)

10.5'-12.5' SILTY SAND; LIGHT GRAY WITH SOME OXIDATION STAINING, TRACE ROOTLETS, DENSE, MOIST. (SM)

T.D. = 12.5'

Notes: NO GROUND WATER SEEPAGE.

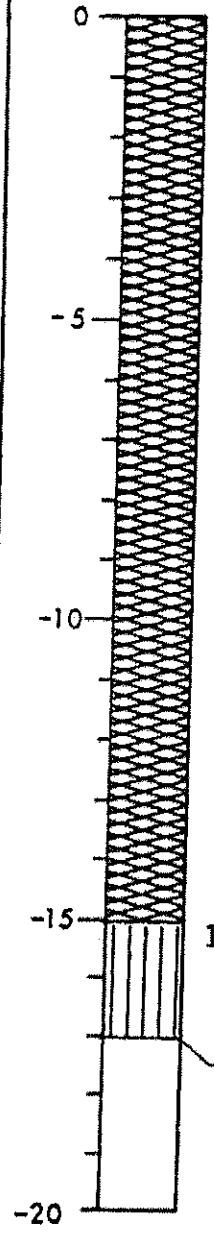
TEST PIT LOG

CASCADE GEOTECHNICAL
A DIVISION OF
CASCADE TESTING LABORATORY, INC.

NORBROOK
NE 155TH ST. OFFICE SITE

Date 07/02/90	Job No. 9006-26G	Dwn. By AEM	Geo/Eng.

T.P.- 3	Soil Description & Classification



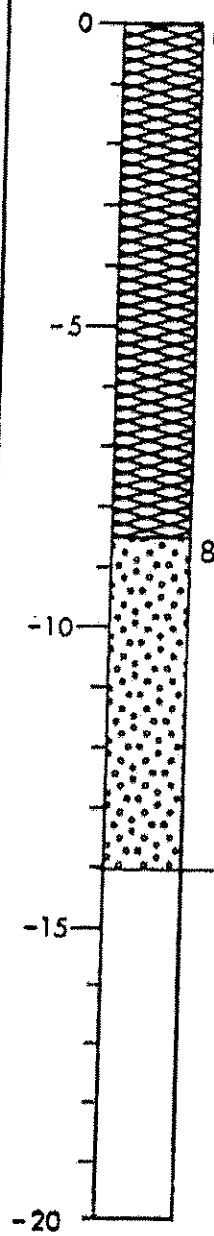
0 -15' UNCONTROLLED FILL; GRAY, MOIST TO WET SANDY SILT AND SILTY SAND WITH TRACE DEBRIS.

15'-17' SANDY SILT; GRAY, WITH MINOR GRAVEL AND CLAY, SOFT TO MEDIUM STIFF, WET. (ML ; uncontrolled fill?)

T.D. = 17'

Notes: CAVING THROUGHOUT TEST PIT.

T.P.- 4	Soil Description & Classification



0 -8.5' UNCONTROLLED FILL; GRAY AND BROWNISH-GRAY SILTY SAND AND SANDY SILT.

8.5'-14' GRAVELLY SAND; LIGHT BROWN, WITH SOME COBBLES AND VERY THIN SILT LAYERS, MEDIUM DENSE, MEDIUM GRAINED, MOIST. (SW)

T.D. = 14'

Notes: 2" METAL PIPE SLOPING DOWN AT 2H:1V ANGLE AT CONTACT, BETWEEN FILL AND NATIVE SOIL.

TEST PIT LOG

CASCADE GEOTECHNICAL
A DIVISION OF
CASCADE TESTING LABORATORY, INC.

NORBROOK
NE 155TH ST. OFFICE SITE

Date 07/02/90	Job No. 9006-26G	Dwn. By AEM	Geo/Eng.

UNIFIED SOILS CLASSIFICATION SYSTEM

MAJOR DIVISIONS			SYMBOL	LETTER	DESCRIPTION
COARSE GRAINED SOILS	GRAVEL & GRAVELLY SOILS	CLEAN GRAVELS		GW	Well-graded gravels or gravel-sand mixtures, little or no fines
				GP	Poorly graded gravels or gravel-sand mixtures, little or no fines
		GRAVELS WITH FINES		GM	Silty gravels or gravel-sand-silt mixtures
				GC	Clayey gravels or gravel-sand-clay mixtures
	SAND & SANDY SOILS	CLEAN SANDS		SW	Well-graded sands or gravelly sands, little or no fines
				SP	Poorly graded sands or gravelly sands, little or no fines
		SANDS WITH FINES		SM	Silty sands or sand-silt mixtures
				SC	Clayey sands or sand-clay mixtures
FINE GRAINED SOILS	SILTS & CLAYS Liquid Limit Less Than 50			ML	Inorganic silts & very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
				CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays or lean clays
				OL	Organic silts & organic silty clays of low plasticity
	SILTS & CLAYS Liquid Limit Greater Than 50			MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
				CH	Inorganic clays of high plasticity, fat clays
				OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS				PT	Peat or other highly organic soils

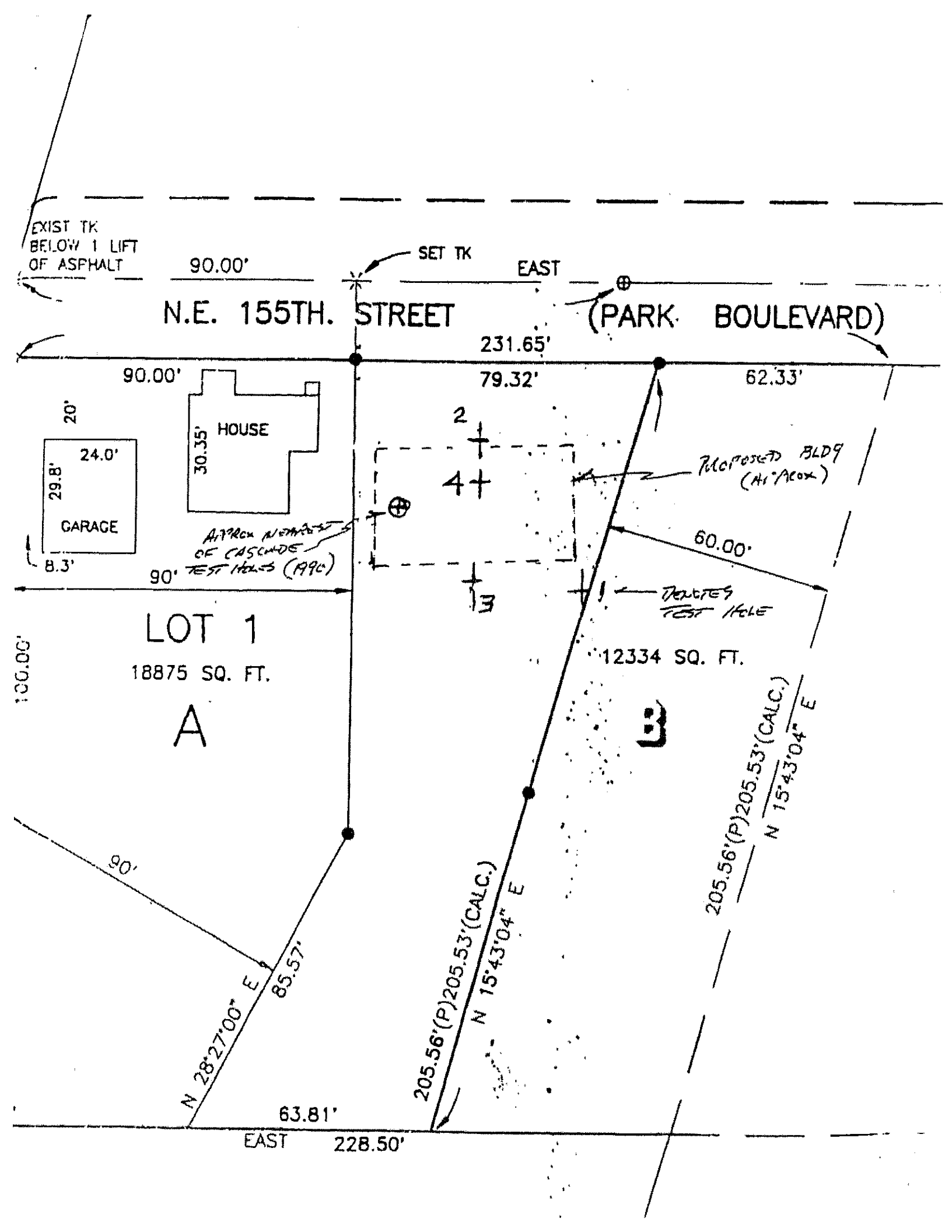
TOPSOIL		Humus & duff layer
FILL		Uncontrolled, with highly variable constituents

