COLORADO
Division of Reclamation, Mining and Safety
Department of Natural Resources

January 5, 2021

Barbara Britton
1224 Ruppel St
Pueblo, CO 81001

RE: Slope Stability Report and Division Review Memo, Native/Pierre Mine, Permit No. M-1977-321, Conversion Application (CN-01)

Dear Ms. Britton:

The Colorado Division of Reclamation, Mining and Safety (DRMS or Division) received as part of the responses to the Preliminary Adequacy Review a Slope Stability Report by Jesik Consulting for the Native/Pierre Mine M1977-321. The report was completed to address any significant, valuable and permanent man-made structures within 200 feet of the affected lands since the Operator was unable to obtain agreements with all structure owners. The Division requires the Operator to maintain a minimum factor of safety of 1.5 for critical structures.

Please find enclosed with this letter a copy of the Slope Stability Report by Jesik Consulting and the Division's Review Memo of the report.

If you need additional information or have any questions, please contact me at Division of Reclamation, Mining and Safety, 1313 Sherman Street, Room 215, Denver, CO 80203, by telephone at **303-866-3567 x8114**, or by email at patrick.lennberg@state.co.us.

Sincerely,

Patrick Lennberg
Environmental Protection Specialist

Enclosure: Slope Stability Report and Division Review Memo

cc: Jared Ebert; DRMS

Jesik Consulting
Geotechnical, Water, Testing

102-D Oneida Street
Pueblo, Colorado 81003
(719) 582-5588
www.jesik.us

SLOPE STABILITY REPORT

FOR

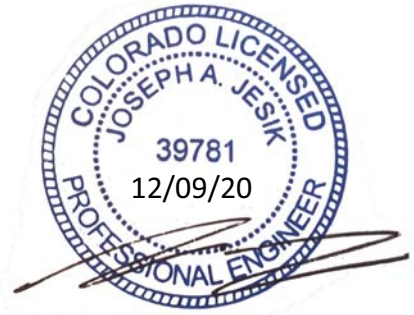
Native/Pierre Mine
Pueblo
Pueblo County, Colorado

PREPARED FOR:

Summit Brick

PREPARED BY

Jesik Consulting
Project Number: 20-8315



1. Introduction

Slope stability analysis is required for buildings or other structures within 200-feet of the proposed mine slopes as part of the 112 (C) permit application (refer to Figure 1). Approximately 10 to 15-feet of material will be removed for the project with 4:1 slope along the eastern side of the project and 3:1 slopes elsewhere.

The purpose of this report is to provide a summary of the geologic and geotechnical models developed and discuss the slope stability factor of safety evaluation during construction and after construction. The scope of this project included:

- Development of a geological and geotechnical model
- Complete a slope stability model using Slope/W
- Evaluate the safety of factor for the proposed mine.

2. Engineering Geology Cross Section

The local geology in the area consists of highly to moderately weathered, Pierre Shale overlain with 12 to 15 feet of low plasticity clay. The highly weathered portions of the Pierre Shale are composed of very stiff, low plasticity, medium hard clay. Highly weathered, low plasticity Pierre shale (claystone) was observed about 12 to 15-feet below clay within our borings drilled near the top of the slope at the northeast corner of the site. The claystone has a blocky structure and is intensely to highly fractured.

Pierre shale material varies from claystone to cemented dark gray shale. Some large clear to cloudy crystals are found withing the shale, likely to be selenite.

Strike and dip angles of the shale bedding planes were not observed. Generally, bedding planes in shale typically found in the area are short and bedding plane slides are unlikely due to the current physical configuration of the site.

Upper-level clays were stiff to very stiff, low plasticity, dry to moist, and brown. Refer to Table 1 below for material properties used in the analysis.

Table 1. Local Geological Materials and Properties

Material Name	Material Description	Material Properties
Pierre Shale	Moderately weathered, blocky, moist, brown claystone	Unit Weight (pcf) = 122 Cohesion (psf) = 600 Phi (°) = 26
Native Clay	Stiff to very stiff (medium dense), dry to moist, brown sandy clay and clayey sand	Unit Weight (pcf) = 105 Cohesion (psf) = 0 Phi (°) = 22

Six (6) sections (Sections A through F) were analyzed for this study. Groundwater was not encountered in our seven (7) borings to depths ranging up to 25 feet below the existing

ground surface. The surrounding parcels are developed and further development around the property is not likely. Significant changes to current surface water runoff are not anticipated. The City of Pueblo reviews drainage reports prior to issuing permits for new developments. The southwest corner of the mine will daylight and it is unlikely that groundwater will develop in the proposed mine slopes.

Section A consists of an east/west trending cross section drawn through the existing highwall, N. La Crosse Ave, existing utilities, and an existing home on the east side of the property.

Section B consists of an east/west trending cross section drawn through the proposed 4:1 slope along the east side of the project, La Crosse Ave, utilities, and an existing home on the east side of the property.

Section C consists of an east/west trending cross section drawn through the proposed 4:1 slope along the east side of the project, La Crosse Ave, utilities, and an existing home on the east side of the property.

Section D consists of a north/south trending cross section drawn through two existing homes, Ruppel Street, and the proposed 3:1 slope on the north side of the property.

Section E consists of north/south trending cross section drawn through a commercial building, parking lot, utilities, and the proposed 3:1 slope on the north side of the property.

Section F consists of east/west trending cross section drawn through Hudson Avenue, utilities, and the proposed 3:1 slope on the west side of the property.

Sections and analysis were not completed for areas where structures are located further than 200-feet from the permit boundary.

Stability analysis cross-section elevations were estimated from 1-foot topographic contours derived using Plex from Google Earth. The cross section is shown in Drawing SS-1.

3. Slope Stability Analysis

The slope stability analysis was conducted using SLOPE/W (2016), a computer-modeling program by GeoStudio. SLOPE/W uses the limit equilibrium theory to compute a factor of safety on earth and rock slopes. It can use a variety of methods to compute the factor of safety of a slope while analyzing complex geometry, stratigraphy, and loading conditions. The limit equilibrium method is usually carried out by establishing a grid and factors of safety are computed for concentric arcs at each point in the grid. When the software is finished computing the factors of safety along each arc, the lowest overall factor of safety is reported. The arc corresponding to this factor of safety is called the potential failure surface.

Morgenstern-Price's method was used as the search technique to determine the factor of safety of the open excavation cut in the stability analysis. This method is considered the most adequate because it satisfies all conditions of static equilibrium and provides a factor of safety based on both force and moment equilibrium.

The existing conditions were modeled to obtain an estimated factor of safety for the Long-Term conditions. Shallow and deep circular failures were determined without groundwater.

The cross section and material properties as described above were input into the software. A Morgenstern-Price analysis was completed for the existing site condition at Section A and proposed slopes for sections B through F. We understand that the proposed slopes will be constructed during mining and no steeper slopes will materialize during mining. Analysis results are presented in Table 2 below and figures for each analysis are attached.

Table 2 – Safety Factors

Analysis	Factor of Safety	Analysis	Factor of Safety
Section A - Deep Failure	2.82	Section D - Deep Failure	4.56
Section A - Shallow Failure	2.42	Section D - Shallow Failure	1.80
Section B - Deep Failure	3.05	Section E - Deep Failure	3.50
Section B - Shallow Failure	1.54	Section E - Shallow Failure	2.27
Section C - Deep Failure	3.47	Section F - Deep Failure	3.06
Section C - Shallow Failure	1.71	Section F - Shallow Failure	2.35

4. Conclusions

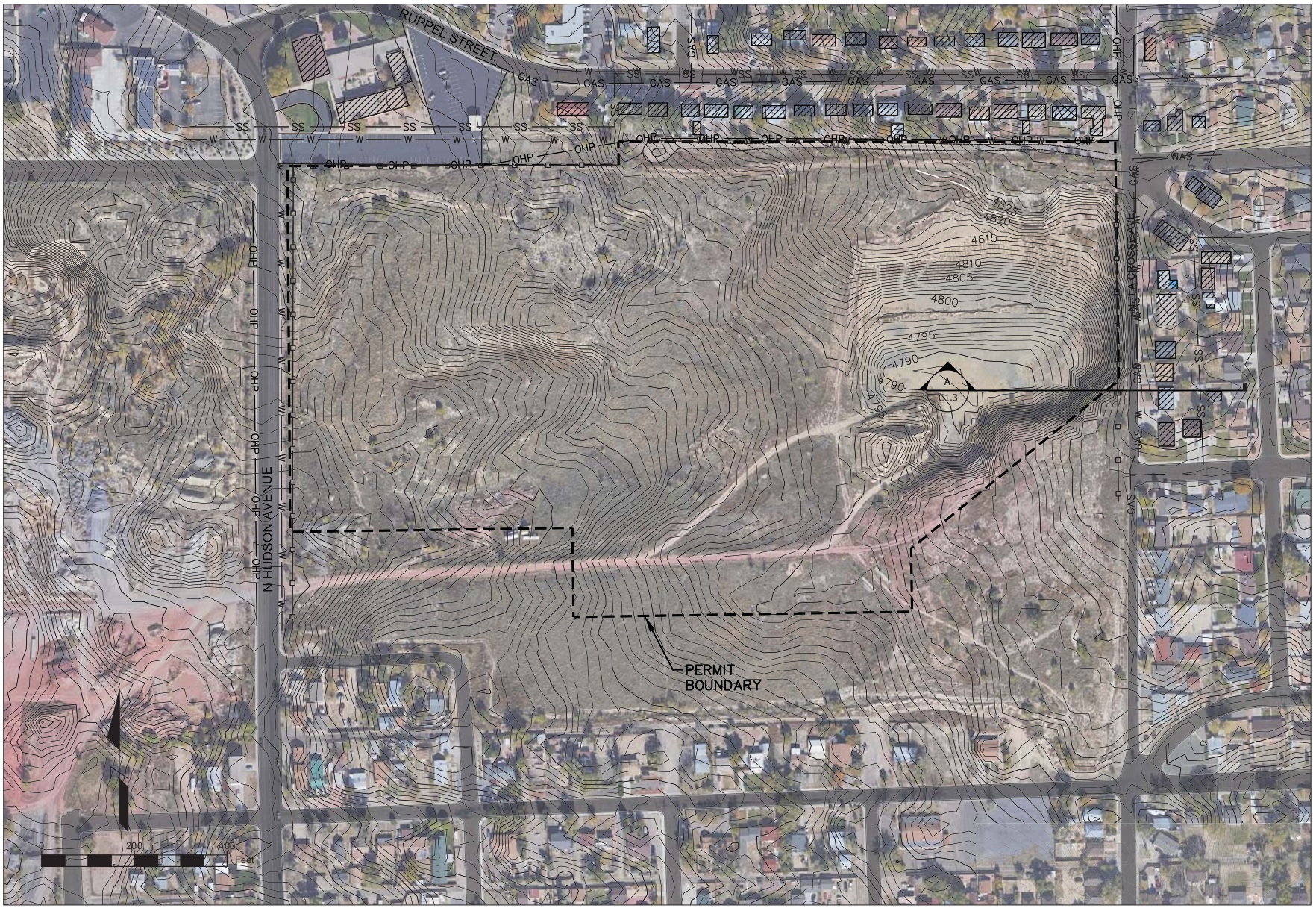
The slope stability analysis shows factor of safety of over 1.5, which is a typical minimum factor of safety for this application. Surface water should be directed away from and around the excavation during and after construction. Surface water should not be introduced within the ground surface within 25-feet of the top of the slope.

The highwall stability analysis (Section A) shows an adequate factor of safety. Backfill of the highwall is not necessary.

Neighboring structures, utilities, parking lots, and roadways are unlikely to be impacted by slope failures when slopes are kept as proposed and groundwater is not introduced into the slopes.

Water infiltration into the pit slope soils from surrounding development is not likely considering the topography and current state of development.

Attachments: Stability Analysis Cross Sections C1.1 – C1.4
Failure Surfaces and Safety Factors



NO.	REVISION	APP'D	DATE
1	SUBDIV SUBM.	JAJ	1/19
2			
3			
4			

NATIVE/PIERRE MINE
CURRENT CONDITIONS
PUEBLO, COLORADO

DESIGNED BY	JAJ
DRAWN BY	JAJ
CHECKED BY	JAJ
PROJECT NUMBER	----

Jesik
102-D Oneida Street
Pueblo, Colorado 81003
(719) 582-5588
WWW.JESIK.US

DATE
12/9/20

SCALE
HORZ :1"=200'
VERT : -

SHEET
C1.1
1 4

NO.	REVISION	APP'D	DATE
1	SUBDIV SUBM.	JAJ	1/19
2			
3			
4			

NATIVE/PIERRE MINE
MINED PIT-HIGHWALL BACKFILLED
PUEBLO, COLORADO

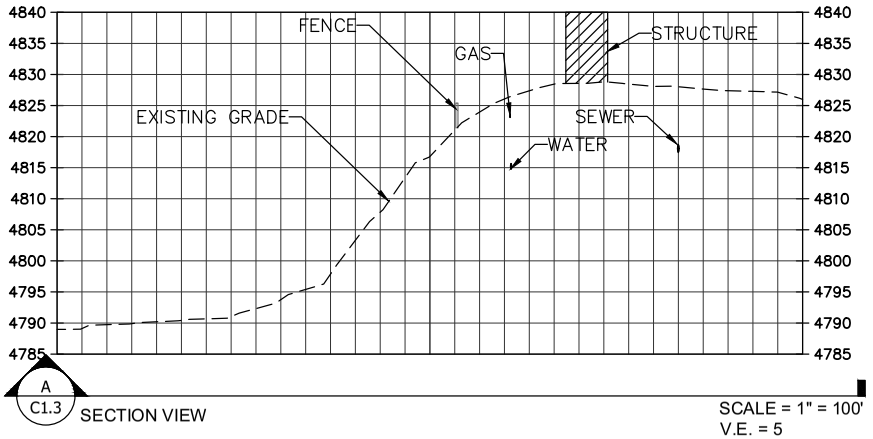
DESIGNED BY JAJ
DRAWN BY JAJ
CHECKED BY JAJ
PROJECT NUMBER ----

Jesik
102-D Oneida Street
Pueblo, Colorado 81003
(719) 582-5588
WWW.JESIK.US

DATE
12/9/20

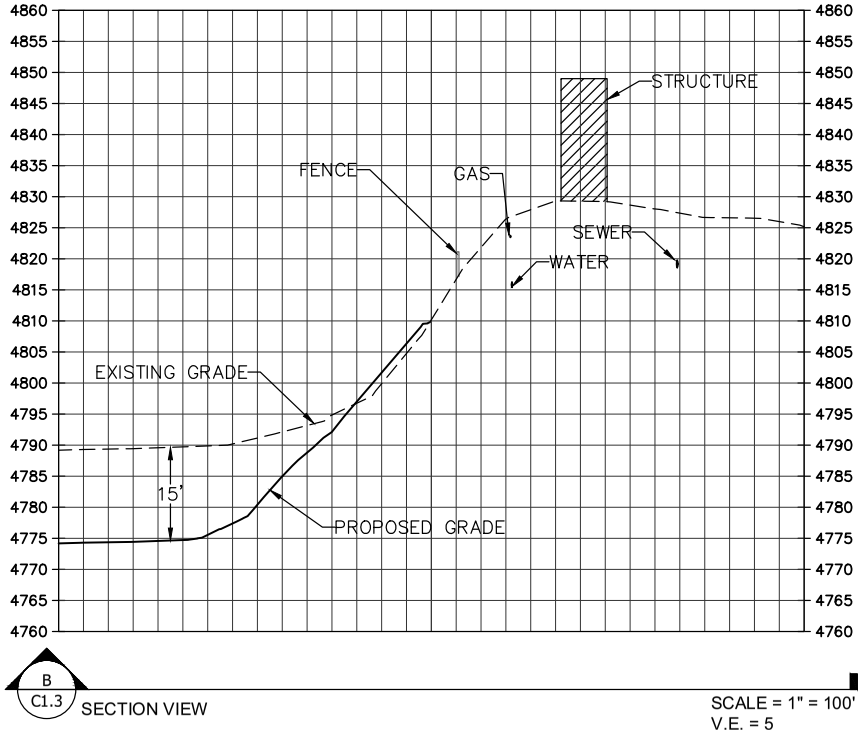
SCALE
HORZ :1"=200'
VERT : -

SHEET
C1.2
2 4



A
C1.3
SECTION VIEW

SCALE = 1" = 100'
V.E. = 5



B
C1.3
SECTION VIEW

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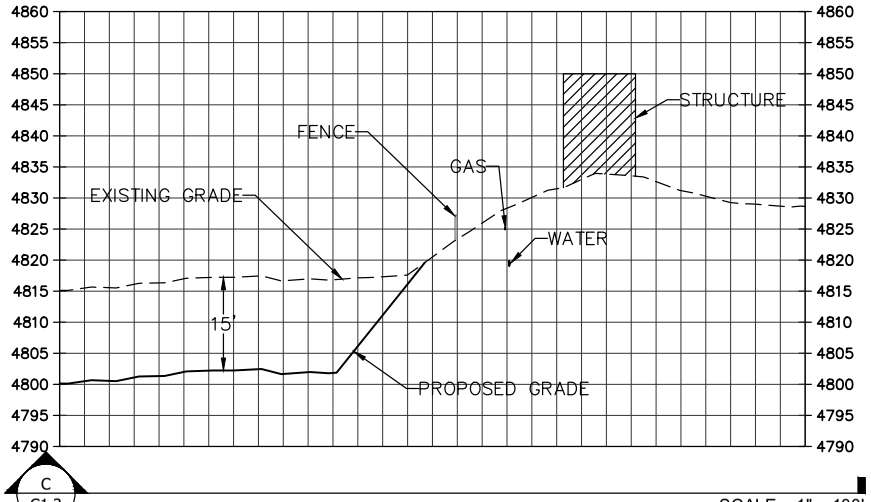
V.E. = 5



