GEODESIGN INC

Memorandum

To:	Aron Faegre	From:	George Saunders, P.E., G.E.
Company:	Aron Faegre & Associates	Date:	March 25, 2019
Address:	520 SW Yamhill Street, Roofgarden 1 Portland, OR 97204		
cc:	n/a		
GDI Project:	AronFA-1-01		
RE:	Preliminary Geotechnical Engineering Results Aurora Airport Business Center Aurora, Oregon		

INTRODUCTION

GeoDesign, Inc. is pleased to submit this memorandum as part of our geotechnical engineering services associated with the proposed land acquisition and future Aurora Airport Business Center (AABC) located east of the Aurora Airport in Aurora, Oregon. Figure 1 shows the site relative to existing topographic and physical features. Existing conditions, the site boundary, and the approximate location of our exploration are shown on Figure 2.

We understand the proposed development will likely consist of new hangars, shops, offices, and associated pavement and taxi lanes. In addition, we understand the future development may include an essential facility.

Based on correspondence with Aron Faegre of Aron Faegre & Associates, we understand the first step for the proposed development is a land zone change to switch the approximately 16 acres of agricultural land to airport use. We understand geologic hazard maps indicate that the area is susceptible to liquefaction and soil amplification during an earthquake. Specifically, the Relative Earthquake Hazard Maps (Madin, Ian P. and Wang, Zhenming, 1999) assigns a Zone B (intermediate to high hazard) earthquake risk to the southern portion of the airport.

BACKGROUND

GeoDesign has conducted numerous projects in the area, including explorations and a geotechnical report for the proposed Lima North Hangar site. In addition, we are currently completing a geotechnical report for a fuel farm on the south portion of the airport. As shown on Figure 1, the Lima North Hangar site is located approximately 800 feet west of the AABC site and the fuel farm is located approximately 2,000 feet southwest of the AABC site.

APPROACH

We have completed one boring and one cone penetration (CPT) probe to supplement our existing subsurface information in the project vicinity to preliminarily evaluate the potential seismic hazards associated with the proposed development. The draft boring and CPT logs from the supplemental explorations completed at the AABC site are presented in Attachment A. The logs from the Lima North Hangar and fuel farm projects are presented in Attachment B.

CONCLUSIONS

INTRODUCTION

Although future explorations will be needed for other areas of the AABC site to prepare a final geotechnical report for the project, based on the results of our subsurface explorations and engineering analyses from this and the nearby sites, our preliminary opinion is that the site can be developed as proposed. Our final report will include a site-specific seismic hazard evaluation of the future business center project; however, for preliminary purposes, a site-specific seismic hazard evaluation was completed for the fuel farm site, which is presented in Attachment C. We anticipate the site-specific seismic hazard evaluation for the AABC site will be similar.

SITE CONDITIONS

A detailed discussion of the site conditions will be presented in our final report. Relative to this preliminary memorandum, the site geology and subsurface conditions from the AABC site, Lima North Hangar site, and the fuel farm site are relatively similar, consisting of silt and silty sand with variable amounts of clay. The silt and silty sand include interbedded layers of sand and silt, respectively. In general, the sand content increases with depth. Based on SPT blow counts, the silt is generally medium stiff to very stiff and the silty sand is generally medium dense to very dense (although an interbedded layer of loose material was encountered at the fuel farm site). The CPT indicates interbedded seams and layers of sand, silty sand, clay, and silt.

SESIMIC CONSIDERATIONS

Although the Relative Earthquake Hazard Maps (Madin, Ian P. and Wang, Zhenming, 1999) assigns a Zone B (intermediate to high hazard) earthquake risk to the southern portion of the airport, the work completed for this evaluation indicates a relatively low seismic risk. More detailed discussions on the following seismic considerations are presented in Attachment C.

Liquefaction

We performed liquefaction analysis using the CPT results from the AABC site, the Lima North Hangar site, and the fuel farm site using the procedures indicated in Attachment C. Based on our analysis, we estimate total post-liquefaction settlement at the AABC site, Lima North Hangar site, and the fuel farm site will be less than approximately 1 inch during a design-level earthquake. We anticipate differential settlement across the site will be less than approximately one-half of the total liquefaction settlement.

Lateral Spreading

Because minimal liquefaction is predicted and there are no open faces near the project, lateral spreading is not a design consideration.

Ground Motion Amplification

Soil capable of significantly amplifying ground motions beyond the levels determined by our site-specific seismic hazard study were not encountered during our subsurface explorations.

Landslide

The site and surrounding area are relatively flat, and seismically induced landslides are not considered a site hazard.

Settlement

We do not anticipate that seismic-induced settlement in addition to liquefaction-induced settlement will occur during design levels of ground shaking.

Subsidence/Uplift

We do not anticipate that subsidence or uplift is a significant design concern.

Lurching

The anticipated ground accelerations shown in Attachment C are below the threshold required to induce lurching of the site soil.

Seiche and Tsunami

Seiches and tsunamis are not considered a hazard in the site vicinity.

LIMITATIONS

We have prepared this memorandum for use by Aron Faegre & Associates to provide a preliminarily evaluation of the potential seismic hazards associated with the proposed development. As discussed above, additional explorations will be needed for other areas of the AABC site to prepare a final geotechnical report for the project. This evaluation also included results from nearby parcels at the Aurora Airport.

Exploration observations indicate soil conditions only at specific locations and only to the depths penetrated. They do not necessarily reflect soil strata or water level variations that may exist between exploration locations. If subsurface conditions differing from those described are noted during subsequent explorations, re-evaluation will be necessary.

The site development plans and design details were preliminary at the time this memorandum was prepared. When the design has been finalized and if there are changes in the site grades or location, configuration, design loads, or type of construction, the conclusions and recommendations presented may not be applicable. If design changes are made, we request that we be retained to review our conclusions and recommendations and to provide a written modification or verification.

The scope does not include services related to construction safety precautions, and our recommendations are not intended to direct the contractor's methods, techniques, sequences, or procedures, except as specifically described in our memorandum for consideration in design.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practices in this area at the time this memorandum was prepared. No warranty, express or implied, should be understood.

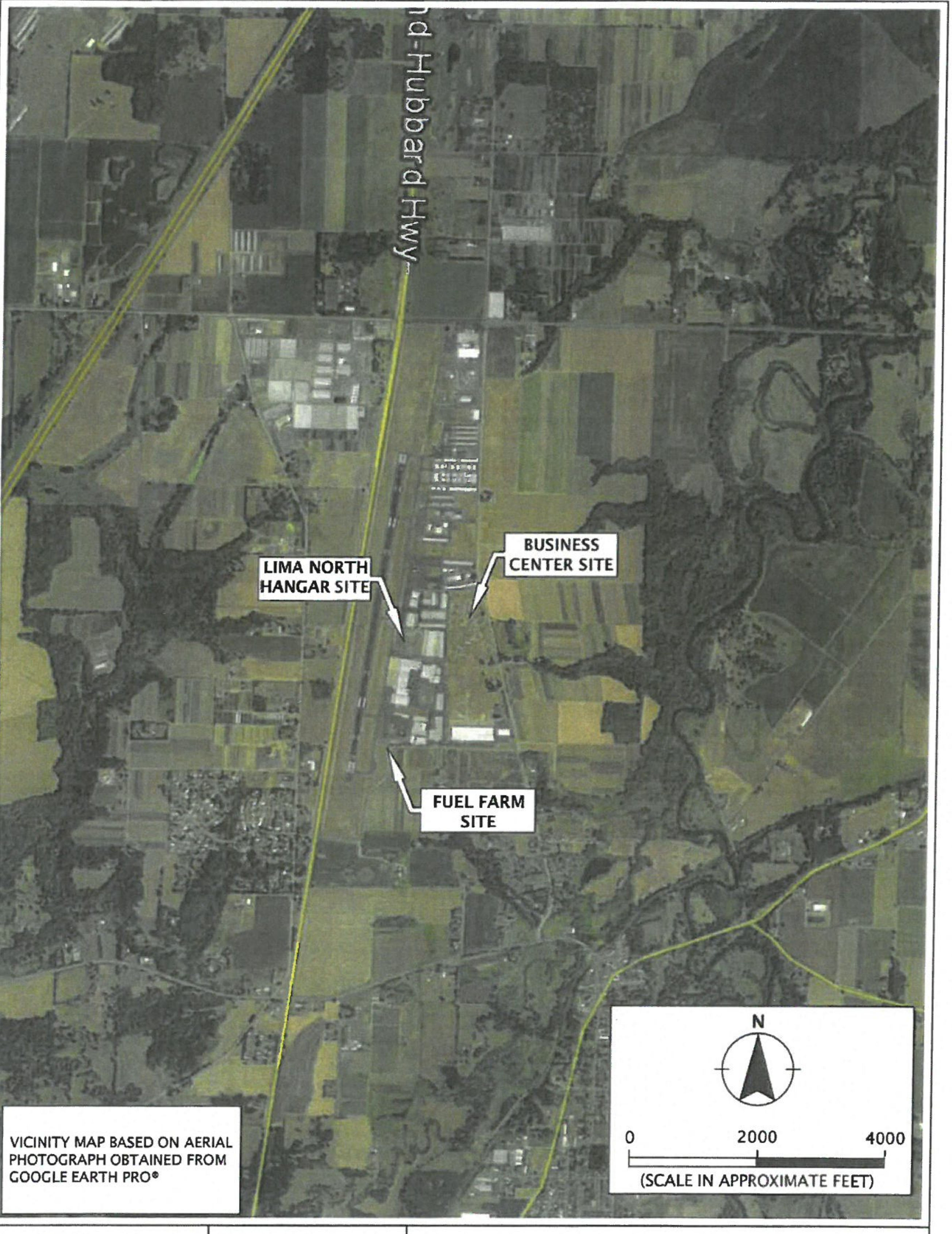
GPS:kt
Attachments
One copy submitted (via email only)
Document ID: AronFA-1-01-032519-geom.docx

REGISTERED PROFESSIONAL ENGINEER
15025
OREGON
July 25, 1990
GEORGE P. SAUNDERS
EXPIRES: 6/30/20

REFERENCES

Madin, Ian P. and Wang, Zhenming, 1999, Interpretive Map Series IMS-8: Relative Earthquake Hazard Maps for Selected Urban Areas in Western Oregon, Canby-Barlow-Aurora, Lebanon, Silverton-Mount Angel, Stayton-Sublimity-Aumsville, Sweet Home, Woodburn-Hubbard: Oregon Department of Geology and Mineral Industries report, p. 9

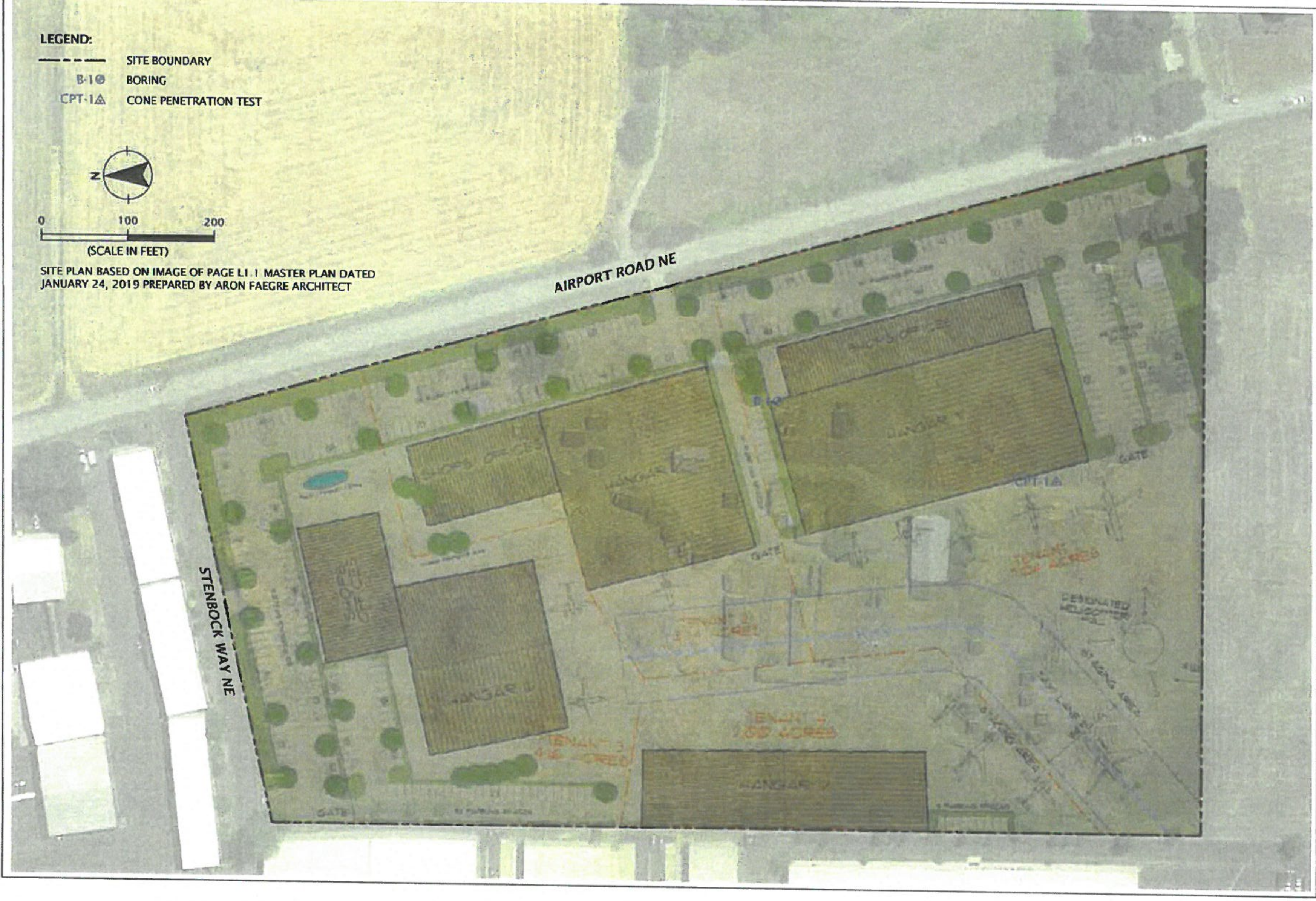
FIGURES



VICINITY MAP BASED ON AERIAL PHOTOGRAPH OBTAINED FROM GOOGLE EARTH PRO®

GEODESIGN INC 9450 SW Commerce Circle - Suite 300 Wilsonville OR 97070 503.968.8787 www.geodesigninc.com	ARONFA-1-01	**VICINITY MAP**	
	MARCH 2019	AURORA AIRPORT BUSINESS CENTER AURORA, OR	**FIGURE 1**

Printed By: mmiller | Print Date: 3/25/2019 8:21:12 AM
File Name: J:\A-D\AronFA\AronFA-1\AronFA-1-01\Figures\CAD\AronFA-1-01-VM01.dwg | Layout: FIGURE 1



SITE PLAN BASED ON IMAGE OF PAGE L1.1 MASTER PLAN DATED JANUARY 24, 2019 PREPARED BY ARON FAEGRE ARCHITECT

GEODESIGN INC 9450 SW Commerce Circle - Suite 100 Wilsonville OR 97070 503.968.8787 www.geodesigninc.com	ARONFA-1-01 MARCH 2019	SITE PLAN AURORA AIRPORT BUSINESS CENTER AURORA, OR
		FIGURE 2

Printed By: mmiller | Print Date: 3/25/2019 8:21:20 AM
File Name: J:\A-D\AronFA\AronFA-1\AronFA-1-01\Figures\CAD\AronFA-1-01-SP01.dwg | Layout: FIGURE 2

ATTACHMENT A

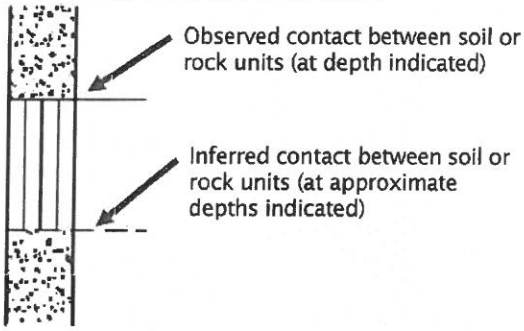
ATTACHMENT A

FIELD EXPLORATIONS (ON SITE)

The boring logs and CPT probes completed on the business center site are presented in this attachment. More detail regarding the attached logs will be provided in our final report.