SYMBOL	DATUM	NOTE
I	2" O.D. Split Spoon Sampler	Sample Interval
II	Ring or Shelby Sampler	Sample Interval
P	Sampler Pushed	Sample Interval
*	Other Sample Type	Sample Interval

SYMBOL	DATUM	NOTE
	Water Level	Date Recorded
Ts	Torvane Reading	
qu	Penetrometer Reading	
	Water Observation Well	Tip Elevation

CASCADE GEOTECHNICAL
A DIVISION OF
CASCADE TESTING LABORATORY, INC.

KEY CHART


EXIST TK
BELOW 1 LIFT
OF ASPHALT
90.00'
SET TK
EAST
N.E. 155TH. STREET
(PARK BOULEVARD)
231.65'
90.00'
79.32'
62.33'
20'
24.0'
29.8'
GARAGE
8.3'
HOUSE
30.35'
2
4
3
PROPOSED BLDG
(APPROX)
60.00'
90'
TEST HOLES (APPX)
APPROX NORTHERLY
OF CASCADE
DENOTES
TEST HOLE
LOT 1
18875 SQ. FT.
A
12334 SQ. FT.
B
90'
N 28°27'00" E
85.57'
205.56'(P)205.53'(CALC.)
N 15°43'04" E
205.56'(P)205.53'(CALC.)
N 15°43'04" E
63.81'
EAST
228.50'

TEST PIT LOGS

#1

0' -- Highly variable gray and brown fill consisting of sand and silt with gravel (loose, soft)

16.5' -- Completed 1-26-96; no groundwater encountered

#2

0' -- Brown variable fill consisting of silt and sand (generally compacted as a result of surface traffic)

2.5' -- Rusty brown silty gravelly sand (weathered glacial till, grades increasingly dense with depth)

4.5' -- Completed 1-26-96; no groundwater encountered

#3

0' -- Highly variable gray and brown fill consisting of sand, silt, and gravel with organic matter throughout (loose, soft)

18' -- Brown silty sand (dense to very dense)

21' -- Completed 1-26-96; groundwater seepage from 16' and below

#4

0' -- Variable brown silty sand fill including pea gravel pipe bedding (generally compacted in upper 1 to 2 feet)

5' -- Brown to gray F-M sand and silty sand (increasingly dense with depth)

6½' -- Completed 1-26-96; no groundwater encountered

APPENDIX B

Operations & Maintenance Manual

Stormwater Management Facility
Operation and Maintenance (O&M) Manual

for:

LAKEVIEW L.L.C.

Located at:

3803 NE 155th Street
Lake Forest Park, WA 98155

Prepared by:

Encompass Engineering & Surveying, Inc.
425-392-0250

Stormwater Management Facility
Operation and Maintenance (O&M) Manual

Table of Contents

I. **Compliance with Stormwater Facility Maintenance Requirements**

II. **Inspection & Maintenance- Annual Reporting**

III. **Preventative Measures to Reduce Maintenance Costs**

IV. **Access and Easements**

V. **Safety**

VI. **Field Inspection Equipment**

VII. **Inspecting Stormwater Management Facilities**
- A. Inspection Procedures
- B. Inspection Report
- C. Verification of Inspection and Form Submittal

VIII. **Maintaining Stormwater Management Facilities**
- A. Maintenance Categories
- B. Maintenance Personnel
- C. Maintenance Forms

Appendices

Appendix A - Maintenance Agreement(s)
Appendix B - Description of Stormwater Management Facilities
Appendix C - Standard Operation Procedures (SOP) for each facility type
Appendix D - Inspection Form(s)
Appendix E - Maintenance Form(s)
Appendix F - Annual Inspection and Maintenance Submittal form
Appendix G - Stormwater Facilities Map; Facility plan and detail sheets

Stormwater Management Facility
Operation and Maintenance (O&M) Manual

I. Compliance with Stormwater Facility Maintenance Requirements

All property owners are responsible for ensuring that stormwater facilities installed on their property are properly maintained and that they function as designed. In some cases, this maintenance responsibility may be assigned to others through special agreements. The maintenance responsibility for a stormwater facility may be designated on the subdivision plat, the site development plan, and/or within a maintenance agreement for the property. Property owners should be aware of their responsibilities regarding stormwater facility maintenance. Maintenance agreement(s) associated with this property are provided in Appendix A.

II. Inspection & Maintenance – Annual Reporting

Requirements for the inspection and maintenance of stormwater facilities, as well as reporting requirements are included in this Stormwater Management Facility Operation and Maintenance (O&M) Manual.

Verification that the Stormwater facilities have been properly inspected and maintained; submittal of the required Inspection and Maintenance Forms and Inspector qualifications shall be provided to Arapahoe County on an annual basis. The annual reporting form shall be provided to Arapahoe County prior to May 31st of each year.

Copies of the Inspection and Maintenance forms for each of the stormwater facilities are located in Appendix D and E. A standard annual reporting form is provided in Appendix F. Each form shall be reviewed and submitted by the property owner or property manager to Arapahoe County.

III. Preventative Measures to Reduce Maintenance Costs

The most effective way to maintain your water quality facility is to prevent the pollutants from entering the facility in the first place. Common pollutants include sediment, trash & debris, chemicals, dog wastes, runoff from stored materials, illicit discharges into the storm drainage system and many others. A thoughtful maintenance program will include measures to address these potential contaminants, and will save money and time in the long run. Key points to consider in your maintenance program include:

- Educate property owners/residents to be aware of how their actions affect water quality, and how they can help reduce maintenance costs.
- Keep properties, streets and gutters, and parking lots free of trash, debris, and lawn clippings.
- Ensure the proper disposal of hazardous wastes and chemicals.
- Plan lawn care to minimize the use of chemicals and pesticides.
- Sweep paved surfaces and put the sweepings back on the lawn.
- Be aware of automobiles leaking fluids. Use absorbents such as cat litter to soak up drippings – dispose of properly.
- Re-vegetate disturbed and bare areas to maintain vegetative stabilization.
- Clean out the upstream components of the storm drainage system, including inlets, storm sewers and outfalls.
- Do not store materials outdoors (including landscaping materials) unless properly protected from runoff.

IV. Access and Easements

All stormwater management facilities located on the site have both a designated access location as well as a maintenance easement. Refer to the Stormwater Facilities Map located in Appendix G for access and easement locations.

V. Safety

Keep safety considerations at the forefront of inspection procedures at all times. Likely hazards should be anticipated and avoided. Never enter a confined space (outlet structure, manhole, etc) without proper training or equipment. A confined space should never be entered without at least one additional person present.

If a toxic or flammable substance is discovered, leave the immediate area and contact the local Sheriff at 911.

Potentially dangerous (e.g., fuel, chemicals, hazardous materials) substances found in the areas must be referred to the local Sheriff's Office immediately for response by the Hazardous Materials Unit. The emergency contact number is 911.

