
February 14, 2022

JN 20255

SR'S Construction
9910 Marine View Drive
Mukilteo, Washington 98275

Attention: Shawn Roten
via email: seattlerestaurantbuilders@gmail.com

Subject: **Slope Stability Considerations**
Proposed Residence
4th Street and Park Avenue
Mukilteo, Washington

Greetings:

Our firm has prepared a geotechnical engineering study for this residence project dated August 11, 2011. We noted that the test borings conducted for this study initially encountered approximately 3 to 7 feet of loose fill that overlays native, mostly sand soil; this sand was initially medium-dense, but became denser at depths ranging from about 10 to 20 feet. Although we did not consider the site a landslide hazard, due to the inconsistent depth to the denser sand, the loose condition of the near-surface soil, and the steep, approximate 12- to 15-foot-tall steep slope that borders the northern side of the proposed residence building, we recommended that the building be founded on driven pile or helical anchor foundations that embed into the denser sand soil. However, we understand that formal slope stability analyses are needed for this project; our analyses are given in this report.

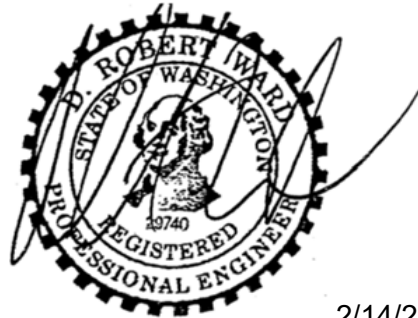
We have performed slope stability analyses on the property/project area using the SLOPE/W computer program. We have shown on the attached site plan where the section that was used in the analyses is located (essentially at the middle of the property). The major inputs into the computer analyses are soil parameters. As noted above, there are essentially three soil layers that were revealed in the test borings (from ground surface down): upper loose fill, then medium-dense native sand, and then denser sand. Because all of these soils are very sandy, the main parameter needed is the internal friction angle (ϕ); cohesion is also generally a parameter used in some analyses, but not when the soil is this sandy. The ϕ used in the analyses, as noted on attached analyses results, for the three soils is: 28 degrees, 34 degrees, and 37 degrees, respectively. Using these parameters, as well as a seismic coefficient of 0.22 (which is one-half of the MCE that was discussed in the 2021 study, the analyses obtained static and dynamic safety factors are 1.5 and 1.2, respectively: these safety factors meet the required safety factors. We have included the cross-sections of the analyses, as well as the computer output of our analyses, with this report.

Based on these analyses, and because the new residence will be placed on a deep foundation system as noted in the 2021 study, it is our professional opinion that the project is suitable from a geotechnical engineering standpoint.

We trust that this letter meets your immediate needs for the proposed development. Please contact us if we can be of further service.

Respectfully submitted,

GEOTECH CONSULTANTS, INC.



