

4.2 Topsoil

Topsoil was observed in all of the exploration pits to a depth of about 6 to 12 inches below existing site grades. These soils consist of loose, wet, dark brown, silty sand with little gravel and frequent organics. Due to the amount of organic material in the topsoil and low density of the soil, we do not consider it suitable for foundation support.

4.3 Lodgement Till

Lodgement till was observed at or near the surface in most of our exploration pits. The explorations for Dubuque Ridge I (EP-12 through EP-21) all terminated in lodgment till, whereas the explorations for Dubuque Ridge II (EP-1 through EP-11) generally encountered lodgement till at the surface, but generally terminated in an older, pre-Fraser deposit. The lodgement till generally consisted of medium dense to very dense, silty sand containing varying amounts of gravel. Lodgement till was deposited at the base of the Vashon-age glacial ice sheet and was subsequently overridden by approximately four thousand feet of ice in the project area. Consequently, these materials are typically dense to very dense, possess high strength, low compressibility characteristics, and are relatively impermeable. The upper portions of the lodgement till were generally weathered and less dense, oxidized brown, and siltier than the lower, unweathered portions of the deposit. The lodgement till is suitable for foundation support. The lodgement till has a large proportion of fine-grained material, making it susceptible to disturbance when wet. The very low permeability of the unweathered till makes the unit unsuitable for storm water infiltration.

4.4 Advance Outwash

Exploration pits EP-5 and EP-7 contained dense, gravelly sand with relatively low silt content. The soils encountered in these exploration pits are tentatively interpreted to be Vashon advance outwash deposits. Advance outwash deposits were deposited ahead of the advancing, Vashon-age, glacial ice sheet in meltwater streams and subsequently overridden by several thousand feet of ice. Consequently, these materials are usually dense to very dense, possess high shear strength, and have low compressibility characteristics. Advance outwash deposits are suitable for direct foundation support.

4.5 Pre-Fraser Deposits

Exploration pits EP-1, EP-2, EP-3, EP-4, EP-8, EP-9, and EP-11 terminated in pre-Fraser deposits. Most of the pre-Fraser deposits consisted of hard, oxidized, brown to gray, micaceous silt with variable percentages of sand. Compressed organic material was encountered in EP-4. EP-11 contained hard, sandy silt, with minor gravel, was unsorted,

exhibited faint fissility, and had a weak reaction to Hydrochloric Acid (HCl). These older deposits are distinguished by greater weathering than Vashon-age deposits. In outcrops, they are generally oxidized throughout the full thickness of the exposure to either a mottled gray and orange or a more uniform orange-brown. Most of the pre-Fraser deposits are tentatively interpreted to be non-glacial in origin. However, the sediments encountered in EP-11 are interpreted to be glacial in origin.

