Western Geotechnical Consultants, Inc.
4183 Saltsprings Dr., Ferndale, WA 98248 Phone/FAX (360)380-2507

CITY OF MONROE
RECEIVED
JUL 18 2012
COMMUNITY DEVELOPMENT

February 20, 2008

Mr. John Dennis
323 Dunbar Lane
Camano Island, WA 98282

Re: Geotechnical Site Investigation
159th St. SE, on the East and West Sides of Dennis Way
Monroe, WA 98272-2009

Western Geotechnical Consultants, Inc. is pleased to provide this geotechnical engineering report prepared for the above referenced property. The property is a rectangular shaped parcel that is located on the south side of 159th St. SE and on the east and west sides of Dennis Way in Monroe, Washington. The plan is to develop a 26 lot plat with on-site infiltration facilities to accommodate stormwater. Figure 1 is a site plan showing the preliminary site plan layout.

The USDA Soils Classification Service "Soil Survey of Snohomish County Area, Washington" has classified the soils as Sultan silt loam. This very deep, moderately well drained soil is located over flood plains. It formed in alluvium in glacial outwash and it is underlain by basins and outwash plains. The permeability of Sultan soils is moderately slow. Runoff is slow and the threat of water erosion is slight. The near surface and underlying soils identified in our investigation are consistent with the Soil Conservation Service (SCS) soil description.

The purpose of our investigation was to evaluate the site with respect to developing the site using on-site infiltration of stormwater. The specific scope of our investigation for the site included the following services:

- Review available published geologic, geotechnical and topographic information for the area including soil and groundwater information for nearby properties contained in our files.
- Excavate 2 test pits and obtain samples to explore soil and groundwater conditions within the proposed infiltration tract (see Figure 1). Piezometers were installed in both of the test pits for future monitoring of groundwater levels.
- Classify soils in accordance with the Unified Soils Classification System (USCS).
- Perform field and laboratory testing as deemed necessary in support of our conclusions and recommendations. Lab testing included grain size analyses performed in accordance with the USDA textural triangle methodology so as to determine design infiltration rate of the site soils.
- Prepare this engineering report including a summary of work performed and our conclusions and recommendations regarding:
  - Soil and groundwater information for use in designing infiltration facilities.
  - Provide design infiltration rates for use in stormwater facilities design.
  - Provide recommended subgrade strength values (California Bearing Ratio) for use in designing the road section.
  - Provide seismic design parameters for structural design
  - General site development recommendations with respect to geotechnical issues identified during our field investigation.

Site Conditions

Surface Conditions

Access to the site is from the south via Dennis Way and from the north via 159th St. SE. The property is a relatively flat, rectangular shaped parcel that is presently partly wooded and partly grass and weed covered.

Subsurface Conditions

Subsurface soil and groundwater conditions were explored on February 11, 2008 when a total of two test pits were advanced using a tracked excavator with a 3-foot wide bucket. In addition 2 test pits were excavated by Cascade Survey and Engineering, Inc. in June 2007 and these logs are attached to this report. The test pits were excavated at the approximate locations shown on the attached Site Plan, Figure 1. Soil and groundwater conditions were continuously logged using the Unified Soils Classification System (USCS) and soil samples were obtained for inspection and testing. Edited tabulated test pit logs are included in this report together with a USCS chart explaining soil descriptions.

Subsurface conditions were found to be very similar at the 2 test pit sites. The subsurface profile consists of about a foot or more of dark brown sandy organic SILT to silty SAND with numerous roots (OL/SM by USCS) (forest duff) with numerous roots and organic debris that was in a soft and wet state. Below the topsoil layer we encountered silty fine SAND to sandy SILT (SM/ML by USCS) that extended to a depth of 2 to 2-1/2 feet below grade. This soil unit is underlain by SILT (ML by USCS) that extended to a depth of 5 to 6 feet below grade. The silt layer was underlain by a medium to coarse sandy GRAVEL and cobbles (GW by USCS) with sandy zones and boulder zones that extended to the depth of the test pits (15.3 feet maximum).