SYMBOL	SAMPLING DESCRIPTION
▯	Location of sample obtained in general accordance with ASTM D 1586 Standard Penetration Test with recovery
▮	Location of sample obtained using thin-wall Shelby tube or Geoprobe® sampler in general accordance with ASTM D 1587 with recovery
▤	Location of sample obtained using Dames & Moore sampler and 300-pound hammer or pushed with recovery
▥	Location of sample obtained using Dames & Moore sampler and 140-pound hammer or pushed with recovery
◨	Location of sample obtained using 3-inch-O.D. California split-spoon sampler and 140-pound hammer
⊠	Location of grab sample
▭	Rock coring interval
▽	Water level during drilling
▼	Water level taken on date shown

Graphic Log of Soil and Rock Types



GEOTECHNICAL TESTING EXPLANATIONS

ATT	Atterberg Limits	P	Pushed Sample
CBR	California Bearing Ratio	PP	Pocket Penetrometer
CON	Consolidation	P200	Percent Passing U.S. Standard No. 200 Sieve
DD	Dry Density		
DS	Direct Shear	RES	Resilient Modulus
HYD	Hydrometer Gradation	SIEV	Sieve Gradation
MC	Moisture Content	TOR	Torvane
MD	Moisture-Density Relationship	UC	Unconfined Compressive Strength
NP	Nonplastic	VS	Vane Shear
OC	Organic Content	kPa	Kilopascal

ENVIRONMENTAL TESTING EXPLANATIONS

CA	Sample Submitted for Chemical Analysis	ND	Not Detected
P	Pushed Sample	NS	No Visible Sheen
PID	Photoionization Detector Headspace Analysis	SS	Slight Sheen
		MS	Moderate Sheen
ppm	Parts per Million	HS	Heavy Sheen

EXPLORATION KEY

TABLE A-1

RELATIVE DENSITY - COARSE-GRAINED SOIL

Relative Density	Standard Penetration Resistance	Dames & Moore Sampler (140-pound hammer)	Dames & Moore Sampler (300-pound hammer)
Very Loose	0 – 4	0 - 11	0 - 4
Loose	4 – 10	11 - 26	4 - 10
Medium Dense	10 – 30	26 - 74	10 - 30
Dense	30 – 50	74 - 120	30 - 47
Very Dense	More than 50	More than 120	More than 47

CONSISTENCY - FINE-GRAINED SOIL

Consistency	Standard Penetration Resistance	Dames & Moore Sampler (140-pound hammer)	Dames & Moore Sampler (300-pound hammer)	Unconfined Compressive Strength (tsf)
Very Soft	Less than 2	Less than 3	Less than 2	Less than 0.25
Soft	2 - 4	3 – 6	2 - 5	0.25 - 0.50
Medium Stiff	4 - 8	6 – 12	5 - 9	0.50 - 1.0
Stiff	8 - 15	12 – 25	9 - 19	1.0 - 2.0
Very Stiff	15 - 30	25 – 65	19 – 31	2.0 - 4.0
Hard	More than 30	More than 65	More than 31	More than 4.0

PRIMARY SOIL DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE-GRAINED SOIL (more than 50% retained on No. 200 sieve)	GRAVEL (more than 50% of coarse fraction retained on No. 4 sieve)	CLEAN GRAVEL (< 5% fines)	GW or GP	GRAVEL
		GRAVEL WITH FINES (≥ 5% and ≤ 12% fines)	GW-GM or GP-GM	GRAVEL with silt
			GW-GC or GP-GC	GRAVEL with clay
		GRAVEL WITH FINES (> 12% fines)	GM	silty GRAVEL
			GC	clayey GRAVEL
			GC-GM	silty, clayey GRAVEL
	SAND (50% or more of coarse fraction passing No. 4 sieve)	CLEAN SAND (<5% fines)	SW or SP	SAND
		SAND WITH FINES (≥ 5% and ≤ 12% fines)	SW-SM or SP-SM	SAND with silt
			SW-SC or SP-SC	SAND with clay
		SAND WITH FINES (> 12% fines)	SM	silty SAND
			SC	clayey SAND
			SC-SM	silty, clayey SAND
FINE-GRAINED SOIL (50% or more passing No. 200 sieve)	SILT AND CLAY	Liquid limit less than 50	ML	SILT
			CL	CLAY
			CL-ML	silty CLAY
			OL	ORGANIC SILT or ORGANIC CLAY
		Liquid limit 50 or greater	MH	SILT
			CH	CLAY
			OH	ORGANIC SILT or ORGANIC CLAY
HIGHLY ORGANIC SOIL			PT	PEAT

MOISTURE CLASSIFICATION

Term	Field Test
dry	very low moisture, dry to touch
moist	damp, without visible moisture
wet	visible free water, usually saturated

ADDITIONAL CONSTITUENTS

Secondary granular components or other materials such as organics, man-made debris, etc.					
Percent	Silt and Clay In:		Percent	Sand and Gravel In:	
	Fine-Grained Soil	Coarse-Grained Soil		Fine-Grained Soil	Coarse-Grained Soil
< 5	trace	trace	< 5	trace	trace
5 – 12	minor	with	5 – 15	minor	minor
> 12	some	silty/clayey	15 – 30	with	with
			> 30	sandy/gravelly	Indicate %

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SOIL CLASSIFICATION SYSTEM

TABLE A-2

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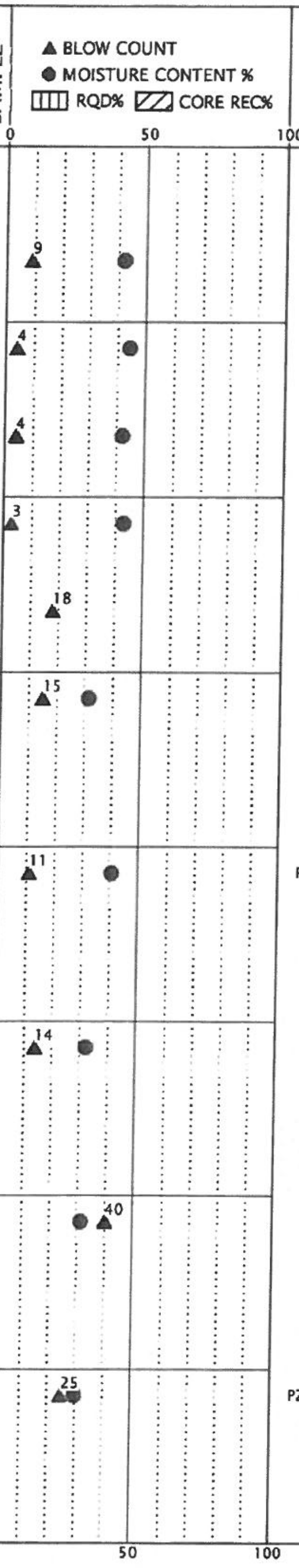
DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	BLOW COUNT	INSTALLATION AND COMMENTS
0	Stiff, brown-gray with red mottled CLAY with sand (CL), minor silt, trace gravel; moist (12-inch-thick root zone).			9	
5	soft to medium stiff at 5.0 feet		ATT	4	LL = 44% PL = 25%
	yellow-brown with brown mottles at 7.0 feet		P200	4	P200 = 84%
10	soft; wet at 10.0 feet			3	
	Very stiff, light gray-brown SILT with sand (ML); moist, sand is fine.	12.0		18	
15	interbeds of CLAY (up to 1 inch thick) at 15.0 feet			15	
20	stiff at 20.0 feet		P200	11	P200 = 81%
25	sandy at 25.0 feet			14	
30	hard; without interbeds at 30.0 feet			40	
	Very stiff, brown-gray, sandy SILT (ML); wet, sand is fine to medium, interbeds of CLAY (up to 2 inches thick).	33.0			
35			P200	25	P200 = 55%
	Very stiff, light gray SILT (ML), trace sand; wet.	38.5			
40					



DRILLED BY: Holt Services, Inc.
LOGGED BY: L. Gose
COMPLETED: 03/06/19

BORING METHOD: mud rotary (see document text)
BORING BIT DIAMETER:

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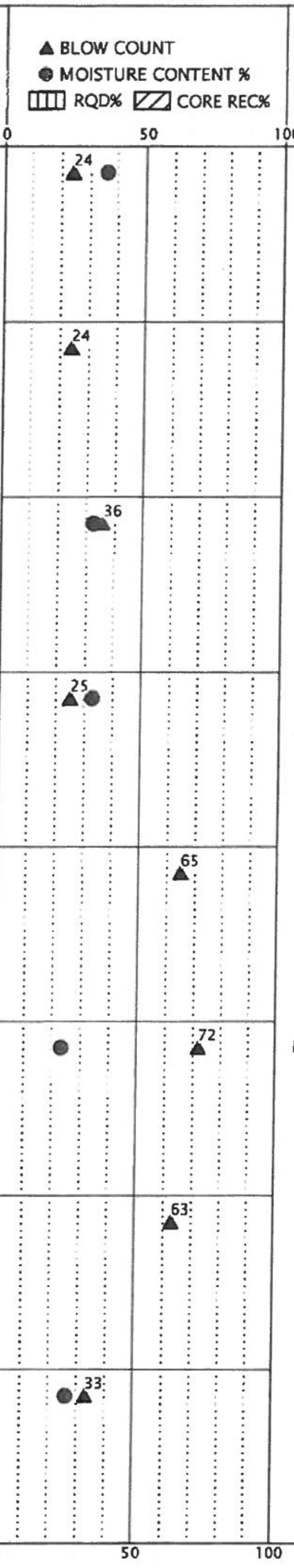
BORING B-1

AURORA AIRPORT BUSINESS CENTER
AURORA, OR

FIGURE A-1

DRAFT

DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	INSTALLATION AND COMMENTS
40	(continued from previous page)		ATT	LL = NP PL = NP
45	with sand at 45.0 feet			
50	hard; moist, interbeds of SAND (approximately 6 inches thick), sand is fine at 50.0 feet			
	very stiff; interbeds of SAND (3 to 4 inches thick) at 53.0 feet			
55				
	Very dense, dark gray, silty SAND (SM); moist, interbeds of CLAY (up to 2 inches thick), sand is fine to medium.	58.5		
60				
65	without interbeds at 65.0 feet		P200	P200 = 17%
70				
75				
80				



DRILLED BY: Holt Services, Inc. LOGGED BY: L. Gose COMPLETED: 03/06/19

BORING METHOD: mud rotary (see document text) BORING BIT DIAMETER:

BORING LOG ARONFA-1-01-B1.GPJ GEODESIGN.GDT PRINT DATE: 3/22/19:KM

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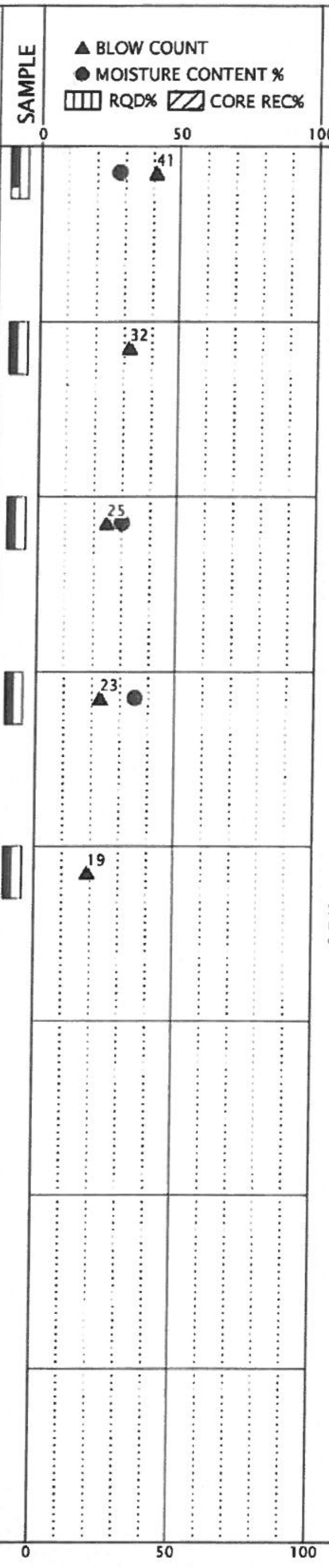
ARONFA-1-01	**BORING B-1** (continued)	
MARCH 2019	AURORA AIRPORT BUSINESS CENTER AURORA, OR	**FIGURE A-1**

DRAFT

DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	INSTALLATION AND COMMENTS
80	(continued from previous page)		P200	P200 = 30%
	Hard, gray CLAY (CL), trace sand; moist.	82.5		
85				
90	very stiff at 90.0 feet			
				Clay stuck on drill rod from 92.0 to 95.0 feet.
	Very stiff, light gray CLAY (CH), trace sand; moist.	93.5		
95				
100				
	Exploration completed at a depth of 101.5 feet. Hammer efficiency factor is 87.0 percent.	101.5		Surface elevation was not measured at the time of exploration.
105				
110				
115				
120				



DRILLED BY: Holt Services, Inc.

LOGGED BY: L. Gose

COMPLETED: 03/06/19

BORING METHOD: mud rotary (see document text)

BORING BIT DIAMETER:

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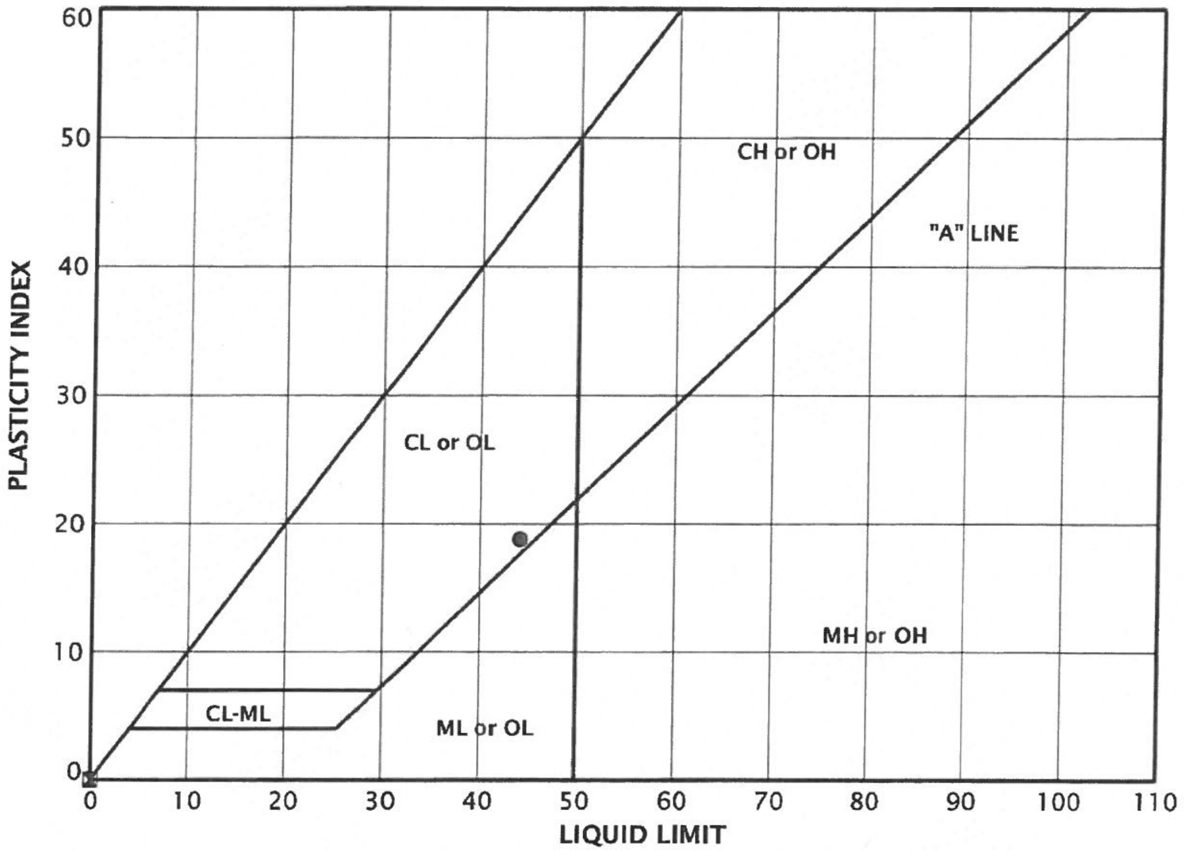
BORING B-1
(continued)

AURORA AIRPORT BUSINESS CENTER
AURORA, OR

FIGURE A-1

DRAFT



KEY	EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	MOISTURE CONTENT (PERCENT)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
●	B-1	5.0	45	44	25	19
☒	B-1	40.0	36	NP	NP	NP

GEODESIGN INC 9450 SW Commerce Circle · Suite 300 Wilsonville OR 97070 503.968.8787 www.geodesigninc.com	ARONFA-1-01	ATTERBERG LIMITS TEST RESULTS	
	MARCH 2019	AURORA AIRPORT BUSINESS CENTER AURORA, OR	FIGURE A-2

DRAFT

SAMPLE INFORMATION			MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)	SIEVE			ATTERBERG LIMITS		
EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	ELEVATION (FEET)			GRAVEL (PERCENT)	SAND (PERCENT)	P200 (PERCENT)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
B-1	2.5		42							
B-1	5.0		45					44	25	19
B-1	7.5		42				84			
B-1	10.0		43							
B-1	15.0		32							
B-1	20.0		41				81			
B-1	25.0		33							
B-1	30.0		32							
B-1	35.0		30				55			
B-1	40.0		36					NP	NP	NP
B-1	50.0		33							
B-1	55.0		33							
B-1	65.0		24				17			
B-1	75.0		27							
B-1	80.0		28				30			
B-1	90.0		30							
B-1	95.0		36							

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MARCH 2019

SUMMARY OF LABORATORY DATA

AURORA AIRPORT BUSINESS CENTER
AURORA, OR

FIGURE A-3

Robert Miner Dynamic Testing, Inc.
Dynamic Measurements and Analyses for Deep Foundations

October 22, 2015

Mr. Dale Abernathy
Holt Services, Inc.
13000 Lakeholme Road Sw
Lakewood, WA 98498

Re: Penetration Test Energy Measurements
Bore Hole: 15-RD-01, October 19, 2015
Truck Mounted Rig 215, Mobile B60, 140lb ram, NW-J Rod
Seattle, Washington

RMDT Job No. 15F48

Dear Mr. Abernathy,

This letter presents energy transfer measurements made during Standard Penetration Tests for the drill hole and drill rig referenced above. Robert Miner Dynamic Testing, Inc. (RMDT) made dynamic measurements with a Pile Driving Analyzer® as a hammer advanced the NW rod during sampling with a split spoon sampler.