4.6 Bedrock

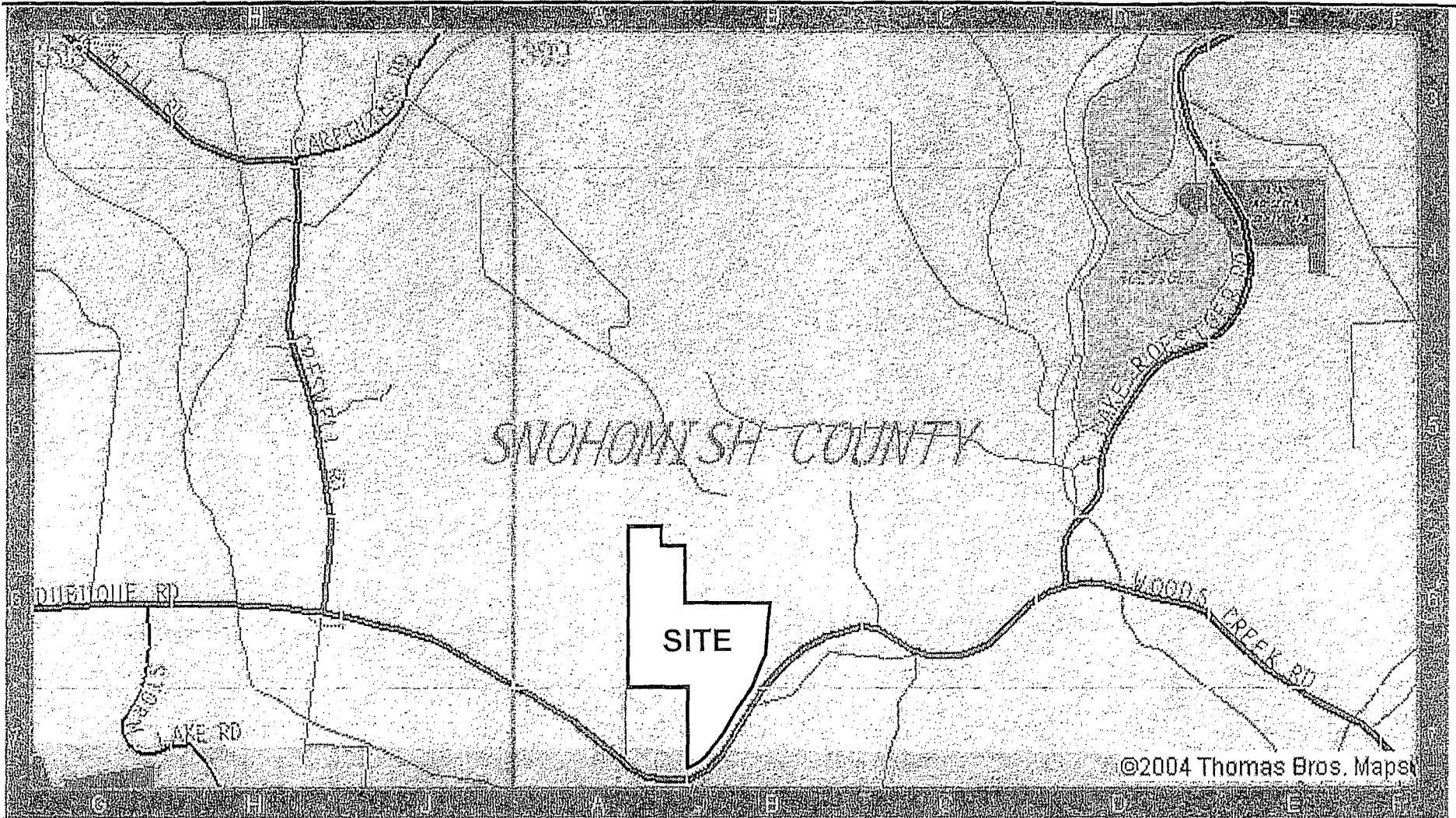
Fresh bedrock was not encountered in the exploration pits completed for this study. However, bedrock is mapped in the immediate vicinity and could be encountered at relatively shallow depths. Supplemental site-specific subsurface exploration should be conducted as design plans progress and the location and cuts or trenches have been determined. If bedrock is present, blasting could be required for deep excavation in some areas.

4.7 Literature Review

We reviewed geologic data for the site based on the United States Geological Survey (USGS) *Surficial Geologic Map of the Skykomish and Snoqualmie Rivers Area, Snohomish and King County, Washington*, by Booth, dated 1990. This map indicates that the near-surface sediment in the site vicinity consists of lodgement till. Advance outwash deposits similar to those encountered in exploration pits EP-5 and EP-7 and the older pre-Fraser deposits encountered in the northern portion (Dubuque II) of the property were not identified on the map by the USGS; however, the USGS maps show regional conditions and may not accurately portray site-specific conditions. AESI's site-specific geologic findings supplement the information presented on the USGS map.