C
C1.3
SECTION VIEW

SCALE = 1" = 100'
V.E. = 5

NO.	REVISION	APPV'D	DATE
1	SUBDIV SUBM.	JAJ	1/19
2			
3			
4			

NATIVE/PIERRE MINE
SECTION VIEWS
PUEBLO, COLORADO

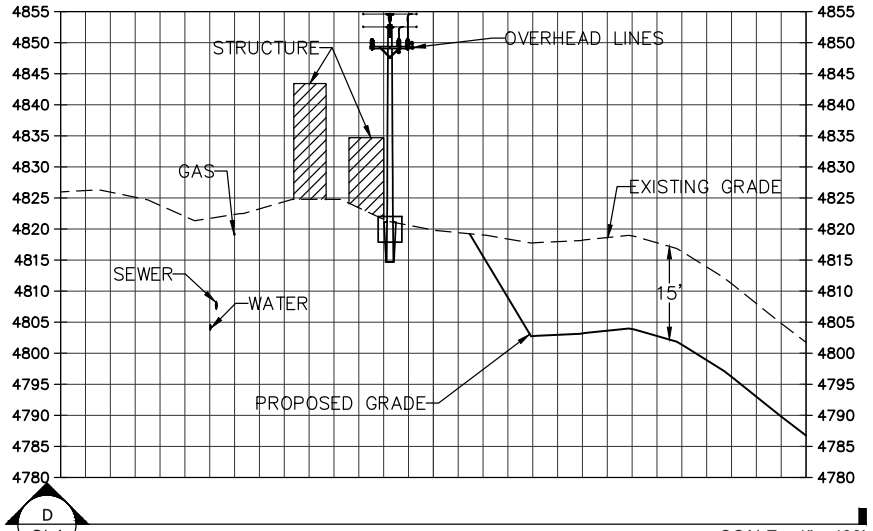
DESIGNED BY	DRAWN BY	CHECKED BY	PROJECT NUMBER
JAJ	JAJ	JAJ	----

Jesik
102-D Oneida Street
Pueblo, Colorado 81003
(719) 582-5588
WWW.JESIK.US

DATE
12/9/20

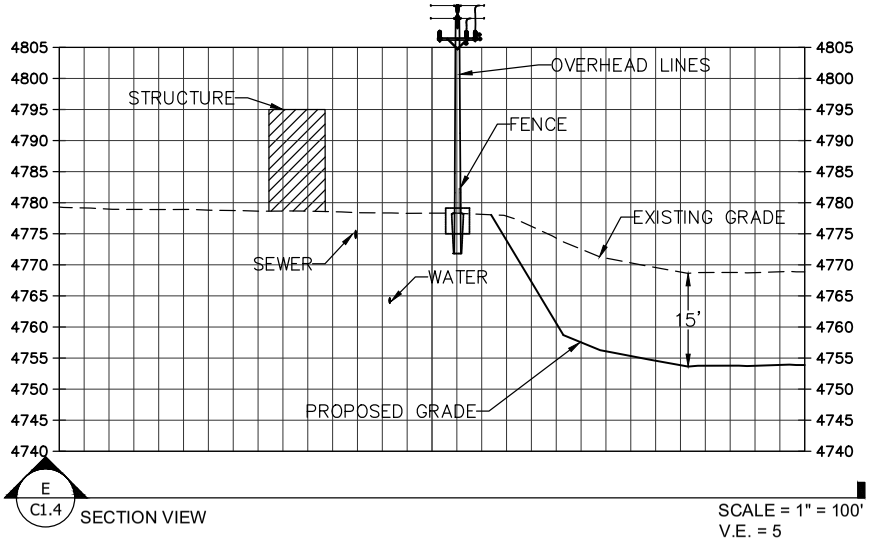
SCALE
HORZ :1" = 100'
VERT : 1" = 20'

SHEET
C1.3



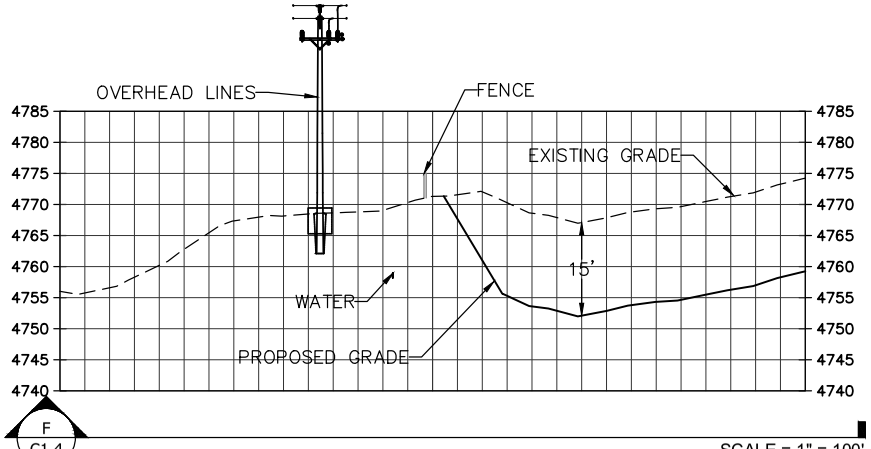
D
C1.4
SECTION VIEW

SCALE = 1" = 100'
V.E. = 5



E
C1.4
SECTION VIEW

SCALE = 1" = 100'
V.E. = 5



F
C1.4
SECTION VIEW

SCALE = 1" = 100'
V.E. = 5

NO.	REVISION	APP'D	DATE
1	SUBDIV SUBM.	JAJ	1/19
2			
3			
4			

NATIVE/PIERRE MINE
SECTION VIEWS
PUEBLO, COLORADO

DESIGNED BY	JAJ
DRAWN BY	JAJ
CHECKED BY	JAJ
PROJECT NUMBER	----

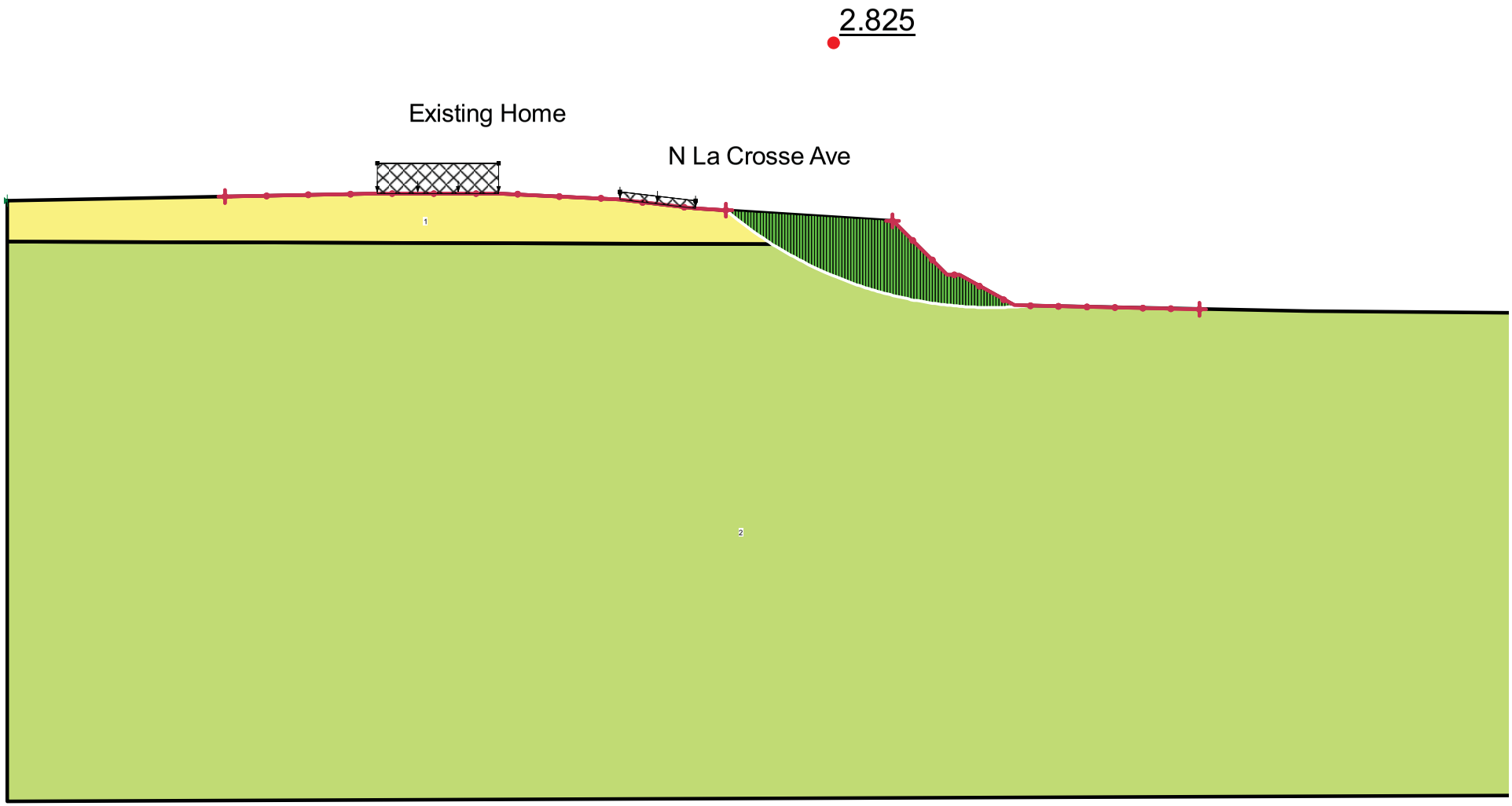
Jesik
102-D Oneida Street
Pueblo, Colorado 81003
(719) 582-5588
WWW.JESIK.US

DATE
12/9/20

SCALE
HORZ :1" = 100'
VERT : 1" = 20

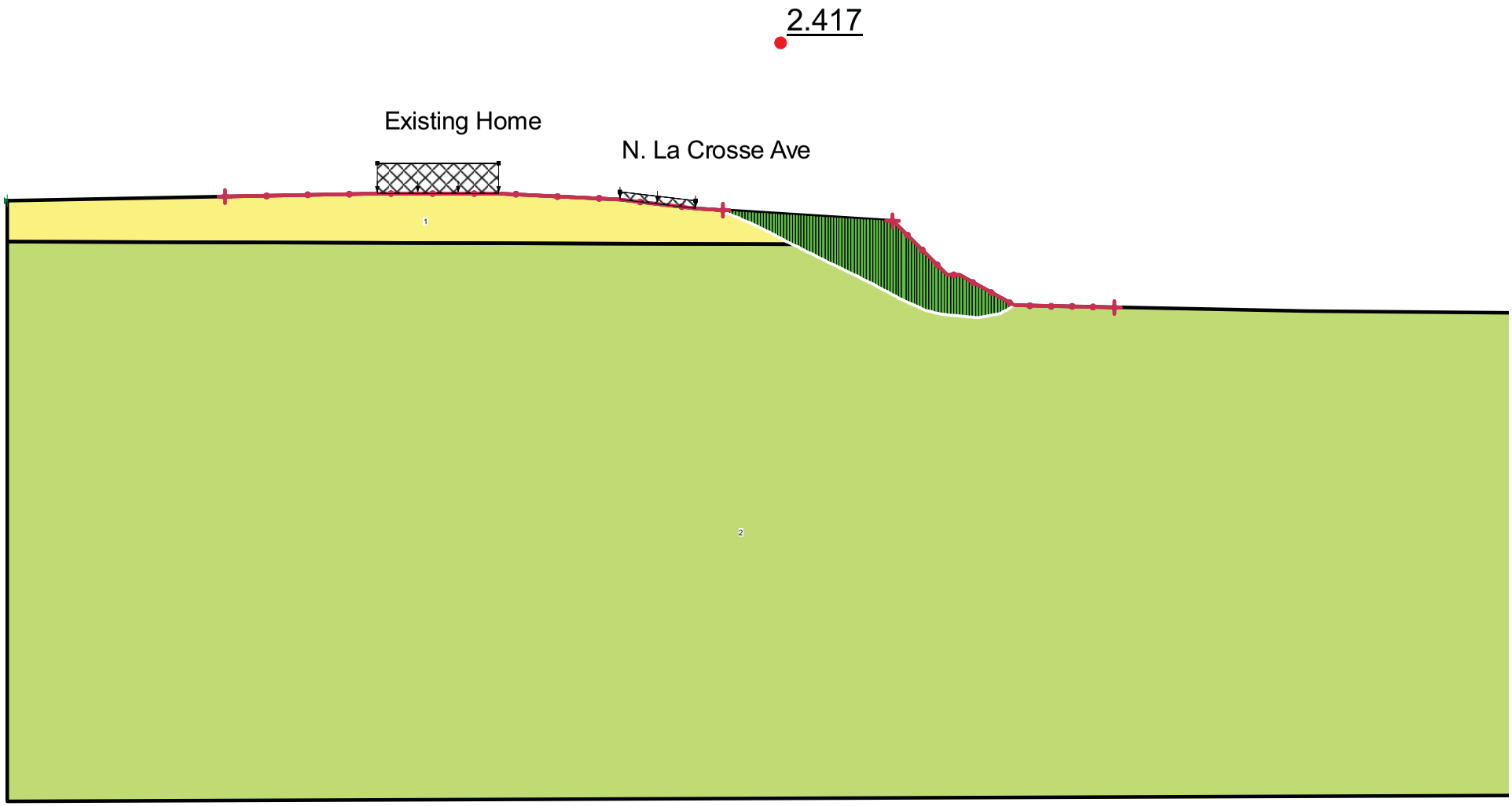
SHEET
C1.4

Name: Existing High Wall - Deep Failure



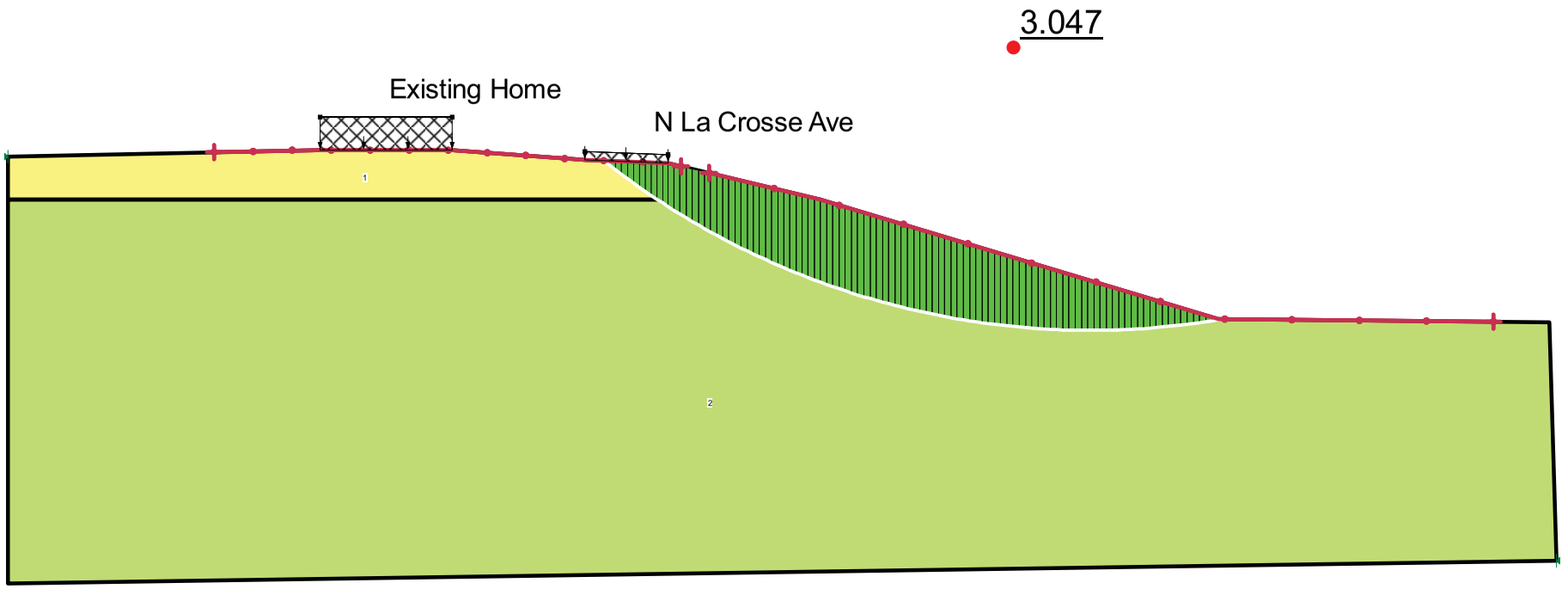
Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Clay	105	0	22
	Pierre	122	600	26

Name: Existing High Wall - Shallow Failure



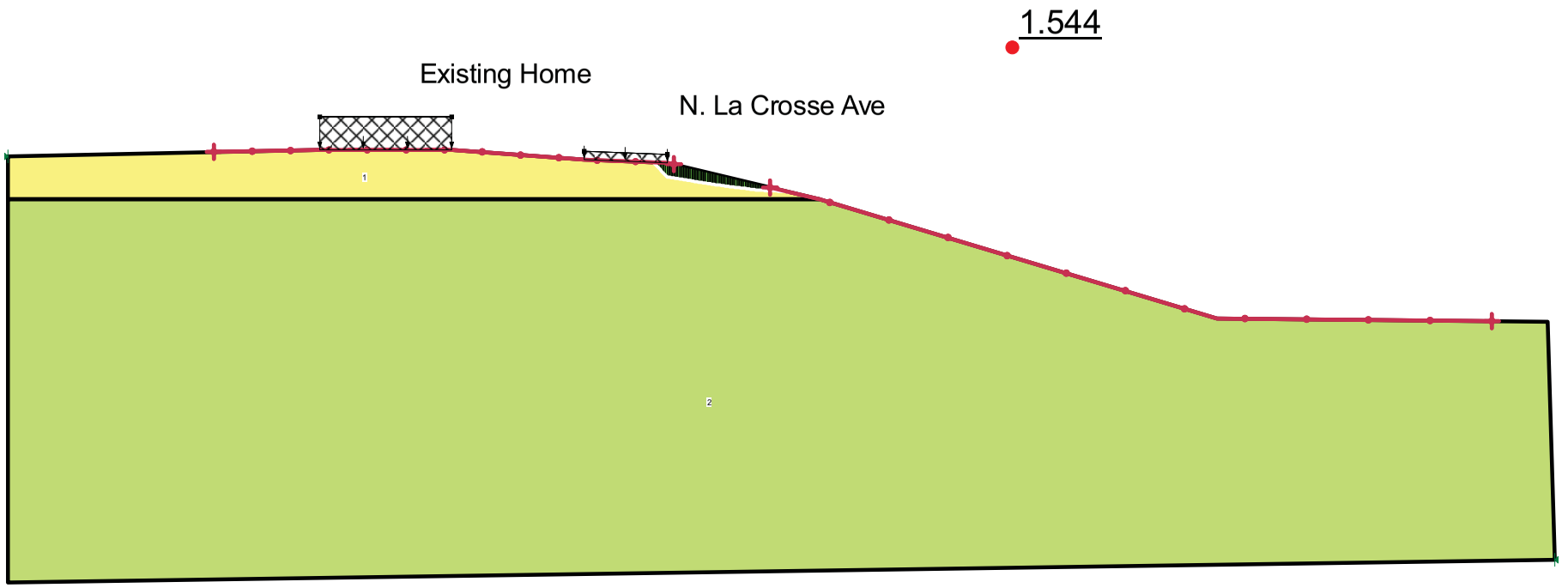
Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Clay	105	0	22
	Pierre	122	600	26