Vertical drops may be encountered in areas located within and around the facility. Avoid walking on top of retaining walls or other structures that have a significant vertical drop. If a vertical drop is identified within the pond that is greater than 48" in height, make the appropriate note/comment on the maintenance inspection form.

If any hazard is found within the facility area that poses an immediate threat to public safety, contact the local Sheriff's Office immediately.

VI. Field Inspection Equipment

It is imperative that the appropriate equipment is taken to the field with the inspector(s). This is to ensure the safety of the inspector and allow the inspections to be performed as efficiently as possible. Below is a list of the equipment that may be necessary to perform the inspections of all Stormwater Management Facilities:

- Protective clothing and boots.
- Safety equipment (vest, hard hat, confined space entry equipment).
- Communication equipment.
- Operation and Maintenance Manual for the site including stormwater management facility location maps.
- Clipboard.
- Stormwater Facility Maintenance Inspection Forms (See Appendix D).
- Manhole Lid Remover
- Shovel.

Some of the items identified above need not be carried by the inspector (manhole lid remover, shovel, and confined space entry equipment). However, this equipment should be available in the vehicle driven to the site.

VII. Inspecting Stormwater Management Facilities

The quality of stormwater entering the waters of the state relies heavily on the proper operation and maintenance of permanent best management practices. Stormwater management facilities must be periodically inspected to ensure that they function as designed. The inspection will determine the appropriate maintenance that is required for the facility.

A. Inspection Procedures

All stormwater management facilities are required to be inspected by a qualified individual at a minimum of once per year. Inspections should follow the inspection guidance found in the SOP for the specific type of facility. (Appendix C of this manual).

B. Inspection Report

The person(s) conducting the inspection activities shall complete the appropriate inspection report for the specific facility. Inspection reports are located in Appendix D.

The following information explains how to fill out the Inspection Forms:

General Information

This section identifies the facility location, person conducting the inspection, the date and time the facility was inspected, and approximate days since the last rainfall. Property classification is identified as single-family residential, multi-family residential, commercial, or other.

The reason for the inspection is also identified on the form depending on the nature of the inspection. All facilities should be inspected on an annual basis at a minimum. In addition, all facilities should be inspected after a significant precipitation event to ensure the facility is draining appropriately and to identify any damage that occurred as a result of the increased runoff.

Inspection Scoring

For each inspection item, a score must be given to identify the urgency of required maintenance. The scoring is as follows:

0 = No deficiencies identified.

1 = Monitor – Although maintenance may not be required at this time, a potential problem exists that will most likely need to be addressed in the future. This can include items like minor erosion, concrete cracks/spalling, or minor sediment accumulation. This item should be revisited at the next inspection.

2 = Routine Maintenance Required – Some inspection items can be addressed through the routine maintenance program (See SOP in Appendix C). This can include items like vegetation management or debris/trash removal.

3 = Immediate Repair Necessary – This item needs immediate attention because failure is imminent or has already occurred. This could include items such as structural failure of a feature (outlet works, forebay, etc), significant erosion, or significant sediment accumulation. This score should be given to an item that can significantly affect the function of the facility.

N/A This is checked by an item that may not exist in a facility. Not all facilities have all of the features identified on the form (forebay, micro-pool, etc.).

Inspection Summary/Additional Comments

Additional explanations to inspection items, and observations about the facility not covered by the form, are recorded in this section.

Overall Facility Rating

An overall rating must be given for each facility inspected. The overall facility rating should correspond with the highest score (0, 1, 2, 3) given to any feature on the inspection form.

C. Verification of Inspection and Form Submittal

The Stormwater Management Facility Inspection Form provides a record of inspection of the facility. Inspection Forms for each facility type are provided in Appendix D. Verification of the inspection of the stormwater facilities, the facility inspection form(s), and Inspector Qualifications shall be provided to Arapahoe County on an annual basis. The verification and the inspection form(s) shall be reviewed and submitted by the property owner or property manager.

Refer to Section II of this Manual regarding the annual reporting of inspections.

VIII. Maintaining Stormwater Management Facilities

Stormwater management facilities must be properly maintained to ensure that they operate correctly and provide the water quality treatment for which they were designed. Routine maintenance performed on a frequently scheduled basis, can help avoid more costly rehabilitative maintenance that results when facilities are not adequately maintained.

A. Maintenance Categories

Stormwater management facility maintenance programs are separated into three broad categories of work. These categories are based largely on the Urban Drainage and Flood Control District's Maintenance Program for regional drainage facilities. The categories are separated based upon the magnitude and type of the maintenance activities performed. A description of each category follows:

Routine Work

The majority of this work consists of scheduled mowings and trash and debris pickups for stormwater management facilities during the growing season. This includes items such as the removal of debris/material that may be clogging the outlet structure well screens and trash racks. It also includes activities such as weed control, mosquito treatment, and algae treatment. These activities normally will be performed numerous times during the year. These items can be completed without any prior correspondence with Arapahoe County; however, completed inspection and maintenance forms shall be submitted to Arapahoe County for each inspection and maintenance activity.

Restoration Work

This work consists of a variety of isolated or small-scale maintenance and work needed to address operational problems. Most of this work can be completed by a small crew, with minor tools, and small equipment. These items require prior correspondence with Arapahoe County and require that completed maintenance forms be submitted to Arapahoe County for each maintenance activity.

Rehabilitation Work

This work consists of large-scale maintenance and major improvements needed to address failures within the stormwater management facilities. This work requires consultation with Arapahoe County and may require an engineering design with construction plans to be prepared for review and approval. This work may also require more specialized maintenance equipment, surveying, construction permits or assistance through private contractors and consultants. These items require prior correspondence with Arapahoe County and require that completed maintenance forms be submitted to Arapahoe County for each maintenance activity.

B. Maintenance Personnel

Maintenance personnel must be qualified to properly maintain stormwater management facilities. Inadequately trained personnel can cause additional problems resulting in additional maintenance costs.

C. Maintenance Forms

The Stormwater Management Facility Maintenance Form provides a record of maintenance activities. Maintenance Forms for each facility type are provided in Appendix E. Maintenance Forms shall be completed by the contractor completing the required maintenance items. The form shall then be reviewed by the property owner or an authorized agent of the property owner and submitted on an annual basis to the Arapahoe County.

Refer to Section II of this Manual regarding the annual reporting of inspections and maintenance activities performed.

NO. 3 – DETENTION TANKS AND VAULTS

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Site	Trash and debris	Any trash and debris which exceed 1 cubic foot per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size office garbage can). In general, there should be no visual evidence of dumping.	Trash and debris cleared from site.
	Noxious weeds	Any noxious or nuisance vegetation which may constitute a hazard to County personnel or the public.	Noxious and nuisance vegetation removed according to applicable regulations. No danger of noxious vegetation where County personnel or the public might normally be.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Grass/groundcover	Grass or groundcover exceeds 18 inches in height.	Grass or groundcover mowed to a height no greater than 6 inches.
Tank or Vault Storage Area	Trash and debris	Any trash and debris accumulated in vault or tank (includes floatables and non-floatables).	No trash or debris in vault.
	Sediment accumulation	Accumulated sediment depth exceeds 10% of the diameter of the storage area for ½ length of storage vault or any point depth exceeds 15% of diameter. Example: 72-inch storage tank would require cleaning when sediment reaches depth of 7 inches for more than ½ length of tank.	All sediment removed from storage area.
Tank Structure	Plugged air vent	Any blockage of the vent.	Tank or vault freely vents.
	Tank bent out of shape	Any part of tank/pipe is bent out of shape more than 10% of its design shape.	Tank repaired or replaced to design.
	Gaps between sections, damaged joints or cracks or tears in wall	A gap wider than ½-inch at the joint of any tank sections or any evidence of soil particles entering the tank at a joint or through a wall.	No water or soil entering tank through joints or walls.
Vault Structure	Damage to wall, frame, bottom, and/or top slab	Cracks wider than ½-inch, any evidence of soil entering the structure through cracks or qualified inspection personnel determines that the vault is not structurally sound.	Vault is sealed and structurally sound.
Inlet/Outlet Pipes	Sediment accumulation	Sediment filling 20% or more of the pipe.	Inlet/outlet pipes clear of sediment.
	Trash and debris	Trash and debris accumulated in inlet/outlet pipes (includes floatables and non-floatables).	No trash or debris in pipes.
	Damaged	Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering at the joints of the inlet/outlet pipes.	No cracks more than ¼-inch wide at the joint of the inlet/outlet pipe.