4.8 Hydrology

Shallow ground water seepage was observed in exploration pits EP-3, EP-5, EP-6, EP-11, EP-17, EP-18, EP-19, EP-20, and EP-21 at depths ranging from about 2.5 to 8 feet below existing site grades. The shallow ground water is typical of perched ground water conditions. During wetter winter and early spring months, perched ground water can develop within weathered till or man-placed fill above the lodgement till. Perched ground water develops when vertical infiltration is impeded by a low permeability horizon (lodgement till) and horizontal flow occurs. The quantity and duration of perched flow from excavations that cut through a perched layer depends on topography, soil grain size, and season. It should be noted that fluctuations in the level of the ground water may also occur at any time of the year due to variations in rainfall and off-site uses.



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VICINITY MAP
 DUBUQUE RIDGE I AND II
 SNOHOMISH COUNTY, WASHINGTON

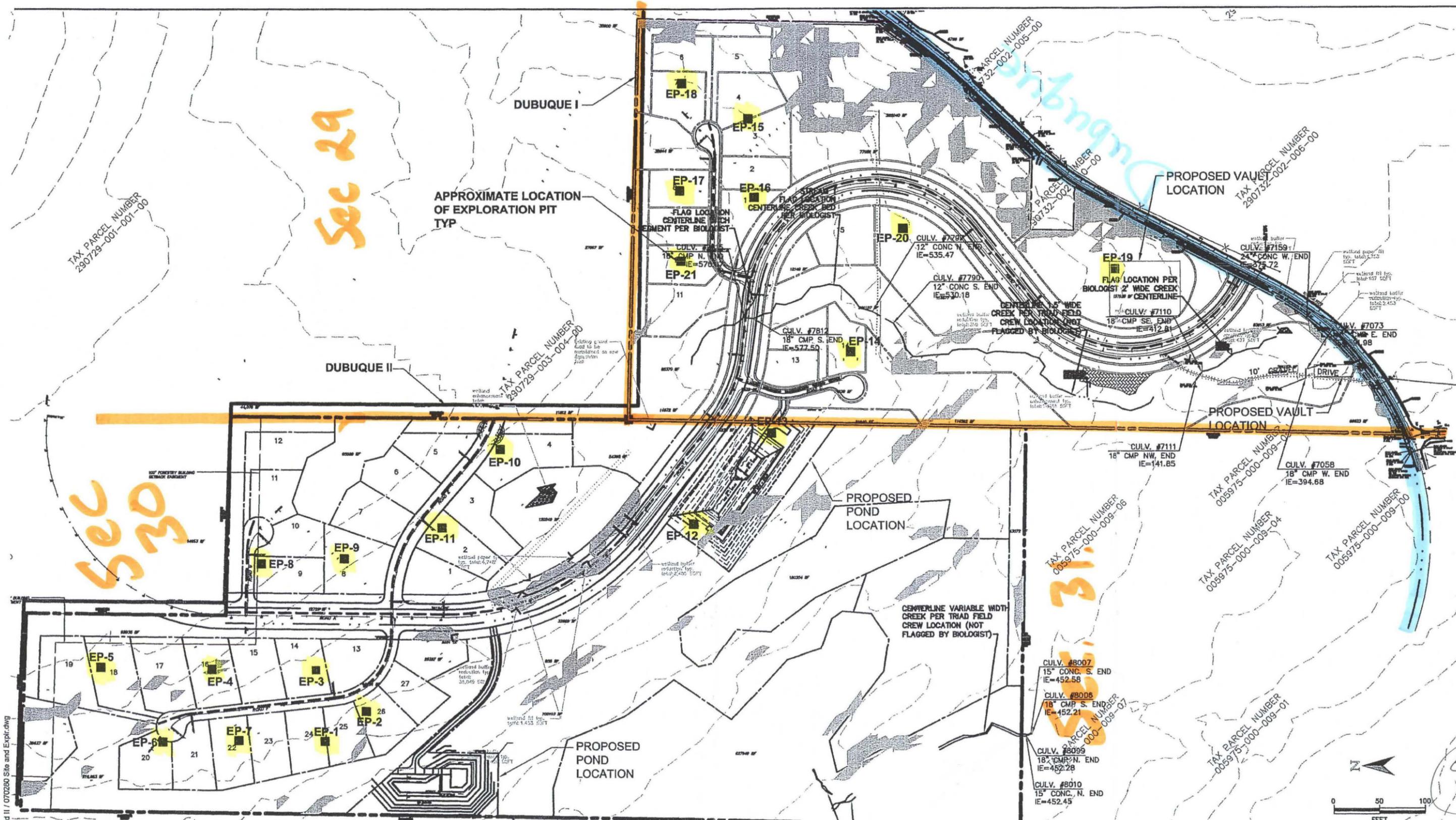
FIGURE 1

DATE 5/07

PROJ. NO. EE070280A

FP12 - FP32

Document ID = 2



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SITE AND EXPLORATION PLAN
DUBUQUE RIDGE I AND II
SNOHOMISH COUNTY, WASHINGTON

FIGURE 2
DATE 5/07
PROJECT NO. EE070280A

5% = 25% → 50% → 40%

070280 Dubuque Ridge I and II / 070280 Site and Explr.dwg

LOG OF EXPLORATION PIT NO. EP-1

TP 12

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.
DESCRIPTION	
	Topsoil
	Lodgement Till
1	Loose, moist, brown, oxidized, silty SAND, few gravel, roots.
2	
3	Grades to medium dense, very moist.
4	Grades to dense, moist, gray-brown, silty SAND, few gravel, some clay.
5	
6	
7	Pre-Fraser Deposit
8	Hard, moist, brown, oxidized, sandy SILT.
9	
10	Hard, moist, blue-gray, SILT, with sand, trace gravel.
11	Bottom of exploration pit at depth 10.5 feet No water. No caving.
12	