Name: Section B - Deep Failure



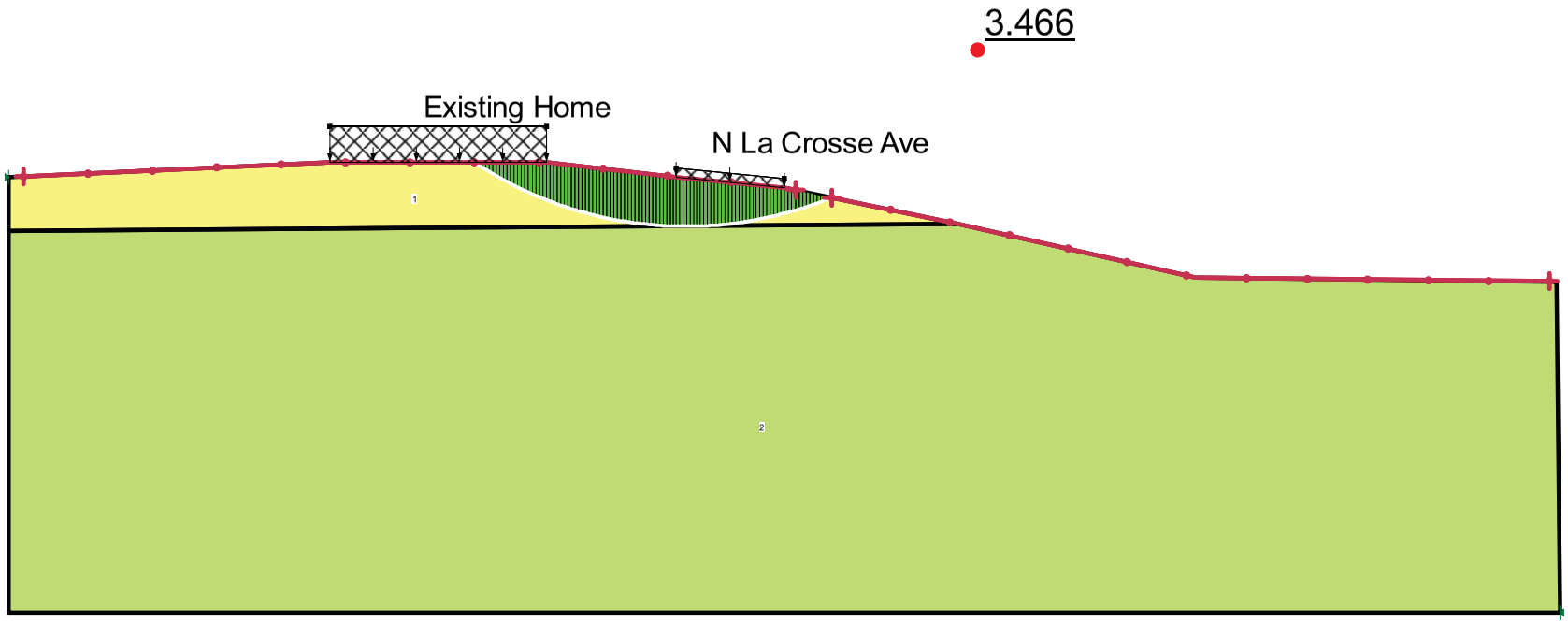
Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Clay	105	0	22
	Pierre	122	600	26

Name: Section B - Shallow Failure



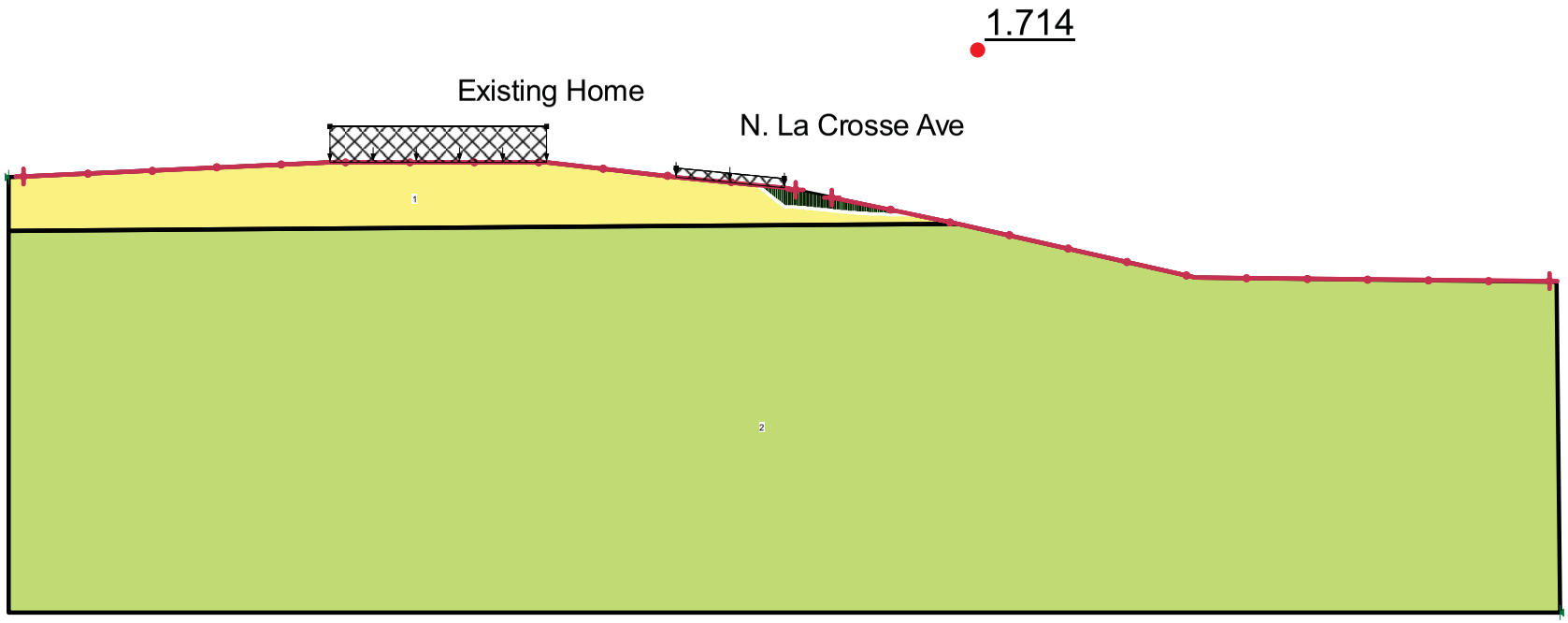
Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Clay	105	0	22
	Pierre	122	600	26

Name: Section C - Deep Failure



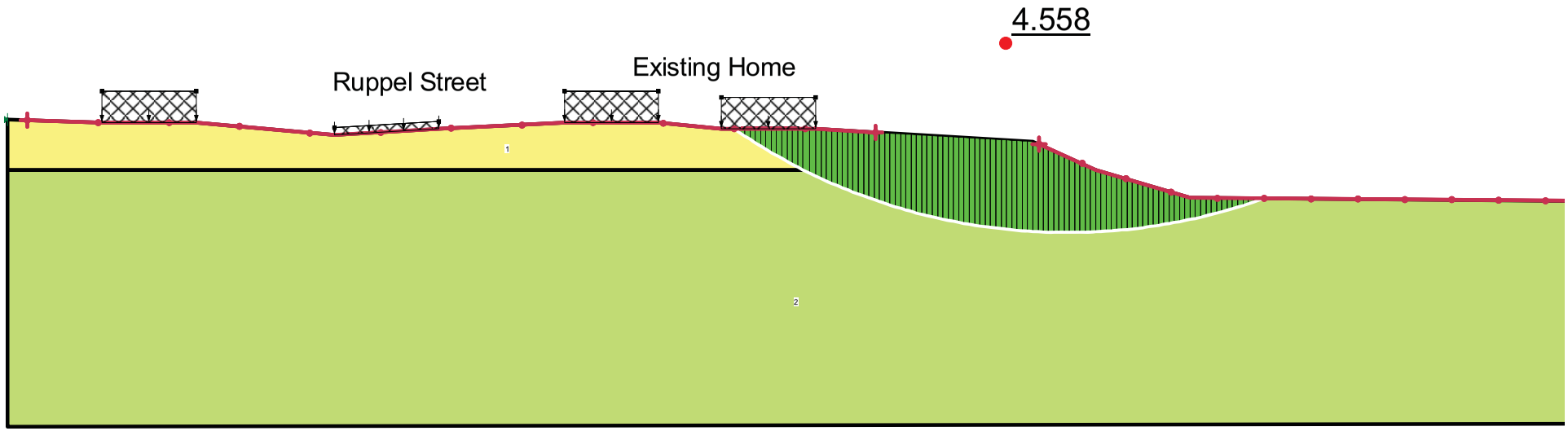
Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Clay	105	0	22
	Pierre	122	600	26

Name: Section C - Shallow Failure



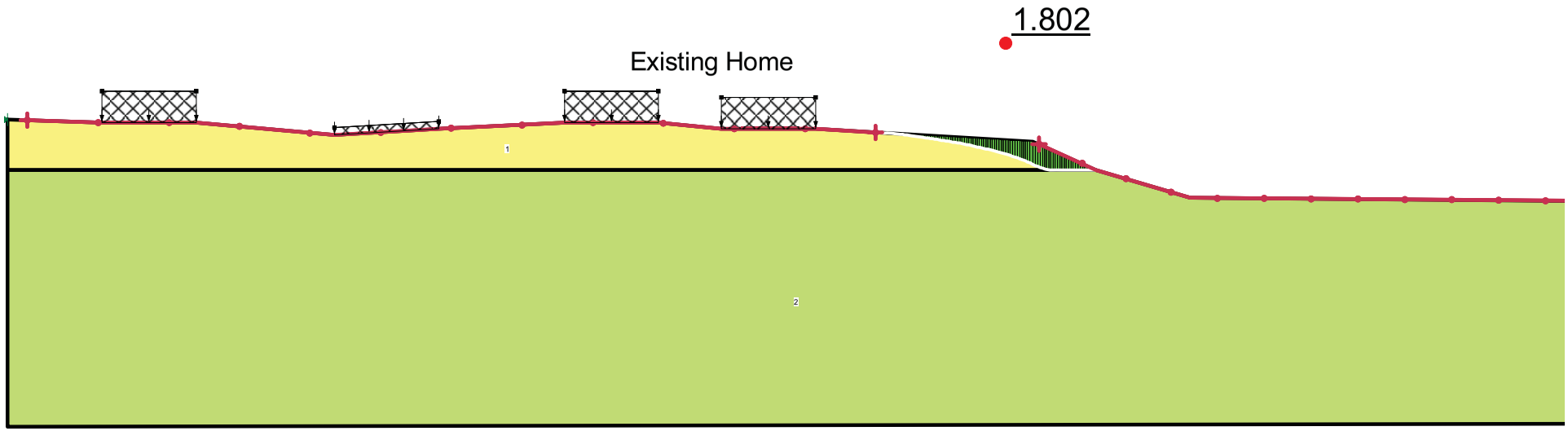
Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Clay	105	0	22
	Pierre	122	600	26

Name: Section D - Deep Failure



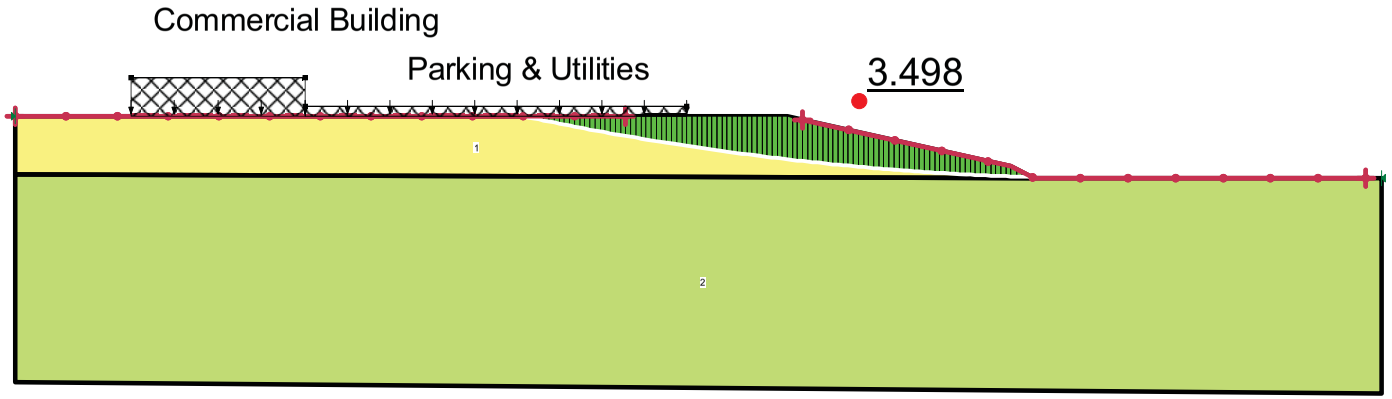
Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Clay	105	0	22
	Pierre	122	600	26

Name: Section D - Shallow Failure



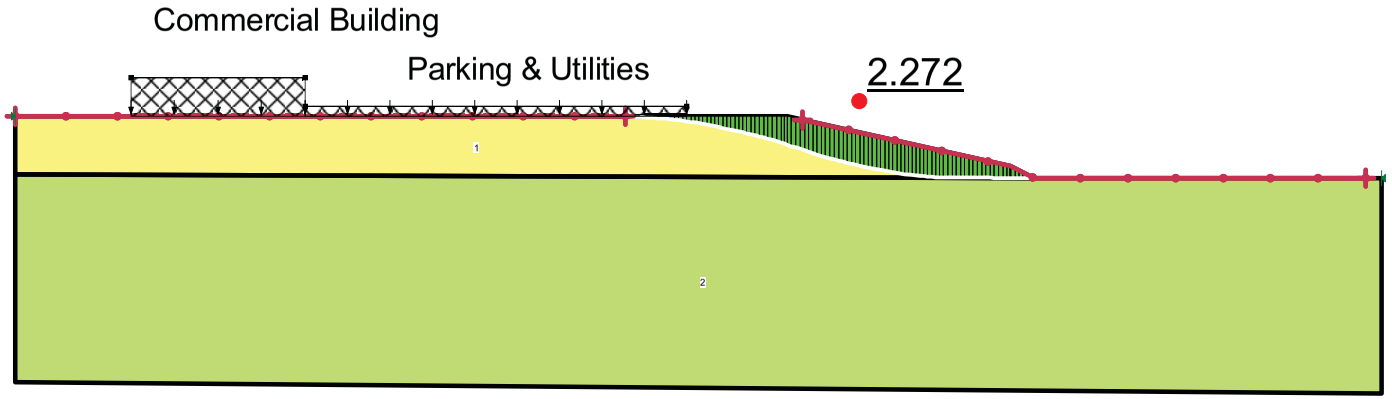
Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Clay	105	0	22
	Pierre	122	600	26

Name: Section E - Deep Failure



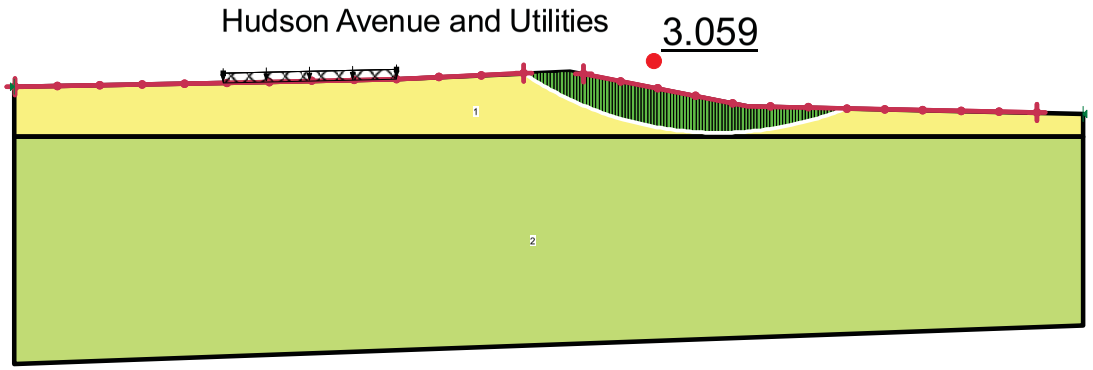
Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Clay	105	0	22
	Pierre	122	600	26

Name: Section E - Shallow Failure



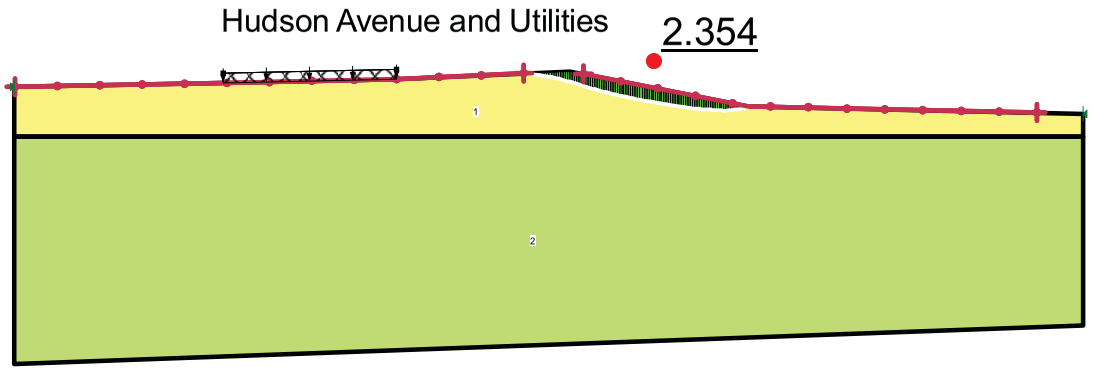
Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Clay	105	0	22
	Pierre	122	600	26

Name: Section F - Deep Failure



Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Clay	105	0	22
	Pierre	122	600	26

Name: Section F - Shallow Failure



Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Clay	105	0	22
	Pierre	122	600	26


Native / Pierre Mine
2020 Bore Hole Map
Legend
Bore Hole
B1
B2
B3
B4
B5
B6
B7
Google Earth
© 2020 Google
900 ft
N