NO. 3 – DETENTION TANKS AND VAULTS

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Access Manhole	Cover/lid not in place	Cover/lid is missing or only partially in place. **Any open manhole requires immediate maintenance.**	Manhole access covered.
	Locking mechanism not working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts cannot be seated. Self-locking cover/lid does not work.	Mechanism opens with proper tools.
	Cover/lid difficult to remove	One maintenance person cannot remove cover/lid after applying 80 lbs of lift.	Cover/lid can be removed and reinstalled by one maintenance person.
	Ladder rungs unsafe	Missing rungs, misalignment, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
Large access doors/plate	Damaged or difficult to open	Large access doors or plates cannot be opened/removed using normal equipment.	Replace or repair access door so it can opened as designed.
	Gaps, doesn't cover completely	Large access doors not flat and/or access opening not completely covered.	Doors close flat and covers access opening completely.
	Lifting Rings missing, rusted	Lifting rings not capable of lifting weight of door or plate.	Lifting rings sufficient to lift or remove door or plate.

NO. 4 – CONTROL STRUCTURE/FLOW RESTRICTOR

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Structure	Trash and debris	Trash or debris of more than ½ cubic foot which is located immediately in front of the structure opening or is blocking capacity of the structure by more than 10%.	No Trash or debris blocking or potentially blocking entrance to structure.
		Trash or debris in the structure that exceeds $^1/_3$ the depth from the bottom of basin to invert the lowest pipe into or out of the basin.	No trash or debris in the structure.
		Deposits of garbage exceeding 1 cubic foot in volume.	No condition present which would attract or support the breeding of insects or rodents.
	Sediment	Sediment exceeds 60% of the depth from the bottom of the structure to the invert of the lowest pipe into or out of the structure or the bottom of the FROP-T section or is within 6 inches of the invert of the lowest pipe into or out of the structure or the bottom of the FROP-T section.	Sump of structure contains no sediment.
	Damage to frame and/or top slab	Corner of frame extends more than ¾ inch past curb face into the street (if applicable).	Frame is even with curb.
		Top slab has holes larger than 2 square inches or cracks wider than ¼ inch.	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than ¾ inch of the frame from the top slab.	Frame is sitting flush on top slab.
	Cracks in walls or bottom	Cracks wider than ½ inch and longer than 3 feet, any evidence of soil particles entering structure through cracks, or maintenance person judges that structure is unsound.	Structure is sealed and structurally sound.
		Cracks wider than ½ inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering structure through cracks.	No cracks more than $^1/_4$ inch wide at the joint of inlet/outlet pipe.
	Settlement/ misalignment	Structure has settled more than 1 inch or has rotated more than 2 inches out of alignment.	Basin replaced or repaired to design standards.
	Damaged pipe joints	Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering the structure at the joint of the inlet/outlet pipes.	No cracks more than ¼-inch wide at the joint of inlet/outlet pipes.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Ladder rungs missing or unsafe	Ladder is unsafe due to missing rungs, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
FROP-T Section	Damage	T section is not securely attached to structure wall and outlet pipe structure should support at least 1,000 lbs of up or down pressure.	T section securely attached to wall and outlet pipe.
		Structure is not in upright position (allow up to 10% from plumb).	Structure in correct position.
		Connections to outlet pipe are not watertight or show signs of deteriorated grout.	Connections to outlet pipe are water tight; structure repaired or replaced and works as designed.
		Any holes—other than designed holes—in the structure.	Structure has no holes other than designed holes.
Cleanout Gate	Damaged or missing	Cleanout gate is missing.	Replace cleanout gate.

NO. 4 – CONTROL STRUCTURE/FLOW RESTRICTOR

Maintenance Component	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance is Performed
		Cleanout gate is not watertight.	Gate is watertight and works as designed.
		Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
		Chain/rod leading to gate is missing or damaged.	Chain is in place and works as designed.
Orifice Plate	Damaged or missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
	Deformed or damaged lip	Lip of overflow pipe is bent or deformed.	Overflow pipe does not allow overflow at an elevation lower than design
Inlet/Outlet Pipe	Sediment accumulation	Sediment filling 20% or more of the pipe.	Inlet/outlet pipes clear of sediment.
	Trash and debris	Trash and debris accumulated in inlet/outlet pipes (includes floatables and non-floatables).	No trash or debris in pipes.
	Damaged	Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering at the joints of the inlet/outlet pipes.	No cracks more than ¼-inch wide at the joint of the inlet/outlet pipe.
Metal Grates (If Applicable)	Unsafe grate opening	Grate with opening wider than $^{7}/_{8}$ inch.	Grate opening meets design standards.
	Trash and debris	Trash and debris that is blocking more than 20% of grate surface.	Grate free of trash and debris. footnote to guidelines for disposal
	Damaged or missing	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.
Manhole Cover/Lid	Cover/lid not in place	Cover/lid is missing or only partially in place. **Any open structure requires urgent maintenance.**	Cover/lid protects opening to structure.
	Locking mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts cannot be seated. Self-locking cover/lid does not work.	Mechanism opens with proper tools.
	Cover/lid difficult to Remove	One maintenance person cannot remove cover/lid after applying 80 lbs. of lift.	Cover/lid can be removed and reinstalled by one maintenance person.

NO. 5 – CATCH BASINS AND MANHOLES

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Structure	Sediment	Sediment exceeds 60% of the depth from the bottom of the catch basin to the invert of the lowest pipe into or out of the catch basin or is within 6 inches of the invert of the lowest pipe into or out of the catch basin.	Sump of catch basin contains no sediment.
	Trash and debris	Trash or debris of more than ½ cubic foot which is located immediately in front of the catch basin opening or is blocking capacity of the catch basin by more than 10%.	No Trash or debris blocking or potentially blocking entrance to catch basin.
		Trash or debris in the catch basin that exceeds $^1/_3$ the depth from the bottom of basin to invert the lowest pipe into or out of the basin.	No trash or debris in the catch basin.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within catch basin.
		Deposits of garbage exceeding 1 cubic foot in volume.	No condition present which would attract or support the breeding of insects or rodents.
	Damage to frame and/or top slab	Corner of frame extends more than ¾ inch past curb face into the street (If applicable).	Frame is even with curb.
		Top slab has holes larger than 2 square inches or cracks wider than ¼ inch.	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than ¾ inch of the frame from the top slab.	Frame is sitting flush on top slab.
	Cracks in walls or bottom	Cracks wider than ½ inch and longer than 3 feet, any evidence of soil particles entering catch basin through cracks, or maintenance person judges that catch basin is unsound.	Catch basin is sealed and structurally sound.
		Cracks wider than ½ inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	No cracks more than $^1/_4$ inch wide at the joint of inlet/outlet pipe.
	Settlement/ misalignment	Catch basin has settled more than 1 inch or has rotated more than 2 inches out of alignment.	Basin replaced or repaired to design standards.
	Damaged pipe joints	Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering the catch basin at the joint of the inlet/outlet pipes.	No cracks more than ¼-inch wide at the joint of inlet/outlet pipes.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
Inlet/Outlet Pipe	Sediment accumulation	Sediment filling 20% or more of the pipe.	Inlet/outlet pipes clear of sediment.
	Trash and debris	Trash and debris accumulated in inlet/outlet pipes (includes floatables and non-floatables).	No trash or debris in pipes.
	Damaged	Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering at the joints of the inlet/outlet pipes.	No cracks more than ¼-inch wide at the joint of the inlet/outlet pipe.