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Q_{gtv}

Q_{ph}

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LOG OF EXPLORATION PIT NO. EP-2

TP13

Depth (ft)	DESCRIPTION	
	Topsoil	
	Lodgement Till	
1	Loose, moist, brown, oxidized, silty SAND, some gravel.	
2	Pre-Fraser Deposit	
3	Very stiff, wet, orange-brown, clayey SILT, little sand.	
4		
5		
6		
7		
8		
9	Hard, wet, brown, clayey SILT.	
10		
11	Bottom of exploration pit at depth 11 feet No water. No caving.	
12		
13		
14		
15		
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17		
18		
19		
20		

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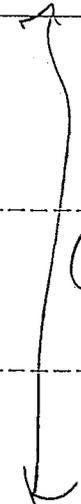
LOG OF EXPLORATION PIT NO. EP-3

TP. 14

Depth (ft)	<p>This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.</p>
DESCRIPTION	
	Topsoil
1	Lodgement Till
	Loose, moist, brown, oxidized, silty SAND, few gravel, scattered cobbles and boulders.
2	
	Medium dense.
3	Pre-Fraser Deposit
	Stiff, wet, orange-brown, clayey SILT, few sand, trace gravel.
4	
5	
6	-----
	Grades to hard.
7	
8	

9	Hard, moist, blue-gray, sandy SILT, trace gravel.
10	
11	
12	Bottom of exploration pit at depth 11 feet Ground water at 8 feet. No caving.
13	
14	
15	
16	
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19	
20	

Q_{st}



Q_{cp}

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LOG OF EXPLORATION PIT NO. EP-4

TP 15

Depth (ft)	DESCRIPTION
	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.
	Topsoil
1	Lodgement Till
2	Medium dense, moist, brown, oxidized, gravelly SAND, with silt, scattered cobbles.
3	
4	Pre-Fraser Deposit
5	Stiff, moist, orange-brown, clayey SILT, few sand.
6	
7	
8	Thin, compressed organic layer.
9	Stiff, wet, gray, clayey SILT, few sand.
10	
11	
12	Bottom of exploration pit at depth 11 feet No water. No caving.
13	
14	
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Q_{ztr}

Q_{cp}

Thin, compressed organic layer.