Project: **Summit Brick** Project Location: **Hudson & 13th St., Pueblo, CO** Project Number: **20-8315**	Log of Boring B1 **Sheet 1 of 1**

Date(s) Drilled **05/13/20**	Logged By **Caleb Lewis**	Checked By
Drilling Method **Solid stem auger**	Drill Bit Size/Type **4" Carbide**	Total Depth of Borehole **25 feet bgs**
Drill Rig Type **Giddings**	Drilling Contractor **Jesik**	Approximate Surface Elevation **4776**
Groundwater Level and Date Measured **NE**	Sampling Method(s)	Hammer Data **SPT 140lbs/30"**
Borehole Backfill **None**	Location **38°17.031' N, 104°35.451' W**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4776	0				CL		Dark tan	
4771	5							
4766	10							
					CL		Grayish tan.	
4761	15							
4756	20							
					CL		Dark grayish brown.	
4751	25						TDD	
4746	30							

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Figure B-1

Project: **Summit Brick** Project Location: **Hudson & 13th St., Pueblo, CO** Project Number: **20-8315**	Log of Boring B2 **Sheet 1 of 1**

Date(s) Drilled **05/13/20**	Logged By **Caleb Lewis**	Checked By
Drilling Method **Solid stem auger**	Drill Bit Size/Type **4" Carbide**	Total Depth of Borehole **25 feet bgs**
Drill Rig Type **Giddings**	Drilling Contractor **Jesik**	Approximate Surface Elevation **4720'**
Groundwater Level and Date Measured **NE**	Sampling Method(s)	Hammer Data **SPT 140lbs/30"**
Borehole Backfill **None**	Location **38°17.030' N, 104°35.424' W**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4720	0				CL		Olive grayish tan.	
					CL		Tan.	
4715	5							
4710	10				CL		Grayish tan.	
4705	15				CL		Dark brown.	
4700	20				CL		Very dark brown/black.	
4695	25						TDD	
4690	30							

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Figure B-2

Project: **Summit Brick** Project Location: **Hudson & 13th St., Pueblo, CO** Project Number: **20-8315**	Log of Boring B3 **Sheet 1 of 1**

Date(s) Drilled **05/13/20**	Logged By **Caleb Lewis**	Checked By
Drilling Method **Solid stem auger**	Drill Bit Size/Type **4" Carbide**	Total Depth of Borehole **25 feet bgs**
Drill Rig Type **Giddings**	Drilling Contractor **Jesik**	Approximate Surface Elevation **4795'**
Groundwater Level and Date Measured **NE**	Sampling Method(s)	Hammer Data **SPT 140lbs/30"**
Borehole Backfill **None**	Location **38°16.989' N, 104°35.403' W**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4795	0				CL		Olive grayish tan.	
4790	5				CL		Slight orangish tan to tan.	
4785	10				CL		Brown.	
4780	15							
4775	20				CL		Dark grayish brown.	
4770	25						TDD	
4765	30							

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Figure B-3

Project: **Summit Brick** Project Location: **Hudson & 13th St., Pueblo, CO** Project Number: **20-8315**	Log of Boring B4 **Sheet 1 of 1**

Date(s) Drilled **05/13/20**	Logged By **Caleb Lewis**	Checked By
Drilling Method **Solid stem auger**	Drill Bit Size/Type **4" Carbide**	Total Depth of Borehole **25 feet bgs**
Drill Rig Type **Giddings**	Drilling Contractor **Jesik**	Approximate Surface Elevation **4787'**
Groundwater Level and Date Measured **NE**	Sampling Method(s)	Hammer Data **SPT 140lbs/30"**
Borehole Backfill **None**	Location **38°17.014' N, 104°35.387' W**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4787	0				CL		Orangish tan to tan.	
4782	5							
					CL		Brown.	
4777	10							
4772	15				CL		Dark brown.	
					CL		Dark grayish black.	
4767	20							
					CL		Gray.	
4762	25						TDD	
4757	30							

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Figure B-4

Project: **Summit Brick** Project Location: **Hudson & 13th St., Pueblo, CO** Project Number: **20-8315**	Log of Boring B5 **Sheet 1 of 1**

Date(s) Drilled **05/14/20**	Logged By **Caleb Lewis**	Checked By
Drilling Method **Solid stem auger**	Drill Bit Size/Type **4" Carbide**	Total Depth of Borehole **22 feet bgs**
Drill Rig Type **Giddings**	Drilling Contractor **Jesik**	Approximate Surface Elevation **4799'**
Groundwater Level and Date Measured **NE**	Sampling Method(s)	Hammer Data **SPT 140lbs/30"**
Borehole Backfill **None**	Location **38°17.021' N, 104°35.373' W**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4799	0				SC		Sand.	
4794	5							
					CL		Brown.	
4789	10							
					CL		Dark brown.	
4784	15				CL		Brown.	
					CL		Dark brown.	
4779	20				CL		Dark gray.	
							TDD - auger refusal on boulder(?).	
4774	25							
4769	30							

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Figure B-5

Project: **Summit Brick** Project Location: **Hudson & 13th St., Pueblo, CO** Project Number: **20-8315**	Log of Boring B6 **Sheet 1 of 1**

Date(s) Drilled **05/14/20**	Logged By **Caleb Lewis**	Checked By
Drilling Method **Solid stem auger**	Drill Bit Size/Type **4" Carbide**	Total Depth of Borehole **25 feet bgs**
Drill Rig Type **Giddings**	Drilling Contractor **Jesik**	Approximate Surface Elevation **4655'**
Groundwater Level and Date Measured **NE**	Sampling Method(s)	Hammer Data **SPT 140lbs/30"**
Borehole Backfill **None**	Location **38°17.024' N, 104°35.419' W**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4655	0				CL		Dull orangish brown.	
4650	5							
					CL		Olive khaki color.	
4645	10							
4640	15				CL		Brown.	
4635	20							
					CL		Brownish gray.	
4630	25				CL		TDD	
4625	30							

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Figure B-6

Project: **Summit Brick** Project Location: **Hudson & 13th St., Pueblo, CO** Project Number: **20-8315**	Log of Boring B7 **Sheet 1 of 1**

Date(s) Drilled **05/14/20**	Logged By **Caleb Lewis**	Checked By
Drilling Method **Solid stem auger**	Drill Bit Size/Type **4" Carbide**	Total Depth of Borehole **25 feet bgs**
Drill Rig Type **Giddings**	Drilling Contractor **Jesik**	Approximate Surface Elevation **4809'**
Groundwater Level and Date Measured **NE**	Sampling Method(s)	Hammer Data **SPT 140lbs/30"**
Borehole Backfill **None**	Location **38°17.011' N, 104°35.446' W**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
4809	0				CL		Khaki tan clay, some shale.	
4804	5							
					CL		Brownish gray.	
4799	10							
					CL		Orangish brown.	
4794	15							
4789	20				CL		Olive brown.	
4784	25						TDD	
4779	30							

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Figure B-7

Project: **Summit Brick**
Project Location: **Hudson & 13th St., Pueblo, CO**
Project Number: **20-8315**

Key to Log of Boring
Sheet 1 of 1

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS
1	2	3	4	5	6	7	8	9

COLUMN DESCRIPTIONS

1 Elevation (feet): Elevation (MSL, feet).
2 Depth (feet): Depth in feet below the ground surface.
3 Sample Type: Type of soil sample collected at the depth interval shown.
4 Sample Number: Sample identification number.
5 Sampling Resistance, blows/ft: Number of blows to advance driven sampler one foot (or distance shown) beyond seating interval using the hammer identified on the boring log.
6 Material Type: Type of material encountered.
7 Graphic Log: Graphic depiction of the subsurface material encountered.
8 MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
9 REMARKS AND OTHER TESTS: Comments and observations regarding drilling or sampling made by driller or field personnel.

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis (percent passing No. 200 Sieve)
UC: Unconfined compressive strength test, Qu, in ksf
WA: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS

Lean CLAY, CLAY w/SAND, SANDY CLAY (CL)

TYPICAL SAMPLER GRAPHIC SYMBOLS

Auger sampler
Bulk Sample
3-inch-OD California w/ brass rings
CME Sampler
Grab Sample
2.5-inch-OD Modified California w/ brass liners
Pitcher Sample
2-inch-OD unlined split spoon (SPT)
Shelby Tube (Thin-walled, fixed head)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)
Water level (after waiting)
Minor change in material properties within a stratum
Inferred/gradational contact between strata
? Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

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Figure B-1

Jesik

102-D Oneida Street
Pueblo, Colorado 81004
(719) 582-5588
www.jesik.us

December 17, 2020

Ms. Julie Welte
Summit Brick Company

RE: Native / Pierre Mine Adequacy Review Comments

Dear Ms. Welte,

Strength testing of the materials were not completed as part of the slope stability analysis, however they were conservatively estimated from testing completed for the 4th Street Bridge for CDOT. A summary of the test results from that study are attached to this letter. The slope stability report for the 4th Street Bridge was completed by Michael W. West & Associates, Inc. in 2006 and titled:

ENGINEERING GEOLOGIC INVESTIGATION AND
SLOPE STABILITY EVALUATION, FINAL DESIGN PHASE,
PROPOSED 4TH STREET BRIDGE OVER THE ARKANSAS
RIVER, PUEBLO, PUEBLO COUNTY, COLORADO

Slope/W data input information is also attached to the letter.

Sincerely,

Joseph A. Jesik, P.E
Chief Engineer

Attachment A – *Table 1 – Summary of Laboratory Test Results, 4th Street Bridge, Southwest Abutment Evaluation*

Attachment B – Slope/W Input Data

TABLE 1
SUMMARY OF LABORATORY TEST RESULTS
4st STREET BRIDGE
SOUTHWEST ABUTMENT EVALUATION

				Atterberg Limits			Grain-Size Distribution					Direct Shear Strength						
												Peak Shear Strength		Ultimate Shear Strength		Swell (+) / Consol (-) at 500 psf Applied Pressure (%)	Tensile Strength (psf)	Unconfined Compressive Strength (psi)
Hole	Depth (ft)	Water Content (%)	Dry Unit Weight (pcf)	Liquid Limit	Plastic Limit	Plasticity Index	Gravel Sizes (%)	Sand Sizes (%)	Minus No. 200 Sieve Fines (%)	Clay Fines (%)	USCS	Cohesion (psf)	Friction Angle (degrees)	Cohesion (psf)	Friction Angle (degrees)			
BR-1	0-5						55.7	27.9	16.4		GM							
BR-1	10	13.9	102	52	27	25	0	22.9	77.1		CH					0.2		
BR-1	15	13.3	106.9															
BR-1	15	14	97	43	23.2	19.7	0	2.5	97.5		CL	89.3	47.9	553.0	34.8			
BR-1	15	11.9	106.8															
BR-1	41.0-42.0																	8,850.0
BR-1	42.0-42.2					NP	0	16.9	83.1	10.7								
BR-1	47.0-48.5													275.5	31.1			11,250.0
BR-1	65.5-66.4	1.6	145.9															2,540.0
BR-1	100.0-101.9																	3,890.0
BR-2	5	2	112.3			NP	8.7	56.6	34.7		SM					-2.7		
BR-2	10																	
BR-2	30.2-32																	10,860.0
BR-2	38.5-39.5			26.7	14.6	12.2	0	73.1	26.9					240.1	24.5			
BR-2	45.7-47.2																	1,670.0
BR-2	55.6-57.3	1.9	139.4															2,590.0
BR-2	69.8-71.4																	12,580.0
BR-2	75.5-76.2			51.3	15.4	35.3	0	18.1	81.9	8.6				59.2	23.0			
BR-3	5	17		32	14	18	23.6	40.1	36.3		SC							
BR-3	11.1-11.8																240	1,250.0
BR-3	24.0-25.0																690	1,050.0
BR-3	32.8-33.6	1	143.4															2,350.0

NOTES:
1. Laboratory testing conducted by Advanced Terra Testing, Inc.
2. Percent fines test result for BR-2 at 38.5-39.5 feet appears to be low likely due to difficulty breaking down shale rock fragments.
3. L/D < 2.0 correction factor applied to Unconfined Compressive Strength for BR-3 at 11.1 to 11.8 feet depth.

Existing High Wall - Deep Failure

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File Information

File Version: 8.16
Title: Native/Pierre Mine
Created By: A. Jesik
Revision Number: 24
Date: 12/9/2020
Time: 12:55:56 PM
Tool Version: 8.16.2.14053
File Name: Native-Pierre Stability.gsz
Directory: C:\Users\Office2\Desktop\Andy\Hudson Clay Pit\

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

Existing High Wall - Deep Failure

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
    Side Function
        Interslice force function option: Half-Sine
    PWP Conditions Source: (none)
Slip Surface
    Direction of movement: Left to Right
    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: 100
    F of S Tolerance: 0.001

Minimum Slip Surface Depth: 10 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

Clay

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion': 0 psf
Phi': 22 °
Phi-B: 0 °

Pierre

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion': 600 psf
Phi': 26 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (71.67266, 4,827.9687) ft
Left-Zone Right Coordinate: (237, 4,823.3846) ft
Left-Zone Increment: 12
Right Projection: Range
Right-Zone Left Coordinate: (291.87253, 4,820.0078) ft
Right-Zone Right Coordinate: (393, 4,790.7423) ft
Right-Zone Increment: 12
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 4,826.5) ft
Right Coordinate: (500, 4,630) ft

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 100 pcf
Direction: Normal

Coordinates

	X (ft)	Y (ft)
	122	4,839
	162	4,839

Surcharge Load 2

Surcharge (Unit Weight): 100 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)
	202	4,829.5
	227	4,826.5

Points

	X (ft)	Y (ft)
Point 1	0	4,826.5
Point 2	122	4,829
Point 3	162	4,829
Point 4	202	4,827
Point 5	227	4,824
Point 6	292	4,820
Point 7	310	4,802
Point 8	314	4,802
Point 9	332	4,792
Point 10	429	4,790
Point 11	499	4,789.5
Point 12	300	4,812
Point 13	0	4,813
Point 14	500	4,630
Point 15	0	4,628

Regions

	Material	Points	Area (ft^2)
Region 1	Clay	1,2,3,4,5,6,12,13	4,111
Region 2	Pierre	13,12,7,8,9,10,11,14,15	87,593

Existing High Wall - Shallow Failure

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File Information

File Version: 8.16
Title: Native/Pierre Mine
Created By: A. Jesik
Revision Number: 25
Date: 12/17/2020
Time: 2:57:01 PM
Tool Version: 8.16.2.14053
File Name: Native-Pierre Stability.gsz
Directory: F:\Hudson Clay Pit\

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

Existing High Wall - Shallow Failure

Description: Slope Stability of Existing High Wall East Side of Property
Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: (none)

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 10
- Resisting Side Maximum Convex Angle: 1 °
- Driving Side Maximum Convex Angle: 5 °
- Optimize Critical Slip Surface Location: Yes
- Critical Slip Surface Optimizations
  - Maximum Iterations: 2,000
  - Convergence Tolerance: 1e-007
  - Starting Points: 8
  - Ending Points: 16
  - Complete Passes per Insertion: 1

Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 100
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

Clay

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion': 0 psf
Phi': 22 °
Phi-B: 0 °

Pierre

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion': 600 psf
Phi': 26 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (71.67266, 4,827.9687) ft
Left-Zone Right Coordinate: (236, 4,823.4462) ft
Left-Zone Increment: 12
Right Projection: Range
Right-Zone Left Coordinate: (291.87253, 4,820.0078) ft
Right-Zone Right Coordinate: (365, 4,791.3196) ft
Right-Zone Increment: 12
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 4,826.5) ft
Right Coordinate: (500, 4,630) ft

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 100 pcf

Direction: Normal

Coordinates

	X (ft)	Y (ft)
	122	4,839
	162	4,839

Surcharge Load 2

Surcharge (Unit Weight): 100 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)
	202	4,829.5
	227	4,826.5

Points

	X (ft)	Y (ft)
Point 1	0	4,826.5
Point 2	122	4,829
Point 3	162	4,829
Point 4	202	4,827
Point 5	227	4,824
Point 6	292	4,820
Point 7	310	4,802
Point 8	314	4,802
Point 9	332	4,792
Point 10	429	4,790
Point 11	499	4,789.5
Point 12	300	4,812
Point 13	0	4,813
Point 14	500	4,630
Point 15	0	4,628

Regions

	Material	Points	Area (ft^2)
Region 1	Clay	1,2,3,4,5,6,12,13	4,111
Region 2	Pierre	13,12,7,8,9,10,11,14,15	87,593

Section B - Deep Failure

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File Information

File Version: 8.16
Title: Native/Pierre Mine
Created By: A. Jesik
Revision Number: 34
Date: 12/9/2020
Time: 2:11:34 PM
Tool Version: 8.16.2.14053
File Name: Section B.gsz
Directory: C:\Users\Office2\Desktop\Andy\Hudson Clay Pit\

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

Section B - Deep Failure

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
    Side Function
        Interslice force function option: Half-Sine
    PWP Conditions Source: (none)
Slip Surface
    Direction of movement: Left to Right
    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: 100
    F of S Tolerance: 0.001

Minimum Slip Surface Depth: 10 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

Clay

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion': 0 psf
Phi': 22 °
Phi-B: 0 °

Pierre

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion': 600 psf
Phi': 26 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (62.1818, 4,829.323) ft
Left-Zone Right Coordinate: (203, 4,825.0435) ft
Left-Zone Increment: 12
Right Projection: Range
Right-Zone Left Coordinate: (211.39907, 4,823.035) ft
Right-Zone Right Coordinate: (448, 4,778.17) ft
Right-Zone Increment: 12
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 4,828) ft
Right Coordinate: (467, 4,706) ft

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 100 pcf
Direction: Normal

Coordinates

	X (ft)	Y (ft)
	94	4,840
	134	4,840

Surcharge Load 2

Surcharge (Unit Weight): 100 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)
	174	4,829.5
	199	4,828.5

Points

	X (ft)	Y (ft)
Point 1	0	4,828
Point 2	94	4,830
Point 3	134	4,830
Point 4	174	4,827
Point 5	199	4,826
Point 6	365	4,779
Point 7	465	4,778
Point 8	245	4,815
Point 9	0	4,815
Point 10	467	4,706
Point 11	0	4,699

Regions

	Material	Points	Area (ft^2)
Region 1	Clay	1,2,3,4,5,8,9	2,996.5
Region 2	Pierre	9,8,6,7,10,11	46,582

Section B - Shallow Failure

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File Information

File Version: 8.16
Title: Native/Pierre Mine
Created By: A. Jesik
Revision Number: 34
Date: 12/9/2020
Time: 2:11:34 PM
Tool Version: 8.16.2.14053
File Name: Section B.gsz
Directory: C:\Users\Office2\Desktop\Andy\Hudson Clay Pit\