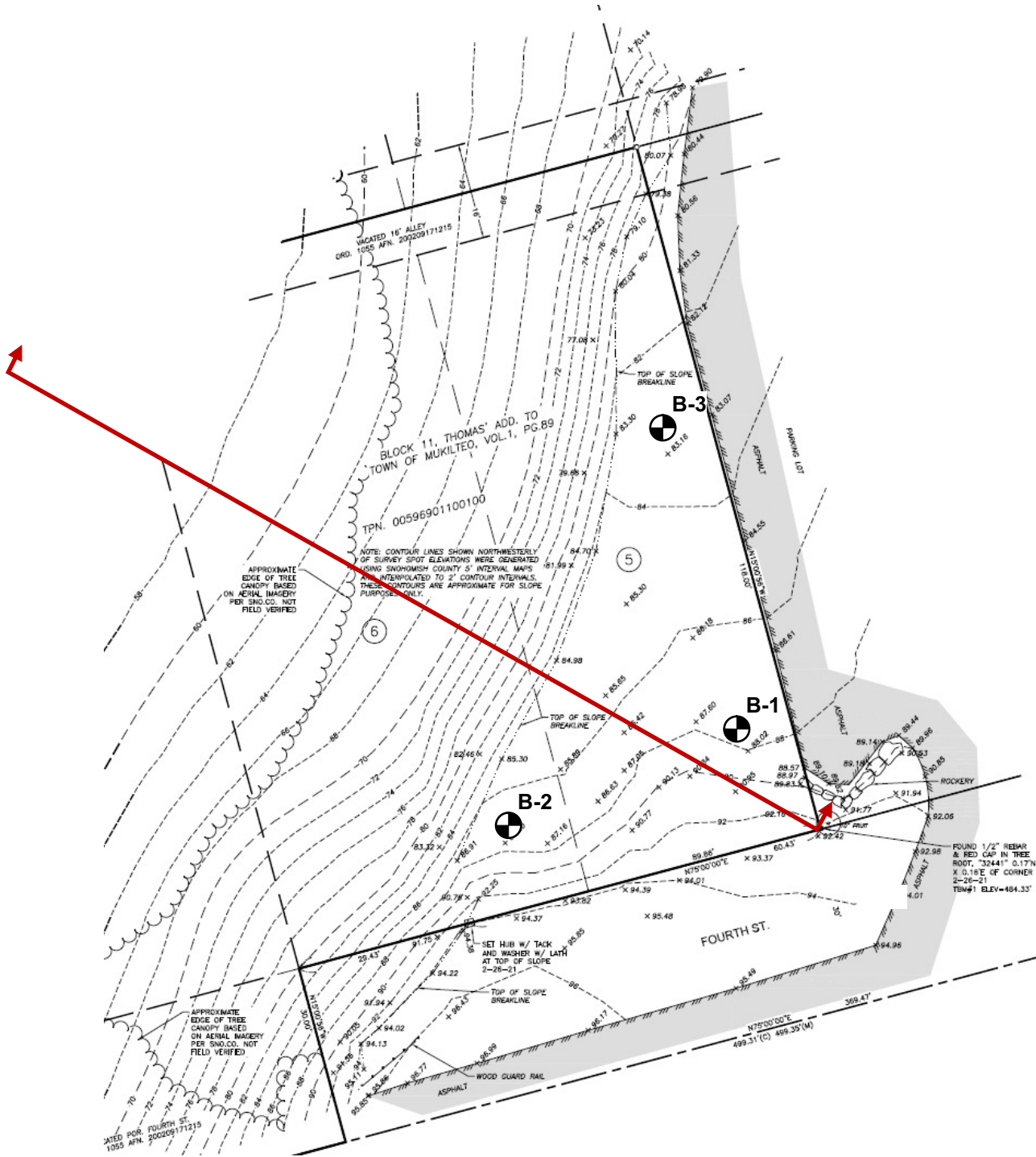
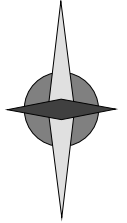
2/14/2022

D. Robert Ward, P.E.
Principal

*Attachment: Site Plan
Results of Slope Stability Analyses for both Static and Dynamic Conditions*

DRW:kg

NORTH



Legend:



Test Boring Location



Slope Stability Analysis Cross Section



GEOTECH
CONSULTANTS, INC.