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LOG OF EXPLORATION PIT NO. EP-5

TP 16

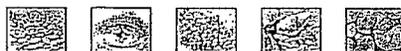
Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.
DESCRIPTION	
	Topsoil
	Lodgement Till
1	Medium dense, moist, brown, gravelly silty SAND.
2	
3	Advance Outwash
4	Dense, wet, gray-brown, coarse SAND, trace to few silt, trace gravel.
5	
6	
7	
8	
9	
10	Dense, wet, blue-gray, silty SAND, trace gravel.
11	
12	Bottom of exploration pit at depth 11 feet Ground water seepage at 6 feet. No caving.
13	
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LOG OF EXPLORATION PIT NO. EP-6

TP 17

Depth (ft)	DESCRIPTION
	Topsoil
	Lodgement Till
1	Medium dense, moist, brown, gravelly silty SAND, scattered cobbles.
2	
3	
4	Grades to dense, light brown, silty SAND, few gravel, scattered cobbles.
5	
6	
7	Grades to very dense, wet, gray, silty SAND.
8	
9	Bottom of exploration pit at depth 8 feet Slight seepage at 7 feet. No caving.
10	
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LOG OF EXPLORATION PIT NO. EP-7 TP 18

Depth (ft)	DESCRIPTION
1	Topsoil Lodgement Till
2	Medium dense, moist, brown, gravelly silty SAND.
3	Grades to dense, light brown, medium SAND, with silt, few gravel.
4	
5	
6	
7	Dense to very dense, wet, light brown, medium to coarse SAND, trace silt and gravel. (Advance Sand)
8	
9	
10	
11	
12	Bottom of exploration pit at depth 11 feet No water. No caving.
13	
14	
15	
16	
17	
18	
19	
20	

Qgtv

Qgan

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LOG OF EXPLORATION PIT NO. EP-8

TP 19

Depth (ft)	DESCRIPTION
	Topsoil
1	Lodgement Till
2	Medium dense, moist, dark brown, silty SAND, few gravel.
3	Pre-Fraser Deposit
4	Stiff, wet, orange-brown, sandy SILT, trace gravel.
5	
6	
7	
8	Hard, wet, brown, sandy SILT, trace gravel.
9	Hard, moist, blue-gray, SILT, little sand.
10	
11	Bottom of exploration pit at depth 10 feet No water. No caving.
12	
13	
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Q_{stv}

Q_{cph}

↑

↓

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LOG OF EXPLORATION PIT NO. EP-9 TP 20

Depth (ft)	DESCRIPTION	
	Topsoil	
1	Medium dense, moist, brown, silty SAND, few gravel.	Qst v
2		
3	Pre-Fraser Deposit	Qcph
4	Stiff, wet, orange-brown, SILT, little sand, trace gravel.	
5		
6		
7	Grades to hard.	
8		
9		
10	Hard, moist, blue-gray, SILT, few sand.	
11		
12	Bottom of exploration pit at depth 11 feet No water. No caving.	
13		
14		
15		
16		
17		
18		
19		
20		

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LOG OF EXPLORATION PIT NO. EP-10 TP 21

Depth (ft)	DESCRIPTION
	Topsoil
1	Loose, moist, brown, gravelly silty SAND.
2	Medium dense.
3	Grades to dense, moist, gray-brown, gravelly silty SAND, scattered cobbles.
4	
5	
6	
7	
8	
9	
10	Bottom of exploration pit at depth 9 feet No water. No caving.
11	
12	
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Qgtv

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LOG OF EXPLORATION PIT NO. EP-11 TP 22