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

Section B - Shallow Failure

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
    Side Function
        Interslice force function option: Half-Sine
    PWP Conditions Source: (none)
Slip Surface
    Direction of movement: Left to Right
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 10
    Resisting Side Maximum Convex Angle: 1 °
    Driving Side Maximum Convex Angle: 5 °
    Optimize Critical Slip Surface Location: Yes
    Critical Slip Surface Optimizations
        Maximum Iterations: 2,000
        Convergence Tolerance: 1e-007
        Starting Points: 8
        Ending Points: 16
        Complete Passes per Insertion: 1
    Tension Crack

Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 100
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

Clay

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion': 0 psf
Phi': 22 °
Phi-B: 0 °

Pierre

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion': 600 psf
Phi': 26 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (62.1818, 4,829.323) ft
Left-Zone Right Coordinate: (201.00008, 4,825.5217) ft
Left-Zone Increment: 12
Right Projection: Range
Right-Zone Left Coordinate: (229.99991, 4,818.587) ft
Right-Zone Right Coordinate: (448, 4,778.17) ft
Right-Zone Increment: 12
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 4,828) ft
Right Coordinate: (467, 4,706) ft

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 100 pcf
Direction: Normal

Coordinates

	X (ft)	Y (ft)
	94	4,840
	134	4,840

Surcharge Load 2

Surcharge (Unit Weight): 100 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)
	174	4,829.5
	199	4,828.5

Points

	X (ft)	Y (ft)
Point 1	0	4,828
Point 2	94	4,830
Point 3	134	4,830
Point 4	174	4,827
Point 5	199	4,826
Point 6	365	4,779
Point 7	465	4,778
Point 8	245	4,815
Point 9	0	4,815
Point 10	467	4,706
Point 11	0	4,699

Regions

	Material	Points	Area (ft^2)
Region 1	Clay	1,2,3,4,5,8,9	2,996.5
Region 2	Pierre	9,8,6,7,10,11	46,582

Section C - Deep Failure

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File Information

File Version: 8.16
Title: Native/Pierre Mine
Created By: A. Jesik
Revision Number: 38
Date: 12/9/2020
Time: 2:37:13 PM
Tool Version: 8.16.2.14053
File Name: Section C.gsz
Directory: C:\Users\Office2\Desktop\Andy\Hudson Clay Pit\

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

Section C - Deep Failure

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
    Side Function
        Interslice force function option: Half-Sine
    PWP Conditions Source: (none)
Slip Surface
    Direction of movement: Left to Right
    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: 100
    F of S Tolerance: 0.001

Minimum Slip Surface Depth: 10 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

Clay

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion': 0 psf
Phi': 22 °
Phi-B: 0 °

Pierre

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion': 600 psf
Phi': 26 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (4.11375, 4,829.1849) ft
Left-Zone Right Coordinate: (218, 4,825.375) ft
Left-Zone Increment: 12
Right Projection: Range
Right-Zone Left Coordinate: (228.00428, 4,823.2908) ft
Right-Zone Right Coordinate: (427, 4,800.02) ft
Right-Zone Increment: 12
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 4,829) ft
Right Coordinate: (430, 4,708) ft

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 100 pcf
Direction: Normal

Coordinates

	X (ft)	Y (ft)
	89	4,843
	149	4,843

Surcharge Load 2

Surcharge (Unit Weight): 100 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)
	185	4,831.5
	215	4,828.5

Points

	X (ft)	Y (ft)
Point 1	0	4,829
Point 2	89	4,833
Point 3	149	4,833
Point 4	185	4,829
Point 5	215	4,826
Point 6	329	4,801
Point 7	429	4,800
Point 8	263	4,816
Point 9	0	4,814
Point 10	430	4,708
Point 11	0	4,708

Regions

	Material	Points	Area (ft^2)
Region 1	Clay	1,2,3,4,5,8,9	3,743
Region 2	Pierre	9,8,6,7,10,11	44,070

Section C - Shallow Failure

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File Information

File Version: 8.16
Title: Native/Pierre Mine
Created By: A. Jesik
Revision Number: 38
Date: 12/9/2020
Time: 2:37:13 PM
Tool Version: 8.16.2.14053
File Name: Section C.gsz
Directory: C:\Users\Office2\Desktop\Andy\Hudson Clay Pit\

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

Section C - Shallow Failure

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: (none)

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 10
- Resisting Side Maximum Convex Angle: 1 °
- Driving Side Maximum Convex Angle: 5 °
- Optimize Critical Slip Surface Location: Yes
- Critical Slip Surface Optimizations
  - Maximum Iterations: 2,000
  - Convergence Tolerance: 1e-007
  - Starting Points: 8
  - Ending Points: 16
  - Complete Passes per Insertion: 1
- Tension Crack

Tension Crack Option: (none)

F of S Distribution

F of S Calculation Option: Constant

Advanced

Number of Slices: 100

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

Clay

Model: Mohr-Coulomb

Unit Weight: 105 pcf

Cohesion': 0 psf

Phi': 22 °

Phi-B: 0 °

Pierre

Model: Mohr-Coulomb

Unit Weight: 122 pcf

Cohesion': 600 psf

Phi': 26 °

Phi-B: 0 °

Slip Surface Entry and Exit

Left Projection: Range

Left-Zone Left Coordinate: (4.11375, 4,829.1849) ft

Left-Zone Right Coordinate: (218, 4,825.375) ft

Left-Zone Increment: 12

Right Projection: Range

Right-Zone Left Coordinate: (228.00428, 4,823.2908) ft

Right-Zone Right Coordinate: (427, 4,800.02) ft

Right-Zone Increment: 12

Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 4,829) ft

Right Coordinate: (430, 4,708) ft

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 100 pcf

Direction: Normal

Coordinates

	X (ft)	Y (ft)
	89	4,843
	149	4,843

Surcharge Load 2

Surcharge (Unit Weight): 100 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)
	185	4,831.5
	215	4,828.5

Points

	X (ft)	Y (ft)
Point 1	0	4,829
Point 2	89	4,833
Point 3	149	4,833
Point 4	185	4,829
Point 5	215	4,826
Point 6	329	4,801
Point 7	429	4,800
Point 8	263	4,816
Point 9	0	4,814
Point 10	430	4,708
Point 11	0	4,708

Regions

	Material	Points	Area (ft^2)
Region 1	Clay	1,2,3,4,5,8,9	3,743
Region 2	Pierre	9,8,6,7,10,11	44,070

Section D - Deep Failure

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File Information

File Version: 8.16
Title: Native/Pierre Mine
Created By: A. Jesik
Revision Number: 53
Date: 12/10/2020
Time: 8:16:49 AM
Tool Version: 8.16.2.14053
File Name: Section D.gsz
Directory: C:\Users\Office2\Desktop\Andy\Hudson Clay Pit\

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

Section D - Deep Failure

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
    Side Function
        Interslice force function option: Half-Sine
    PWP Conditions Source: (none)
Slip Surface
    Direction of movement: Left to Right
    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: 100
    F of S Tolerance: 0.001

Minimum Slip Surface Depth: 10 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

Clay

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion': 0 psf
Phi': 22 °
Phi-B: 0 °

Pierre

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion': 600 psf
Phi': 26 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (6.21354, 4,825.7929) ft
Left-Zone Right Coordinate: (276, 4,821.8986) ft
Left-Zone Increment: 12
Right Projection: Range
Right-Zone Left Coordinate: (328, 4,818.1) ft
Right-Zone Right Coordinate: (504, 4,800.0791) ft
Right-Zone Increment: 12
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 4,826) ft
Right Coordinate: (516, 4,729) ft

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 100 pcf
Direction: Normal

Coordinates

	X (ft)	Y (ft)
	30	4,835
	60	4,835

Surcharge Load 2

Surcharge (Unit Weight): 100 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)
	104	4,823.5
	137	4,825.5

Surcharge Load 3

Surcharge (Unit Weight): 100 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)
	177	4,835
	207	4,835

Surcharge Load 4

Surcharge (Unit Weight): 100 pcf
Direction: Normal

Coordinates

	X (ft)	Y (ft)
	227	4,833
	257	4,833

Points

	X (ft)	Y (ft)
Point 1	0	4,826
Point 2	30	4,825
Point 3	60	4,825
Point 4	104	4,821
Point 5	137	4,823
Point 6	177	4,825
Point 7	207	4,825
Point 8	227	4,823
Point 9	257	4,823
Point 10	326	4,819
Point 11	376	4,801
Point 12	515	4,800
Point 13	346	4,810
Point 14	0	4,810
Point 15	516	4,729
Point 16	0	4,728

Regions

	Material	Points	Area (ft^2)

Region 1	Clay	1,2,3,4,5,6,7,8,9,10,13,14	4,412
Region 2	Pierre	14,13,11,12,15,16	40,553

Section D - Shallow Failure

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File Information

File Version: 8.16
Title: Native/Pierre Mine
Created By: A. Jesik
Revision Number: 53
Date: 12/10/2020
Time: 8:16:49 AM
Tool Version: 8.16.2.14053
File Name: Section D.gsz
Directory: C:\Users\Office2\Desktop\Andy\Hudson Clay Pit\

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

Section D - Shallow Failure

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
    Side Function
        Interslice force function option: Half-Sine
    PWP Conditions Source: (none)
Slip Surface
    Direction of movement: Left to Right
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 10
    Resisting Side Maximum Convex Angle: 1 °
    Driving Side Maximum Convex Angle: 5 °
    Optimize Critical Slip Surface Location: Yes
    Critical Slip Surface Optimizations
        Maximum Iterations: 2,000
        Convergence Tolerance: 1e-007
        Starting Points: 8
        Ending Points: 16
        Complete Passes per Insertion: 1
    Tension Crack

Tension Crack Option: (none)

F of S Distribution

F of S Calculation Option: Constant

Advanced

Number of Slices: 100

F of S Tolerance: 0.001

Minimum Slip Surface Depth: 5 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

Clay

Model: Mohr-Coulomb

Unit Weight: 105 pcf

Cohesion': 0 psf

Phi': 22 °

Phi-B: 0 °

Pierre

Model: Mohr-Coulomb

Unit Weight: 122 pcf

Cohesion': 600 psf

Phi': 26 °

Phi-B: 0 °

Slip Surface Entry and Exit

Left Projection: Range

Left-Zone Left Coordinate: (6.21354, 4,825.7929) ft

Left-Zone Right Coordinate: (276, 4,821.8986) ft

Left-Zone Increment: 12

Right Projection: Range

Right-Zone Left Coordinate: (328, 4,818.1) ft

Right-Zone Right Coordinate: (504, 4,800.0791) ft

Right-Zone Increment: 12

Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 4,826) ft

Right Coordinate: (516, 4,729) ft

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 100 pcf

Direction: Normal

Coordinates

	X (ft)	Y (ft)
	30	4,835
	60	4,835

Surcharge Load 2

Surcharge (Unit Weight): 100 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)
	104	4,823.5
	137	4,825.5

Surcharge Load 3

Surcharge (Unit Weight): 100 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)
	177	4,835
	207	4,835

Surcharge Load 4

Surcharge (Unit Weight): 100 pcf
Direction: Normal

Coordinates

	X (ft)	Y (ft)
	227	4,833
	257	4,833

Points

	X (ft)	Y (ft)
Point 1	0	4,826
Point 2	30	4,825
Point 3	60	4,825
Point 4	104	4,821
Point 5	137	4,823
Point 6	177	4,825
Point 7	207	4,825
Point 8	227	4,823
Point 9	257	4,823
Point 10	326	4,819
Point 11	376	4,801
Point 12	515	4,800
Point 13	346	4,810
Point 14	0	4,810
Point 15	516	4,729

Point 16	0	4,728

Regions

	Material	Points	Area (ft²)
Region 1	Clay	1,2,3,4,5,6,7,8,9,10,13,14	4,412
Region 2	Pierre	14,13,11,12,15,16	40,553

Section E - Deep Failure

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File Information

File Version: 8.16
Title: Native/Pierre Mine
Created By: A. Jesik
Revision Number: 41
Date: 12/10/2020
Time: 8:18:32 AM
Tool Version: 8.16.2.14053
File Name: Section E.gsz
Directory: C:\Users\Office2\Desktop\Andy\Hudson Clay Pit\

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

Section E - Deep Failure

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
    Side Function
        Interslice force function option: Half-Sine
    PWP Conditions Source: (none)
Slip Surface
    Direction of movement: Left to Right
    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: 100
    F of S Tolerance: 0.001

Minimum Slip Surface Depth: 10 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

Clay

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion': 0 psf
Phi': 22 °
Phi-B: 0 °

Pierre

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion': 600 psf
Phi': 26 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (0, 4,783) ft
Left-Zone Right Coordinate: (158, 4,783) ft
Left-Zone Increment: 12
Right Projection: Range
Right-Zone Left Coordinate: (203.87628, 4,782.1312) ft
Right-Zone Right Coordinate: (350, 4,767) ft
Right-Zone Increment: 12
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 4,783) ft
Right Coordinate: (354, 4,767) ft

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 100 pcf
Direction: Normal

Coordinates

	X (ft)	Y (ft)
	30	4,793
	75	4,793

Surcharge Load 2

Surcharge (Unit Weight): 0 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)
	75	4,785.5
	174	4,785.5

Points

	X (ft)	Y (ft)
Point 1	0	4,783
Point 2	200	4,783
Point 3	258	4,770
Point 4	354	4,767
Point 5	264	4,767
Point 6	0	4,768
Point 7	354	4,711
Point 8	0	4,714

Regions

	Material	Points	Area (ft²)
Region 1	Clay	1,2,3,5,6	3,628
Region 2	Pierre	6,5,4,7,8	19,425

Section E - Shallow Failure

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File Information

File Version: 8.16
Title: Native/Pierre Mine
Created By: A. Jesik
Revision Number: 41
Date: 12/10/2020
Time: 8:18:32 AM
Tool Version: 8.16.2.14053
File Name: Section E.gsz
Directory: C:\Users\Office2\Desktop\Andy\Hudson Clay Pit\

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

Section E - Shallow Failure

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
    Side Function
        Interslice force function option: Half-Sine
    PWP Conditions Source: (none)
Slip Surface
    Direction of movement: Left to Right
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 10
    Resisting Side Maximum Convex Angle: 1 °
    Driving Side Maximum Convex Angle: 5 °
    Optimize Critical Slip Surface Location: Yes
    Critical Slip Surface Optimizations
        Maximum Iterations: 2,000
        Convergence Tolerance: 1e-007
        Starting Points: 8
        Ending Points: 16
        Complete Passes per Insertion: 1
    Tension Crack

Tension Crack Option: (none)

F of S Distribution

F of S Calculation Option: Constant

Advanced

Number of Slices: 100

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

Clay

Model: Mohr-Coulomb

Unit Weight: 105 pcf

Cohesion': 0 psf

Phi': 22 °

Phi-B: 0 °

Pierre

Model: Mohr-Coulomb

Unit Weight: 122 pcf

Cohesion': 600 psf

Phi': 26 °

Phi-B: 0 °

Slip Surface Entry and Exit

Left Projection: Range

Left-Zone Left Coordinate: (0, 4,783) ft

Left-Zone Right Coordinate: (158, 4,783) ft

Left-Zone Increment: 12

Right Projection: Range

Right-Zone Left Coordinate: (203.87628, 4,782.1312) ft

Right-Zone Right Coordinate: (350, 4,767) ft

Right-Zone Increment: 12

Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 4,783) ft

Right Coordinate: (354, 4,767) ft

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 100 pcf

Direction: Normal

Coordinates

	X (ft)	Y (ft)
	30	4,793
	75	4,793

Surcharge Load 2

Surcharge (Unit Weight): 0 pcf
Direction: Vertical

Coordinates

	X (ft)	Y (ft)
	75	4,785.5
	174	4,785.5

Points

	X (ft)	Y (ft)
Point 1	0	4,783
Point 2	200	4,783
Point 3	258	4,770
Point 4	354	4,767
Point 5	264	4,767
Point 6	0	4,768
Point 7	354	4,711
Point 8	0	4,714

Regions

	Material	Points	Area (ft²)
Region 1	Clay	1,2,3,5,6	3,628
Region 2	Pierre	6,5,4,7,8	19,425

Section F - Deep Failure

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File Information

File Version: 8.16
Title: Native/Pierre Mine
Created By: A. Jesik
Revision Number: 40
Date: 12/10/2020
Time: 8:19:14 AM
Tool Version: 8.16.2.14053
File Name: Section F.gsz
Directory: C:\Users\Office2\Desktop\Andy\Hudson Clay Pit\

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

Section F - Deep Failure

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
    Side Function
        Interslice force function option: Half-Sine
    PWP Conditions Source: (none)
Slip Surface
    Direction of movement: Left to Right
    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: 100
    F of S Tolerance: 0.001

Minimum Slip Surface Depth: 10 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

Clay

Model: Mohr-Coulomb
Unit Weight: 105 pcf
Cohesion': 0 psf
Phi': 22 °
Phi-B: 0 °

Pierre

Model: Mohr-Coulomb
Unit Weight: 122 pcf
Cohesion': 600 psf
Phi': 26 °
Phi-B: 0 °

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (0.15363, 4,773.0028) ft
Left-Zone Right Coordinate: (132, 4,776.4667) ft
Left-Zone Increment: 12
Right Projection: Range
Right-Zone Left Coordinate: (147.40046, 4,776.3347) ft
Right-Zone Right Coordinate: (265, 4,766.2759) ft
Right-Zone Increment: 12
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 4,773) ft
Right Coordinate: (277, 4,766) ft

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 100 pcf
Direction: Normal

Coordinates

	X (ft)	Y (ft)
	54	4,776.5
	99	4,777.5

Points

	X (ft)	Y (ft)
Point 1	0	4,773
Point 2	54	4,774
Point 3	99	4,775
Point 4	144	4,777
Point 5	190	4,768
Point 6	277	4,766
Point 7	277	4,760
Point 8	0	4,760
Point 9	277	4,711
Point 10	0	4,701

Regions

	Material	Points	Area (ft^2)
Region 1	Clay	1,2,3,4,5,6,7,8	3,285.5
Region 2	Pierre	8,7,9,10	14,958

Section F - Shallow Failure

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File Information

File Version: 8.16
Title: Native/Pierre Mine
Created By: A. Jesik
Revision Number: 40
Date: 12/10/2020
Time: 8:19:14 AM
Tool Version: 8.16.2.14053
File Name: Section F.gsz
Directory: C:\Users\Office2\Desktop\Andy\Hudson Clay Pit\