The purpose of RMDT's testing was the measurement of energy transferred to the drill rods. Measurements were made on a section of NW gauge rod at the top of the drill rod. Strain gages and accelerometers on the rod were connected to a Pile Driving Analyzer® (PDA) which generally processed acceleration and strain measurements from each hammer blow and stored both the measurements and computed results. Measurements and data processing generally followed the ASTM D 4633-10 standard. Energy transfer past the gage location, EFV, was computed by the PDA using force and velocity records as follows:

$$EFV = \int_a^b F(t)\ v(t)\ dt$$

The value "a" corresponds to the start of the record which is when the energy transfer begins and *"b"* is the time at which energy transferred to the rod reaches a maximum value. Appendix A contains more information on our measurement equipment and methods of analysis. The EFV energy calculation is identical to the EMX energy result discussed in Appendix A. The EFV and EMX values apply to the sensor location near the top of the rod.

TEST DETAILS

Testing occurred on October 19, 2015. Boring 15-RD-01 was advanced on the north shore of the Ballard Locks near of the locker room building of the Army Corps of Engineers Facility in Seattle, WA. During all measurements, a NW size rod was used to advance a standard split spoon sampler. The automatic hammer in use during our testing was manufactured by Mobile

Drill International and was reported to use a 140 lb ram. The drill rig was a truck-mounted Mobile B60 and referred to as Rig 215 by the operator (Licence No. WAB71109W) .

RESULTS

A summary of testing and monitoring results is given in Table 1. The tabulated results include the starting sample depth, the penetration resistance, the number of hammers blows in our data set, measured energy transfer, EFV, the computed transfer efficiency, ETR, and the hammer blow rate, BPM. Appendix B contains detailed numeric results for each individual test.

Energy measurements must be divided by the theoretical free fall energy of the hammer to obtain an efficiency. A 140 lb ram raised 30 inches above an impact surface has 350 lb-ft of potential energy. Thus, the transfer energy results for sampling with the 140 lb ram may be divided by 350 lb-ft to yield the ratio of the delivered energy to the nominal potential energy. This efficiency ratio, ETR, is given for each sample interval as a percent efficiency.

Table 1. Summary of Test Details and Results for the 140-lb ram and Split Spoon Sampler

Sample Name and Depth	Penetration Resistance (Blow/Set)	Number of Blows in Data Set	Average Transfer Energy EFV (lb-ft)	Average Transfer Efficiency ETR (percent)	Average Hammer Blow Rate BPM (blow/min)
27.5 ft Sample	5/1ft	5	299	85	39
35 ft Sample	4/1ft	4	297	85	45
45 ft Sample	35/1ft	35	303	87	45
55 ft Sample	32/1ft	32	305	87	49
60 ft Sample	32/1ft	31	310	89	44
Average for Split Spoon Samples:			**303**	**87**	**44**

5 sample returns were monitored while the 140 lb ram and standard split spoon sampler were in use. The overall average ETR and hammer blow rate was 87 percent and 44 blows per minute, respectively.

It was a pleasure to assist you and to participate on this project with the staff of Holt Services, Inc. Please do not hesitate to contact us if you or your client have any questions about this report.

Sincerely,

Robert Miner Dynamic Testing, Inc.

ANDREW J. BANAS
STATE OF WASHINGTON
51528
REGISTERED PROFESSIONAL ENGINEER
October 22, 2015

Andrew Banas, P.E.
Staff Engineer

ATTACHMENT B

ATTACHMENT B

FIELD EXPLORATIONS (OFF SITE)

The boring logs and CPT probes completed on the nearby Lima North Hangar and fuel farm sites are presented in attachment. The locations of the sites relative to the AABC site are provided on Figure 1.

VICINITY MAP BASED ON AERIAL PHOTOGRAPH OBTAINED FROM GOOGLE EARTH PRO®

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CENTREXCON-3-01

VICINITY MAP

JANUARY 2019

LIMA NORTH HANGAR
AURORA, OR

FIGURE 1

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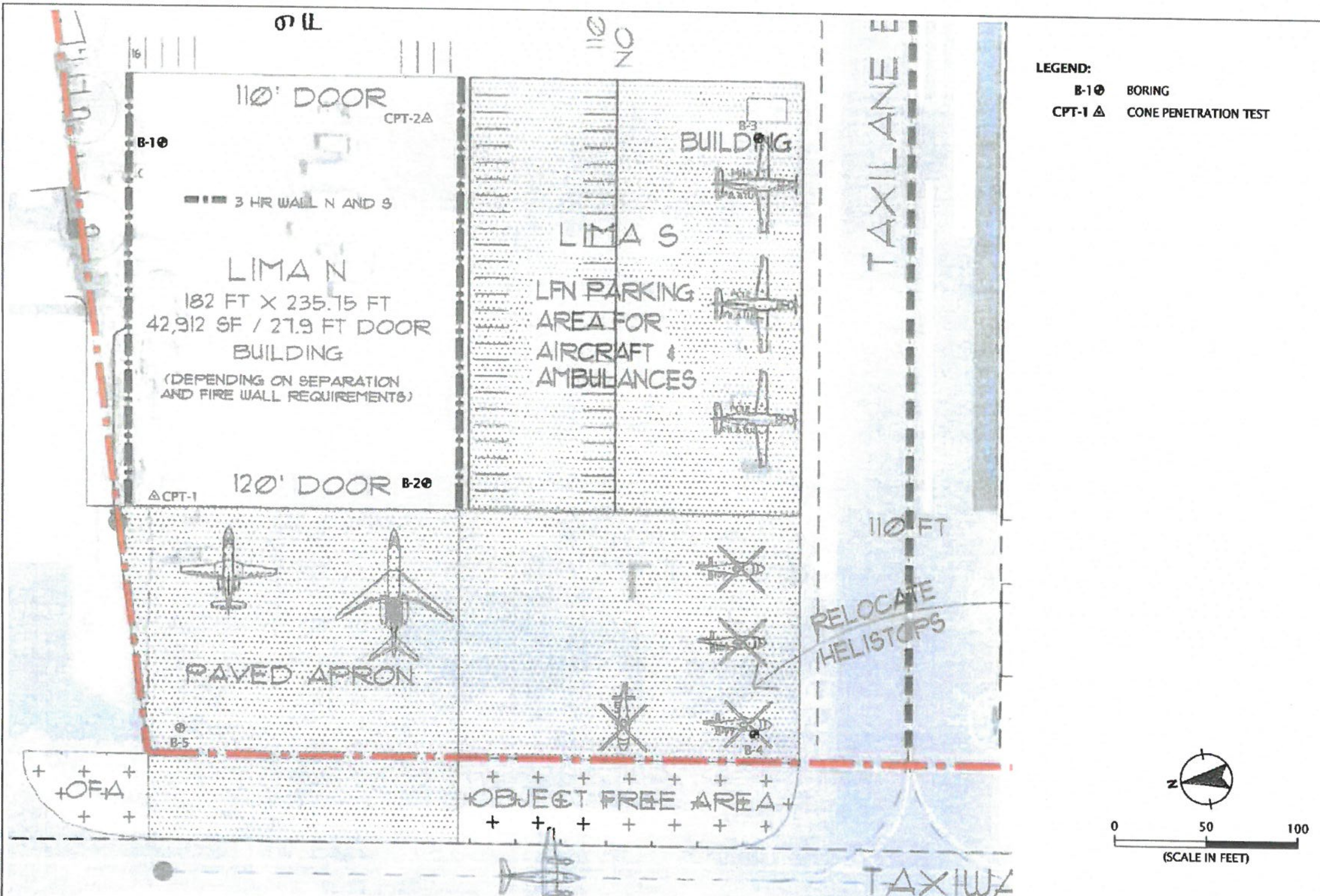
File Name: J:\A-D\CentrexCon\CentrexCon-3\CentrexCon-3-01\Figures\CAD\CentrexCon-3-01-VM01.dwg | Layout: FIGURE 1



SITE PLAN BASED ON IMAGE OF PAGE L1.0
MASTER SITE PLAN DATED 1/5/2018
PREPARED BY ARON FAEGRE ARCHITECT

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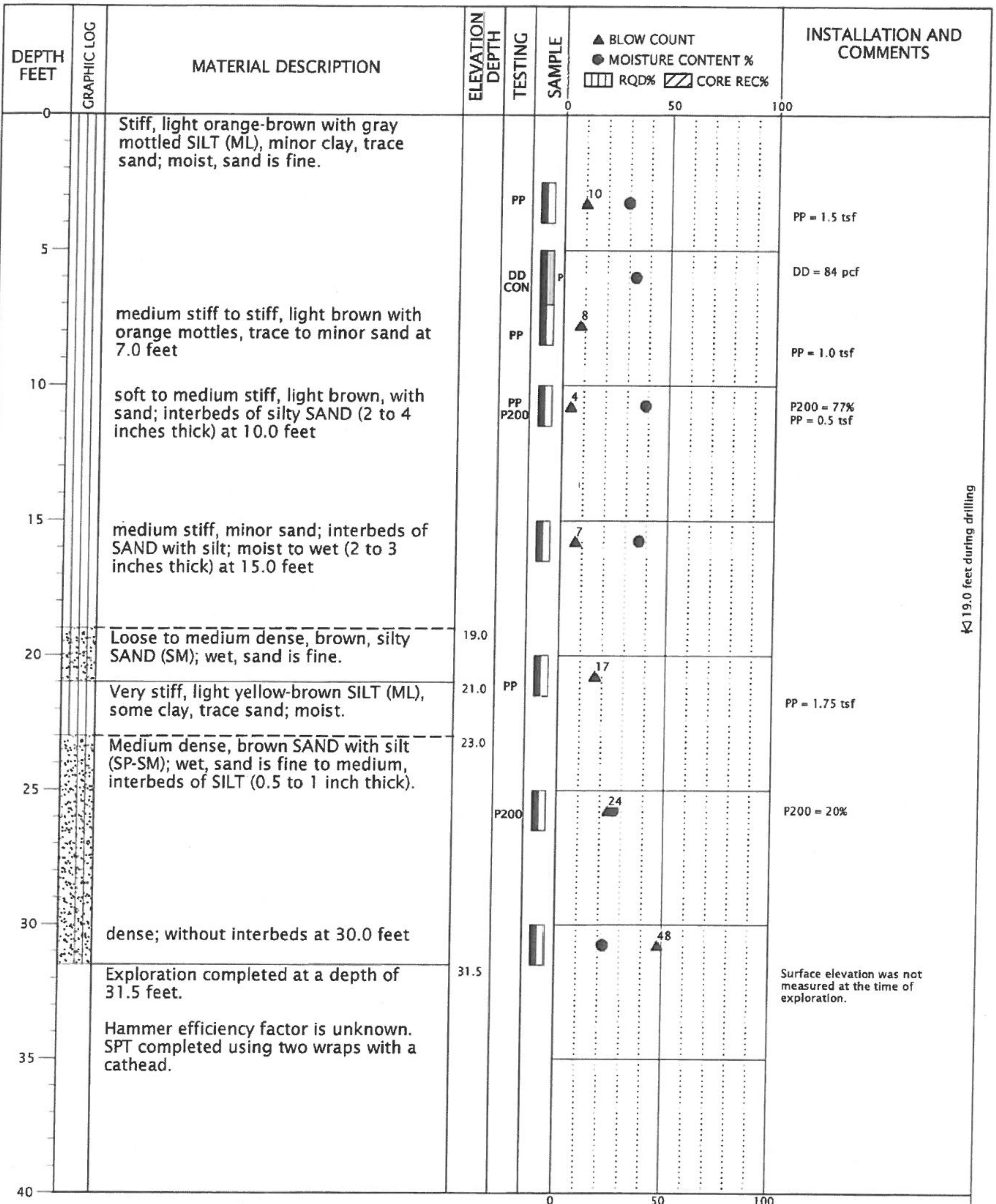
CENTREXCON-3-01
JANUARY 2019

SITE PLAN

LIMA NORTH HANGAR
AURORA, OR

FIGURE 2

Printed By: mmiller | Print Date: 1/17/2019 11:43:09 AM
File Name: J:\A-D\CentrexCon\CentrexCon-3\CentrexCon-3-01\Figures\CAD\CentrexCon-3-01-SP01.dwg | Layout: FIGURE 2



MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	INSTALLATION AND COMMENTS
Stiff, light orange-brown with gray mottled SILT (ML), minor clay, trace sand; moist, sand is fine.		PP	PP = 1.5 tsf
		DD CON	DD = 84 pcf
medium stiff to stiff, light brown with orange mottles, trace to minor sand at 7.0 feet		PP	PP = 1.0 tsf
soft to medium stiff, light brown, with sand; interbeds of silty SAND (2 to 4 inches thick) at 10.0 feet		PP P200	P200 = 77% PP = 0.5 tsf
medium stiff, minor sand; interbeds of SAND with silt; moist to wet (2 to 3 inches thick) at 15.0 feet			
Loose to medium dense, brown, silty SAND (SM); wet, sand is fine.	19.0		
Very stiff, light yellow-brown SILT (ML), some clay, trace sand; moist.	21.0	PP	PP = 1.75 tsf
Medium dense, brown SAND with silt (SP-SM); wet, sand is fine to medium, interbeds of SILT (0.5 to 1 inch thick).	23.0	P200	P200 = 20%
dense; without interbeds at 30.0 feet			
Exploration completed at a depth of 31.5 feet. Hammer efficiency factor is unknown. SPT completed using two wraps with a cathead.	31.5		Surface elevation was not measured at the time of exploration.

DRILLED BY: Dan J. Fischer Excavating, Inc.
LOGGED BY: J. Hook
COMPLETED: 11/21/18

BORING METHOD: solid-stem auger (see document text)
BORING BIT DIAMETER: 4 inches

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CENTREXCON-3-01

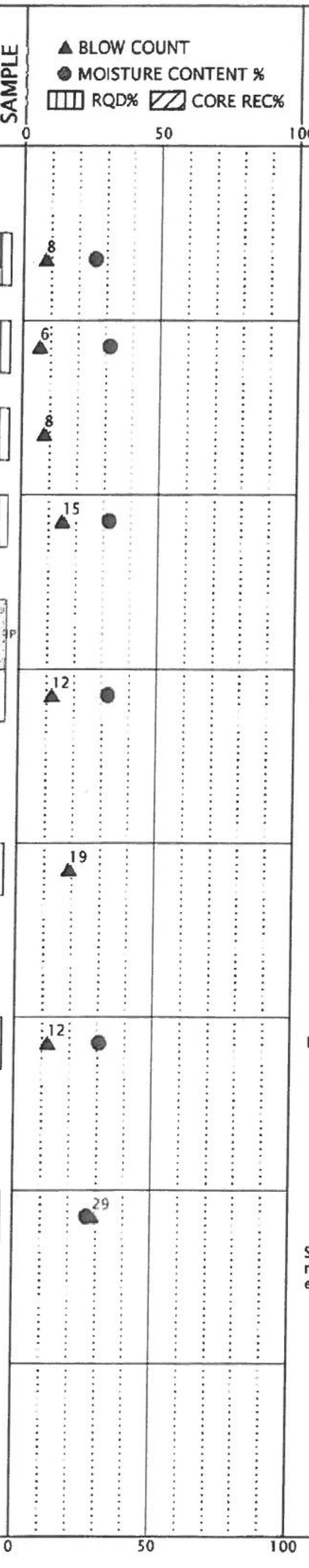
BORING B-1

JANUARY 2019

LIMA NORTH HANGAR
AURORA, OR

FIGURE A-1

DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	INSTALLATION AND COMMENTS
0	AGGREGATE BASE (14.0 inches).			
	Medium stiff to stiff, light gray SILT (ML), minor sand and clay, trace organics (rootlets); moist, sand is fine.	1.2	PP ATT	LL = 43% PL = 24% PP = 1.5 tsf
5	medium stiff, light gray-brown at 5.0 feet		PP	PP = 1.0 tsf
	interbeds of SAND (1 to 3 inches thick) at 7.5 feet		PP	PP = 1.0 tsf
10	stiff to very stiff, light brown; interbeds of silty SAND (2 to 4 inches thick) at 10.0 feet		P200 PP	P200 = 84% PP = 1.5 tsf
15	Medium dense, light brown SAND with silt (SP-SM); wet, sand is fine, interbeds of SILT (2 to 3 inches thick).	14.0	P200	P200 = 73%
	Medium dense, light brown, silty SAND (SM); wet, sand is fine.	18.0		19.0 to 20.0 feet during drilling
20	Very stiff, light brown SILT (ML), minor sand, trace clay; moist.	20.5		
	Medium dense, brown SAND with silt (SP-SM); wet, sand is fine.	21.0		
25	sand is fine to medium at 25.0 feet		P200	P200 = 21%
30	interbeds of light brown SILT (2 to 3 inches thick) at 30.0 feet			
	Exploration completed at a depth of 31.5 feet. Hammer efficiency factor is unknown. SPT completed using two wraps with a cathead.	31.5		Surface elevation was not measured at the time of exploration.
35				
40				