Groundwater

Groundwater was not encountered in either of the test pits at the time of the investigation on 2/11/2008. Piezometers were installed in both test pits for future monitoring of the groundwater levels.

We returned to the site on February 18, 2008 to read the piezometers and we determined that the piezometers were dry full depth. The results of the piezometer readings are summarized below.

Test Pit No.	Depth of Test Pit (feet)	Water Level (BGS)
1	15.0'	Dry
2	15.3'	Dry

Laboratory Testing

Laboratory tests were performed on selected soil samples obtained during our test pit investigation. Laboratory testing included soil inspection under controlled laboratory conditions, moisture content determination, and grain size analyses performed in accordance with the USDA textural triangle methodology. The moisture content test results are included in the tabulated log of test pits and the results of the grain size analyses are attached to this report in the form of grain size distribution curves. The results of the USDA grain size tests are also plotted on the attached USDA Textural Triangle.

Conclusions and Recommendations

General

Based on our geotechnical investigation, we conclude that stormwater infiltration will be feasible for the property. The following section provides our analyses and recommendations for the infiltration rate based on our geotechnical investigation and subsequent laboratory testing of the representative relatively clean granular soils located below the silty soil layer.

Infiltration Rate

We determined the infiltration rate for representative soils encountered in the Test Pits at the site in accordance with the 2005 edition of the Washington Department of Ecology (DOE) Stormwater Management Manual for Western Washington. Representative, relatively free-draining soil samples taken from beneath the topsoil and near surface silty soils were tested. The soils were classified in the field and are documented on the test pit logs as sandy GRAVEL (GW by the USCS). A total of 2 grain size analyses were performed. The test results are attached to this report in the form of grain size distribution curves and the results are also plotted on the USDA textural triangle.

Based on the testing the soil is sandy GRAVEL. The 2005 Stormwater Management Manual recommends a long term (design) infiltration rate of 6.5 inches an hour for the sandy gravel with a $D_{10} \geq 0.3$mm (see Table 3.8 in the Stormwater Management Manual).

General Site Development

The following sections of this report contain recommendations for general site development. Note that these recommendations are based on the limited scope of subsurface exploration performed as a part of our geotechnical services for the project.

Site Preparation: All topsoil or other organic, soft or deleterious material must be stripped and removed from those areas to be developed. Based on our test pit investigation, a stripping depth of about 1 foot should be anticipated. Note that deeper over-excavation may be required where deeper unsuitable soils such as tree root balls or unidentified fill soils are encountered.

IBC Site Classification: Based on our geotechnical investigation the site soils are classified as soil type D, stiff soil profile. The earthquake spectral responses (S_{ms} and S_{m1}) may be computed using Soil Class D and Tables 1615.1.2 (1) and 1615.1.2(2) of the IBC (2003 ed.).

Access Road Subgrade Strength Design Parameters
On the basis of our review of site soil conditions mapped by the SCS and soil conditions along the infiltration site, a minimum CBR value of 7 has been assumed for the near surface soils. This value is based on correlation of soil type and our experience at sites with similar soil conditions.

Some of the important factors that affect the durability of pavement surfacing include stability and permeability of the subgrade soils and base materials, the presence of ground water, design life of the road section, the traffic volume, and the frequency of heavy truck traffic. The road section design should include the factors listed above or should meet the City of Monroe standards for residential roads.

The pavement section should be installed over firm sub-grade. Following excavation and/or filling to establish sub-grade elevation, but immediately prior to road section installation, the sub-grade surface should be proof rolled with a loaded 10 cubic yard dump truck or equivalent. Any soft areas exposed by the proof rolling which cannot be easily compacted should be over-excavated and back filled with compacted granular fill.

Erosion Control: Erosion control during construction of the proposed facilities can be accomplished through placement of proper sedimentation control facilities. We recommend siltation control facilities, consisting of either hay bales or silt fences, be fabricated around all construction areas. Typical details for siltation control facilities using either hay bales or silt fences are attached to this report.