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

Section F - Shallow Failure

Kind: SLOPE/W
Method: Morgenstern-Price
Settings
- Side Function
  - Interslice force function option: Half-Sine
- PWP Conditions Source: (none)

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 10
- Resisting Side Maximum Convex Angle: 1 °
- Driving Side Maximum Convex Angle: 5 °
- Optimize Critical Slip Surface Location: Yes
- Critical Slip Surface Optimizations
  - Maximum Iterations: 2,000
  - Convergence Tolerance: 1e-007
  - Starting Points: 8
  - Ending Points: 16
  - Complete Passes per Insertion: 1
- Tension Crack

Tension Crack Option: (none)

F of S Distribution

F of S Calculation Option: Constant

Advanced

Number of Slices: 100

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

Clay

Model: Mohr-Coulomb

Unit Weight: 105 pcf

Cohesion': 0 psf

Phi': 22 °

Phi-B: 0 °

Pierre

Model: Mohr-Coulomb

Unit Weight: 122 pcf

Cohesion': 600 psf

Phi': 26 °

Phi-B: 0 °

Slip Surface Entry and Exit

Left Projection: Range

Left-Zone Left Coordinate: (0.15363, 4,773.0028) ft

Left-Zone Right Coordinate: (132, 4,776.4667) ft

Left-Zone Increment: 12

Right Projection: Range

Right-Zone Left Coordinate: (147.40046, 4,776.3347) ft

Right-Zone Right Coordinate: (265, 4,766.2759) ft

Right-Zone Increment: 12

Radius Increments: 4

Slip Surface Limits

Left Coordinate: (0, 4,773) ft

Right Coordinate: (277, 4,766) ft

Surcharge Loads

Surcharge Load 1

Surcharge (Unit Weight): 100 pcf

Direction: Normal

Coordinates

	X (ft)	Y (ft)
	54	4,776.5
	99	4,777.5

Points

	X (ft)	Y (ft)
Point 1	0	4,773
Point 2	54	4,774
Point 3	99	4,775
Point 4	144	4,777
Point 5	190	4,768
Point 6	277	4,766
Point 7	277	4,760
Point 8	0	4,760
Point 9	277	4,711
Point 10	0	4,701

Regions

	Material	Points	Area (ft^2)
Region 1	Clay	1,2,3,4,5,6,7,8	3,285.5
Region 2	Pierre	8,7,9,10	14,958

COLORADO
Division of Reclamation, Mining and Safety
Department of Natural Resources
1313 Sherman Street, Room 215
Denver, CO 80203

MEMORANDUM

Date: January 5, 2021

To: Patrick Lennberg; Division of Reclamation, Mining & Safety

From: Peter Hays; Division of Reclamation, Mining & Safety

Re: Native/Pierre Mine; M-1977-321; Conversion Application (CN-01); Jesik Consulting Slope Stability Report; Geotechnical Review Memo

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The Division of Reclamation, Mining and Safety (Division/DRMS) reviewed the Slope Stability Report received from Jesik Consulting on December 28, 2020 for the Native/Pierre Mine permit conversion application (CN-01), File No. M-1977-321.

The Slope Stability Analysis was submitted to address any significant, valuable and permanent man-made structures within 200 feet of the affected lands, since the Operator was not able to obtain agreements with all structure owners as required by Rule 6.4.19.

In accordance with Table 1 - Recommended Factors of Safety for Slope Stability Analysis for Operations and Reclamation within Section 30.4 of the Policies of the Mined Land Reclamation Board (MLRB) effective May 16, 2018, the Division will require the Operator to comply with the factor of safety (FOS) of 1.5 for critical structures in static conditions since the Operator utilized generalized strength measurements in the analysis.

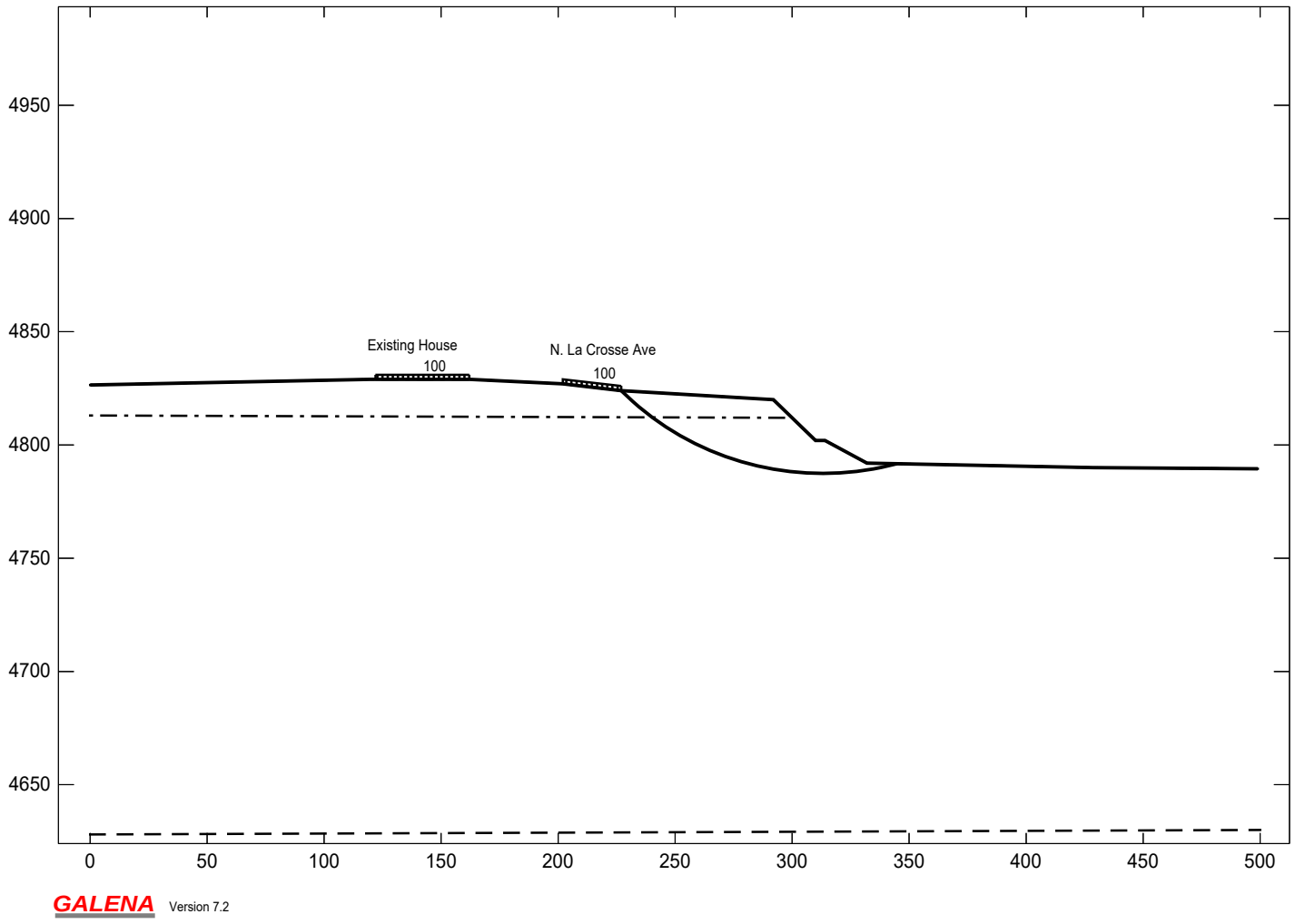
The Division replicated the Operator's slope stability analysis using Clover Technologies Galena Slope Stability Analysis System, Version 7.2 with the X-Left coordinate maintained at the edge of closest man-made structure. The Division did not replicate the shallow failure model analysis, since shallow failures would be repaired during the life of mine and are unlikely to cause damage to the nearby structures. A table of the Applicant's and the Division's analysis factor of safety (FOS) results for the deep failure models are below:

Analysis Name	Applicant's FOS	DRMS FOS
Existing Highwall – Deep Failure	2.82	2.98
Section B – Deep Failure	3.04	3.16
Section C – Deep Failure	3.46	5.13
Section D – Deep Failure	4.55	4.92
Section E – Deep Failure	3.49	2.62
Section F – Deep Failure	3.05	4.51

The Division accepts the Jesik Consulting slope stability analysis as an alternative to the Operator obtaining agreements with all structure owners within 200-feet of the affected lands.

If groundwater is intercepted and/or the soils differ from the expected profiles, the Operator must contact the Division immediately and reevaluate the slope stability analysis based on the updated information. Please note any transgression from the proposed slope geometries will be considered a violation if the conversion application is approved and issued by the Division. The Division's stability analysis model results are attached.

If you have any questions, please contact me at peter.hays@state.co.us or (303) 866-3567 Ext. 8124.



Project Native/Pierre Mine
Existiing Highwall

File: G:\My Drive\1 - My Projects Google\8 Galena - Stability Analysis Models\NativePierre\Existing Highwall.gmf

Analysis 1

Single Stability Analysis

Method: Bishop Simplified

Surface: Circular

Results

Factor of Safety: 2.98

Edited: 5 Jan 2021 *Processed:* 5 Jan 2021

Dept of the Interior - Office of Surface Mining

GALENA 7.2 Analysis Results Version: 7.20.2.01 Licensee: Dept of the Interior - Office of Surface Mining

Project: Native/Pierre Mine
File: G:\My Drive\1 - My Projects Google\8 Galena - Stability Analysis Models\NativePierre\Existing Highwall.gmf
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DATA: Analysis 1 - Existiing Highwall

Material Properties (2 materials)

Material: 1 (Mohr-Coulomb Isotropic) - Clay

Cohesion	Phi	UnitWeight	Ru
0.00	22.0	105.00	Auto

Material: 2 (Mohr-Coulomb Isotropic) - Pierre Shale

Cohesion	Phi	UnitWeight	Ru
600.00	26.0	122.00	Auto

Water Properties

Unit weight of water: 62.400 Unit weight of water/medium above ground: 62.400

Material Profiles (2 profiles)

Profile: 1 (2 points) Material beneath: 1 - Clay

0.00	4830.00	499.00	4830.00

Profile: 2 (3 points) Material beneath: 2 - Pierre Shale

0.00	4813.00	300.00	4812.00	499.00	4812.00

Slope Surface (12 points)

0.00	4826.50	120.00	4829.00	162.00	4829.00	202.00	4827.00	227.00	4824.00
292.00	4820.00	300.00	4812.00	310.00	4802.00	314.00	4802.00	332.00	4792.00
429.00	4790.00	499.00	4789.50						

Phreatic Surface (2 points)

0.00	4628.00	500.00	4630.00

Failure Surface

Circular surface defined by: XL,XR,R

Intersects:	XL:	227.00	YL:	4824.00	XR:	344.83	YR: 4791.74
Centre:	XC:	313.14	YC:	4907.30	Radius:	R:	119.83

Distributed Loads (2 loads)

Load	X-Left	Pressure	X-Right	Pressure
1	122.00	100.0	162.00	100.0
2	202.00	100.0	227.00	100.0

RESULTS: Analysis 1 - Existiing Highwall

Bishop Simplified Method of Analysis - Circular Failure Surface

Factor of Safety: 2.98

Slice Geometry and Properties (42 slices)

Slice	X-Left	X-S Area	Base Angle	Base Width	Base Length	Base Matl	Base Cohesion	Base Phi	Weight	PoreWater Force	Normal Stress	Test Factor
1	227.00	2.66	44.3	2.41	3.37	1	0.00	22.0	279.75	0.00	102.41	1.23
2	229.41	7.99	44.3	2.41	3.37	1	0.00	22.0	839.36	0.00	307.27	1.23
3	231.82	13.85	41.1	2.54	3.37	1	0.00	22.0	1454.00	0.00	511.70	1.19
4	234.37	19.09	41.1	2.54	3.37	1	0.00	22.0	2004.15	0.00	705.29	1.19
5	236.91	33.22	37.9	3.40	4.31	1	0.00	22.0	3488.15	0.00	927.24	1.15
6	240.31	22.41	37.9	1.92	2.43	2	600.00	26.0	2377.76	0.00	959.36	1.12
7	242.23	36.71	34.7	2.77	3.37	2	600.00	26.0	3969.80	0.00	1160.53	1.09
8	245.00	41.56	34.7	2.77	3.37	2	600.00	26.0	4568.90	0.00	1354.60	1.09
9	247.78	47.90	31.4	2.88	3.37	2	600.00	26.0	5332.30	0.00	1572.62	1.07
10	250.66	52.46	31.4	2.88	3.37	2	600.00	26.0	5896.09	0.00	1750.73	1.07
11	253.53	58.63	28.2	2.97	3.37	2	600.00	26.0	6641.27	0.00	1954.94	1.04
12	256.51	62.83	28.2	2.97	3.37	2	600.00	26.0	7161.89	0.00	2115.97	1.04
13	259.48	68.67	25.0	3.06	3.37	2	600.00	26.0	7869.79	0.00	2304.62	1.03
14	262.54	72.45	25.0	3.06	3.37	2	600.00	26.0	8340.46	0.00	2447.78	1.03
15	265.59	77.83	21.8	3.13	3.37	2	600.00	26.0	8994.23	0.00	2619.72	1.01
16	268.73	81.15	21.8	3.13	3.37	2	600.00	26.0	9408.13	0.00	2743.84	1.01
17	271.86	85.93	18.5	3.20	3.37	2	600.00	26.0	9991.87	0.00	2897.91	1.00
18	275.06	88.74	18.5	3.20	3.37	2	600.00	26.0	10343.66	0.00	3002.32	1.00
19	278.25	92.82	15.3	3.25	3.37	2	600.00	26.0	10843.55	0.00	3137.54	0.99
20	281.51	95.06	15.3	3.25	3.37	2	600.00	26.0	11128.36	0.00	3221.19	0.99
21	284.76	98.35	12.1	3.30	3.37	2	600.00	26.0	11533.23	0.00	3336.71	0.99
22	288.06	100.01	12.1	3.30	3.37	2	600.00	26.0	11746.53	0.00	3399.30	0.99
23	291.36	19.68	8.8	0.64	0.65	2	600.00	26.0	2313.05	0.00	3477.88	0.99
24	292.00	88.42	8.9	3.01	3.05	2	600.00	26.0	10455.94	0.00	3355.19	0.99
25	295.01	80.77	8.9	3.01	3.05	2	600.00	26.0	9675.79	0.00	3102.60	0.99
26	298.02	48.76	5.6	1.98	1.99	2	600.00	26.0	5915.52	0.00	2924.72	0.99
27	300.00	53.76	5.6	2.37	2.38	2	600.00	26.0	6558.42	0.00	2705.90	0.99
28	302.37	48.70	5.6	2.37	2.38	2	600.00	26.0	5941.67	0.00	2449.72	0.99
29	304.74	48.00	2.4	2.63	2.63	2	600.00	26.0	5856.00	0.00	2201.37	0.99
30	307.37	41.36	2.4	2.63	2.63	2	600.00	26.0	5046.53	0.00	1895.92	0.99
31	310.00	21.39	2.4	1.48	1.48	2	600.00	26.0	2609.43	0.00	1747.00	0.99
32	311.48	36.59	-0.8	2.52	2.52	2	600.00	26.0	4464.44	0.00	1776.10	1.00
33	314.00	29.30	-0.8	2.11	2.11	2	600.00	26.0	3574.74	0.00	1700.23	1.00
34	316.11	26.76	-0.8	2.11	2.11	2	600.00	26.0	3265.02	0.00	1553.27	1.00
35	318.22	37.09	-4.0	3.36	3.37	2	600.00	26.0	4525.03	0.00	1374.97	1.01
36	321.59	30.00	-4.0	3.36	3.37	2	600.00	26.0	3659.95	0.00	1114.86	1.01
37	324.95	22.49	-7.3	3.35	3.37	2	600.00	26.0	2743.25	0.00	863.54	1.03
38	328.30	14.84	-7.3	3.35	3.37	2	600.00	26.0	1810.23	0.00	578.75	1.03
39	331.64	9.15	-10.5	3.32	3.37	2	600.00	26.0	1116.49	0.00	385.57	1.05
40	334.96	6.89	-10.5	3.32	3.37	2	600.00	26.0	840.27	0.00	299.69	1.05
41	338.28	4.27	-13.7	3.28	3.37	2	600.00	26.0	520.40	0.00	216.61	1.07
42	341.55	1.42	-13.7	3.28	3.37	2	600.00	26.0	173.34	0.00	106.25	1.07
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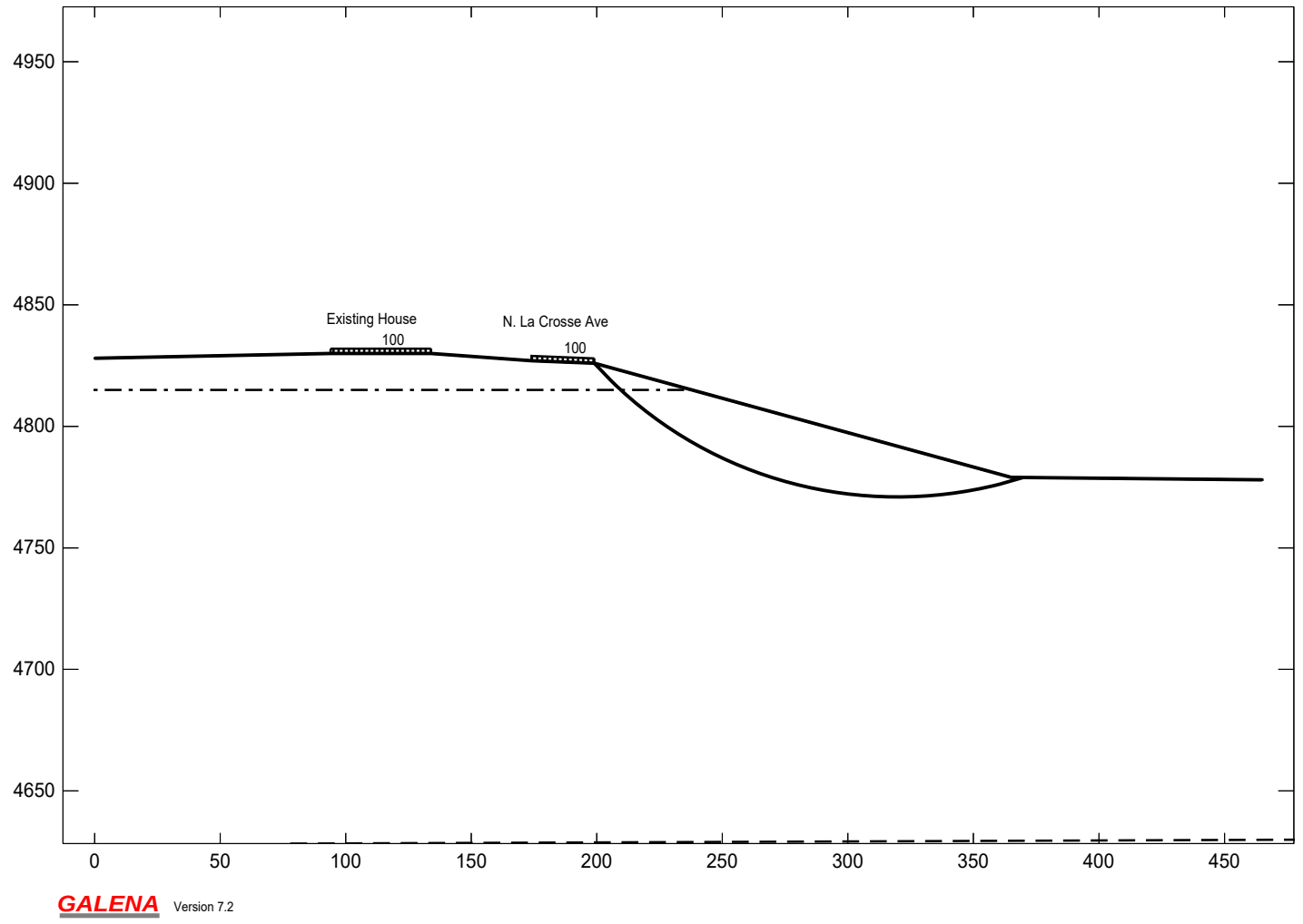