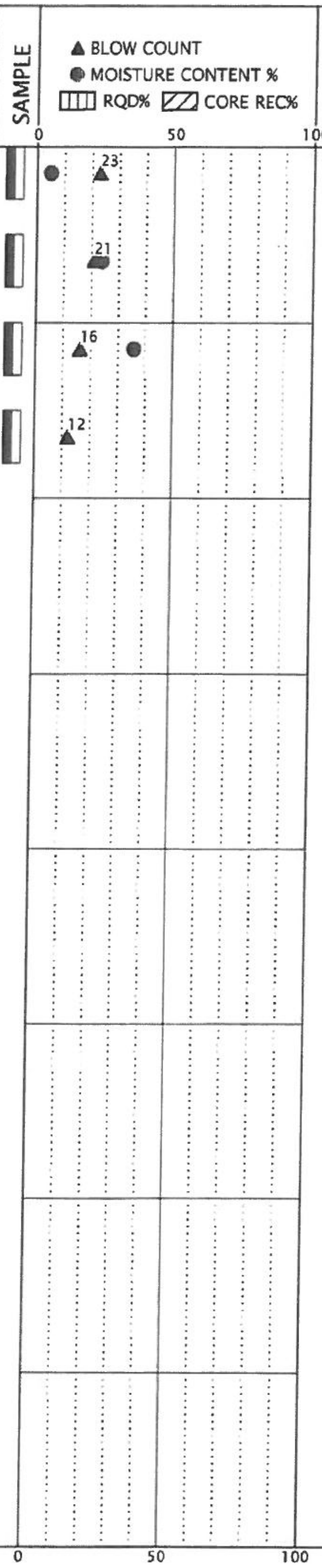
DRILLED BY: Dan J. Fischer Excavating, Inc.
LOGGED BY: J. Hook
COMPLETED: 11/21/18

BORING METHOD: solid-stem auger (see document text)
BORING BIT DIAMETER: 4 inches

GEODESIGN INC 9450 SW Commerce Circle - Suite 300 Wilsonville OR 97070 503.968.8787 www.geodesigninc.com	CENTREXCON-3-01	**BORING B-2**
	JANUARY 2019	LIMA NORTH HANGAR AURORA, OR
		FIGURE A-2

BORING LOG CENTREXCON-3-01-B1_5.GPJ GEODESIGN.GDT PRINT DATE: 1/22/19:KM:KT

DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	INSTALLATION AND COMMENTS
0	Medium dense, gray-brown, silty GRAVEL with sand (GM), trace organics (rootlets); moist - **FILL**.	0.8		
	Stiff to very stiff, gray-brown SILT (ML), minor clay, trace sand and organics (rootlets); moist.		PP	PP = 1.75 tsf
	gray-brown with orange mottles, without organics at 2.5 feet		PP	PP = 2.0 tsf
5	light brown with gray mottles; interbeds of SAND (2 to 3 inches thick) at 5.0 feet		PP	PP = 1.5 tsf
	moist to wet at 7.5 feet			
10	Exploration completed at a depth of 9.0 feet. Hammer efficiency factor is unknown. SPT completed using two wraps with a cathead.	9.0		Surface elevation was not measured at the time of exploration.
15				
20				
25				
30				
35				
40				



DRILLED BY: Dan J. Fischer Excavating, Inc.
LOGGED BY: J. Hook
COMPLETED: 11/21/18

BORING METHOD: solid-stem auger (see document text)
BORING BIT DIAMETER: 4 inches

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CENTREXCON-3-01

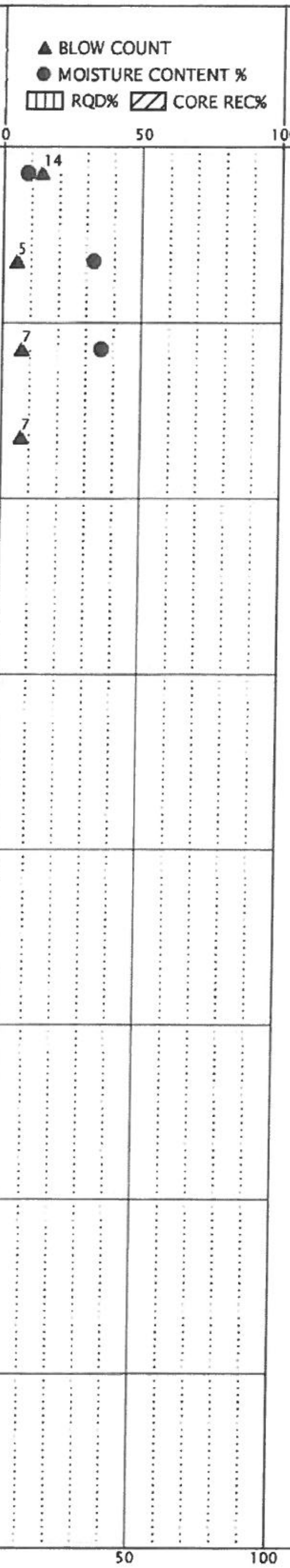
JANUARY 2019

BORING B-3

LIMA NORTH HANGAR
AURORA, OR

FIGURE A-3

DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	INSTALLATION AND COMMENTS
0	Medium dense, gray-brown GRAVEL with silt and sand (GP-GM); moist - **FILL**.	0.8	PP	PP = 1.0 tsf
	Stiff, brown SILT (ML), minor clay and sand, trace organics (rootlets); moist - **BURIED TOPSOIL.**	2.0	PP	PP = 1.25 tsf
5	Medium stiff, light brown SILT (ML), minor sand, trace clay; moist, sand is fine. light brown with brown mottles, trace sand at 5.0 feet with sand at 7.5 feet trace sand at 8.0 feet with sand at 8.5 feet	9.0	PP PP	PP = 1.0 tsf PP = 1.0 tsf Surface elevation was not measured at the time of exploration.
10	Exploration completed at a depth of 9.0 feet. Hammer efficiency factor is unknown. SPT completed using two wraps with a cathead.			



DRILLED BY: Dan J. Fischer Excavating, Inc.
LOGGED BY: J. Hook
COMPLETED: 11/21/18

BORING METHOD: solid-stem auger (see document text)
BORING BIT DIAMETER: 4 inches

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CENTREXCON-3-01

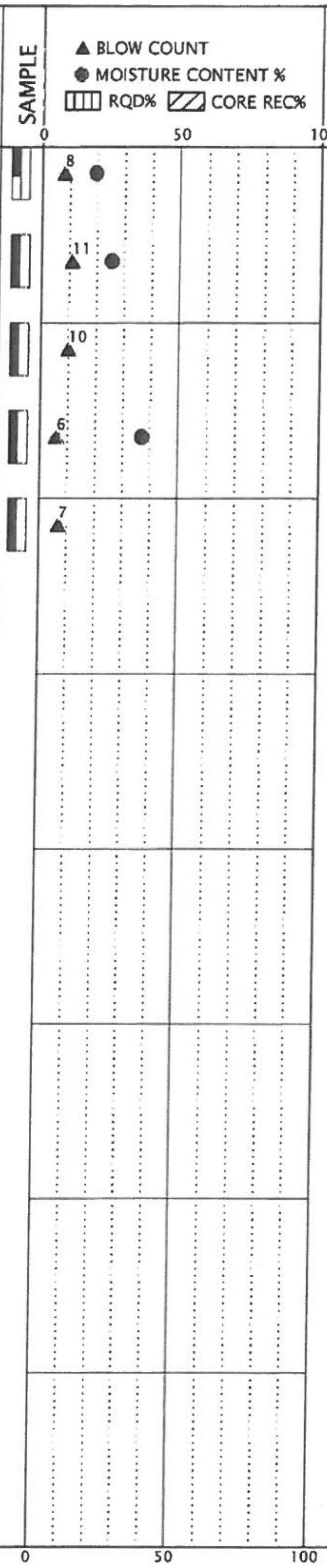
JANUARY 2019

BORING B-4

LIMA NORTH HANGAR
AURORA, OR

FIGURE A-4

DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	INSTALLATION AND COMMENTS
0	Loose, light gray-brown, silty GRAVEL with sand (GM), trace clay and organics (rootlets); moist (2-inch-thick root zone) - **FILL**.	0.5		
	Medium stiff to stiff, brown SILT (ML), minor sand and clay, trace organics (rootlets); moist - **BURIED TOPSOIL**.	1.0	PP	PP = 1.5 tsf
5	Medium stiff to stiff, gray-brown with red mottled SILT (ML), minor sand; moist.		PP	PP = 1.0 tsf
	with sand at 8.5 feet		PP	PP = 1.0 tsf
10	Loose, light brown, silty SAND (SM); wet, sand is fine.	9.5		
	Medium stiff, light brown SILT (ML), trace to minor sand, trace clay; moist, sand is fine. with sand at 11.0 feet	10.5		Surface elevation was not measured at the time of exploration.
	Exploration completed at a depth of 11.5 feet.	11.5		
15	Hammer efficiency factor is unknown. SPT completed using two wraps with a cathead.			
20				
25				
30				
35				
40				



DRILLED BY: Dan J. Fischer Excavating, Inc.
LOGGED BY: J. Hook
COMPLETED: 11/21/18

BORING METHOD: solid-stem auger (see document text)
BORING BIT DIAMETER: 4 inches

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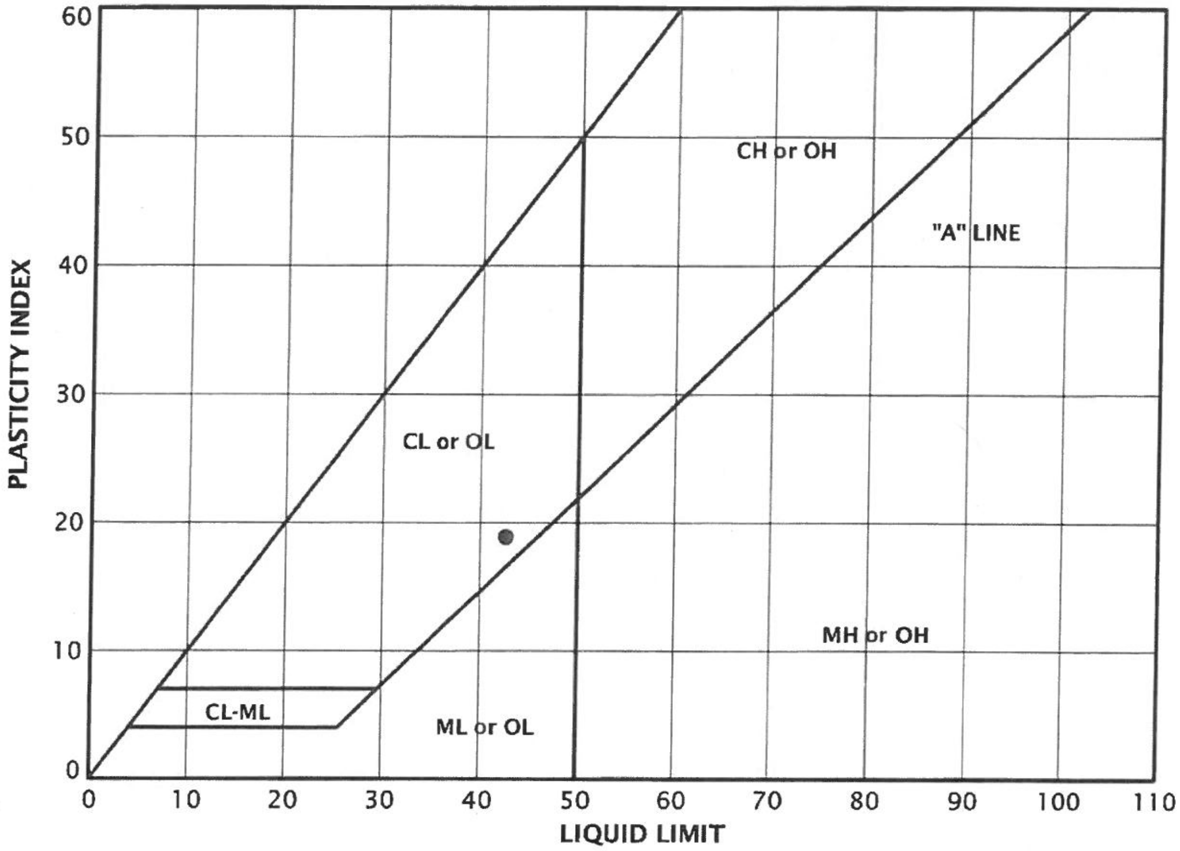
CENTREXCON-3-01

JANUARY 2019

BORING B-5

LIMA NORTH HANGAR
AURORA, OR

FIGURE A-5



KEY	EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	MOISTURE CONTENT (PERCENT)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
●	B-2	2.5	26	43	24	19

ATTERBERG_LIMITS 7 CENTREXCON-3-01-B1_5.GPJ GEODESIGN.GDT PRINT DATE: 1/17/19:KM

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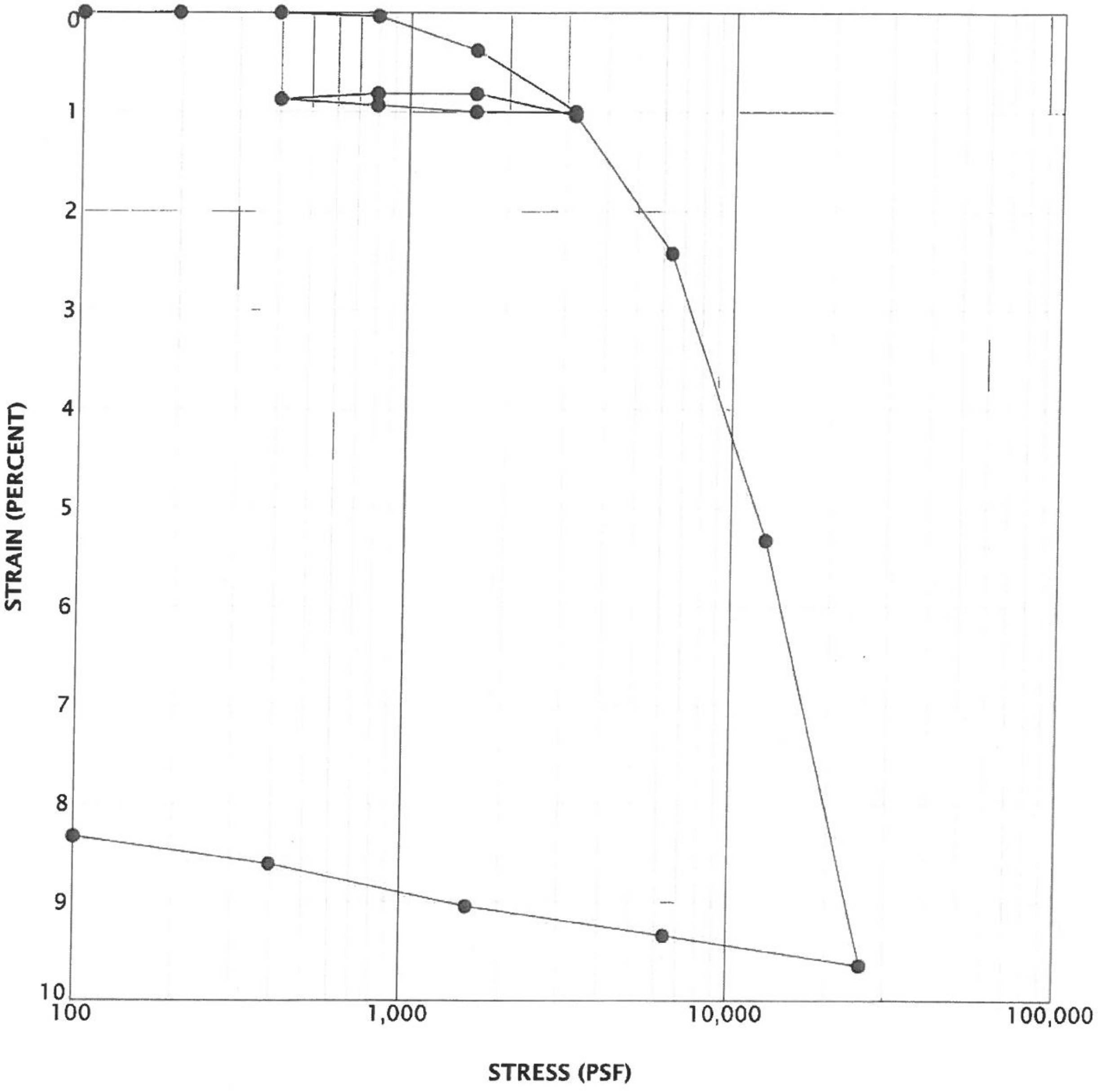
CENTREXCON-3-01	**ATTERBERG LIMITS TEST RESULTS**	
JANUARY 2019	LIMA NORTH HANGAR AURORA, OR	**FIGURE A-6**