SITE EXPLORATION PLAN

4th Street and Park Avenue
Parcel No. 00596901100100
Mukilteo, Washington

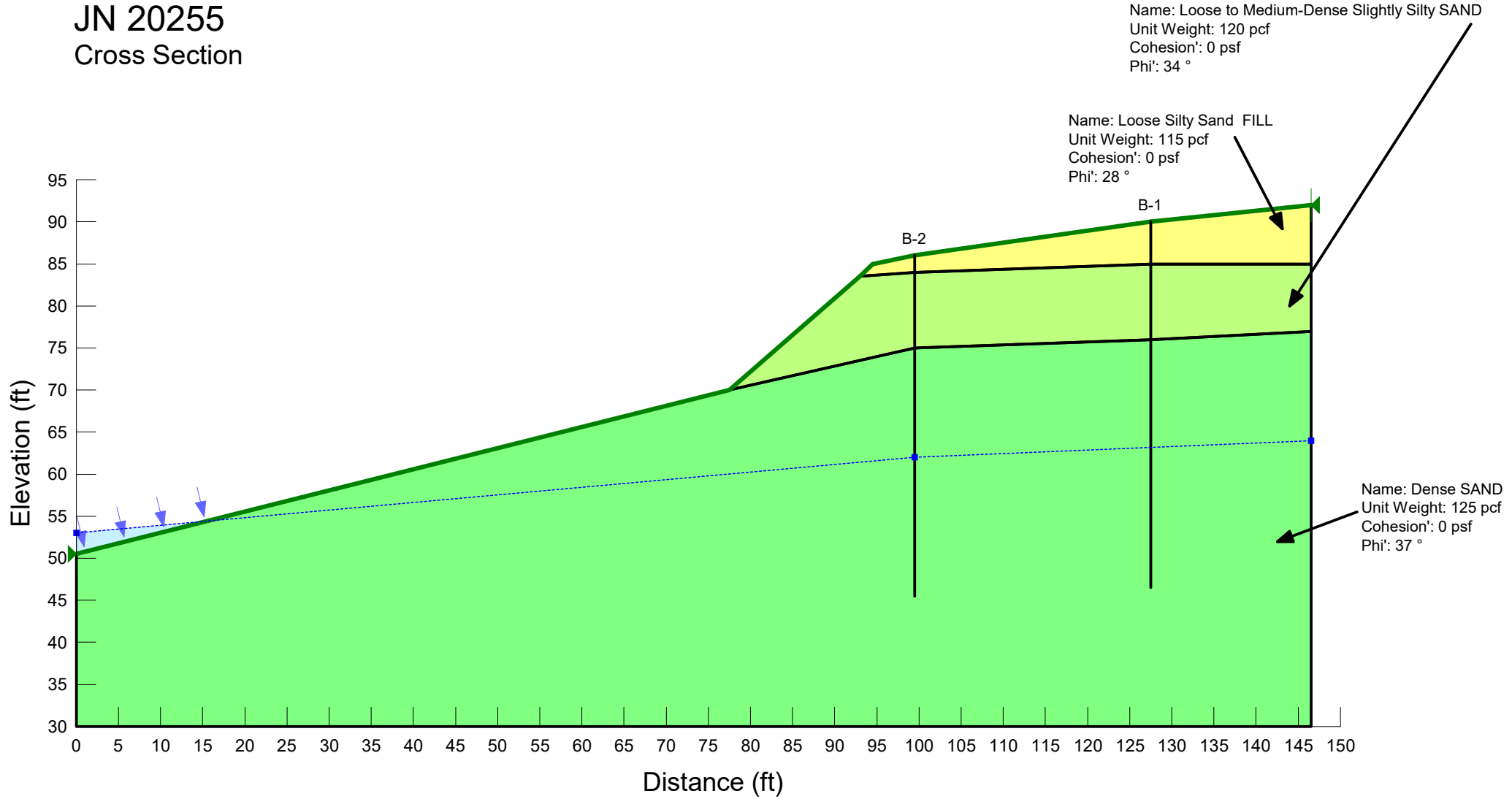
Job No:
20255

Date:
June 2021

No Scale

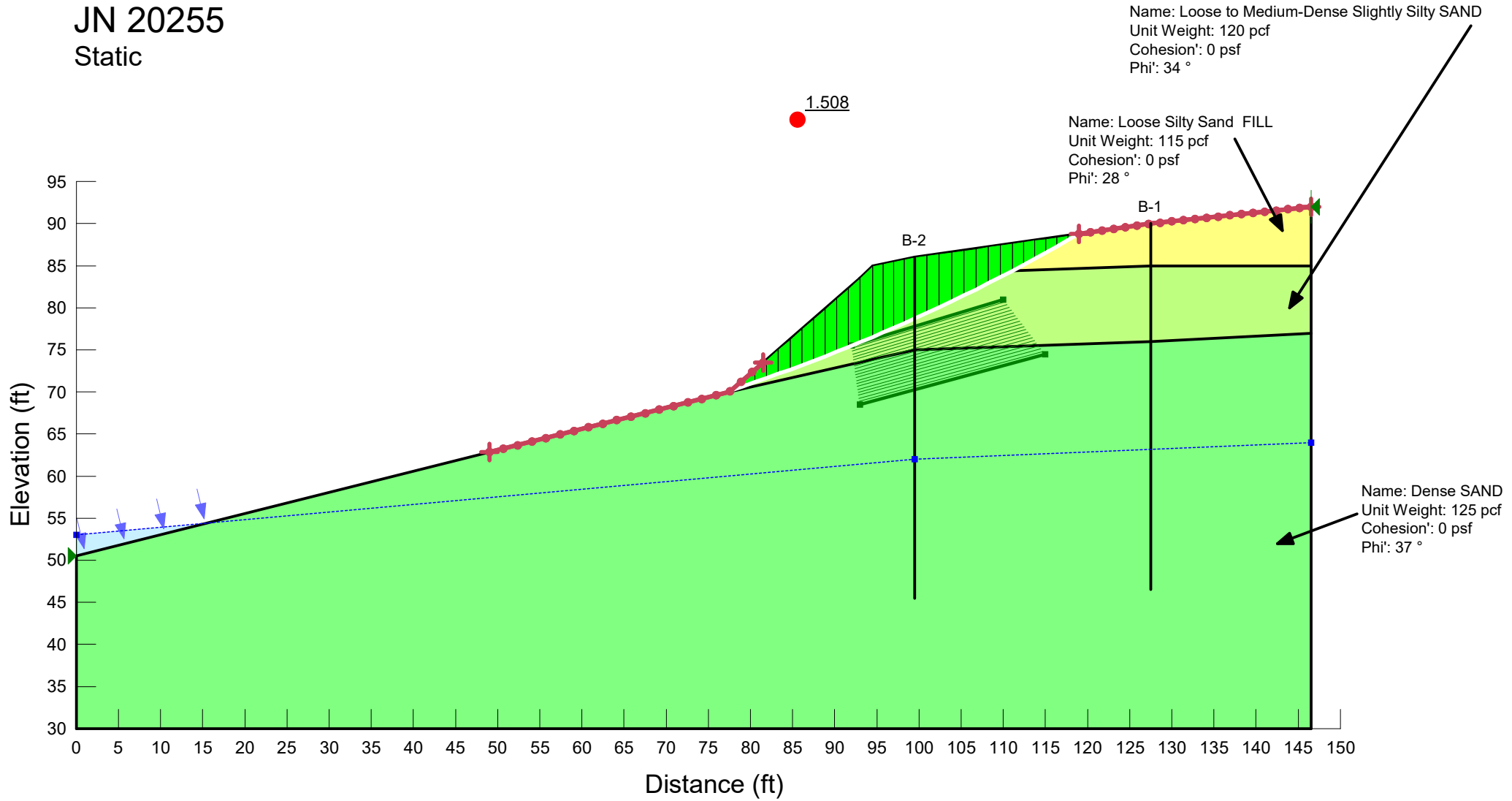
Plate:

JN 20255 Cross Section



JN 20255

Static



Static

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File Information

File Version: 8.15

Title: 20225 Slope Stability Analysis

Created By: Adam Moyer

Last Edited By: Adam Moyer

Revision Number: 62

Date: 2/10/2022

Time: 9:35:49 AM

Tool Version: 8.15.6.13446

File Name: 20255 Slope Stability - SR's Construction.gsz

Directory: C:\Users\AdamM\Geotech Consultants\Shared Documents - Documents\2020 Jobs\20255 SR'S Construction (DRW)\

Last Solved Date: 2/10/2022

Last Solved Time: 9:36:00 AM

Project Settings

Length(L) Units: Feet

Time(t) Units: Seconds

Force(F) Units: Pounds

Pressure(p) Units: psf

Strength Units: psf

Unit Weight of Water: 62.4 pcf

View: 2D

Element Thickness: 1

Analysis Settings

Static

Kind: SLOPE/W

Method: Morgenstern-Price

Settings

Side Function

Interslice force function option: Half-Sine

PWP Conditions Source: Piezometric Line

Apply Phreatic Correction: No

Use Staged Rapid Drawdown: No

Slip Surface

Direction of movement: Right to Left

Use Passive Mode: No

Slip Surface Option: Entry and Exit

Critical slip surfaces saved: **1**
Resisting Side Maximum Convex Angle: **1 °**
Driving Side Maximum Convex Angle: **5 °**
Optimize Critical Slip Surface Location: **No**
Tension Crack
Tension Crack Option: **(none)**

F of S Distribution

F of S Calculation Option: **Constant**

Advanced

Number of Slices: **30**
F of S Tolerance: **0.001**
Minimum Slip Surface Depth: **0.1 ft**
Search Method: **Root Finder**
Tolerable difference between starting and converged F of S: **3**
Maximum iterations to calculate converged lambda: **20**
Max Absolute Lambda: **2**