Project Native/Pierre Mine
Section B

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Analysis 1

Single Stability Analysis

Method: Bishop Simplified

Surface: Circular

Results

Factor of Safety: 3.16

Edited: 5 Jan 2021 *Processed:* 5 Jan 2021

Dept of the Interior - Office of Surface Mining

Project: Native/Pierre Mine
File: G:\My Drive\1 - My Projects Google\8 Galena - Stability Analysis Models\NativePierre\Section B.gmf
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DATA: Analysis 1 - Section B

Material Properties (2 materials)

Material: 1 (Mohr-Coulomb Isotropic) - Clay

Cohesion	Phi	UnitWeight	Ru
0.00	22.0	105.00	Auto

Material: 2 (Mohr-Coulomb Isotropic) - Pierre Shale

Cohesion	Phi	UnitWeight	Ru
600.00	26.0	122.00	Auto

Water Properties

Unit weight of water: 62.400 Unit weight of water/medium above ground: 62.400

Material Profiles (2 profiles)

Profile: 1 (2 points) Material beneath: 1 - Clay

0.00	4830.00	465.00	4830.00

Profile: 2 (3 points) Material beneath: 2 - Pierre Shale

0.00	4815.00	245.00	4815.00	465.00	4815.00

Slope Surface (7 points)

0.00	4828.00	94.00	4830.00	134.00	4830.00	174.00	4827.00	199.00	4826.00		
365.00	4779.00	465.00	4778.00								

Phreatic Surface (2 points)

0.00	4628.00	500.00	4630.00

Failure Surface

Circular surface defined by: XL,XR,R

Intersects:	XL:	199.00	YL:	4826.00	XR:	369.75	YR: 4778.95
Centre:	XC:	319.77	YC:	4930.95	Radius:	R:	160.00

Distributed Loads (2 loads)

Load	X-Left	Pressure	X-Right	Pressure
1	94.00	100.0	134.00	100.0
2	174.00	100.0	199.00	100.0

RESULTS: Analysis 1 - Section B

Bishop Simplified Method of Analysis - Circular Failure Surface

Factor of Safety: 3.16

Slice Geometry and Properties (39 slices)

Slice	X-Left	X-S Area	Base Angle	Base Width	Base Length	Base Matl	Base Cohesion	Base Phi	Weight	PoreWater Force	Normal Stress	Test Factor
1	199.00	4.49	47.2	3.35	4.94	1	0.00	22.0	471.17	0.00	123.44	1.29
2	202.35	13.46	47.2	3.35	4.94	1	0.00	22.0	1413.51	0.00	370.33	1.29
3	205.71	26.17	43.7	3.92	5.42	1	0.00	22.0	2747.43	0.00	624.24	1.23
4	209.63	29.20	43.7	3.22	4.45	2	600.00	26.0	3150.64	0.00	694.68	1.21
5	212.85	42.32	40.2	3.77	4.94	2	600.00	26.0	4743.25	0.00	969.96	1.16
6	216.62	50.31	40.2	3.77	4.94	2	600.00	26.0	5786.32	0.00	1214.52	1.16
7	220.39	60.64	36.6	3.96	4.94	2	600.00	26.0	7103.25	0.00	1480.95	1.12
8	224.36	67.88	36.6	3.96	4.94	2	600.00	26.0	8061.13	0.00	1697.69	1.12
9	228.32	77.79	33.1	4.14	4.94	2	600.00	26.0	9341.38	0.00	1938.74	1.08
10	232.46	84.10	33.1	4.14	4.94	2	600.00	26.0	10193.45	0.00	2125.85	1.08
11	236.59	26.72	29.6	1.26	1.44	2	600.00	26.0	3256.23	0.00	2283.72	1.06
12	237.85	80.56	29.6	3.67	4.22	2	600.00	26.0	9828.67	0.00	2364.91	1.06
13	241.52	84.38	29.6	3.67	4.22	2	600.00	26.0	10294.44	0.00	2481.68	1.06
14	245.19	106.43	26.0	4.44	4.94	2	600.00	26.0	12984.69	0.00	2634.34	1.03
15	249.62	110.47	26.0	4.44	4.94	2	600.00	26.0	13477.22	0.00	2737.60	1.03
16	254.06	117.02	22.5	4.56	4.94	2	600.00	26.0	14276.58	0.00	2866.73	1.02
17	258.63	119.74	22.5	4.56	4.94	2	600.00	26.0	14608.76	0.00	2935.16	1.02
18	263.19	124.62	18.9	4.67	4.94	2	600.00	26.0	15203.81	0.00	3029.03	1.00
19	267.86	125.93	18.9	4.67	4.94	2	600.00	26.0	15363.52	0.00	3061.57	1.00
20	272.53	128.94	15.4	4.76	4.94	2	600.00	26.0	15730.44	0.00	3118.92	0.99
21	277.29	128.77	15.4	4.76	4.94	2	600.00	26.0	15709.83	0.00	3114.68	0.99
22	282.05	129.77	11.9	4.83	4.94	2	600.00	26.0	15832.00	0.00	3134.20	0.99
23	286.89	128.07	11.9	4.83	4.94	2	600.00	26.0	15624.14	0.00	3092.54	0.99
24	291.72	126.99	8.3	4.89	4.94	2	600.00	26.0	15492.52	0.00	3073.24	0.99
25	296.60	123.73	8.3	4.89	4.94	2	600.00	26.0	15094.62	0.00	2993.61	0.99
26	301.49	120.55	4.8	4.92	4.94	2	600.00	26.0	14706.84	0.00	2934.52	0.99
27	306.41	115.72	4.8	4.92	4.94	2	600.00	26.0	14118.27	0.00	2816.43	0.99
28	311.33	110.50	1.3	4.94	4.94	2	600.00	26.0	13480.50	0.00	2716.96	1.00
29	316.27	104.13	1.3	4.94	4.94	2	600.00	26.0	12703.37	0.00	2560.16	1.00
30	321.21	96.96	-2.3	4.93	4.94	2	600.00	26.0	11828.56	0.00	2419.59	1.01
31	326.14	89.09	-2.3	4.93	4.94	2	600.00	26.0	10868.88	0.00	2223.89	1.01
32	331.08	80.14	-5.8	4.91	4.94	2	600.00	26.0	9776.89	0.00	2041.50	1.02
33	335.99	70.84	-5.8	4.91	4.94	2	600.00	26.0	8643.09	0.00	1807.08	1.02
34	340.90	60.34	-9.4	4.87	4.94	2	600.00	26.0	7361.22	0.00	1582.28	1.04
35	345.78	49.70	-9.4	4.87	4.94	2	600.00	26.0	6063.47	0.00	1309.03	1.04
36	350.65	37.91	-12.9	4.81	4.94	2	600.00	26.0	4625.53	0.00	1041.20	1.06
37	355.46	26.05	-12.9	4.81	4.94	2	600.00	26.0	3178.22	0.00	729.53	1.06
38	360.28	13.29	-16.4	4.72	4.92	2	600.00	26.0	1621.28	0.00	418.36	1.09
39	365.00	3.44	-16.4	4.75	4.95	2	600.00	26.0	419.63	0.00	151.29	1.09
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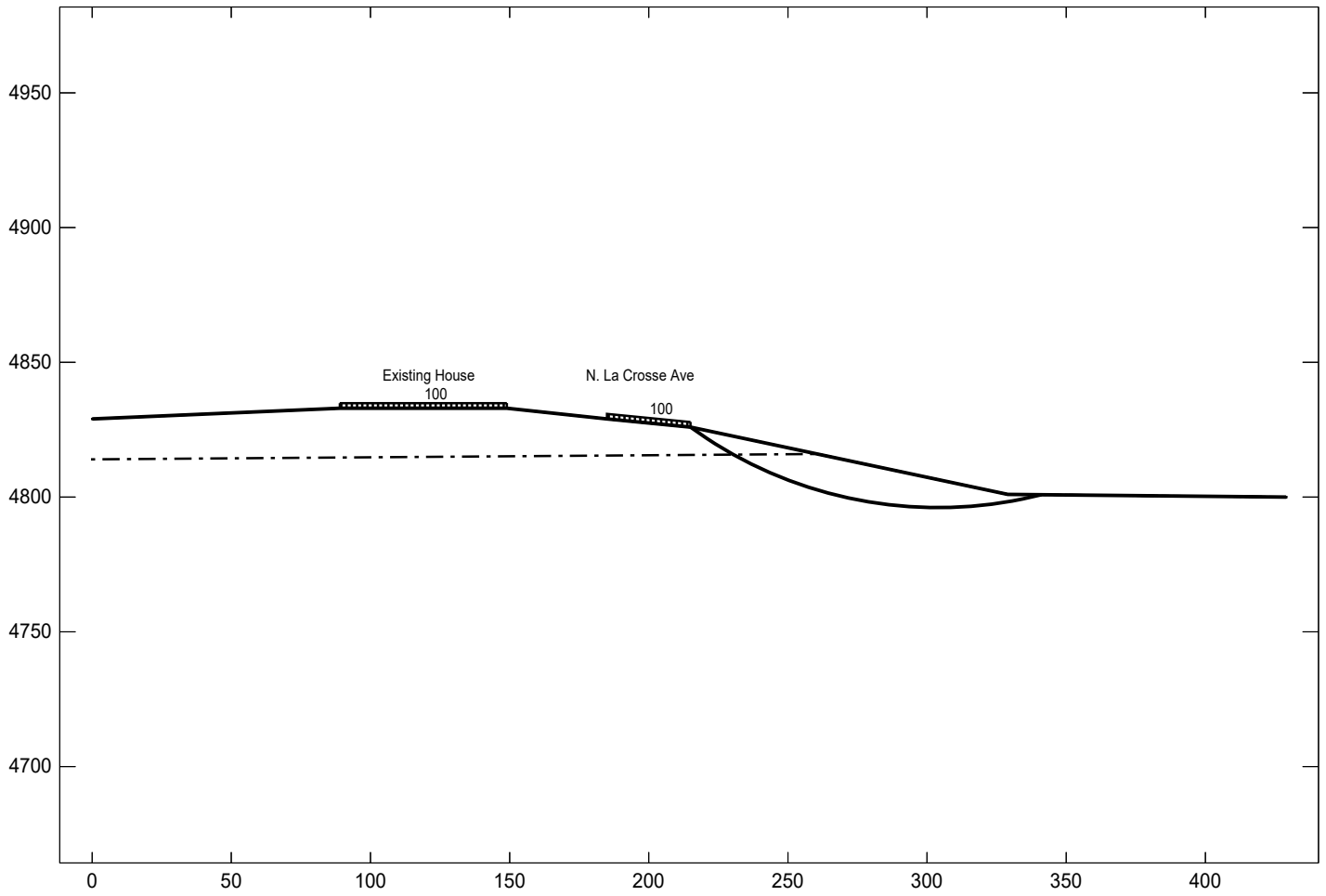

Project Native/Pierre Mine
Section C

File: G:\My Drive\1 - My Projects Google\8 Galena - Stability Analysis Models\NativePierre\Section C.gmf

Analysis 1

Single Stability Analysis

Method: Bishop Simplified

Surface: Circular

Results

Factor of Safety: 5.13

Edited: 5 Jan 2021 *Processed:* 5 Jan 2021

Dept of the Interior - Office of Surface Mining

GALENA 7.2 Analysis Results Version: 7.20.2.01 Licensee: Dept of the Interior - Office of Surface Mining

Project: Native/Pierre Mine
File: G:\My Drive\1 - My Projects Google\8 Galena - Stability Analysis Models\NativePierre\Section C.gmf
Processed: 05 Jan 2021 07:30:08

DATA: Analysis 1 - Section C

Material Properties (2 materials)

Material: 1 (Mohr-Coulomb Isotropic) - Clay

Cohesion	Phi	UnitWeight	Ru
0.00	22.0	105.00	Auto

Material: 2 (Mohr-Coulomb Isotropic) - Pierre Shale

Cohesion	Phi	UnitWeight	Ru
600.00	26.0	122.00	Auto

Water Properties

Unit weight of water: 62.400 Unit weight of water/medium above ground: 62.400

Material Profiles (2 profiles)

Profile: 1 (2 points) Material beneath: 1 - Clay

0.00	4850.00	429.00	4850.00

Profile: 2 (3 points) Material beneath: 2 - Pierre Shale

0.00	4814.00	263.00	4816.00	429.00	4815.00

Slope Surface (7 points)

0.00	4829.00	89.00	4833.00	149.00	4833.00	185.00	4829.00	215.00	4826.00	329.00	4801.00
429.00	4800.00										

Phreatic Surface (2 points)

0.00	4628.00	500.00	4630.00

Failure Surface

Circular surface defined by: XL,XR,R

Intersects:	XL:	215.00	YL:	4826.00	XR:	341.08	YR: 4800.88
Centre:	XC:	303.98	YC:	4943.64	Radius:	R:	147.50

Distributed Loads (2 loads)

Load	X-Left	Pressure	X-Right	Pressure
1	89.00	100.0	149.00	100.0
2	185.00	100.0	215.00	100.0

RESULTS: Analysis 1 - Section C

Bishop Simplified Method of Analysis - Circular Failure Surface

Factor of Safety: 5.13

Slice Geometry and Properties (40 slices)