KEY	EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)
●	B-1	5.0	34	84

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CENTREXCON-3-01

JANUARY 2019

CONSOLIDATION TEST RESULTS

LIMA NORTH HANGAR
AURORA, OR

FIGURE A-7

CONSOL_STRAIN_100K CENTREXCON-3-01-B1_5.GPJ GEODESIGN.GDT PRINT DATE: 1/17/19:KM

SAMPLE INFORMATION			MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)	SIEVE			ATTERBERG LIMITS		
EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	ELEVATION (FEET)			GRAVEL (PERCENT)	SAND (PERCENT)	P200 (PERCENT)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
B-1	2.5		30							
B-1	5.0		34	84						
B-1	10.0		39				77			
B-1	15.0		37							
B-1	25.0		26				20			
B-1	30.0		22							
B-2	2.5		26					43	24	19
B-2	5.0		32							
B-2	10.0		32				84			
B-2	15.0		33				73			
B-2	25.0		31				21			
B-2	30.0		27							
B-3	0.0		5							
B-3	2.5		24							
B-3	5.0		36							
B-4	0.0		9							
B-4	2.5		33							
B-4	5.0		36							
B-5	0.0		20							
B-5	2.5		26							
B-5	7.5		37							

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CENTREXCON-3-01

JANUARY 2019

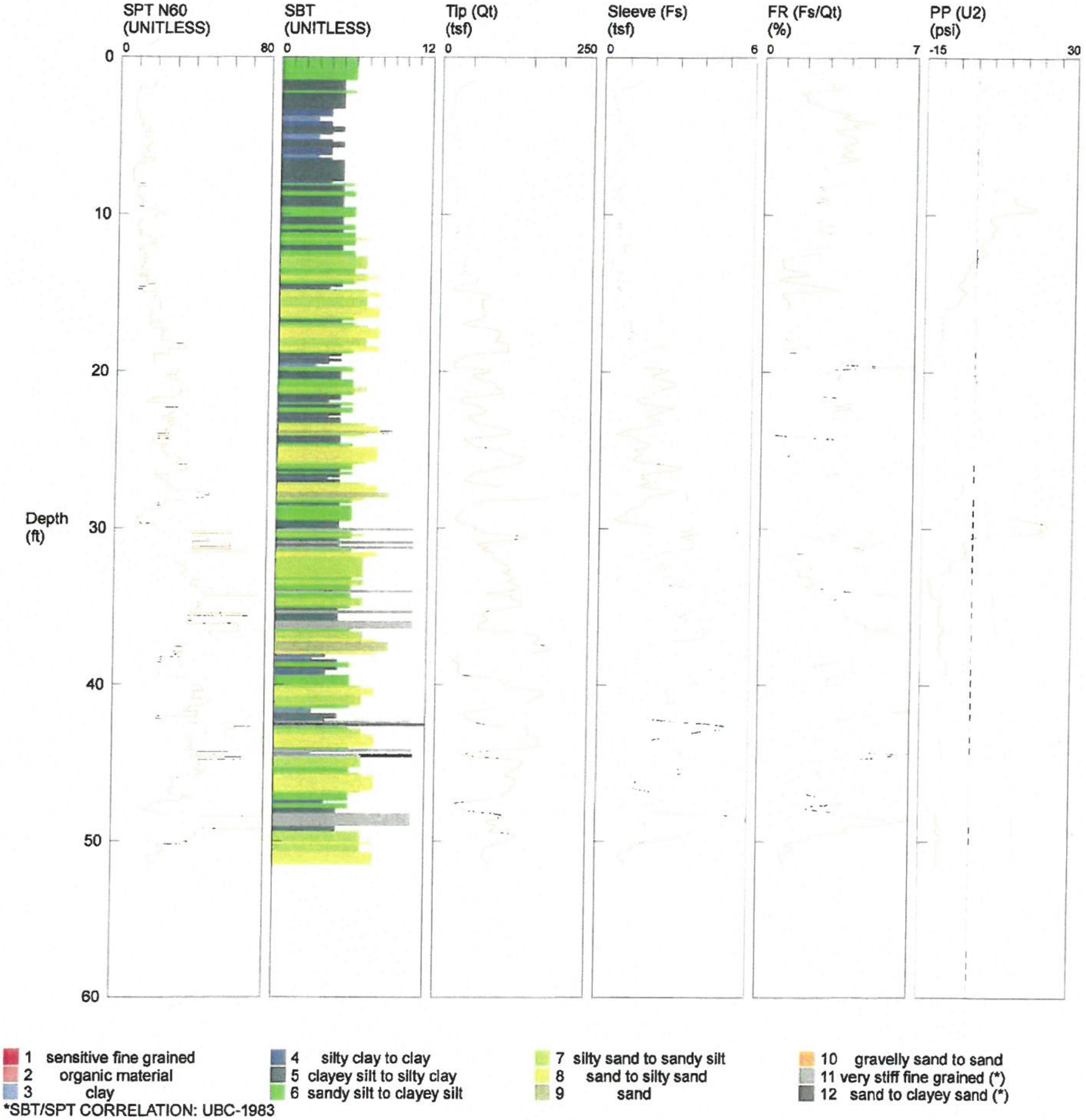
SUMMARY OF LABORATORY DATA

LIMA NORTH HANGAR
AURORA, OR

FIGURE A-8

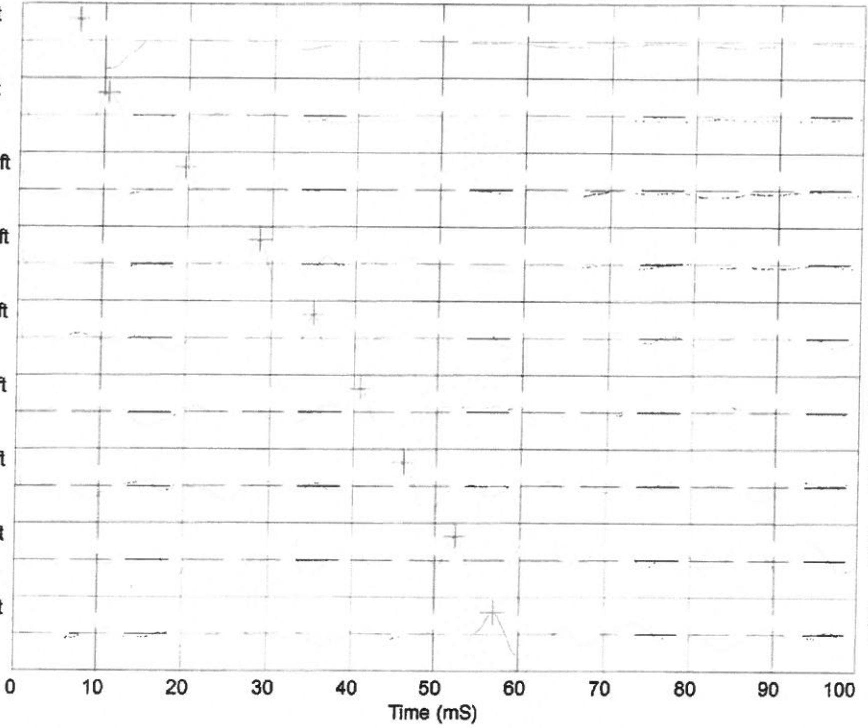
GeoDesign / CPT-1 / Aurora Airport

OPERATOR: OGE BAK
CONE ID: DPG1386
HOLE NUMBER: CPT-1
TEST DATE: 11/21/2018 8:52:39 AM
TOTAL DEPTH: 51.509 ft



*SBT/SPT CORRELATION: UBC-1983

COMMENT: GeoDesign / CPT-1 / Aurora Airport



Depth 3.28ft	Ref*	Arrival 6.95mS	Velocity*
Depth 6.56ft	Ref 3.28ft	Arrival 10.47mS	Velocity 695.52ft/S
Depth 13.12ft	Ref 6.56ft	Arrival 19.69mS	Velocity 647.96ft/S
Depth 19.69ft	Ref 13.12ft	Arrival 28.47mS	Velocity 721.71ft/S
Depth 26.25ft	Ref 19.69ft	Arrival 35.00mS	Velocity 988.68ft/S
Depth 32.81ft	Ref 26.25ft	Arrival 40.78mS	Velocity 1123.27ft/S
Depth 39.37ft	Ref 32.81ft	Arrival 46.13mS	Velocity 1217.66ft/S
Depth 45.93ft	Ref 39.37ft	Arrival 52.34mS	Velocity 1051.27ft/S
Depth 51.51ft	Ref 45.93ft	Arrival 56.95mS	Velocity 1205.47ft/S

Hammer to Rod String Distance (ft): 4.27
* = Not Determined

Printed By: mmiller | Print Date: 3/6/2019 4:52:23 PM
File Name: J:\A-D\CentrexCon\CentrexCon-4\CentrexCon-4-01\Figures\CAD\CentrexCon-4-01-VM01.dwg | Layout: FIGURE 1

VICINITY MAP BASED ON AERIAL PHOTOGRAPH OBTAINED FROM GOOGLE EARTH PRO®

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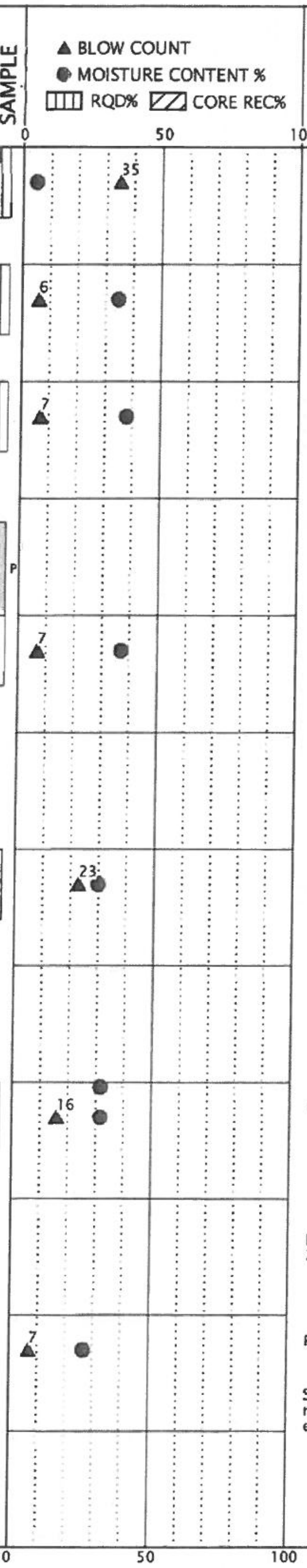
CENTEREXCON-4-01	**VICINITY MAP**	
MARCH 2019	AURORA AIRPORT FUEL FARM AURORA, OR	**FIGURE 1**

Printed By: mmiller | Print Date: 3/6/2019 4:52:25 PM
File Name: J:\A-D\CentrexCon\CentrexCon-4\CentrexCon-4-01\Figures\CAD\CentrexCon-4-01-SP01.dwg | Layout: FIGURE 2

SITE PLAN BASED ON AERIAL PHOTOGRAPH OBTAINED FROM GOOGLE EARTH PRO®, MARCH 6, 2019

GEODESIGN INC 9450 SW Commerce Circle - Suite 300 Wilsonville OR 97070 503.968.8787 www.geodesigninc.com	CENTEREXCON-4-01	**SITE PLAN**	
	MARCH 2019	AURORA AIRPORT FUEL FARM AURORA, OR	**FIGURE 2**



DEPTH FEET	MATERIAL DESCRIPTION	ELEVATION DEPTH	TESTING	SAMPLE	INSTALLATION AND COMMENTS
0.0	Dense, gray-brown, silty GRAVEL with sand and cobbles (GM), trace organics (rootlets, woody debris); moist - **FILL**.				
2.5					Perched water at 2.0 feet.
	Medium stiff, yellow-brown with brown mottled SILT (ML), minor clay, trace sand; moist, sand is fine.	3.0	PP		PP = 1.25 tsf
5.0	with sand at 5.0 feet		P200 PP		P200 = 83% PP = 1.0 tsf
7.5	wet, interbeds of CLAY and silty SAND (1 to 3 inches thick) at 8.0 feet			P	
10.0			P200 PP		P200 = 76% PP = 1.0 tsf
12.5					
15.0	very stiff; without interbeds, laminated (1 to 2 inches thick) at 15.0 feet		ATT PP		PP = 1.75 tsf LL = 28% PL = 24%
17.5					
	Medium dense, light gray-brown, silty SAND (SM); wet, sand is fine.	18.5			
20.0			P200		P200 = 32%
	Stiff, light brown SILT (ML), trace sand and clay; moist.	21.0			
22.5					
	Loose, light brown, silty SAND (SM); wet, sand is medium, micaceous.	23.0			Driller Comment: sand at 23.0 feet.
25.0			P200		P200 = 12%
	Exploration terminated at a depth of 26.5 feet due to heavy, wet sand. Hammer efficiency factor is unknown. SPT completed using two wraps with a cathead.	26.5			Surface elevation was not measured at the time of exploration.
27.5					
30.0					

∇ 8.0 feet during drilling

DRILLED BY: Dan J. Fischer Excavating, Inc. LOGGED BY: J. Hook COMPLETED: 02/22/19

BORING METHOD: solid-stem auger (see document text) BORING BIT DIAMETER: 4 inches

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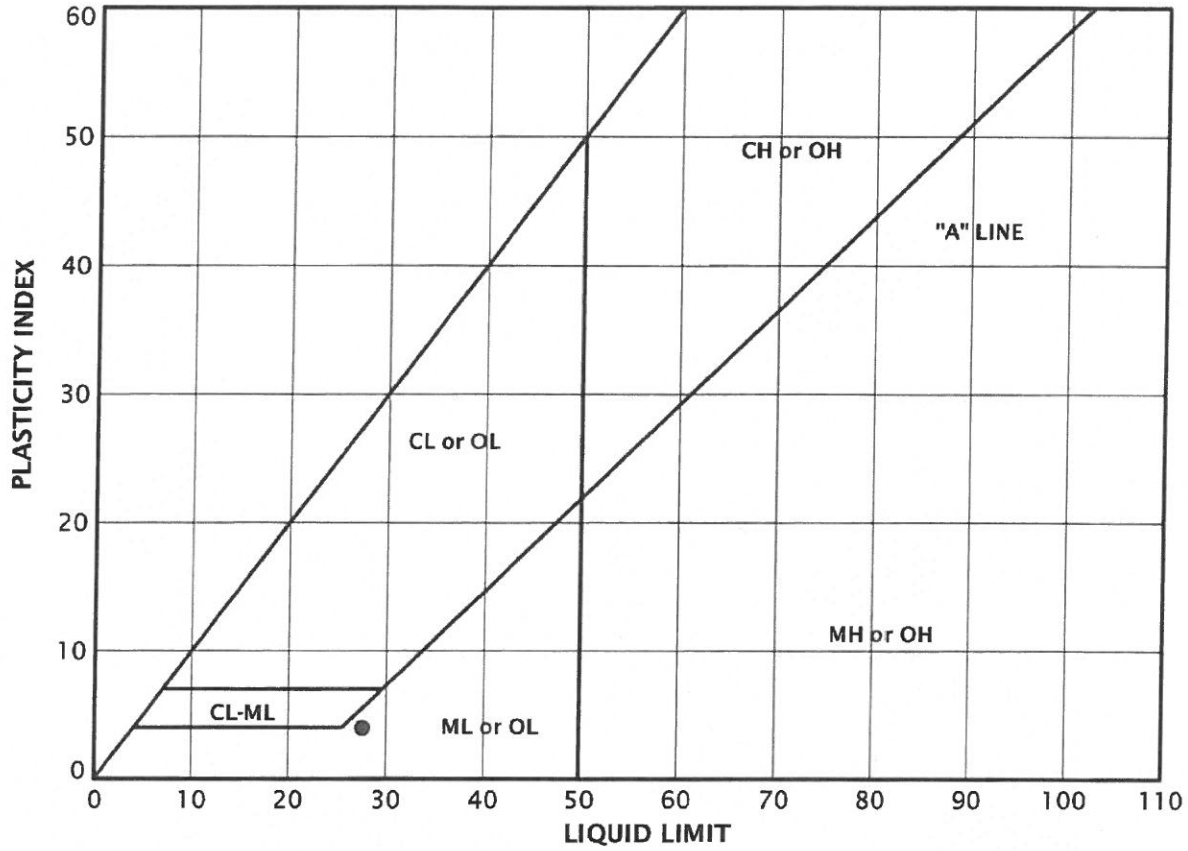
	MARCH 2019	AURORA AIRPORT FUEL FARM AURORA, OR	**FIGURE A-1**