Siltation devices should be placed down gradient of all construction areas and cleared areas to provide siltation control during construction. All siltation control devices should be maintained in operable condition during construction, and left in operable condition until the site has been revegetated and siltation is no longer a threat. At that time the siltation facilities should be removed.

Closure

The scope of our services was limited to two test pits excavated across the proposed infiltration site to obtain subsurface information for stormwater infiltration design and general site development. If subsurface soil conditions encountered during the site development are different or appear to be different from those indicated in this report, we should be advised immediately so we can review and revise our recommendations, if necessary.

Thank you for the opportunity to be of assistance to you on this project. If you have any questions regarding the contents of this report or if we can be of further assistance please contact our office.

Sincerely,

Western Geotechnical Consultants, Inc.

Theodore A. Hammer, P.E.
Geotechnical Engineer

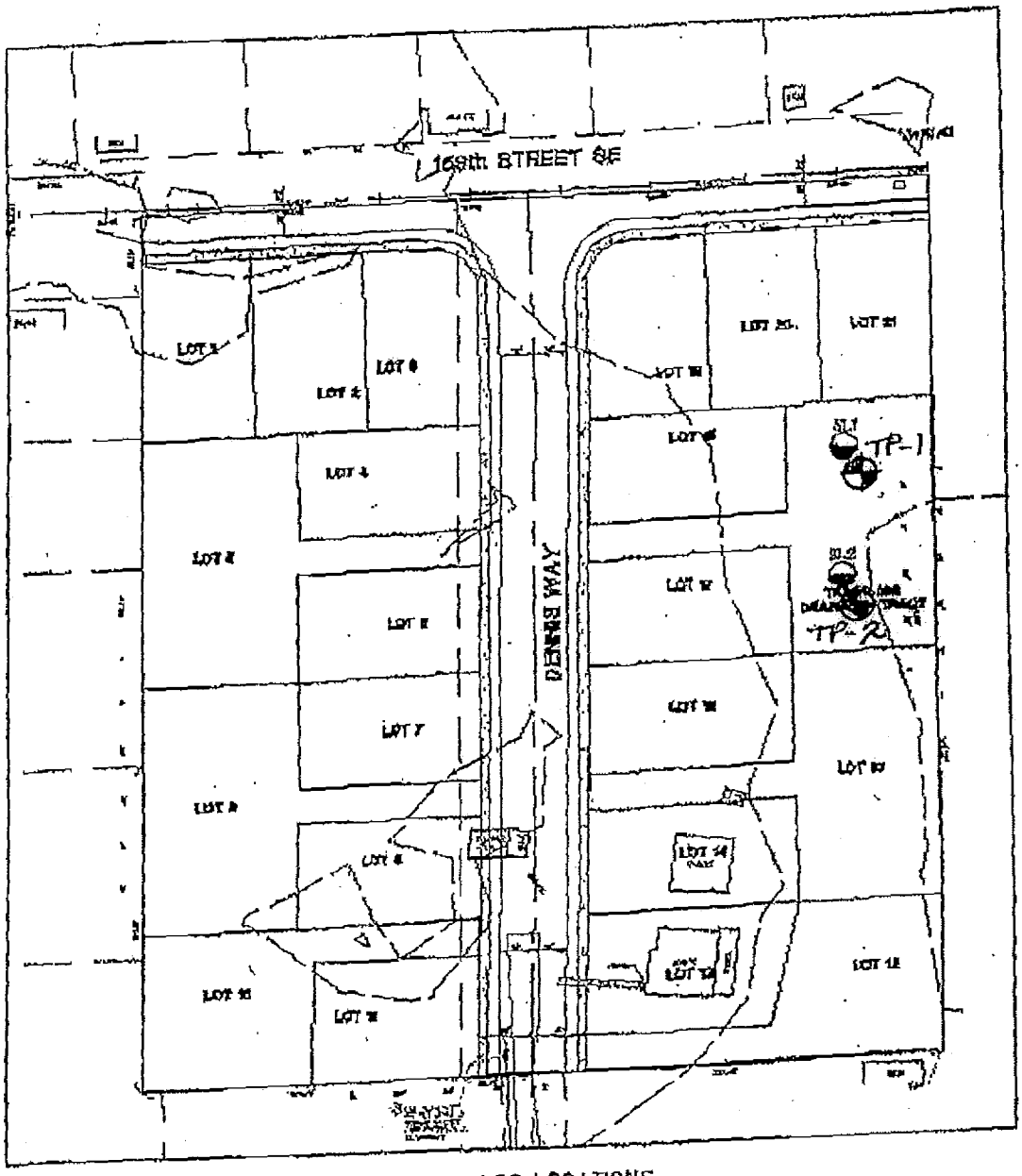
THEODORE A. HAMMER
STATE OF WASHINGTON
25870
REGISTERED
PROFESSIONAL ENGINEER
EXPIRES 12/27/09