Materials

Loose Silty Sand FILL

Model: **Mohr-Coulomb**
Unit Weight: **115 pcf**
Cohesion': **0 psf**
Phi': **28 °**
Phi-B: **0 °**
Pore Water Pressure
Piezometric Line: **1**

Loose to Medium-Dense Slightly Silty SAND

Model: **Mohr-Coulomb**
Unit Weight: **120 pcf**
Cohesion': **0 psf**
Phi': **34 °**
Phi-B: **0 °**
Pore Water Pressure
Piezometric Line: **1**

Dense SAND

Model: **Mohr-Coulomb**
Unit Weight: **125 pcf**
Cohesion': **0 psf**
Phi': **37 °**
Phi-B: **0 °**
Pore Water Pressure
Piezometric Line: **1**

Slip Surface Entry and Exit

Left Projection: [Range](#)

Left-Zone Left Coordinate: [\(49, 62.82903\) ft](#)

Left-Zone Right Coordinate: [\(81.5, 73.48387\) ft](#)

Left-Zone Increment: [20](#)

Right Projection: [Range](#)

Right-Zone Left Coordinate: [\(119, 88.78571\) ft](#)

Right-Zone Right Coordinate: [\(146.5, 92\) ft](#)

Right-Zone Increment: [20](#)

Radius Increments: [20](#)

Slip Surface Limits

Left Coordinate: [\(0, 50.5\) ft](#)

Right Coordinate: [\(146.5, 92\) ft](#)

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	53
Coordinate 2	99.5	62
Coordinate 3	146.5	64

Points

	X (ft)	Y (ft)
Point 1	0	50.5
Point 2	77.5	70
Point 3	94.5	85
Point 4	99.5	86
Point 5	127.5	90
Point 6	146.5	92
Point 7	0	30
Point 8	146.5	30
Point 9	127.5	85
Point 10	127.5	76
Point 11	127.5	46.5
Point 12	99.5	84
Point 13	99.5	75
Point 14	99.5	45.5
Point 15	146.5	85
Point 16	146.5	77

Point 17	93	83.5
Point 18	127.5	63
Point 19	99.5	62

Regions

	Material	Points	Area (ft ²)
Region 1	Loose to Medium-Dense Slightly Silty SAND	2,17,12,9,15,16,10,13	552.5
Region 2	Loose Silty Sand FILL	17,3,4,5,6,15,9,12	221.5
Region 3	Dense SAND	1,7,8,16,10,13,2	5,436.9