NO. 5 – CATCH BASINS AND MANHOLES

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Metal Grates (Catch Basins)	Unsafe grate opening	Grate with opening wider than $^{7}/_{8}$ inch.	Grate opening meets design standards.
	Trash and debris	Trash and debris that is blocking more than 20% of grate surface.	Grate free of trash and debris. footnote to guidelines for disposal
	Damaged or missing	Grate missing or broken member(s) of the grate. **Any open structure requires urgent maintenance.**	Grate is in place and meets design standards.
Manhole Cover/Lid	Cover/lid not in place	Cover/lid is missing or only partially in place. **Any open structure requires urgent maintenance.**	Cover/lid protects opening to structure.
	Locking mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts cannot be seated. Self-locking cover/lid does not work.	Mechanism opens with proper tools.
	Cover/lid difficult to Remove	One maintenance person cannot remove cover/lid after applying 80 lbs. of lift.	Cover/lid can be removed and reinstalled by one maintenance person.

NO. 6 – CONVEYANCE PIPES AND DITCHES

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Pipes	Sediment & debris accumulation	Accumulated sediment or debris that exceeds 20% of the diameter of the pipe.	Water flows freely through pipes.
	Vegetation/roots	Vegetation/roots that reduce free movement of water through pipes.	Water flows freely through pipes.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Damage to protective coating or corrosion	Protective coating is damaged; rust or corrosion is weakening the structural integrity of any part of pipe.	Pipe repaired or replaced.
	Damaged	Any dent that decreases the cross section area of pipe by more than 20% or is determined to have weakened structural integrity of the pipe.	Pipe repaired or replaced.
Ditches	Trash and debris	Trash and debris exceeds 1 cubic foot per 1,000 square feet of ditch and slopes.	Trash and debris cleared from ditches.
	Sediment accumulation	Accumulated sediment that exceeds 20% of the design depth.	Ditch cleaned/flushed of all sediment and debris so that it matches design.
	Noxious weeds	Any noxious or nuisance vegetation which may constitute a hazard to County personnel or the public.	Noxious and nuisance vegetation removed according to applicable regulations. No danger of noxious vegetation where County personnel or the public might normally be.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Vegetation	Vegetation that reduces free movement of water through ditches.	Water flows freely through ditches.
	Erosion damage to slopes	Any erosion observed on a ditch slope.	Slopes are not eroding.
	Rock lining out of place or missing (If Applicable)	One layer or less of rock exists above native soil area 5 square feet or more, any exposed native soil.	Replace rocks to design standards.

NO. 7 – DEBRIS BARRIERS (E.G., TRASH RACKS)

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed.
Site	Trash and debris	Trash or debris plugging more than 20% of the area of the barrier.	Barrier clear to receive capacity flow.
	Sediment accumulation	Sediment accumulation of greater than 20% of the area of the barrier	Barrier clear to receive capacity flow.
Structure	Cracked broken or loose	Structure which bars attached to is damaged - pipe is loose or cracked or concrete structure is cracked, broken of loose.	Structure barrier attached to is sound.
Bars	Bar spacing	Bar spacing exceeds 6 inches.	Bars have at most 6 inche spacing.
	Damaged or missing bars	Bars are bent out of shape more than 3 inches.	Bars in place with no bends more than ¾ inch.
		Bars are missing or entire barrier missing.	Bars in place according to design.
		Bars are loose and rust is causing 50% deterioration to any part of barrier.	Repair or replace barrier to design standards.

NO. 11 – GROUNDS (LANDSCAPING)

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Site	Trash or litter	Any trash and debris which exceed 1 cubic foot per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size office garbage can). In general, there should be no visual evidence of dumping.	Trash and debris cleared from site.
	Noxious weeds	Any noxious or nuisance vegetation which may constitute a hazard to County personnel or the public.	Noxious and nuisance vegetation removed according to applicable regulations. No danger of noxious vegetation where County personnel or the public might normally be.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Grass/groundcover	Grass or groundcover exceeds 18 inches in height.	Grass or groundcover mowed to a height no greater than 6 inches.
Trees and Shrubs	Hazard	Any tree or limb of a tree identified as having a potential to fall and cause property damage or threaten human life. **A hazard tree identified by a qualified arborist must be removed as soon as possible.**	No hazard trees in facility.
	Damaged	Limbs or parts of trees or shrubs that are split or broken which affect more than 25% of the total foliage of the tree or shrub.	Trees and shrubs with less than 5% of total foliage with split or broken limbs.
		Trees or shrubs that have been blown down or knocked over.	No blown down vegetation or knocked over vegetation. Trees or shrubs free of injury.
		Trees or shrubs which are not adequately supported or are leaning over, causing exposure of the roots.	Tree or shrub in place and adequately supported; dead or diseased trees removed.

NO. 12 – ACCESS ROADS

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Site	Trash and debris	Trash and debris exceeds 1 cubic foot per 1,000 square feet (i.e., trash and debris would fill up one standards size garbage can).	Roadway drivable by maintenance vehicles.
		Debris which could damage vehicle tires or prohibit use of road.	Roadway drivable by maintenance vehicles.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Blocked roadway	Any obstruction which reduces clearance above road surface to less than 14 feet.	Roadway overhead clear to 14 feet high.
		Any obstruction restricting the access to a 10- to 12 foot width for a distance of more than 12 feet or any point restricting access to less than a 10 foot width.	At least 12-foot of width on access road.
Road Surface	Erosion, settlement, potholes, soft spots, ruts	Any surface defect which hinders or prevents maintenance access.	Road drivable by maintenance vehicles.
	Vegetation on road surface	Trees or other vegetation prevent access to facility by maintenance vehicles.	Maintenance vehicles can access facility.
Shoulders and Ditches	Erosion	Erosion within 1 foot of the roadway more than 8 inches wide and 6 inches deep.	Shoulder free of erosion and matching the surrounding road.
	Weeds and brush	Weeds and brush exceed 18 inches in height or hinder maintenance access.	Weeds and brush cut to 2 inches in height or cleared in such a way as to allow maintenance access.
Modular Grid Pavement	Contaminants and pollution	Any evidence of contaminants or pollution such as oil, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Damaged or missing	Access surface compacted because of broken on missing modular block.	Access road surface restored so road infiltrates.

NO. 21 – STORMFILTER (CARTRIDGE TYPE)

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Site	Trash and debris	Any trash or debris which impairs the function of the facility.	Trash and debris removed from facility.
	Contaminants and pollution	Any evidence of contaminants or pollution such as oils, gasoline, concrete slurries or paint.	Materials removed and disposed of according to applicable regulations. Source control BMPs implemented if appropriate. No contaminants present other than a surface oil film.
	Life cycle	System has not been inspected for three years.	Facility is re-inspected and any needed maintenance performed.
Vault Treatment Area	Sediment on vault floor	Greater than 2 inches of sediment.	Vault is free of sediment.
	Sediment on top of cartridges	Greater than ½ inch of sediment.	Vault is free of sediment.
	Multiple scum lines above top of cartridges	Thick or multiple scum lines above top of cartridges. Probably due to plugged canisters or underdrain manifold.	Cause of plugging corrected, canisters replaced if necessary.
Vault Structure	Damage to wall, Frame, Bottom, and/or Top Slab	Cracks wider than ½-inch and any evidence of soil particles entering the structure through the cracks, or qualified inspection personnel determines the vault is not structurally sound.	Vault replaced or repaired to design specifications.
	Baffles damaged	Baffles corroding, cracking warping, and/or showing signs of failure as determined by maintenance/inspection person.	Repair or replace baffles to specification.
Filter Media	Standing water in vault	9 inches or greater of static water in the vault for more than 24 hours following a rain event and/or overflow occurs frequently. Probably due to plugged filter media, underdrain or outlet pipe.	No standing water in vault 24 hours after a rain event.
	Short circuiting	Flows do not properly enter filter cartridges.	Flows go through filter media.
Underdrains and Clean-Outs	Sediment/debris	Underdrains or clean-outs partially plugged or filled with sediment and/or debris.	Underdrains and clean-outs free of sediment and debris.
Inlet/Outlet Pipe	Sediment accumulation	Sediment filling 20% or more of the pipe.	Inlet/outlet pipes clear of sediment.
	Trash and debris	Trash and debris accumulated in inlet/outlet pipes (includes floatables and non-floatables).	No trash or debris in pipes.
	Damaged	Cracks wider than ½-inch at the joint of the inlet/outlet pipes or any evidence of soil entering at the joints of the inlet/outlet pipes.	No cracks more than ¼-inch wide at the joint of the inlet/outlet pipe.
Access Manhole	Cover/lid not in place	Cover/lid is missing or only partially in place. **Any open manhole requires immediate maintenance.**	Manhole access covered.
	Locking mechanism not working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts cannot be seated. Self-locking cover/lid does not work.	Mechanism opens with proper tools.
	Cover/lid difficult to remove	One maintenance person cannot remove cover/lid after applying 80 lbs of lift.	Cover/lid can be removed and reinstalled by one maintenance person.
	Ladder rungs unsafe	Missing rungs, misalignment, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
Large access doors/plate	Damaged or difficult to open	Large access doors or plates cannot be opened/removed using normal equipment.	Replace or repair access door so it can opened as designed.