Inclusions: Figure 1, Site Plan
USCS Classification Chart
Log of Test Pits
Attachments: Grain Size Distribution Curves
USDA Textural Triangle
Log of Test Pits Prepared by Cascade Surveying and Engineering, Inc.

File: 08 09 1

Geotechnical Site Investigation
Dennis Property
159th St SE
Monroe, WA
February 20, 2008

Figure 1
Site Plan & Test Pit Locations
Dennis Property – 159th St. SE
Monroe, Washington



SOIL LOG LOCATIONS

VICINITY MAP AND SOIL LOG LOCATIONS

Geotechnical Site Investigation
Dennis Property
159th St SE
Monroe, WA
February 20, 2008

Western Geotechnical Consultants, Inc.
08 09 1

(Page 7 of 9)

USCS Chart & Key to Test Pit Descriptions

UNIFIED SOIL CLASSIFICATION CHART (USCS)

MAJOR DIVISIONS			GRAPH SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES) <5%		GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES) <12%		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES) <5%		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES) <12%		SM	SILTY SANDS, SAND-SILT MIXTURES
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND 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, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

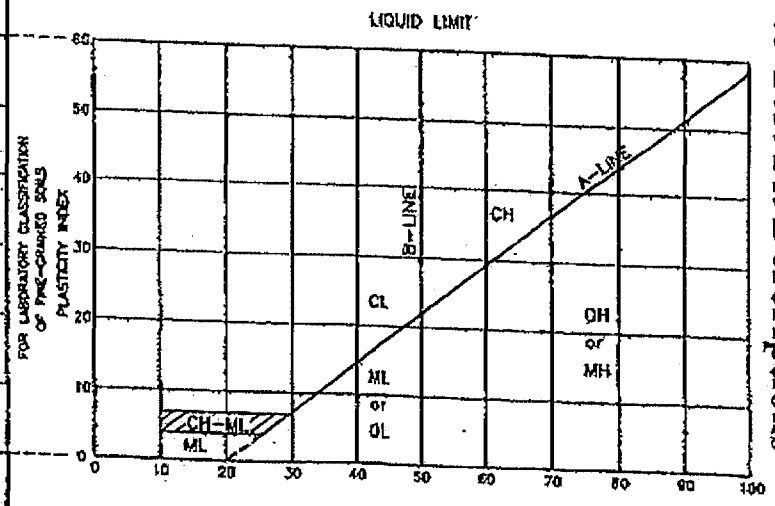
GRADATION CHART

MATERIAL SIZE		PARTICLE SIZE			
		LOWER LIMIT		UPPER LIMIT	
		MILLIMETERS	SIEVE SIZE	MILLIMETERS	SIEVE SIZE
SAND	FINE	.074	#200 *	0.42	#40 *
	MEDIUM	0.42	#40 *	2.00	#10 *
	COARSE	2.00	#10 *	4.76	#4 *
GRAVEL	FINE	4.76	#4 *	191	3/4" *
	COARSE	191	3/4" *	752	3" *
COBBLES		78.2	3" *	304.8	12" *
BOULDERS		304.8	12" *	914.1	

* U.S. STANDARD * CLEAR SQUARE OPENINGS

5-12% FINES (SILT & CLAY) DUAL CLASS

PLASTICITY CHART



Western Geotechnical Consultants, Inc.