Current Slip Surface

Slip Surface: 4

F of S: 1.508

Volume: 185.75282 ft³

Weight: 22,025.371 lbs

Resisting Moment: 2,943,651.9 lbs-ft

Activating Moment: 1,951,518.7 lbs-ft

Resisting Force: 12,271.91 lbs

Activating Force: 8,137.1296 lbs

F of S Rank (Analysis): 1 of 9,261 slip surfaces

F of S Rank (Query): 1 of 9,261 slip surfaces

Exit: (77.764691, 70.230537) ft

Entry: (119, 88.785714) ft

Radius: 219.37611 ft

Center: (8.8403587, 278.49795) ft

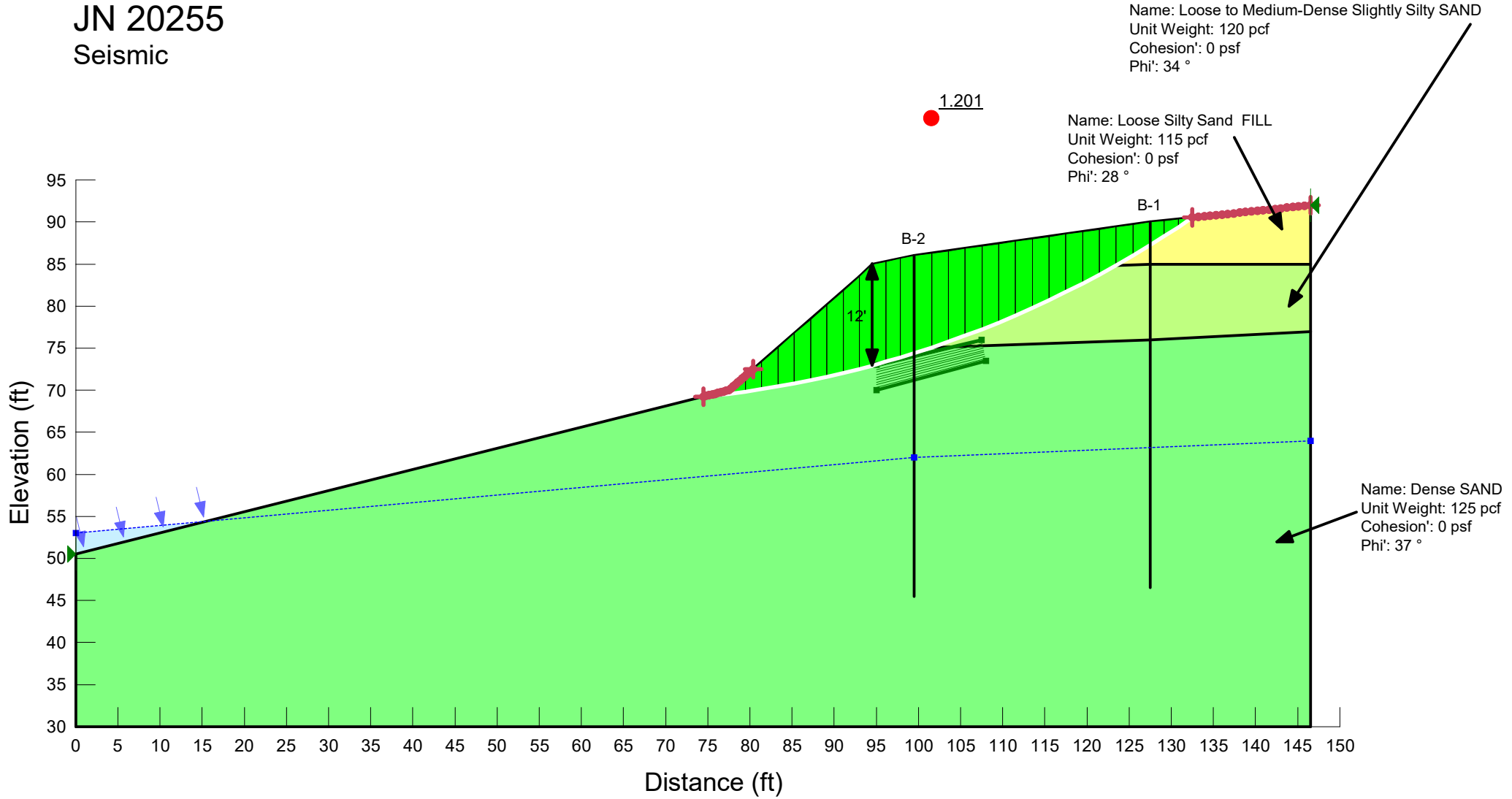
Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	78.457205	70.462279	-646.81641	38.984238	26.2952	0
Slice 2	79.842233	70.930908	-668.24142	116.83685	78.807447	0
Slice 3	81.227261	71.40986	-690.31063	194.08338	130.9109	0
Slice 4	82.612289	71.899207	-713.02852	270.40569	182.39094	0
Slice 5	83.997317	72.399024	-736.39969	345.47205	233.02384	0
Slice 6	85.382345	72.909387	-760.42893	418.95583	282.58928	0
Slice 7	86.767373	73.430375	-785.12114	490.5533	330.88238	0
Slice 8	88.152402	73.962068	-810.48139	559.99974	377.7246	0
Slice 9	89.53743	74.504551	-836.51491	627.08281	422.97269	0
Slice 10	90.922458	75.057909	-863.22707	691.6526	466.52557	0
Slice 11	92.307486	75.622232	-890.62344	753.62802	508.32852	0
Slice 12	93.75	76.221975	-919.90551	822.32318	554.66399	0
Slice 13	95.125	76.804179	-948.47421	842.63681	568.3657	0