NO. 21 – STORMFILTER (CARTRIDGE TYPE)			
Maintenance Component	**Defect or Problem**	**Condition When Maintenance is Needed**	**Results Expected When Maintenance is Performed**
	Gaps, doesn't cover completely	Large access doors not flat and/or access opening not completely covered.	Doors close flat and cover access opening completely.
	Lifting Rings missing, rusted	Lifting rings not capable of lifting weight of door or plate.	Lifting rings sufficient to lift or remove door or plate.

NO. 24 – CATCH BASIN INSERT

Maintenance Component	Defect or Problem	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Media Insert	Visible Oil	Visible oil sheen passing through media	Media inset replaced.
	Insert does not fit catch basin properly	Flow gets into catch basin without going through media.	All flow goes through media.
	Filter media plugged	Filter media plugged.	Flow through filter media is normal.
	Oil absorbent media saturated	Media oil saturated.	Oil absorbent media replaced.
	Water saturated	Catch basin insert is saturated with water, which no longer has the capacity to absorb.	Insert replaced.
	Service life exceeded	Regular interval replacement due to typical average life of media insert product, typically one month.	Media replaced at manufacturer's recommended interval.
	Seasonal maintenance	When storms occur and during the wet season.	Remove, clean and replace or install new insert after major storms, monthly during the wet season or at manufacturer's recommended interval.

APPENDIX C

KCRTS Drainage Calculations

Level 3 Detention Vault

Retention/Detention Facility

Type of Facility:	Detention Vault	
Facility Length:	44.00	ft
Facility Width:	12.00	ft
Facility Area:	528.	sq. ft
Effective Storage Depth:	9.30	ft
Stage 0 Elevation:	0.00	ft
Storage Volume:	**4910.**	**cu. ft**
Riser Head:	9.30	ft
Riser Diameter:	18.00	inches
Number of orifices:	2	

Orifice #	Height (ft)	Diameter (in)	Full Head Discharge (CFS)	Pipe Diameter (in)
1	0.00	0.28	0.007	
2	7.00	0.47	0.010	4.0

Top Notch Weir: None

Outflow Rating Curve: None

Stage (ft)	Elevation (ft)	Storage (cu. ft)	Storage (ac-ft)	Discharge (cfs)	Percolation (cfs)
0.00	0.00	0.	0.000	0.000	0.00
0.01	0.01	5.	0.000	0.000	0.00
0.02	0.02	11.	0.000	0.000	0.00
0.18	0.18	95.	0.002	0.001	0.00
0.34	0.34	180.	0.004	0.001	0.00
0.50	0.50	264.	0.006	0.002	0.00
0.65	0.65	343.	0.008	0.002	0.00
0.81	0.81	428.	0.010	0.002	0.00
0.97	0.97	512.	0.012	0.002	0.00
1.13	1.13	597.	0.014	0.002	0.00
1.28	1.28	676.	0.016	0.002	0.00
1.44	1.44	760.	0.017	0.003	0.00
1.60	1.60	845.	0.019	0.003	0.00
1.76	1.76	929.	0.021	0.003	0.00
1.91	1.91	1009.	0.023	0.003	0.00
2.07	2.07	1093.	0.025	0.003	0.00
2.23	2.23	1177.	0.027	0.003	0.00
2.39	2.39	1262.	0.029	0.003	0.00
2.55	2.55	1346.	0.031	0.003	0.00
2.70	2.70	1426.	0.033	0.004	0.00
2.86	2.86	1510.	0.035	0.004	0.00
3.02	3.02	1595.	0.037	0.004	0.00
3.18	3.18	1679.	0.039	0.004	0.00
3.33	3.33	1758.	0.040	0.004	0.00
3.49	3.49	1843.	0.042	0.004	0.00
3.65	3.65	1927.	0.044	0.004	0.00
3.81	3.81	2012.	0.046	0.004	0.00
3.96	3.96	2091.	0.048	0.004	0.00

4.12	4.12	2175.	0.050	0.004	0.00
4.28	4.28	2260.	0.052	0.004	0.00
4.44	4.44	2344.	0.054	0.005	0.00
4.59	4.59	2424.	0.056	0.005	0.00
4.75	4.75	2508.	0.058	0.005	0.00
4.91	4.91	2593.	0.060	0.005	0.00
5.07	5.07	2677.	0.061	0.005	0.00
5.23	5.23	2761.	0.063	0.005	0.00
5.38	5.38	2841.	0.065	0.005	0.00
5.54	5.54	2925.	0.067	0.005	0.00
5.70	5.70	3010.	0.069	0.005	0.00
5.86	5.86	3094.	0.071	0.005	0.00
6.01	6.01	3173.	0.073	0.005	0.00
6.17	6.17	3258.	0.075	0.005	0.00
6.33	6.33	3342.	0.077	0.005	0.00
6.49	6.49	3427.	0.079	0.005	0.00
6.64	6.64	3506.	0.080	0.006	0.00
6.80	6.80	3590.	0.082	0.006	0.00
6.96	6.96	3675.	0.084	0.006	0.00
7.00	7.00	3696.	0.085	0.006	0.00
7.01	7.01	3701.	0.085	0.006	0.00
7.02	7.02	3707.	0.085	0.007	0.00
7.03	7.03	3712.	0.085	0.007	0.00
7.04	7.04	3717.	0.085	0.007	0.00
7.20	7.20	3802.	0.087	0.008	0.00
7.36	7.36	3886.	0.089	0.009	0.00
7.52	7.52	3971.	0.091	0.010	0.00
7.67	7.67	4050.	0.093	0.011	0.00
7.83	7.83	4134.	0.095	0.011	0.00
7.99	7.99	4219.	0.097	0.012	0.00
8.15	8.15	4303.	0.099	0.013	0.00
8.30	8.30	4382.	0.101	0.013	0.00
8.46	8.46	4467.	0.103	0.013	0.00
8.62	8.62	4551.	0.104	0.014	0.00
8.78	8.78	4636.	0.106	0.014	0.00
8.94	8.94	4720.	0.108	0.015	0.00
9.09	9.09	4800.	0.110	0.015	0.00
9.25	9.25	4884.	0.112	0.015	0.00
9.30	9.30	4910.	0.113	0.016	0.00
9.40	9.40	4963.	0.114	0.478	0.00
9.50	9.50	5016.	0.115	1.320	0.00
9.60	9.60	5069.	0.116	2.420	0.00
9.70	9.70	5122.	0.118	3.710	0.00
9.80	9.80	5174.	0.119	5.180	0.00
9.90	9.90	5227.	0.120	6.610	0.00
10.00	10.00	5280.	0.121	7.140	0.00
10.10	10.10	5333.	0.122	7.630	0.00
10.20	10.20	5386.	0.124	8.090	0.00
10.30	10.30	5438.	0.125	8.530	0.00
10.40	10.40	5491.	0.126	8.940	0.00
10.50	10.50	5544.	0.127	9.340	0.00
10.60	10.60	5597.	0.128	9.720	0.00
10.70	10.70	5650.	0.130	10.090	0.00
10.80	10.80	5702.	0.131	10.440	0.00