4181 Saltsprings Drive • Ferndale, WA 98248
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Key to Test Pit Logs Using the Unified Soil Classification System

DATE: 8/11/95 SCALE: N/A N/A

A:TEST PITS

			Log of Test Pits		File: 08 09 1	
Test Pit No.	Depth Interval (feet)	USCS Class.	Soil Description	Sample No./ Depth (feet)	Water Content (%)	Lab Testing
TP-1	0.0-1.0	OL/SM	Dark brown sandy organic SILT to silty SAND with numerous roots and organic debris (soft, wet) (forest duff)			
	1.0-2.5	SM/ML	Brown silty fine SAND to sandy SILT, some roots (very wet, relatively non-compact)	1-1/1.5'	27.1%	
	2.5-5.0	ML	Gray brown SILT (very wet, relatively compact)	1-2/4.0'	34.8%	
	5.0-15.0	GW	Multi colored medium to coarse sandy GRAVEL with numerous cobbles (moist, relatively compact) (gravel & cobbles are rounded) (sandy zone at 8 to 8-1/2 ft. (SP)) (cobbly w/occasional boulders at 11 feet) (boulders at 13-1/2 ft., hard to excavate)	1-3/7.0' 1-4/13.0' 1-5/14.5'	8.4% 4.7% 5.4%	*GS

Notes:

- Test Pit terminated on 02/11/08 at 15.0 feet.
- No groundwater seepage encountered.
- Piezometer installed full depth.
- Piezometer read on 2/18/08 and test pit was dry full depth.
- Test pit backfilled upon completion.

*GS indicates a grain size test was performed in accordance with the textural triangle methodology.

			Log of Test Pits		File: 08 09 1	
Test Pit No.	Depth Interval (feet)	USCS Class.	Soil Description	Sample No./ Depth (feet)	Water Content (%)	Lab Testing
TP-2	0.0-1.3	OL/SM	Dark brown sandy organic SILT to silty SAND with numerous roots and organic debris (soft, wet) (forest duff)	2-1/0.8'	70.0%	
	1.3-2.1	SM/ML	Brown silty fine SAND to sandy SILT, some roots (very wet, relatively non-compact)	2-2/3.0'	34.7%	
	2.1-6.0	ML	Gray brown SILT (wet, relatively compact)	2-3/8.0'	11.0%	
	6.0-15.3	GW	Multi colored medium to coarse sandy GRAVEL with numerous cobbles (moist, relatively compact) (gravel & cobbles are rounded) (sandy zones at 6.6 to 7.3 ft. (SP)) (boulders and cobbles at 9 ft.) (hard to excavate at 10.0 ft.) (sandy zone at 14.0 ft.) (hard to excavate at 15 ft.)	2-4/15.0'	6.7%	*GS

Notes:

- Test Pit terminated on 02/11/08 at 15.3 feet.
- No groundwater seepage encountered.
- Piezometer installed full depth.
- Piezometer read on 2/18/08 and test pit was dry full depth.
- Test pit backfilled upon completion.

*GS indicates a grain size test was performed in accordance with the textural triangle methodology.