Slice 14	96.375	77.34353	-975.07444	806.58695	544.04977	0
Slice 15	97.625	77.89212	-1,002.2512	769.74267	519.19799	0
Slice 16	98.875	78.450025	-1,030.0092	732.28072	493.92959	0
Slice 17	100.22512	79.063581	-1,062.842	687.20452	463.5253	0
Slice 18	101.67537	79.734525	-1,100.8581	634.73468	428.13395	0
Slice 19	103.12562	80.41836	-1,139.6785	582.07938	392.6175	0
Slice 20	104.57586	81.115219	-1,179.3116	529.31975	357.03068	0
Slice 21	106.02611	81.825241	-1,219.7661	476.4775	321.38813	0
Slice 22	107.47636	82.548569	-1,261.0509	423.5169	285.66575	0
Slice 23	108.9266	83.285351	-1,303.1753	370.34845	249.80318	0
Slice 24	110.37685	84.03574	-1,346.1487	316.83373	213.70705	0
Slice 25	111.76014	84.764004	-1,387.9192	272.30521	144.78725	0
Slice 26	113.07648	85.469064	-1,428.4197	226.24531	120.29676	0
Slice 27	114.39282	86.18572	-1,469.6437	178.97858	95.164597	0
Slice 28	115.70915	86.914101	-1,511.5994	130.21256	69.235248	0
Slice 29	117.02549	87.65434	-1,554.2951	79.649042	42.350147	0
Slice 30	118.34183	88.406578	-1,597.7394	26.99068	14.351199	0

JN 20255

Seismic



Seismic

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File Information

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Title: 20225 Slope Stability Analysis

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Directory: C:\Users\AdamM\Geotech Consultants\Shared Documents - Documents\2020 Jobs\20255 SR'S Construction (DRW)\

Last Solved Date: 2/10/2022

Last Solved Time: 9:35:59 AM

Project Settings

Length(L) Units: Feet

Time(t) Units: Seconds

Force(F) Units: Pounds

Pressure(p) Units: psf

Strength Units: psf

Unit Weight of Water: 62.4 pcf

View: 2D

Element Thickness: 1

Analysis Settings

Seismic

Kind: SLOPE/W

Method: Morgenstern-Price

Settings

Side Function

Interslice force function option: Half-Sine

PWP Conditions Source: Piezometric Line

Apply Phreatic Correction: No

Use Staged Rapid Drawdown: No

Slip Surface

Direction of movement: Right to Left

Use Passive Mode: No

Slip Surface Option: Entry and Exit

Critical slip surfaces saved: **1**
Resisting Side Maximum Convex Angle: **1 °**
Driving Side Maximum Convex Angle: **5 °**
Optimize Critical Slip Surface Location: **No**
Tension Crack
Tension Crack Option: **(none)**

F of S Distribution

F of S Calculation Option: **Constant**

Advanced

Number of Slices: **30**
F of S Tolerance: **0.001**
Minimum Slip Surface Depth: **0.1 ft**
Search Method: **Root Finder**
Tolerable difference between starting and converged F of S: **3**
Maximum iterations to calculate converged lambda: **20**
Max Absolute Lambda: **2**

Materials

Loose Silty Sand FILL

Model: **Mohr-Coulomb**
Unit Weight: **115 pcf**
Cohesion': **0 psf**
Phi': **28 °**
Phi-B: **0 °**
Pore Water Pressure
Piezometric Line: **1**

Loose to Medium-Dense Slightly Silty SAND

Model: **Mohr-Coulomb**
Unit Weight: **120 pcf**
Cohesion': **0 psf**
Phi': **34 °**
Phi-B: **0 °**
Pore Water Pressure
Piezometric Line: **1**

Dense SAND

Model: **Mohr-Coulomb**
Unit Weight: **125 pcf**
Cohesion': **0 psf**
Phi': **37 °**
Phi-B: **0 °**
Pore Water Pressure
Piezometric Line: **1**

Slip Surface Entry and Exit

Left Projection: [Range](#)

Left-Zone Left Coordinate: [\(74.5, 69.24516\) ft](#)

Left-Zone Right Coordinate: [\(80.37037, 72.5\) ft](#)

Left-Zone Increment: [20](#)

Right Projection: [Range](#)

Right-Zone Left Coordinate: [\(132.5, 90.52632\) ft](#)

Right-Zone Right Coordinate: [\(146.5, 92\) ft](#)

Right-Zone Increment: [20](#)