KEY	EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	MOISTURE CONTENT (PERCENT)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
●	B-1	15.0	30	28	24	4

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	MARCH 2019	AURORA AIRPORT FUEL FARM AURORA, OR	**FIGURE A-2**

SAMPLE INFORMATION			MOISTURE CONTENT (PERCENT)	DRY DENSITY (PCF)	SIEVE			ATTERBERG LIMITS		
EXPLORATION NUMBER	SAMPLE DEPTH (FEET)	ELEVATION (FEET)			GRAVEL (PERCENT)	SAND (PERCENT)	P200 (PERCENT)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
B-1	0.0		5							
B-1	2.5		35							
B-1	5.0		38				83			
B-1	10.0		37				76			
B-1	15.0		30					28	24	4
B-1	20.0		32				32			
B-1	20.1		32							
B-1	25.0		27				12			

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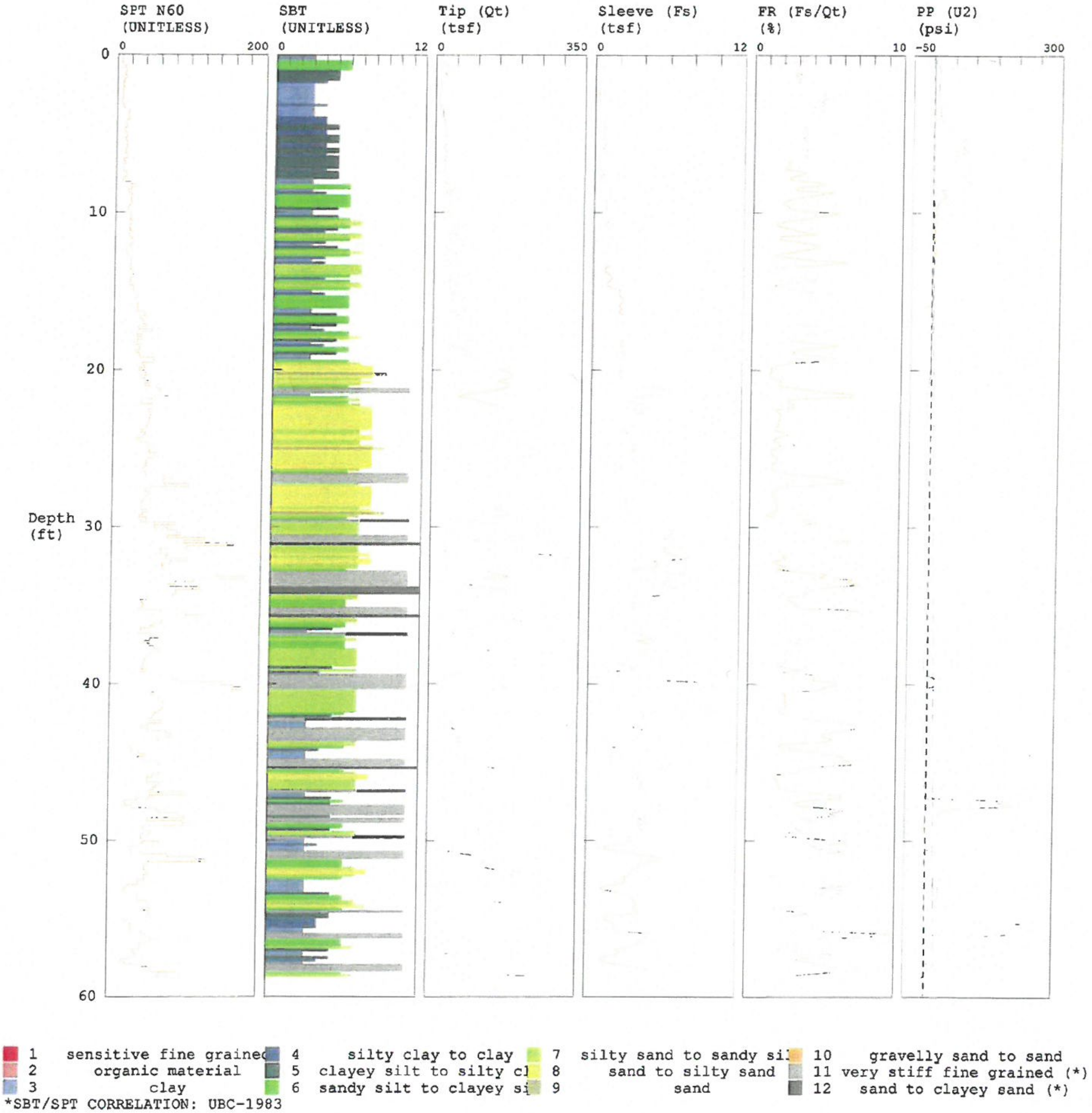
CENTREXCON-4-01	**SUMMARY OF LABORATORY DATA**	
MARCH 2019	AURORA AIRPORT FUEL FARM AURORA, OR	**FIGURE A-3**

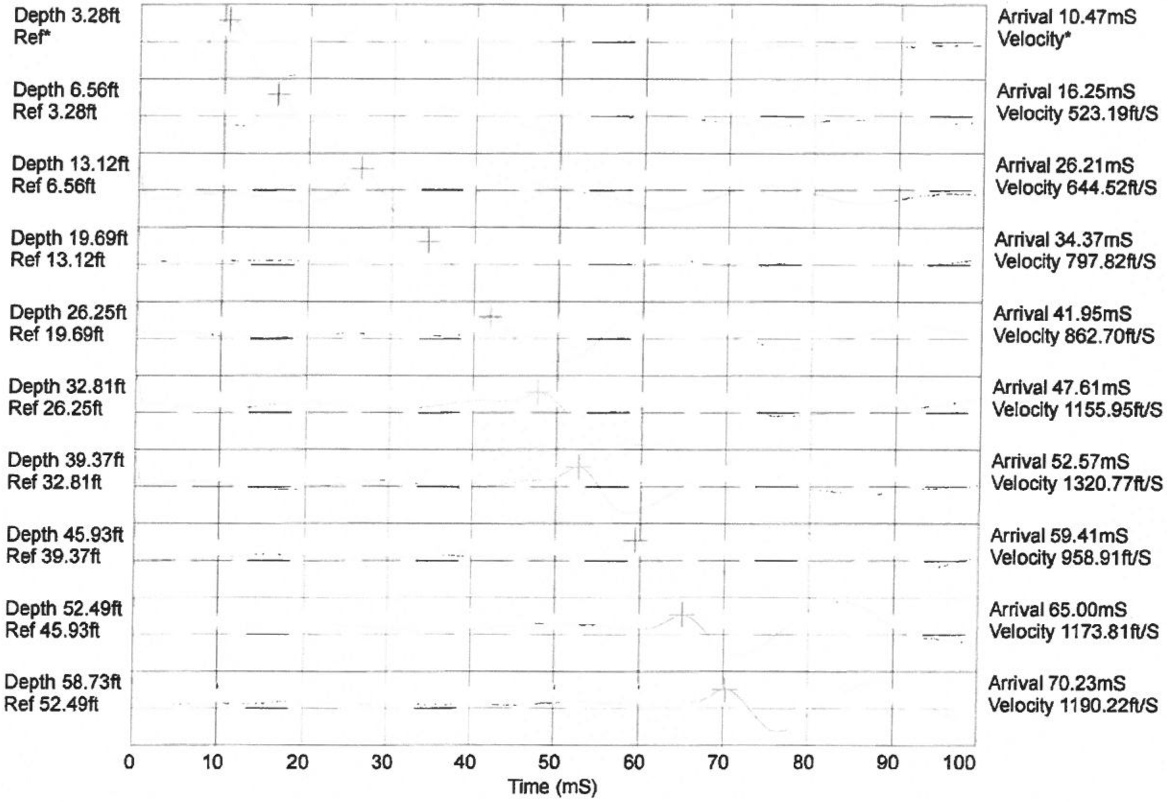
GeoDesign / CPT-1 / 14357 Keil Rd NE Aurora

OPERATOR: OGE DMM
CONE ID: DPG1323
HOLE NUMBER: CPT-1
TEST DATE: 2/18/2019 8:34:35 AM
TOTAL DEPTH: 58.727 ft



*SBT/SPT CORRELATION: UBC-1983

COMMENT: GeoDesign / CPT-1 / 14357 Keil Rd NE Aurora



Hammer to Rod String Distance (ft): 1.97
* = Not Determined

ATTACHMENT C

ATTACHMENT C

SITE-SPECIFIC SEISMIC HAZARD EVALUATION

INTRODUCTION

The information in this attachment summarizes the results of a site-specific seismic hazard evaluation for the proposed fuel farm at the Aurora Airport in Aurora, Oregon. This seismic hazard evaluation was performed in accordance with the requirements ASCE 7-16. We understand the project will consist of new fuel tanks within an approximately 3,000-square-foot area on the southern portion of the airport.

SITE CONDITIONS

REGIONAL GEOLOGY AND SUBSURFACE CONDITIONS

The regional geology in the area and site subsurface conditions are discussed in the fuel farm report.

SEISMIC SETTING

Earthquake Source Zones

Three scenario earthquakes were considered for this study consistent with the local seismic setting. Two of the possible earthquake sources are associated with the Cascadia subduction zone (CSZ), and the third event is a shallow, local crustal earthquake that could occur in the North American Plate. The three earthquake scenarios are discussed below.

Regional Events

The CSZ is the region where the Juan de Fuca Plate is being subducted beneath the North American Plate. This subduction is occurring in the coastal region between Vancouver Island and northern California. Evidence has accumulated suggesting that this subduction zone has generated eight great earthquakes in the last 4,000 years, with the most recent event occurring approximately 300 years ago (Weaver and Shedlock, 1991). The fault trace is mapped approximately 50 to 120 kilometers (km) off the Washington Coast.

Two types of subduction zone earthquakes are possible and considered in this study:

1. An interface event earthquake on the seismogenic part of the interface between the Juan de Fuca Plate and the North American Plate on the CSZ. This source is capable of generating earthquakes with a moment magnitude M_w 9.0 or greater.
2. A deep intraplate earthquake on the seismogenic part of the subducting Juan de Fuca Plate. These events typically occur at depths of between 30 and 60 km. This source is capable of generating an event with a moment magnitude of up to 8.0.

Local Events

An earthquake could occur on a local fault near the site within the design life of the facility. Figure C-1 shows the locations of faults with potential Quaternary movement within a 20-mile radius of the site. Figure C-2 shows the interpreted locations of seismic events that occurred between 1833 and 2014 (USGS, 2014). The closest local faults in the site vicinity are the Canby-Molalla and Newberg faults. Table C-1 presents the closest mapped distance and mapped length of these faults.

Table C-1. Significant Crustal Faults

Source	Closest Mapped Distance[1] (miles)	Mapped Length[1] (km)
Canby-Molalla	5.5	50
Newberg	9.5	5

1. Reported by the U.S. Geological Survey (USGS, 2019)

CODE-BASED SEISMIC DESIGN PARAMETERS

Due to the potential for minor liquefaction, the site is considered a Site Class F. ASCE 7-16 Section 20.3.1 requires a site-specific ground motion analysis be completed for structures with a fundamental period (T) greater than 0.5 second that are located within a Site Class F. If structures have a fundamental period of less than 0.5 second, seismic design parameters can be determined using the pre-liquefaction class. Structural elements for the project are expected to have fundamental period of less than 0.5 second; however, the project will house explosive substances and the airport will likely be a used as a critical facility after a seismic event. A site-specific seismic evaluation has been requested irrespective of the fundamental period of the structures.

If code-based parameters were used, a site classification of D would be appropriate based on shear wave velocity testing in CPT-1. Code-based seismic design criteria in accordance with ASCE 7-16 are summarized in Table C-2.

Table C-2. Seismic Design Parameters

Seismic Design Parameter	Short Period (T_s = 0.2 second)	1 Second Period (T_1 = 1.0 second)
MCE Spectral Acceleration	$S_s = 0.808$ g	$S_1 = 0.380$ g
Site Class	D	
Site Coefficient	$F_a = 1.177$	$F_v = 1.92$
Adjusted Spectral Acceleration	$S_{MS} = 0.951$ g	$S_{M1} = 0.730$ g
Design Spectral Response Acceleration Parameters	$S_{DS} = 0.634$ g	$S_{D1} = 0.487$ g

Parameters correspond to Site Class D per ASCE 7-16. A site-specific analysis is required for the project.
g: gravitational acceleration (32.2 feet/second^2)
MCE: maximum considered earthquake

SITE RESPONSE ANALYSIS

RISK TARGETED BEDROCK SPECTRUM

A probabilistic bedrock spectrum for the site was determined using the computer program EZ-FRISK 8.0 and the 2014 USGS fault source parameters. The ground motion models and weighting in the analysis are consistent with the 2014 USGS fault source parameters. Near-source effects were included in the analysis per Bayless and Somerville (2013). We determined the spectral accelerations for the outcropping bedrock response spectrum for periods ranging from 0 to 10 seconds. The response spectrum is consistent with a shear wave velocity equal to 760 meters per second. Table C-3 presents a summary of values used to compute the MCE target bedrock response spectrum.

Table C-3. Target Bedrock Spectrum

Period (seconds)	MCE Target Bedrock Spectral Acceleration (g)
0.01	0.369
0.02	0.391
0.03	0.422
0.05	0.495
0.075	0.644
0.1	0.764
0.15	0.842
0.2	0.808
0.25	0.749
0.3	0.704
0.4	0.615
0.5	0.534
0.75	0.409
1	0.334
1.5	0.235
2	0.181
3	0.116
4	0.0873
5	0.0667
7.5	0.0397
10	0.0294

BASE GROUND MOTIONS

Six recorded base ground motions were selected to represent the local seismic setting. Based on deaggregation at the peak ground acceleration, ground motions are generally equally controlled by CSZ (approximately 55 percent) and crustal events (approximately 40 percent of hazard, predominately gridded sources). The remainder is deep background seismicity. Based on the deaggregation results, we selected three time histories for the CSZ and three time histories for the crustal event. Table C-4 provides the ground motions selected for this study. The base motions were spectrally matched to the MCE target spectrum using EZ-FRISK 8.0.

Table C-4. Selected Ground Motions

Ground Motion/Recording Station	Magnitude	Distance (km)	Component
CSZ Zone Records			
Tohoku – Tsukuba City Hall	9.0	106.9	004
Maule – Curico Hospital	8.8	76.3	EW
Tokachi-oki – Estacion de Medicisn	8.29	65.8	EW
Crustal Zone Records			
Chi-Chi, Taiwan – CHY065	7.62	9	E
Kobe, Japan - Abeno	6.9	1.0	000
Darfield, New Zealand - DFHS	7.0	11.86	S73W

SITE CONDITION MODELING

A non-linear seismic site response analysis was conducted on the six spectrally matched acceleration time histories to determine the site response. The site response analysis was performed using DEEPSOIL version 7.0 software and the soil parameters described in Table C-5. As part of our analysis both effect stress analysis (ESA) and total stress analysis (TSA) were completed.

The input soil models used in analysis are based on the findings of our subsurface exploration program, shear wave velocity testing from the CPT, a review of well logs, and our experience in the site vicinity.

Three cases were analyzed for each profile to capture the epistemic uncertainty at the site. Profile 1 used the shear wave velocities in Table C-5. Profile 2 reduced the shear wave velocities in Table C-5 at the site by 20 percent (i.e., divide by 1.25). Profile 3 increased the shear wave velocities in Table C-5 by 25 percent (i.e., multiply by 1.25). A weighted average of the results of the site response (Profile 1 = 0.6, Profile 2 = 0.2, and Profile 3 = 0.2) were taken as the site response spectra for the site.

Table C-5. Input Soil Profile

Depth Interval (feet)	Subsurface Unit	Shear Wave Velocity (fps)	Modulus Reduction Curve	Damping Curve	Pore Water Pressure Model
0 to 10	Silt and Clay	550 to 600	Vucetic and Dobry, 1991	Vucetic and Dobry, 1991	Pacific NW Silt (Dickenson, unpublished)
10 to 20	Silty Sand to Sandy Silt	600 to 800	Vucetic and Dobry, 1991	Vucetic and Dobry, 1991	Pacific NW Silt (Dickenson, unpublished)
20 to 32	Sand	850 to 1,200	Seed and Idriss, 1970	Seed and Idriss, 1970	Herber Road Sand PB (Vucetic and Dobry 1988)
32 to 44	Sandy Silt	1,000 to 1,200	Vucetic and Dobry, 1991	Vucetic and Dobry, 1991	Pacific NW Silt (Dickenson, unpublished)
44 to 60	Sandy Clay	1,200	Vucetic and Dobry, 1991	Vucetic and Dobry, 1991	Pacific NW Silt (Dickenson, unpublished)
60 to 100	Sand	1,200 to 1,300	Seed and Idriss, 1970	Seed and Idriss, 1970	Santa Monica Beach Sand (Matasovic 1993)
100 to 400[1]	Clay	1,300	Vucetic and Dobry, 1991	Vucetic and Dobry, 1991	Warrenton, Oregon, Silt (Dickenson, 2008)

1. Input ground motion is at a depth of 400 feet.
2. Groundwater assumed at a depth of 8 feet below ground surface.

fps: feet per second

Because the ground motion models used in the hazard calculation compute the average horizontal component of ground motions, scale factors were applied to adjust the site response results to the maximum rotated component as described in ASCE 7-16 (C21.2). According to ASCE 7-16 Supplement 1, a scale factor of 1.1 should be used for periods of 0.2 second and shorter, a scale factor of 1.3 should be used for periods of 1.0 second, and a scale factor of 1.5 was used for periods greater than 5.0 seconds (with averaging in between 0.2 and 1.0 second and between 1.0 second and 1.5 seconds).