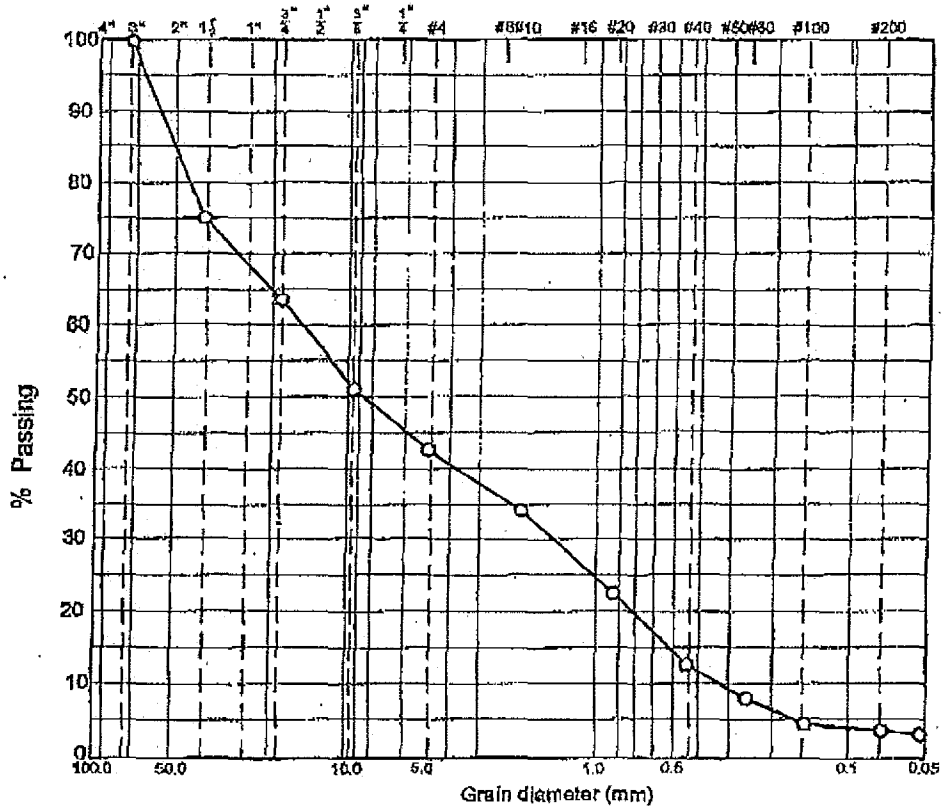
GEOTEST
741 Marine Drive
Bellingham, WA 98225
PHONE 360 733_7318
TOLL FREE 888 251_5276
FAX 360 733_7418

TEST REPORT
SOIL SIEVE ANALYSIS

PROJECT: Dennis Addition Site - General Services
CLIENT: Western Geotechnical
AGG. TYPE: USDA - Sand, USCS - Gravel w/ Sand (GP)
SOURCE: Native, Test Pit 1
LOCATION: -
LAB SAMPLE #: 5831

JOB NO: 08-0042
REPORT NO: S7
DATE: 2-22-08
PAGE NO: 1 of 1
SAMPLE DATE: 2-19-08
SAMPLED BY: Client

GRAIN-SIZE DISTRIBUTION CURVE



Coarse	Fine	Coarse	Medium	Fine
GRAVEL		SAND		

SIEVE SIZE	PASSING %	SPEC. *
3"	100	-
1-1/2"	75	-
3/4"	64	-
3/8"	51	-
#4	43	-
#10	34	-
#20	23	-
#40	13	-
#60	7	-
#100	4	-
#200	3.4	-
#270	2.9	-

Specification:

TEST PROCEDURES:
Dry Sieve: ASTM D422
Wet Sieve: ASTM D1140

Comments:

Copies: Client

Submitted By: Grant Richardson
Technical Director

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Bellingham, WA 98225
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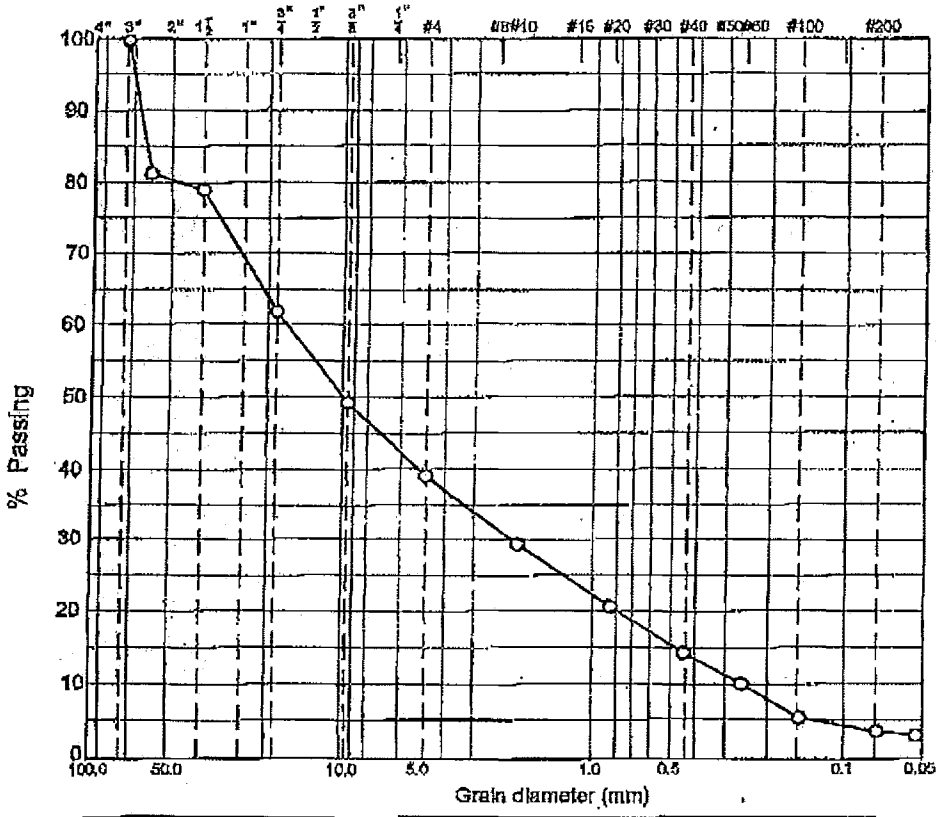
TOLL FREE 888 251_5276
FAX 360 733_7418

TEST REPORT
SOIL SIEVE ANALYSIS

PROJECT:	Dennis Addition Site - General Services	JOB NO:	08-0042
CLIENT:	Western Geotechnical	REPORT NO:	S8
AGG. TYPE:	USDA - Sand, USCS - Gravel w/ Sand (GW)	DATE:	2-22-08
SOURCE:	Native, Test Pit 2	PAGE NO:	1 of 1
LOCATION:	-	SAMPLE DATE:	2-19-08
LAB SAMPLE #:	5832	SAMPLED BY:	Client

GRAIN-SIZE DISTRIBUTION CURVE



SIEVE SIZE	PASSING %	SPEC. *
3"	100	-
2-1/2"	82	-
1-1/2"	79	-
3/4"	62	-
3/8"	49	-
#4	39	-
#10	29	-
#20	21	-
#40	14	-
#80	10	-
#100	5	-
#200	4.0	-
#270	3.2	-

Specification:

TEST PROCEDURES:
Dry Sieve: ASTM D422
Wet Sieve: ASTM D1140

Comments: * There was one large 2-1/2" rock in the sample.