Radius Increments: [10](#)

Slip Surface Limits

Left Coordinate: [\(0, 50.5\) ft](#)

Right Coordinate: [\(146.5, 92\) ft](#)

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	53
Coordinate 2	99.5	62
Coordinate 3	146.5	64

Seismic Coefficients

Horz Seismic Coef.: [0.22](#)

Points

	X (ft)	Y (ft)
Point 1	0	50.5
Point 2	77.5	70
Point 3	94.5	85
Point 4	99.5	86
Point 5	127.5	90
Point 6	146.5	92
Point 7	0	30
Point 8	146.5	30
Point 9	127.5	85
Point 10	127.5	76
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Regions

	Material	Points	Area (ft ²)
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Region 2	Loose Silty Sand FILL	17,3,4,5,6,15,9,12	221.5
Region 3	Dense SAND	1,7,8,16,10,13,2	5,436.9

Current Slip Surface

Slip Surface: 1

F of S: 1.201

Volume: 395.34021 ft³

Weight: 46,991.361 lbs

Resisting Moment: 3,694,007.3 lbs-ft

Activating Moment: 3,075,327.4 lbs-ft

Resisting Force: 28,142.014 lbs

Activating Force: 23,422.823 lbs

F of S Rank (Analysis): 1 of 4,851 slip surfaces

F of S Rank (Query): 1 of 4,851 slip surfaces

Exit: (74.5, 69.245161) ft

Entry: (132.5, 90.526316) ft

Radius: 124.23854 ft

Center: (62.048557, 192.85817) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	75.25	69.325311	-593.97174	13.004628	9.7996905	0
Slice 2	76.75	69.494839	-596.08398	38.744319	29.195939	0
Slice 3	78.46875	69.713392	-600.02066	137.80291	103.84194	0
Slice 4	80.40625	69.987303	-606.17703	314.09633	236.68856	0
Slice 5	82.34375	70.292452	-614.28266	493.33847	371.7572	0
Slice 6	84.28125	70.629073	-624.35214	671.94838	506.34942	0
Slice 7	86.21875	70.997427	-636.40175	845.48571	637.11918	0
Slice 8	88.15625	71.397802	-650.44951	1,009.111	760.41967	0
Slice 9	90.09375	71.830518	-666.51526	1,158.2026	872.76826	0
Slice 10	92.03125	72.295921	-684.62073	1,288.9998	971.33103	0
Slice 11	93.75	72.73477	-702.30393	1,395.9222	1,051.9028	0

Slice 12	95.333333	73.164436	-720.17842	1,416.2225	1,067.2002	0
Slice 13	97	73.640483	-740.47671	1,358.855	1,023.9707	0
Slice 14	98.666667	74.141836	-762.35411	1,293.424	974.66491	0
Slice 15	100.53601	74.73644	-792.00289	1,206.353	909.05217	0
Slice 16	102.56665	75.417159	-829.08778	1,055.9619	712.2553	0
Slice 17	104.55593	76.122499	-867.81884	965.24332	651.06484	0
Slice 18	106.54521	76.866243	-908.94627	879.16797	593.00628	0
Slice 19	108.53449	77.649134	-952.51651	798.70019	538.73008	0
Slice 20	110.52377	78.471977	-998.57973	724.08913	488.40428	0
Slice 21	112.51305	79.33564	-1,047.1902	654.99879	441.80226	0
Slice 22	114.50233	80.241064	-1,098.4064	590.64579	398.39562	0
Slice 23	116.4916	81.189265	-1,152.292	529.92367	357.43803	0
Slice 24	118.48088	82.181341	-1,208.9154	471.50293	318.03274	0
Slice 25	120.47016	83.218486	-1,268.3511	413.90338	279.18136	0
Slice 26	122.45944	84.301992	-1,330.6797	355.54045	239.81506	0
Slice 27	124.46556	85.443257	-1,396.5677	301.77231	160.45518	0
Slice 28	126.48852	86.644678	-1,466.1648	243.98101	129.727	0
Slice 29	128.33333	87.784044	-1,532.3627	182.1987	96.876766	0
Slice 30	130	88.854205	-1,594.7152	115.85445	61.600905	0
Slice 31	131.66667	89.962491	-1,659.4467	40.644972	21.611315	0