Depth (ft)	DESCRIPTION
	<p>This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.</p>
	<p>Topsoil</p>
1	<p>Lodgement Till Medium dense, moist, brown, gravelly silty SAND.</p>
2	
3	
4	<p>Grades to dense, moist, gray-brown, gravelly silty SAND, scattered cobbles.</p>
5	
6	
7	
8	<p>Pre-Fraser Deposit</p>
9	<p>Hard, wet, blue-gray, sandy SILT, little gravel.</p>
10	
11	<p>Bottom of exploration pit at depth 10 feet Slight seepage at 3 feet. No caving.</p>
12	
13	
14	
15	
16	
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19	
20	

Q₁ to Q₂
 Q₂ to Q₃
 Q₃ to Q₄
 Q₄ to Q₅
 Q₅ to Q₆
 Q₆ to Q₇
 Q₇ to Q₈
 Q₈ to Q₉
 Q₉ to Q₁₀
 Q₁₀ to Q₁₁
 Q₁₁ to Q₁₂
 Q₁₂ to Q₁₃
 Q₁₃ to Q₁₄
 Q₁₄ to Q₁₅
 Q₁₅ to Q₁₆
 Q₁₆ to Q₁₇
 Q₁₇ to Q₁₈
 Q₁₈ to Q₁₉
 Q₁₉ to Q₂₀

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LOG OF EXPLORATION PIT NO. EP-12

TP 23

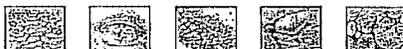
Depth (ft)	DESCRIPTION
	Topsoil
	Lodgement Till
1	Medium dense, moist, brown, silty SAND, few gravel.
2	
3	
4	Grades to dense, moist, gray-tan, gravelly silty SAND.
5	
6	Grades to very dense.
7	
8	Bottom of exploration pit at depth 7 feet No water. No caving.
9	
10	
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Handwritten note: A circled 'P' and the letters 'gtr' are written in the right side of the log, spanning depths 3 to 5 feet.

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LOG OF EXPLORATION PIT NO. EP-13

TP 24

Depth (#)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.
DESCRIPTION	
1	<p style="text-align: center;">Topsoil</p> <p style="text-align: center;">Lodgement Till</p> <p>Medium dense, moist, brown, silty SAND, little gravel.</p>
2	
3	
4	<p>Grades to dense, moist, gray-tan, gravelly silty SAND, scattered cobbles.</p>
5	
6	
7	
8	
9	<p>Bottom of exploration pit at depth 8 feet No water. No caving.</p>
10	
11	
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LOG OF EXPLORATION PIT NO. EP-14

TP 25

Depth (ft)	DESCRIPTION
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	Topsoil
	Lodgement Till
1	Medium dense, moist, brown, silty SAND, little gravel.
2	
3	Grades to dense, moist, gray, gravelly silty SAND, scattered cobbles.
4	
5	
6	Grades to very dense.
7	
8	Bottom of exploration pit at depth 7 feet No water. No caving.
9	
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EGH

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Snohomish County, WA**

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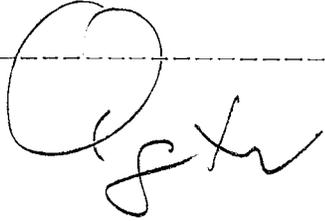


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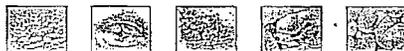
LOG OF EXPLORATION PIT NO. EP-15 TP 26

Depth (ft)	DESCRIPTION
1	<p style="font-size: small;">This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.</p> <p style="text-align: center;">Topsoil Lodgement Till</p> <p>Medium dense, moist, brown, silty SAND, with gravel.</p>
2	
3	
4	<p>Grades to dense, moist, light brown, silty SAND, little gravel.</p> <div style="text-align: right; font-size: 2em; font-family: cursive;">  </div>
5	
6	
7	
8	<p>Bottom of exploration pit at depth 7 feet No water. No caving.</p>
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

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LOG OF EXPLORATION PIT NO. EP-16