Copies: Client

Submitted By:
Grant Richardson
Technical Director

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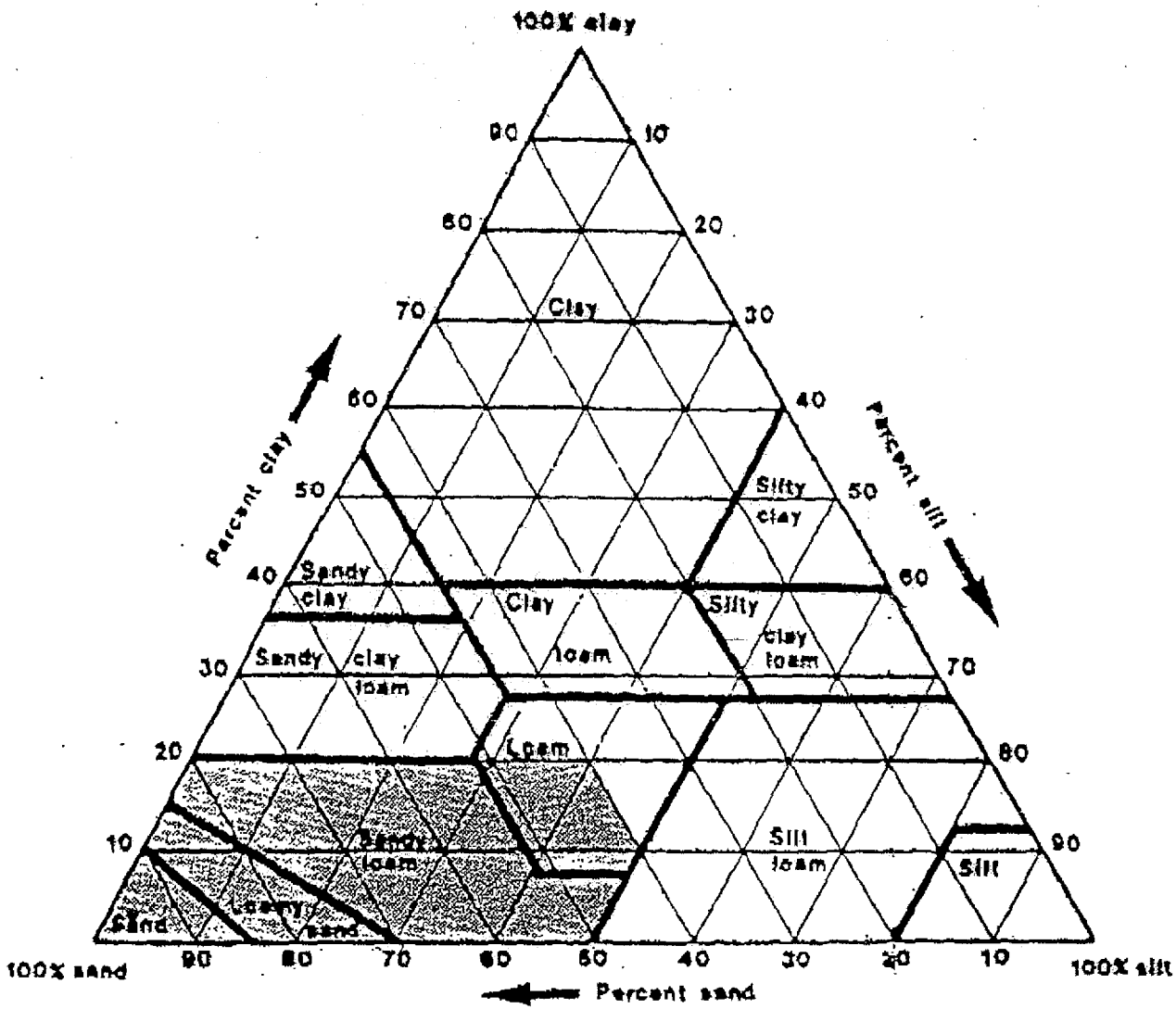
Textural Triangle U.S.D.A.



JOB NO.	Western Geotechnical Consultants
SUBMITTED BY	4183 Salt Spring Drive Ferndale, WA 98248 (360) 380-2307
DRAWN BY	
CHECKED BY	

DATE

SCALE N/A

Figure 1
Test Pit Logs by
Cascade Surveying & Engineering, Inc.
Dennis Property – 159th St. SE
Monroe, Washington

SOIL LOGS

TEST PIT	DEPTH	DESCRIPTION
SL1	0'-3'	BRN SA LOAM
	3'-7'	TAN SI SA LOAM
	7'-11'	GRAY GR MED SA
	11'-15'+	GRAY GR MED SA W/COBBLES
		NO HARDPAN OR WATER FOUND
		ROOTS AT 7'
SL2	0'-3.5'	BR SA LOAM
	3.5'-10'	GRAY MED SAND
	10'-15'+	GRAY GR MED SA
		NO HARDPAN OR WATER FOUND
		ROOTS AT 4.5'