10.90	10.90	5755.	0.132	10.780	0.00
11.00	11.00	5808.	0.133	11.110	0.00

Hyd	Inflow	Outflow		Peak		Storage	
		Target	Calc	Stage	Elev	(Cu-Ft)	(Ac-Ft)
1	0.10	0.02	0.02	9.29	9.29	4903.	0.113
2	0.07	*******	0.01	7.51	7.51	3966.	0.091
3	0.06	0.01	0.01	7.29	7.29	3848.	0.088
4	0.04	*******	0.00	5.34	5.34	2820.	0.065
5	0.04	*******	0.00	4.89	4.89	2579.	0.059
6	0.07	0.01	0.00	3.87	3.87	2043.	0.047
7	0.08	*******	0.00	3.15	3.15	1661.	0.038
8	0.04	*******	0.00	2.06	2.06	1086.	0.025

Route Time Series through Facility
Inflow Time Series File:15620d.tsf
Outflow Time Series File:Level3

Inflow/Outflow Analysis
Peak Inflow Discharge: 0.096 CFS at 7:00 on Jan 9 in Year 8
Peak Outflow Discharge: 0.016 CFS at 19:00 on Jan 9 in Year 8
Peak Reservoir Stage: 9.29 Ft
Peak Reservoir Elev: 9.29 Ft
Peak Reservoir Storage: 4903. Cu-Ft
: 0.113 Ac-Ft

Flow Frequency Analysis
Time Series File:level3.tsf
Project Location:Landsburg

---Annual Peak Flow Rates---			-----Flow Frequency Analysis-------					
Flow Rate (CFS)	Rank	Time of Peak	- - Peaks - - (CFS)	(ft)	Rank	Return Period	Prob	
0.009	3	2/09/01 21:00	0.016	9.29	1	100.00	0.990	**100yr**
0.003	8	11/05/01 3:00	0.010	7.51	2	25.00	0.960	
0.005	5	3/06/03 23:00	0.009	7.31	3	10.00	0.900	**10yr**
0.004	7	8/26/04 6:00	0.005	5.34	4	5.00	0.800	
0.005	4	1/08/05 7:00	0.005	4.91	5	3.00	0.667	
0.004	6	10/28/05 2:00	0.004	3.87	6	2.00	0.500	**2yr**
0.010	2	11/24/06 8:00	0.004	3.18	7	1.30	0.231	
0.016	1	1/09/08 19:00	0.003	2.06	8	1.10	0.091	
Computed Peaks			0.014	8.59		50.00	0.980	

Flow Duration from Time Series File:level3.tsf

Cutoff CFS	Count	Frequency %	CDF %	Exceedence_Probability %	
0.000	77	0.126	0.126	99.874	0.999E+00
0.000	16435	26.802	26.928	73.072	0.731E+00
0.001	13811	22.523	49.450	50.550	0.505E+00
0.001	2334	3.806	53.257	46.743	0.467E+00
0.001	8405	13.707	66.963	33.037	0.330E+00
0.001	1472	2.401	69.364	30.636	0.306E+00
0.002	1245	2.030	71.394	28.606	0.286E+00

0.002	974	1.588	72.983	27.017	0.270E+00
0.002	10587	17.265	90.248	9.752	0.975E-01
0.002	339	0.553	90.801	9.199	0.920E-01
0.003	269	0.439	91.239	8.761	0.876E-01
0.003	216	0.352	91.592	8.408	0.841E-01
0.003	3226	5.261	96.853	3.147	0.315E-01
0.003	99	0.161	97.014	2.986	0.299E-01
0.004	79	0.129	97.143	2.857	0.286E-01
0.004	54	0.088	97.231	2.769	0.277E-01
0.004	1233	2.011	99.242	0.758	0.758E-02
0.004	15	0.024	99.266	0.734	0.734E-02
0.005	15	0.024	99.291	0.709	0.709E-02
0.005	9	0.015	99.305	0.695	0.695E-02
0.005	349	0.569	99.874	0.126	0.126E-02
0.005	2	0.003	99.878	0.122	0.122E-02
0.006	2	0.003	99.881	0.119	0.119E-02
0.006	4	0.007	99.887	0.113	0.113E-02
0.006	39	0.064	99.951	0.049	0.489E-03
0.006	0	0.000	99.951	0.049	0.489E-03
0.007	1	0.002	99.953	0.047	0.473E-03
0.007	0	0.000	99.953	0.047	0.473E-03
0.007	6	0.010	99.962	0.038	0.375E-03
0.007	4	0.007	99.969	0.031	0.310E-03
0.008	2	0.003	99.972	0.028	0.277E-03
0.008	1	0.002	99.974	0.026	0.261E-03
0.008	3	0.005	99.979	0.021	0.212E-03
0.008	2	0.003	99.982	0.018	0.179E-03
0.009	4	0.007	99.989	0.011	0.114E-03
0.009	1	0.002	99.990	0.010	0.978E-04

Route Time Series through Facility
  Inflow Time Series File:15620d.tsf
 Outflow Time Series File:Level3

Inflow/Outflow Analysis
   Peak Inflow Discharge: 0.096 CFS at 7:00 on Jan 9 in Year 8
  Peak Outflow Discharge: 0.016 CFS at 19:00 on Jan 9 in Year 8
    Peak Reservoir Stage: 9.29 Ft
     Peak Reservoir Elev: 9.29 Ft
  Peak Reservoir Storage: 4903. Cu-Ft
                        : 0.113 Ac-Ft

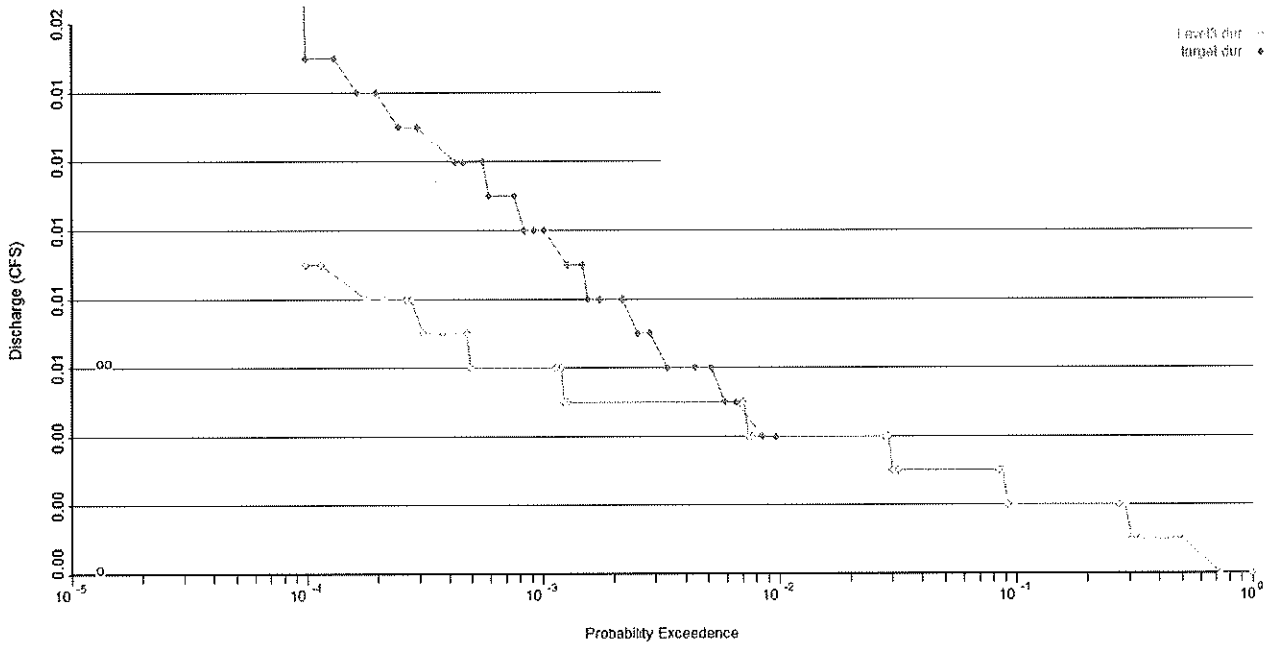
Flow Frequency Analysis
  Time Series File:level3.tsf
  Project Location:Landsburg