TP 27

Depth (ft)	DESCRIPTION
	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.
	Topsoil
	Lodgement Till
1	Medium dense, moist, brown, silty SAND, little gravel.
2	
3	
4	Grades to dense, moist, tan-gray, silty SAND, with gravel, scattered cobbles.
5	
6	
7	Grades to very dense.
8	
9	Bottom of exploration pit at depth 8 feet No water. No caving.
10	
11	
12	
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Handwritten signature and initials: EG tr

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Snohomish County, WA**

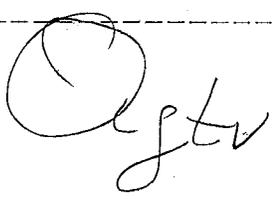
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5/4/07

LOG OF EXPLORATION PIT NO. EP-17 TP 28

Depth (ft)	<p>This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.</p>	
	DESCRIPTION	
	Topsoil	
1	Lodgement Till	
2	Loose, wet, brown, silty SAND, with gravel.	
3	Medium dense.	
4	Grades to dense, moist, gray, gravelly silty SAND.	
5		
6		
7		
8		
9	Bottom of exploration pit at depth 8 feet Ground water seepage at 3.5 feet. No caving.	
10		
11		
12		
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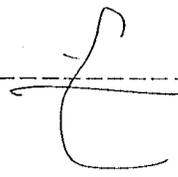
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LOG OF EXPLORATION PIT NO. EP-18

TP 29

Depth (ft)	DESCRIPTION
	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.
	Topsoil
	Lodgement Till
1	Medium dense, moist, brown, silty SAND, with gravel.
2	
3	Grades to wet.
4	Grades to dense, moist, gray, gravelly silty SAND, scattered cobbles.
5	
6	
7	
8	
9	Bottom of exploration pit at depth 8 feet Ground water seepage at 3 feet. No caving.
10	
11	
12	
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KCTP3 070280A.GPJ May 24, 2007

Dubuque Ridge I & II
Snohomish County, WA

Associated Earth Sciences, Inc.



Logged by: EG
Approved by:

Project No. EE070280A

5/4/07

LOG OF EXPLORATION PIT NO. EP-19

TP 30

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.
DESCRIPTION	
1	Topsoil Lodgement Till
2	Medium dense, moist, brown, silty SAND, with gravel.
3	Grades to dense, moist, brown, gravelly silty SAND.
4	Bottom of exploration pit at depth 9 feet Slight seepage at 3 feet. No caving.
5	
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Handwritten signature/initials

KCTP3 070280A.GPJ May 24, 2007

Dubuque Ridge I & II
Snohomish County, WA

Associated Earth Sciences, Inc.



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5/4/07

LOG OF EXPLORATION PIT NO. EP-20

TP 31

Depth (ft)	DESCRIPTION
	<p>This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.</p>
	Fill
1	Loose, moist, dark brown, silty SAND, with gravel, organics, and crushed rock.
2	
	Lodgement Till
3	Medium dense, moist, brown, gravelly silty SAND.
4	
5	Grades to dense, moist, brown, gravelly silty SAND, scattered cobbles.
6	
7	
8	Grades to very dense.
9	
10	Bottom of exploration pit at depth 9 feet Slight seepage at 2.5 feet. No caving.
11	
12	
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**Dubuque Ridge I & II
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5/4/07

LOG OF EXPLORATION PIT NO. EP-21

TP 32

Depth (ft)	DESCRIPTION
	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.
	Topsoil
	Lodgement Till
1	Medium dense, moist, brown, silty SAND, little gravel.
2	
3	Grades to dense, moist, tan, gravelly silty SAND, scattered cobbles.
4	
5	
6	
7	
8	
9	Bottom of exploration pit at depth 8 feet Slight seepage at 3 feet. No caving.
10	
11	
12	
13	
14	
15	
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17	
18	
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20	

P 32

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