The results of the site response were also modified with risk coefficients using Method 2 outlined in ASCE 7-16 Section 21.2.1.2. The intent of this is to achieve a uniform 1 percent probability of collapse in a 50-year period. A risk coefficient of $C_{RS} = 0.884$ was applied to the spectrum at periods of 0.2 second or less and a risk coefficient of $C_{R1} = 0.875$ was applied to the spectrum at periods greater than 1.0 second. Linear interpolation was used to compute risk coefficients between periods of 0.2 and 1.0 second.

The acceleration response spectra for the ESA and TSA with maximum rotated component and risk coefficients are presented on Figure C-3. Because only minor liquefaction occurs the TSA and ESA spectra are very similar. The upper envelope of the TSA and ESA was used as the project site response spectrum as shown in Figure C-3.

PROBABILISTIC MCE_R RESPONSE SPECTRUM

Per ASCE 7-16 Section 21.1.3, the recommended probabilistic seismic hazard analysis site-specific MCE_R shall not be lower than the MCE_R response spectrum of the base motion multiplied by the average spectral amplitude ratio (SAR) obtained from the site response analysis. The SAR for the site is shown on Figure C-4. The upper envelope of the TSA and ESA events were multiplied by the SAR to determine the MCE_R. Figure C-5 provides the probabilistic site-specific MCE_R spectrum for the site (upper envelope of SAR multiplied by the target bedrock spectrum in Table C-3).

DETERMINISTIC MCE_R RESPONSE SPECTRUM

The deterministic approach considers the maximum ground acceleration that may occur at the site as a result of a characteristic earthquake on all known active faults in the region. ASCE 7-16 Section 21.2.2 requires that the spectral response at each period be calculated as an 84th percentile 5 percent damped spectral response acceleration in the direction of maximum horizontal response. However, the lower limit is computed in accordance with ASCE 7-16 Figure 21.2-1 where:

1. For Site Classes A, B, and C: F_a and F_v are determined using Tables 11.4-1 and 11.4-2, with the value of S_s taken as 1.5 and the value S_1 taken and 0.6
2. For Site Class D: F_a is 1.0 and F_v is 2.5
3. For Site Class E and F: F_a is 1.0 and F_v is 4.0

Figure C-5 shows the deterministic lower limit as prescribed by ASCE 7-16 Section 21.2.2. Since the code-prescribed deterministic lower limit is greater than the probabilistic results, a deterministic analysis of individual faults is not necessary.

SITE-SPECIFIC MCE_R RESPONSE SPECTRUM

As outlined in ASCE 7-16 Section 21.2.3, the site-specific MCE_R shall be taken as the lesser of the probabilistic MCE_R and the deterministic MCE_R. Figure C-5 shows the site-specific design response spectrum.

DESIGN RESPONSE SPECTRUM

In accordance with ASCE 7-16 Section 21.3, the design response spectrum is two-thirds of the MCE_R at all periods; however, the design response spectrum at any period shall not be taken less than 80 percent of S_a determined in accordance with ASCE 7-16 Section 11.4.6, where F_a and F_v are determined as follows:

1. For Site Classes A, B, and C: F_a and F_v are determined using Tables 11.4-1 and 11.4-2, respectively
2. For Site Class D: F_a is determined using Table 11.4-1 and F_v is taken as 2.4 for $S_1 < 0.2$ or 2.5 for $S_1 \geq 0.2$
3. For Site Class E: F_a is determined using Table 11.4-1 for $S_S < 1.0$ or taken as 1.0 for $S_S \geq 1.0$ and F_v is taken as 4.2 for $S_1 \leq 0.1$ or 4.0 for $S_1 > 0.1$

DESIGN ACCELERATION PARAMETERS

The parameter S_{DS} is taken as 90 percent of the maximum spectral acceleration from the site-specific design response spectrum at any period within the range of 0.2 second to 5.0 seconds. The parameter S_{D1} shall be taken as the maximum value of the product, TS_a, for periods from 1.0 second to 2.0 seconds for sites with $Vs_{30} > 1{,}200$ fps and for periods from 1.0 second to 5.0 seconds for sites with $Vs_{30} \leq 1{,}200$ fps. Figure C-6 shows the design response spectrum for ASCE 7-16.

The values of S_{MS} and S_{M1} shall be taken as 1.5 times S_{DS} and S_{D1} but shall not be less than 80 percent of the values determined in accordance with ASCE 7-16 Section 11.4.3 for S_{MS} and S_{M1} and ASCE 7-16 Section 11.4.5 for S_{DS} and S_{D1}. Therefore, the site-specific design parameters are as follows:

- $S_{DS} = 0.671$ g
- $S_{D1} = 1.007$ g
- $S_{MS} = 0.430$ g
- $S_{M1} = 0.645$ g

FAULT SURFACE RUPTURE

The closest mapped fault is more than 5 miles northeast of the site as described in Table C-1. Consequently, it is our opinion that the probability of surface fault rupture beneath the site is low.

LIQUEFACTION

Liquefaction is caused by a rapid increase in pore water pressure that reduces the effective stress between soil particles to near zero. Granular soil, which relies on interparticle friction for strength, is susceptible to liquefaction until the excess pore pressures can dissipate. In general, loose, saturated sand soil with low silt and clay content is most susceptible to liquefaction. Silty soil with low plasticity is also susceptible to liquefaction or strain softening under relatively higher levels of ground shaking.

We performed liquefaction analysis using the CPT results in accordance with Boulanger and Idriss (2014) employing the depth weighting methods from Cetin (2009). The CPT probe provides continuous soil strength data for the full depth of penetration. The two strength parameters obtained are tip resistance and frictional resistance along the probe.

Based on our analysis, we estimate total post-liquefaction settlement at the existing ground surface will be less than approximately 1 inch during a design-level earthquake. We anticipate differential settlement across the site will be less than approximately one-half of the total liquefaction settlement.

LATERAL SPREADING

Lateral spreading is a liquefaction-related seismic hazard and occurs on gently sloping or flat sites underlain by liquefiable sediment adjacent to an open face, such as a riverbank. Liquefied soil adjacent to an open face can flow toward the open face, resulting in lateral ground displacement. The primary difference between a conventional slope stability failure and lateral spreading is that no distinct failure plane is formed during a lateral spreading event.

Because minimal liquefaction is predicted and there are no open faces near the project lateral spreading is not a design consideration.

GROUND MOTION AMPLIFICATION

Soil capable of significantly amplifying ground motions beyond the levels determined by our site-specific seismic study were not encountered during our subsurface explorations. The main report for the fuel farm report provides a detailed description of the subsurface conditions encountered.

LANDSLIDE

Earthquake-induced landsliding generally occurs in steeper slopes comprised of relatively weak soil deposits. The site and surrounding area are relatively flat, and seismically induced landslides are not considered a site hazard.

SETTLEMENT

Settlement due to earthquakes is most prevalent in relatively deep deposits of dry, clean sand. We do not anticipate that seismic-induced settlement in addition to liquefaction-induced settlement will occur during design levels of ground shaking.

SUBSIDENCE/UPLIFT

CSZ earthquakes can cause vertical tectonic movements. The movements reflect coseismic strain release accumulation associated with interplate coupling in the CSZ. Based on our review of the literature, the locked zone of the CSZ is located in excess of 50 miles from the site. Consequently, we do not anticipate that subsidence or uplift is a significant design concern.

LURCHING

Lurching is a phenomenon generally associated with very high levels of ground shaking, which cause localized failures and distortion of the soil. The anticipated ground accelerations shown on the figures in this appendix are below the threshold required to induce lurching of the site soil.

SEICHE AND TSUNAMI

The site is inland and elevated away from tsunami inundation zones and away from large bodies of water that may develop seiches. Seiches and tsunamis are not considered a hazard in the site vicinity.

REFERENCES

ASCE, 2016. Minimum Design Loads for Buildings and Other Structures. ASCE Standard ASCE/SEI 7-016. American Society of Civil Engineers.

Bayless and Somerville, 2013. Final Report of the NGA-West2 Directivity Working Group. May 2013. PEER2013/09.

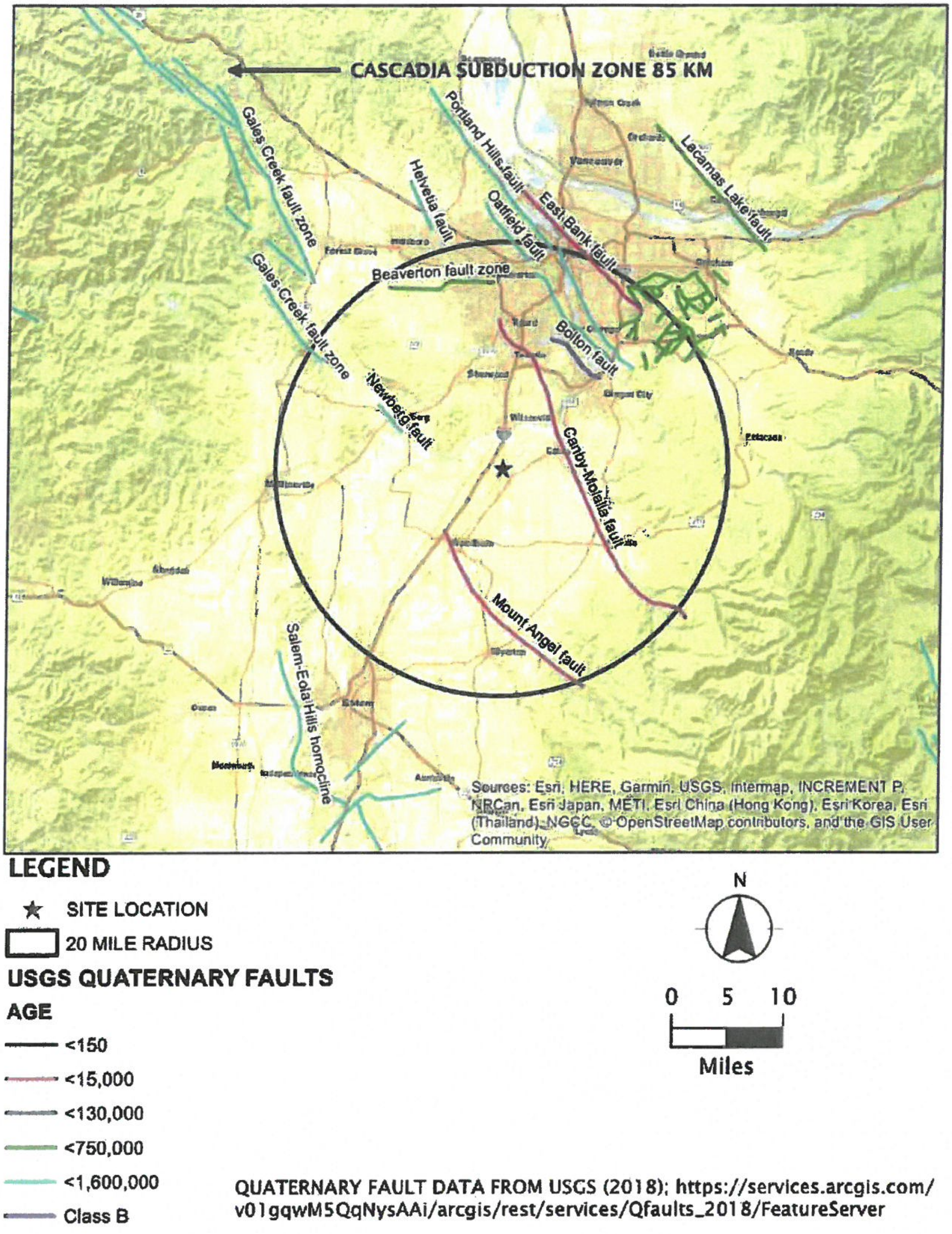
Boulanger, R. W., and Idriss, I. M., 2014, "CPT and SPT based liquefaction triggering procedures." Report No. UCD/CGM-14/01, Center for Geotechnical Modeling, Department of Civil and Environmental Engineering, University of California, Davis, CA, 134 pp. Boulanger_Idriss_CPT_and_SPT_Liq_triggering_CGM-14-01_2014.

Cetin, K.O., Bilge, H.T., Wu, J., Kammerer, A.M., and Seed R.B. (2009). Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements. *Journal of Geotechnical and Geoenvironmental Engineering*, ASCE. 135(3), 387-398.

USGS, 2014. Documentation for the 2014 Update of the United States National Seismic Hazard Maps. Peterson et al 2014.

USGS, 2019. www.usgs.gov

Weaver, C.S. and Shedlock, K.M., 1991, Program for earthquake hazards assessment in the Pacific Northwest: U.S. Geological Survey Circular 1067, 29 pgs.



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QUATERNARY FAULT DATA FROM USGS (2018); https://services.arcgis.com/v01gqwM5QqNysAAi/arcgis/rest/services/Qfaults_2018/FeatureServer

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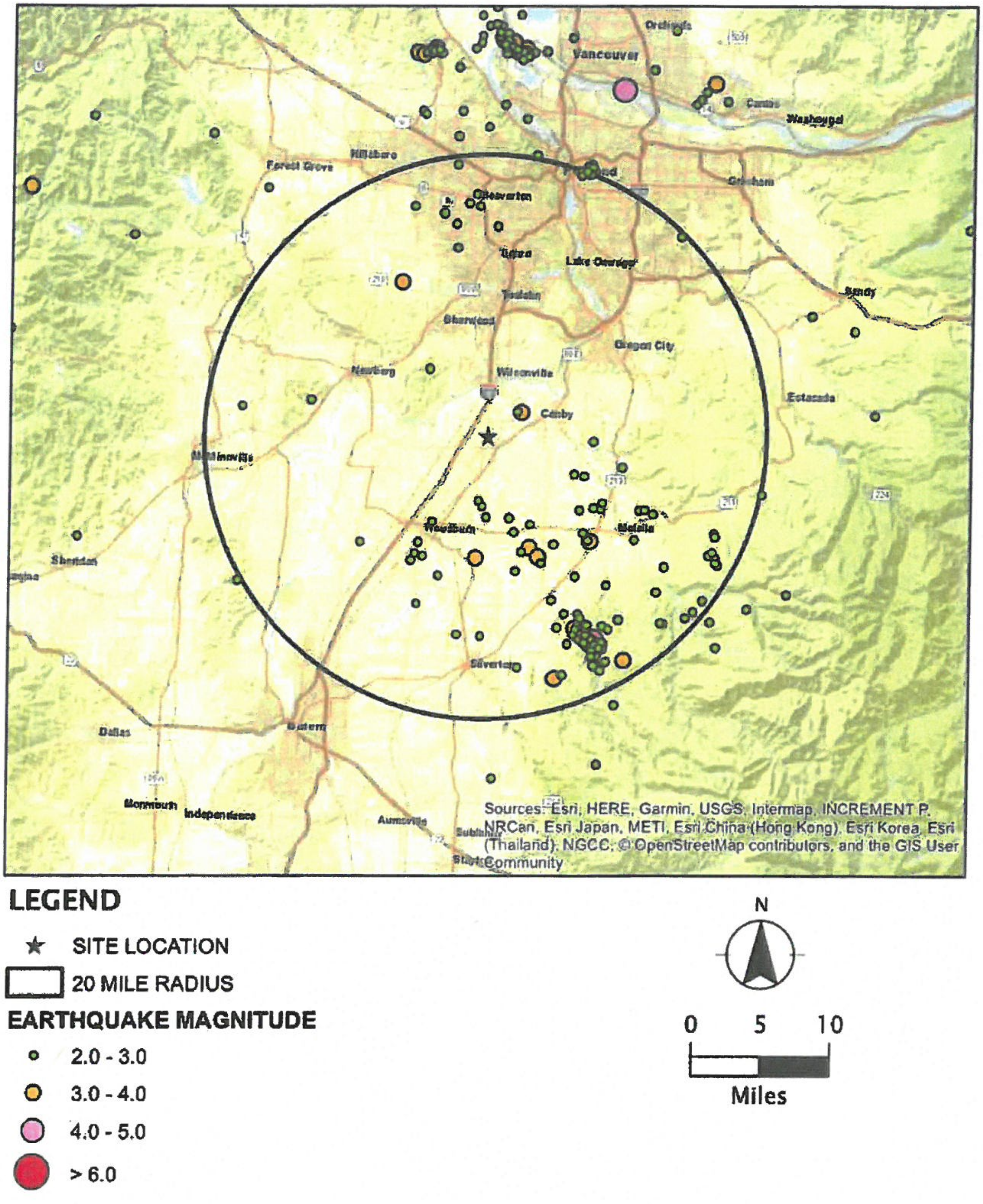
GEODESIGN INC 9450 SW Commerce Circle - Suite 300 Wilsonville OR 97070 503.968.8787 www.geodesigninc.com	CENTREXCON-4-01	QUATERNARY FAULT MAP	
	MARCH 2019	AURORA AIRPORT FUEL FARM AURORA, OR	FIGURE C-1



Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

USGS, 2018, Earthquake Hazards Program, US Earthquake Information by State, U. S. Geological Survey, Available: http://earthquake.usgs.gov/earthquakes/search.