---Annual Peak Flow Rates---				-----Flow Frequency Analysis-------				
Flow Rate (CFS)	Rank	Time of Peak		- - Peaks - - (CFS)	(ft)	Rank	Return Period	Prob
0.009	3	2/09/01	21:00	0.016	9.29	1	100.00	0.990
0.003	8	11/05/01	3:00	0.010	7.51	2	25.00	0.960
0.005	5	3/06/03	23:00	0.009	7.31	3	10.00	0.900
0.004	7	8/26/04	6:00	0.005	5.34	4	5.00	0.800

0.005	4	1/08/05	7:00	0.005	4.91	5	3.00	0.667
0.004	6	10/28/05	2:00	0.004	3.87	6	2.00	0.500
0.010	2	11/24/06	8:00	0.004	3.18	7	1.30	0.231
0.016	1	1/09/08	19:00	0.003	2.06	8	1.10	0.091
Computed Peaks				0.014	8.59		50.00	0.980

Flow Duration from Time Series File:level3.tsf

Cutoff CFS	Count	Frequency %	CDF %	Exceedence_Probability %	
0.000	77	0.126	0.126	99.874	0.999E+00
0.000	16435	26.802	26.928	73.072	0.731E+00
0.001	13811	22.523	49.450	50.550	0.505E+00
0.001	2334	3.806	53.257	46.743	0.467E+00
0.001	8405	13.707	66.963	33.037	0.330E+00
0.001	1472	2.401	69.364	30.636	0.306E+00
0.002	1245	2.030	71.394	28.606	0.286E+00
0.002	974	1.588	72.983	27.017	0.270E+00
0.002	10587	17.265	90.248	9.752	0.975E-01
0.002	339	0.553	90.801	9.199	0.920E-01
0.003	269	0.439	91.239	8.761	0.876E-01
0.003	216	0.352	91.592	8.408	0.841E-01
0.003	3226	5.261	96.853	3.147	0.315E-01
0.003	99	0.161	97.014	2.986	0.299E-01
0.004	79	0.129	97.143	2.857	0.286E-01
0.004	54	0.088	97.231	2.769	0.277E-01
0.004	1233	2.011	99.242	0.758	0.758E-02
0.004	15	0.024	99.266	0.734	0.734E-02
0.005	15	0.024	99.291	0.709	0.709E-02
0.005	9	0.015	99.305	0.695	0.695E-02
0.005	349	0.569	99.874	0.126	0.126E-02
0.005	2	0.003	99.878	0.122	0.122E-02
0.006	2	0.003	99.881	0.119	0.119E-02
0.006	4	0.007	99.887	0.113	0.113E-02
0.006	39	0.064	99.951	0.049	0.489E-03
0.006	0	0.000	99.951	0.049	0.489E-03
0.007	1	0.002	99.953	0.047	0.473E-03
0.007	0	0.000	99.953	0.047	0.473E-03
0.007	6	0.010	99.962	0.038	0.375E-03
0.007	4	0.007	99.969	0.031	0.310E-03
0.008	2	0.003	99.972	0.028	0.277E-03
0.008	1	0.002	99.974	0.026	0.261E-03
0.008	3	0.005	99.979	0.021	0.212E-03
0.008	2	0.003	99.982	0.018	0.179E-03
0.009	4	0.007	99.989	0.011	0.114E-03
0.009	1	0.002	99.990	0.010	0.978E-04


Discharge (CFS)
0.02
0.01
0.01
0.01
0.01
0.01
0.00
0.00
0.00
oo
o
Level1 dur
target dur
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
Probability Exceedence

Existing Conditions KCRTS Peaks

Flow Frequency Analysis
Time Series File:15620u.tsf
Project Location:Landsburg

---Annual Peak Flow Rates---			-----Flow Frequency Analysis-------			
Flow Rate (CFS)	Rank	Time of Peak	- - Peaks - - (CFS)	Rank	Return Period	Prob
0.016	2	2/09/01 15:00	**0.019**	1	**100.00**	0.990
0.003	7	1/05/02 16:00	0.016	2	25.00	0.960
0.011	4	2/28/03 16:00	**0.013**	3	**10.00**	0.900
0.002	8	3/03/04 1:00	0.011	4	5.00	0.800
0.010	5	1/05/05 11:00	0.010	5	3.00	0.667
0.008	6	1/18/06 21:00	**0.008**	6	**2.00**	0.500
0.013	3	11/24/06 5:00	0.003	7	1.30	0.231
0.019	1	1/09/08 7:00	0.002	8	1.10	0.091

Computed Peaks

Developed Conditions KCRTS Peaks

Flow Frequency Analysis
Time Series File:15620d.tsf
Project Location:Landsburg

---Annual Peak Flow Rates---			-----Flow Frequency Analysis-------			
Flow Rate (CFS)	Rank	Time of Peak	- - Peaks - - (CFS)	Rank	Return Period	Prob
0.057	7	2/09/01 2:00	**0.096**	1	**100.00**	0.990
0.040	8	12/03/01 17:00	0.076	2	25.00	0.960
0.071	4	9/10/03 15:00	**0.074**	3	**10.00**	0.900
0.076	2	8/26/04 1:00	0.071	4	5.00	0.800
0.063	6	10/28/04 18:00	0.066	5	3.00	0.667
0.066	5	10/22/05 17:00	**0.063**	6	**2.00**	0.500
0.074	3	10/26/06 3:00	0.057	7	1.30	0.231
0.096	1	1/09/08 7:00	0.040	8	1.10	0.091

Computed Peaks

PROGRAM INPUT DATA

```
   KCRTS Program...File Directory:
C:\KC_SWDM\KC_DATA\
[C] CREATE a new Time Series
LA
       0.21        0.00        0.000000  Till Forest
       0.00        0.00        0.000000  Till Pasture
       0.00        0.00        0.000000  Till Grass
       0.00        0.00        0.000000  Outwash Forest
       0.00        0.00        0.000000  Outwash Pasture
       0.00        0.00        0.000000  Outwash Grass
       0.00        0.00        0.000000  Wetland
       0.00        0.00        0.000000  Impervious
15620u.tsf
 T
    0.85
 T
[T] Enter the Analysis TOOLS Module
[P] Compute PEAKS and Flow Frequencies
15620u.tsf
15620u.pks
[R] RETURN to Previous Menu
[C] CREATE a new Time Series
LA
       0.00        0.00        0.000000  Till Forest
       0.00        0.00        0.000000  Till Pasture
       0.00        0.00        0.000000  Till Grass
       0.00        0.00        0.000000  Outwash Forest
       0.00        0.00        0.000000  Outwash Pasture
       0.00        0.00        0.000000  Outwash Grass
       0.00        0.00        0.000000  Wetland
       0.21        0.00        0.000000  Impervious  (Impervious Roof Area)
15620d.tsf
 T
    0.85
```