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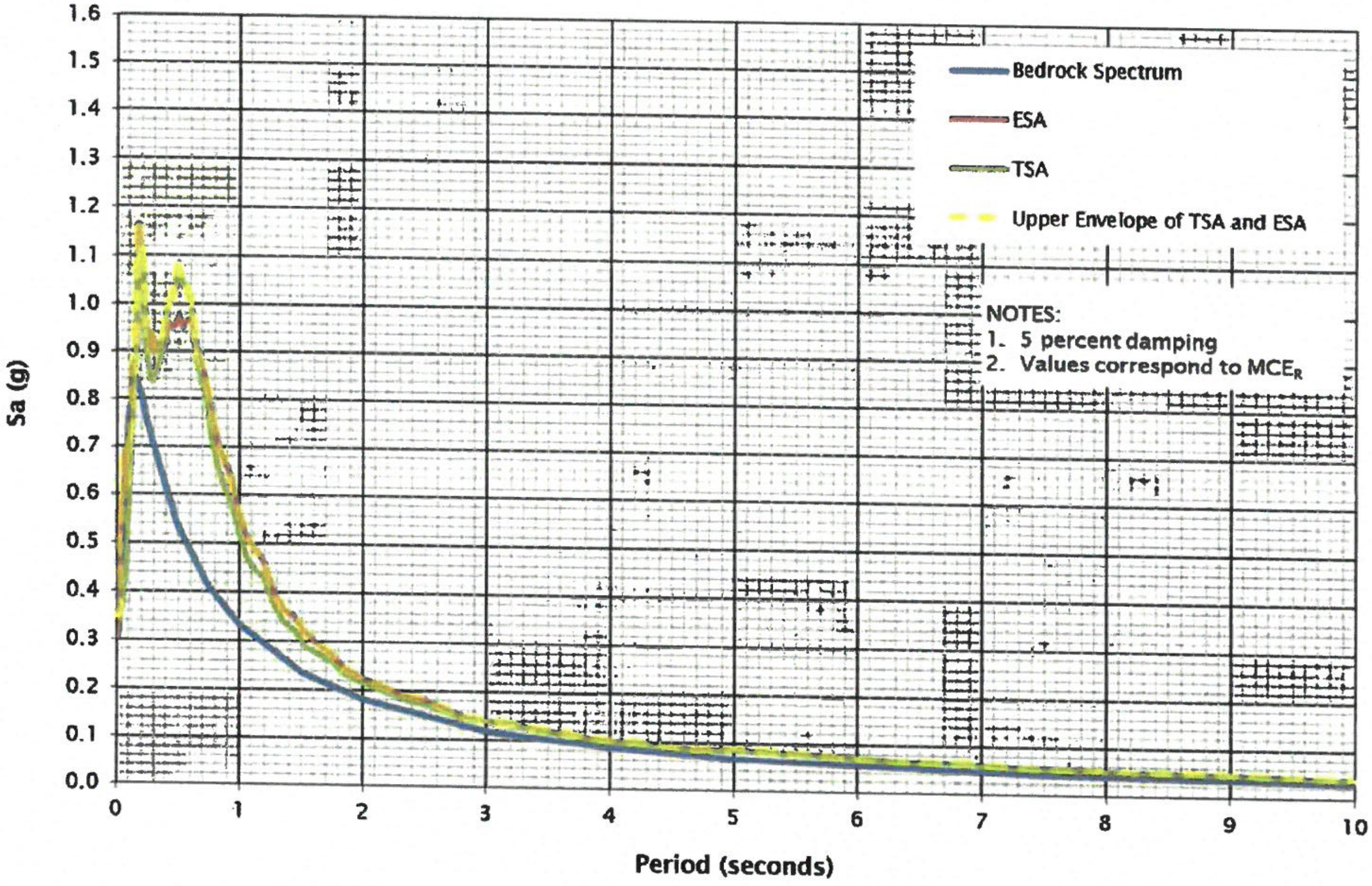
GEODESIGN INC 9450 SW Commerce Circle - Suite 300 Wilsonville OR 97070 503.968.8787 www.geodesigninc.com	CENTREXCON-4-01	HISTORICAL SEISMICITY MAP	
	MARCH 2019	AURORA AIRPORT FUEL FARM AURORA, OR	FIGURE C-2



NOTES:
1. 5 percent damping
2. Values correspond to MCE_R

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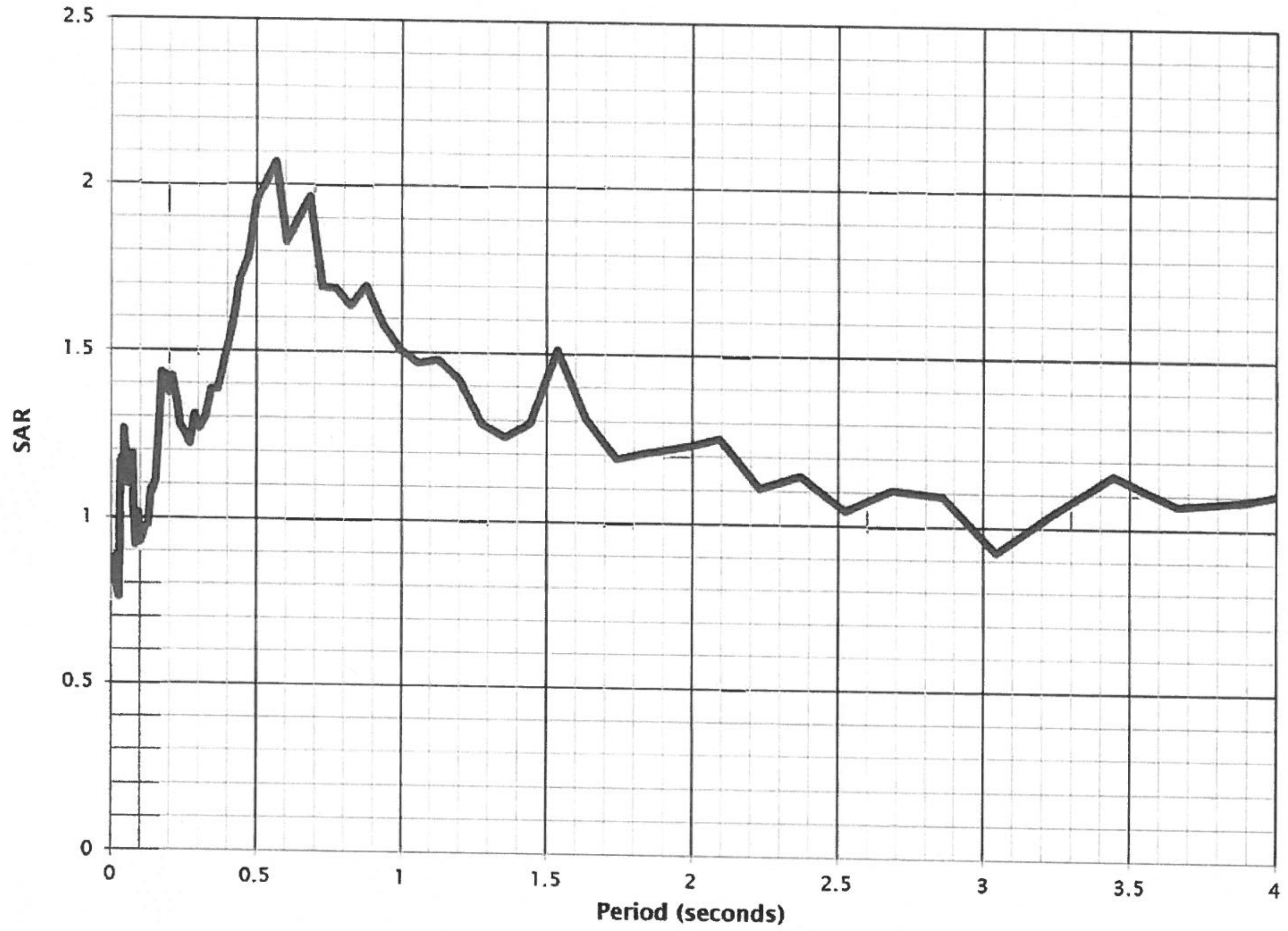
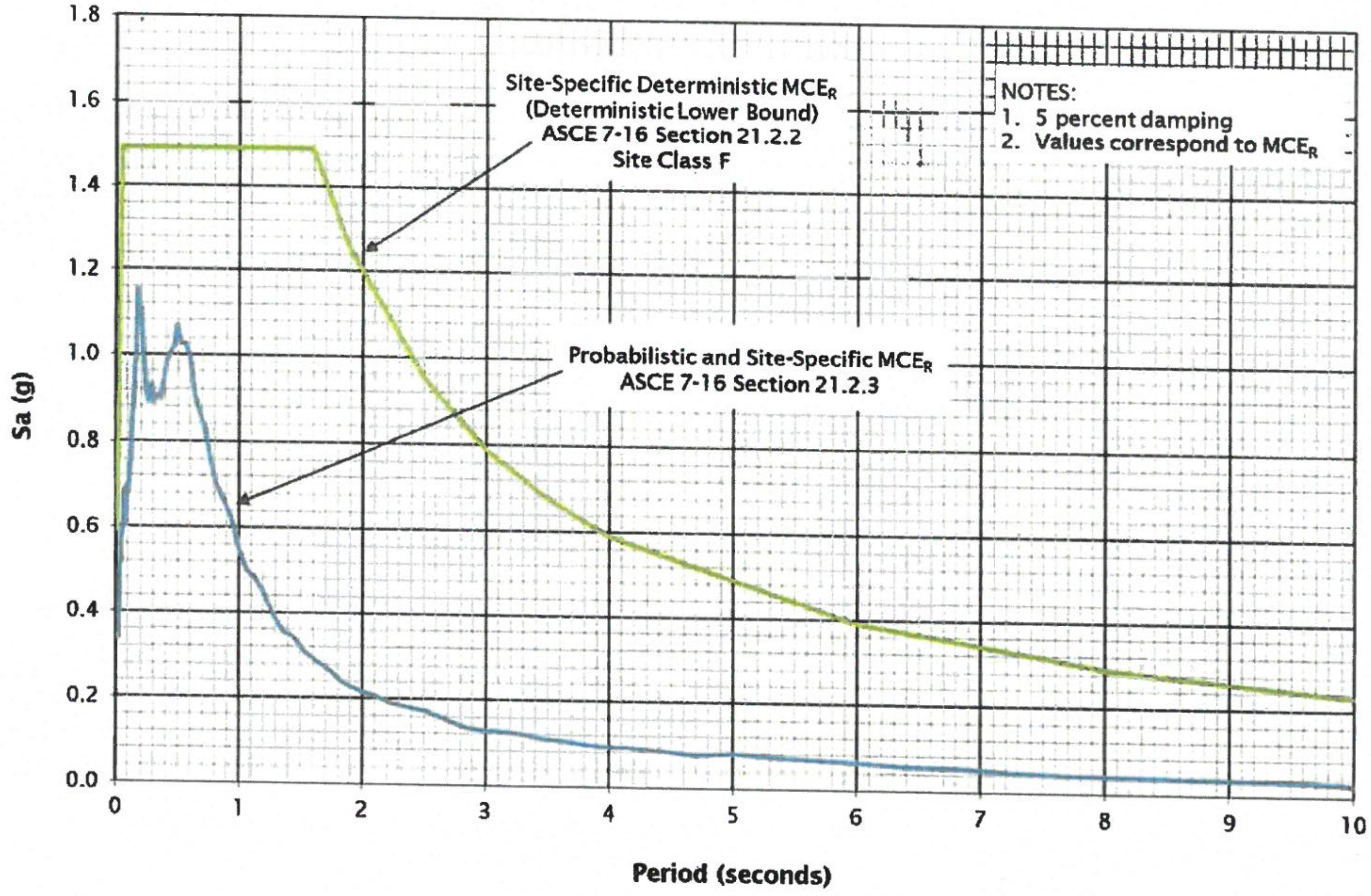
SITE RESPONSE SPECTRA

AURORA AIRPORT FUEL FARM
AURORA, OR

FIGURE C-3



GEODESIGN INC 9450 SW Commerce Circle - Suite 300 Wilsonville OR 97070 503.968.8787 www.geodesigninc.com	CENTREXCON-4-01 MARCH 2019	**SAR PLOT** AURORA AIRPORT FUEL FARM AURORA, OR **FIGURE C-4**



NOTES:
1. 5 percent damping
2. Values correspond to MCE_R

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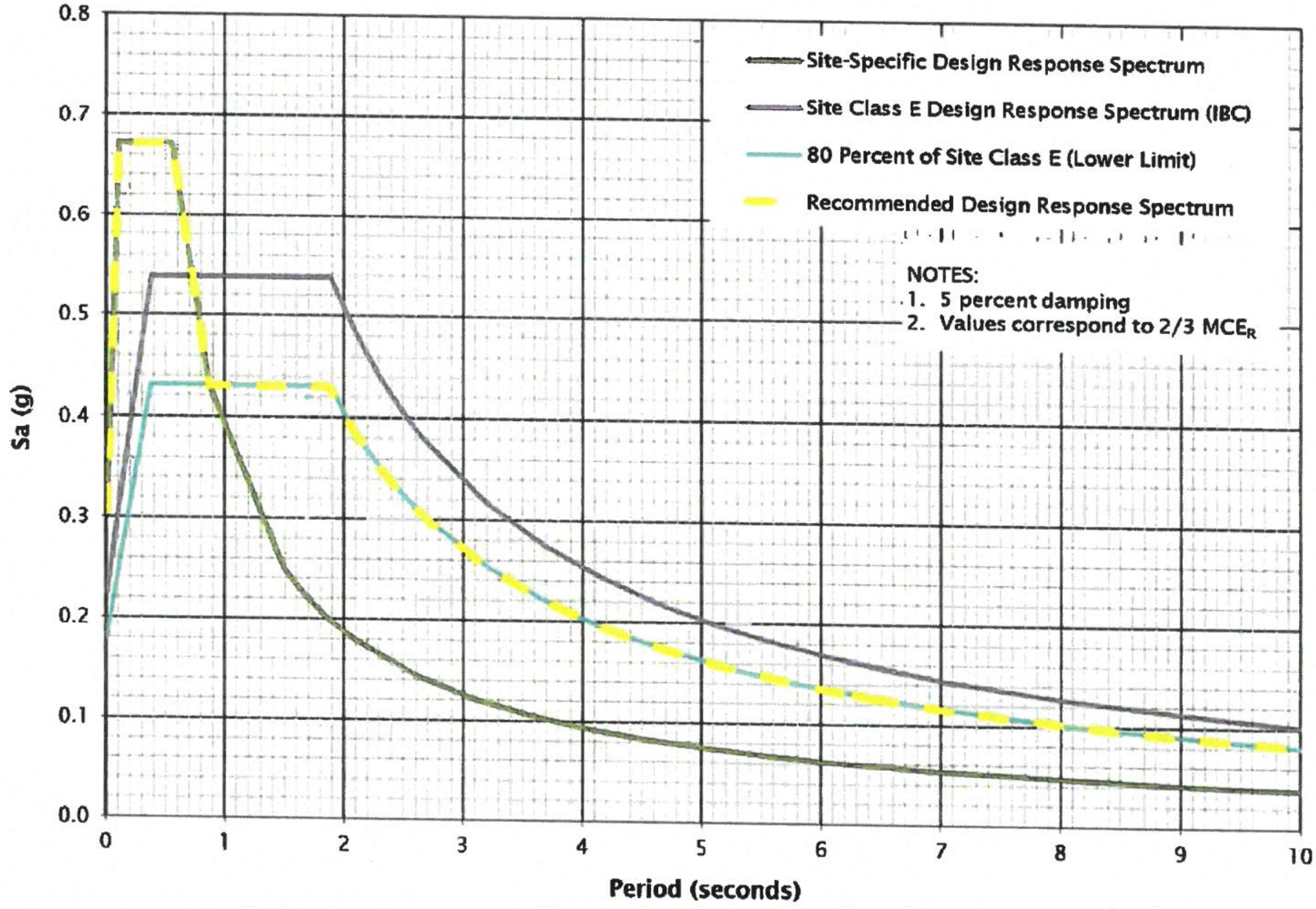
SITE-SPECIFIC RESPONSE SPECTRA

AURORA AIRPORT FUEL FARM
AURORA, OR

FIGURE C-5



NOTES:
1. 5 percent damping
2. Values correspond to 2/3 MCE_R

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DESIGN RESPONSE SPECTRUM

AURORA AIRPORT FUEL FARM
AURORA, OR

FIGURE C-6