Slice	X-Left	X-S Area	Base Angle	Base Width	Base Length	Base Matl	Base Cohesion	Base Phi	Weight	PoreWater Force	Normal Stress	Test Factor
1	215.00	2.02	35.7	2.84	3.50	1	0.00	22.0	212.07	0.00	70.64	1.17
2	217.84	6.06	35.7	2.84	3.50	1	0.00	22.0	636.06	0.00	211.89	1.17
3	220.68	10.20	33.0	2.93	3.50	1	0.00	22.0	1070.83	0.00	347.12	1.13
4	223.62	13.91	33.0	2.93	3.50	1	0.00	22.0	1460.52	0.00	473.44	1.13
5	226.55	24.46	30.3	4.01	4.64	1	0.00	22.0	2567.85	0.00	612.62	1.11
6	230.56	14.68	30.3	2.04	2.36	2	600.00	26.0	1562.01	0.00	661.81	1.10
7	232.60	24.97	27.6	3.10	3.50	2	600.00	26.0	2728.80	0.00	779.79	1.07
8	235.70	27.89	27.6	3.10	3.50	2	600.00	26.0	3121.86	0.00	900.46	1.07
9	238.80	31.27	24.9	3.18	3.50	2	600.00	26.0	3566.62	0.00	1023.78	1.06
10	241.98	33.74	24.9	3.18	3.50	2	600.00	26.0	3906.11	0.00	1126.14	1.06
11	245.15	36.68	22.1	3.24	3.50	2	600.00	26.0	4301.20	0.00	1231.49	1.04
12	248.39	38.65	22.1	3.24	3.50	2	600.00	26.0	4582.39	0.00	1314.99	1.04
13	251.64	41.09	19.4	3.30	3.50	2	600.00	26.0	4918.54	0.00	1401.81	1.03
14	254.94	42.54	19.4	3.30	3.50	2	600.00	26.0	5138.11	0.00	1466.13	1.03
15	258.24	32.27	16.7	2.44	2.55	2	600.00	26.0	3925.56	0.00	1527.85	1.02
16	260.68	28.53	16.7	2.13	2.22	2	600.00	26.0	3481.10	0.00	1554.37	1.02
17	262.81	28.90	16.7	2.13	2.22	2	600.00	26.0	3525.77	0.00	1574.69	1.02
18	264.94	46.53	14.0	3.40	3.50	2	600.00	26.0	5677.07	0.00	1604.35	1.01
19	268.34	46.88	14.0	3.40	3.50	2	600.00	26.0	5718.90	0.00	1616.39	1.01
20	271.73	47.43	11.3	3.43	3.50	2	600.00	26.0	5786.84	0.00	1631.56	1.00
21	275.17	47.20	11.3	3.43	3.50	2	600.00	26.0	5758.22	0.00	1623.42	1.00
22	278.60	47.06	8.6	3.46	3.50	2	600.00	26.0	5741.02	0.00	1617.90	1.00
23	282.06	46.23	8.5	3.46	3.50	2	600.00	26.0	5640.15	0.00	1589.22	1.00
24	285.52	45.38	5.8	3.48	3.50	2	600.00	26.0	5536.74	0.00	1562.94	1.00
25	289.00	43.96	5.8	3.48	3.50	2	600.00	26.0	5363.28	0.00	1513.62	1.00
26	292.49	42.40	3.1	3.50	3.50	2	600.00	26.0	5173.35	0.00	1466.27	1.00
27	295.98	40.39	3.1	3.50	3.50	2	600.00	26.0	4927.30	0.00	1396.22	1.00
28	299.48	38.14	0.4	3.50	3.50	2	600.00	26.0	4652.75	0.00	1327.65	1.00
29	302.98	35.53	0.4	3.50	3.50	2	600.00	26.0	4334.99	0.00	1236.92	1.00
30	306.48	32.61	-2.3	3.50	3.50	2	600.00	26.0	3979.01	0.00	1146.91	1.00
31	309.97	29.44	-2.3	3.50	3.50	2	600.00	26.0	3591.09	0.00	1035.59	1.00
32	313.47	25.89	-5.0	3.49	3.50	2	600.00	26.0	3158.52	0.00	923.98	1.01
33	316.96	22.15	-5.0	3.49	3.50	2	600.00	26.0	2702.41	0.00	792.06	1.01
34	320.45	18.03	-7.8	3.47	3.50	2	600.00	26.0	2200.03	0.00	658.87	1.02
35	323.91	13.76	-7.8	3.47	3.50	2	600.00	26.0	1678.17	0.00	506.41	1.02
36	327.38	4.89	-10.5	1.62	1.65	2	600.00	26.0	596.65	0.00	397.23	1.04
37	329.00	6.42	-10.5	2.63	2.68	2	600.00	26.0	782.98	0.00	324.80	1.04
38	331.63	5.07	-10.5	2.63	2.68	2	600.00	26.0	618.00	0.00	261.01	1.04
39	334.26	4.26	-13.2	3.41	3.50	2	600.00	26.0	519.86	0.00	184.12	1.05
40	337.67	1.42	-13.2	3.41	3.50	2	600.00	26.0	173.15	0.00	80.05	1.05
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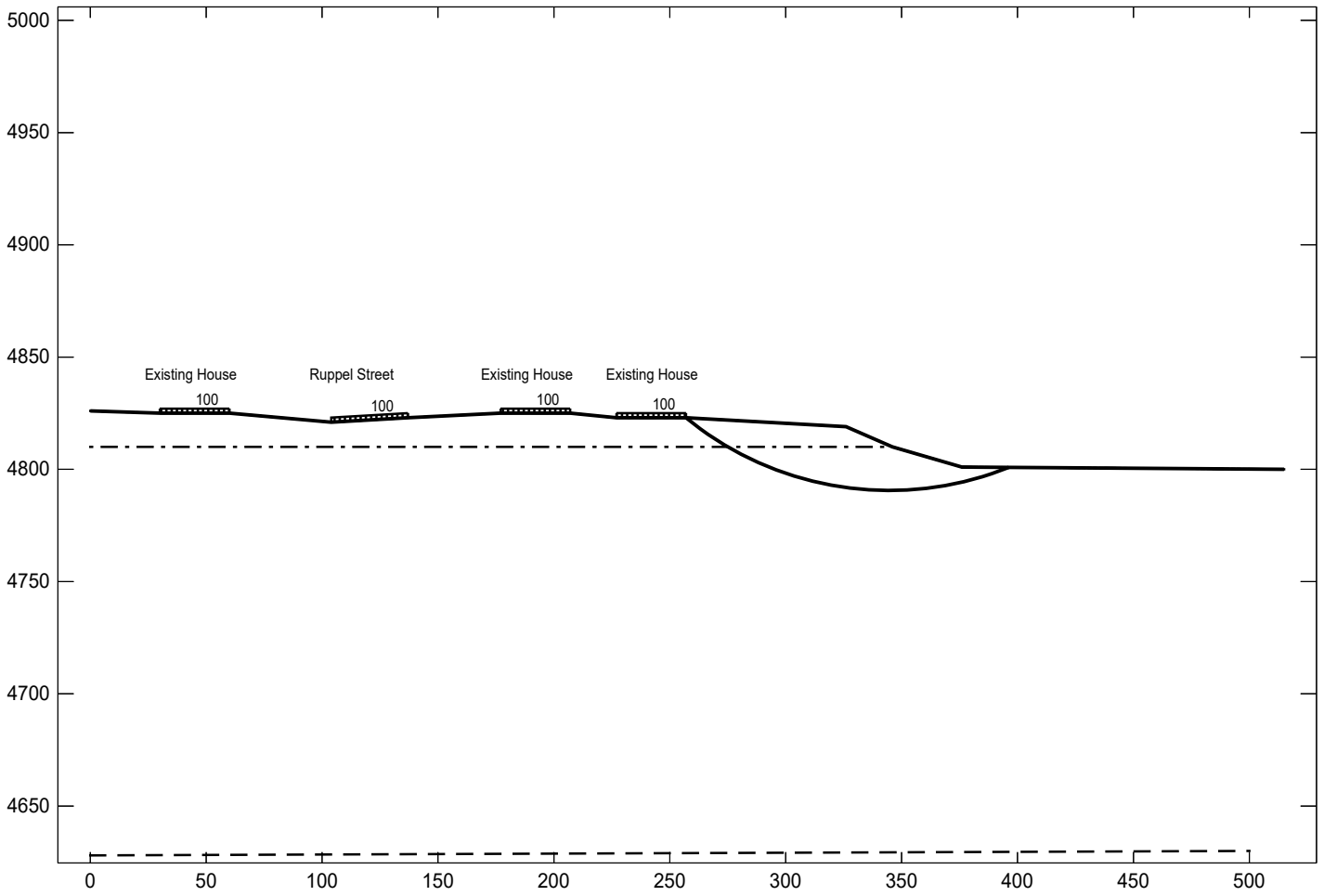


GALENA Version 7.2

Project Native/Pierre Mine
Section D

File: G:\My Drive\1 - My Projects Google\8 Galena - Stability Analysis Models\NativePierre\Section D.gmf

Analysis 1

Single Stability Analysis

Method: Bishop Simplified

Surface: Circular

Results

Factor of Safety: 4.92

Edited: 5 Jan 2021 *Processed:* 5 Jan 2021

Dept of the Interior - Office of Surface Mining

Project: Native/Pierre Mine
File: G:\My Drive\1 - My Projects Google\8 Galena - Stability Analysis Models\NativePierre\Section D.gmf
Processed: 05 Jan 2021 08:24:02

DATA: Analysis 1 - Section D

Material Properties (2 materials)

Material: 1 (Mohr-Coulomb Isotropic) - Clay

Cohesion	Phi	UnitWeight	Ru
0.00	22.0	105.00	Auto

Material: 2 (Mohr-Coulomb Isotropic) - Pierre Shale

Cohesion	Phi	UnitWeight	Ru
600.00	26.0	122.00	Auto

Water Properties

Unit weight of water: 62.400 Unit weight of water/medium above ground: 62.400

Material Profiles (2 profiles)

Profile: 1 (2 points) Material beneath: 1 - Clay

0.00	4840.00	515.00	4840.00

Profile: 2 (3 points) Material beneath: 2 - Pierre Shale

0.00	4810.00	346.00	4810.00	515.00	4810.00

Slope Surface (13 points)

0.00	4826.00	30.00	4825.00	60.00	4825.00	104.00	4821.00	137.00	4823.00
177.00	4825.00	207.00	4825.00	227.00	4823.00	257.00	4823.00	326.00	4819.00
346.00	4810.00	376.00	4801.00	515.00	4800.00				

Phreatic Surface (2 points)

0.00	4628.00	500.00	4630.00

Failure Surface

Circular surface defined by: XL,XR,R

Intersects: XL: 257.00 YL: 4823.00 XR: 396.27 YR: 4800.85

Centre: XC: 344.71 YC: 4925.62 Radius: R: 135.00

Distributed Loads (4 loads)

Load	X-Left	Pressure	X-Right	Pressure
1	30.00	100.0	60.00	100.0
2	104.00	100.0	137.00	100.0
3	177.00	100.0	207.00	100.0
4	227.00	100.0	257.00	100.0

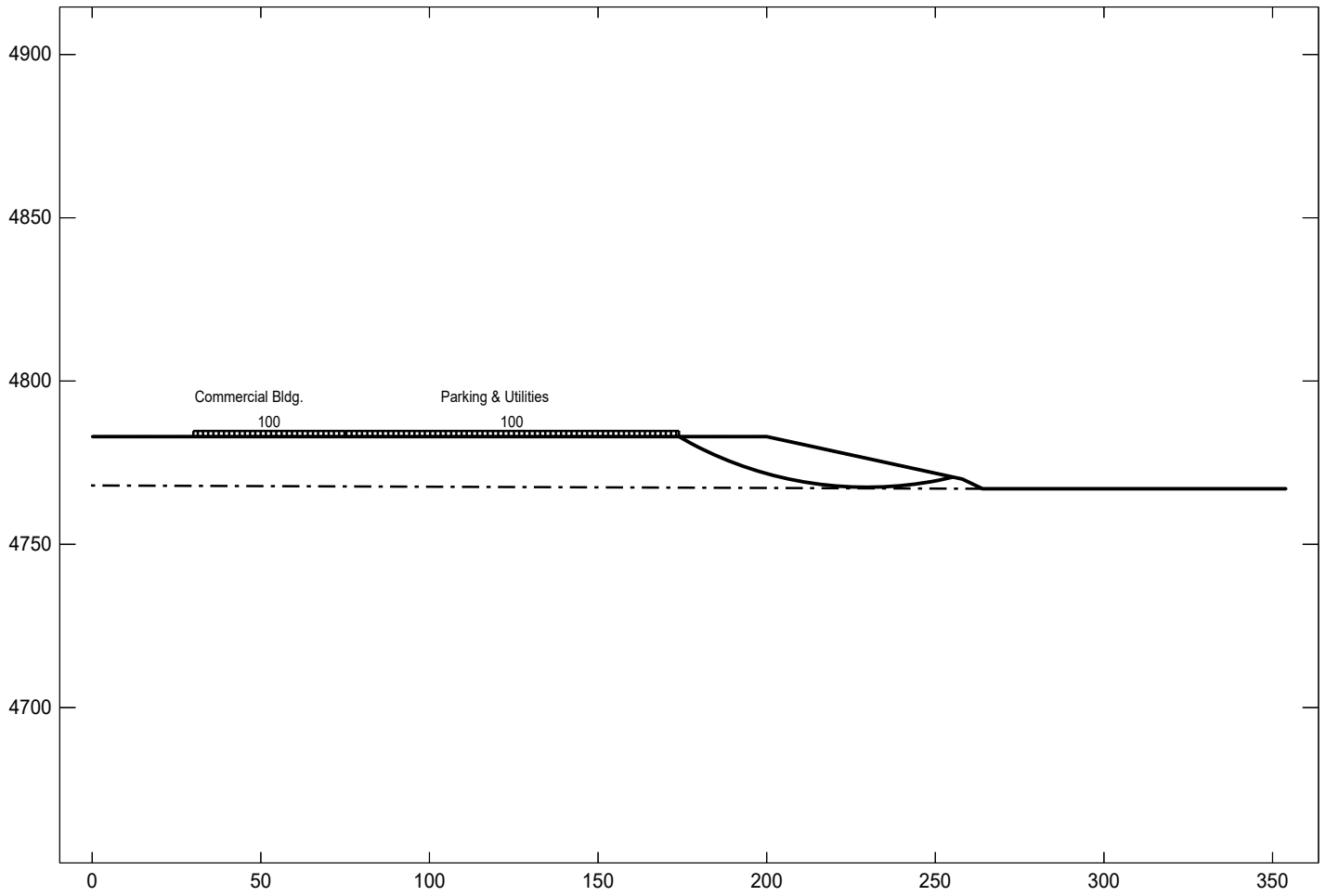
RESULTS: Analysis 1 - Section D

Bishop Simplified Method of Analysis - Circular Failure Surface

Factor of Safety: 4.92

Slice Geometry and Properties (42 slices)

Slice	X-Left	X-S Area	Base Angle	Base Width	Base Length	Base Matl	Base Cohesion	Base Phi	Weight	PoreWater Force	Normal Stress	Test Factor
1	257.00	3.46	38.9	3.04	3.90	1	0.00	22.0	362.82	0.00	111.95	1.20
2	260.04	10.37	38.9	3.04	3.90	1	0.00	22.0	1088.46	0.00	335.84	1.20
3	263.08	17.76	35.6	3.18	3.90	1	0.00	22.0	1864.51	0.00	554.45	1.16
4	266.26	24.38	35.6	3.18	3.90	1	0.00	22.0	2560.20	0.00	761.33	1.16
5	269.43	26.89	32.2	2.82	3.34	1	0.00	22.0	2823.96	0.00	951.07	1.12
6	272.26	31.46	32.2	2.82	3.34	1	0.00	22.0	3303.15	0.00	1112.47	1.12
7	275.08	11.72	32.2	0.96	1.13	2	600.00	26.0	1235.51	0.00	1140.72	1.11
8	276.04	45.60	28.9	3.42	3.90	2	600.00	26.0	4878.39	0.00	1289.64	1.08
9	279.45	51.38	28.9	3.42	3.90	2	600.00	26.0	5594.48	0.00	1488.27	1.08
10	282.87	58.52	25.6	3.52	3.90	2	600.00	26.0	6457.28	0.00	1695.18	1.06
11	286.39	63.74	25.6	3.52	3.90	2	600.00	26.0	7106.50	0.00	1871.16	1.06
12	289.91	70.38	22.3	3.61	3.90	2	600.00	26.0	7911.14	0.00	2056.50	1.04
13	293.52	74.97	22.3	3.61	3.90	2	600.00	26.0	8484.41	0.00	2208.99	1.04
14	297.14	80.92	19.0	3.69	3.90	2	600.00	26.0	9208.93	0.00	2371.55	1.02
15	300.83	84.82	19.0	3.69	3.90	2	600.00	26.0	9697.78	0.00	2499.66	1.02
16	304.52	89.92	15.7	3.76	3.90	2	600.00	26.0	10322.01	0.00	2638.32	1.01
17	308.28	93.06	15.7	3.76	3.90	2	600.00	26.0	10719.44	0.00	2741.25	1.01
18	312.04	97.18	12.4	3.81	3.90	2	600.00	26.0	11226.78	0.00	2855.03	1.00
19	315.85	99.52	12.3	3.81	3.90	2	600.00	26.0	11526.83	0.00	2932.11	1.00
20	319.67	84.11	9.0	3.17	3.21	2	600.00	26.0	9762.25	0.00	3015.97	1.00
21	322.83	85.12	9.0	3.17	3.21	2	600.00	26.0	9895.78	0.00	3057.46	1.00
22	326.00	36.99	9.0	1.38	1.40	2	600.00	26.0	4309.14	0.00	3059.27	1.00
23	327.38	100.85	5.7	3.88	3.90	2	600.00	26.0	11807.80	0.00	2997.65	1.00
24	331.26	95.57	5.7	3.88	3.90	2	600.00	26.0	11279.32	0.00	2862.92	1.00
25	335.15	90.21	2.4	3.90	3.90	2	600.00	26.0	10739.96	0.00	2736.90	1.00
26	339.05	84.00	2.4	3.90	3.90	2	600.00	26.0	10099.14	0.00	2573.22	1.00
27	342.95	61.12	-0.9	3.05	3.05	2	600.00	26.0	7420.61	0.00	2437.66	1.00
28	346.00	45.05	-0.9	2.38	2.38	2	600.00	26.0	5495.61	0.00	2316.65	1.00
29	348.38	43.26	-0.9	2.38	2.38	2	600.00	26.0	5277.60	0.00	2224.83	1.00
30	350.76	66.54	-4.2	3.89	3.90	2	600.00	26.0	8117.32	0.00	2109.25	1.01
31	354.65	60.87	-4.2	3.89	3.90	2	600.00	26.0	7425.92	0.00	1930.40	1.01
32	358.54	54.45	-7.5	3.87	3.90	2	600.00	26.0	6643.32	0.00	1755.63	1.02
33	362.41	47.98	-7.5	3.87	3.90	2	600.00	26.0	5853.24	0.00	1548.77	1.02
34	366.28	40.71	-10.8	3.83	3.90	2	600.00	26.0	4966.05	0.00	1344.08	1.04
35	370.12	33.48	-10.8	3.83	3.90	2	600.00	26.0	4084.39	0.00	1109.69	1.04
36	373.95	14.79	-14.2	2.05	2.11	2	600.00	26.0	1804.64	0.00	935.37	1.06
37	376.00	17.40	-14.2	2.76	2.85	2	600.00	26.0	2122.22	0.00	819.83	1.06
38	378.76	15.42	-14.2	2.76	2.85	2	600.00	26.0	1880.73	0.00	730.10	1.06
39	381.52	17.22	-17.5	3.72	3.90	2	600.00	26.0	2100.72	0.00	621.96	1.08
40	385.25	12.75	-17.5	3.72	3.90	2	600.00	26.0	1555.70	0.00	470.87	1.08
41	388.97	7.73	-20.8	3.65	3.90	2	600.00	26.0	943.36	0.00	316.72	1.11
42	392.62	2.58	-20.8	3.65	3.90	2	600.00	26.0	314.38	0.00	137.62	1.11
X-S Area:		2154.21	Path Length:		148.36			X-S Weight:	250271.77			



GALENA Version 7.2

Project Native/Pierre Mine
Section E

File: G:\My Drive\1 - My Projects Google\8 Galena - Stability Analysis Models\NativePierre\Section E.gmf

Analysis 1

Single Stability Analysis

Method: Bishop Simplified

Surface: Circular

Results

Factor of Safety: 2.62

Edited: 5 Jan 2021 *Processed:* 5 Jan 2021

Dept of the Interior - Office of Surface Mining

GALENA 7.2 Analysis Results Version: 7.20.2.01 Licensee: Dept of the Interior - Office of Surface Mining

Project: Native/Pierre Mine
File: G:\My Drive\1 - My Projects Google\8 Galena - Stability Analysis Models\NativePierre\Section E.gmf
Processed: 05 Jan 2021 08:26:54

DATA: Analysis 1 - Section E

Material Properties (2 materials)

Material: 1 (Mohr-Coulomb Isotropic) - Clay

Cohesion	Phi	UnitWeight	Ru
0.00	22.0	105.00	Auto

Material: 2 (Mohr-Coulomb Isotropic) - Pierre Shale

Cohesion	Phi	UnitWeight	Ru
600.00	26.0	122.00	Auto

Water Properties

Unit weight of water: 62.400 Unit weight of water/medium above ground: 62.400

Material Profiles (2 profiles)

Profile: 1 (2 points) Material beneath: 1 - Clay

0.00	4800.00	354.00	4800.00

Profile: 2 (3 points) Material beneath: 2 - Pierre Shale

0.00	4768.00	264.00	4767.00	354.00	4767.00

Slope Surface (5 points)

0.00	4783.00	200.00	4783.00	258.00	4770.00	264.00	4767.00	354.00	4767.00

Phreatic Surface (2 points)

0.00	4628.00	500.00	4630.00

Failure Surface

Circular surface defined by: XL,XR,R

Intersects: XL: 174.00 YL: 4783.00 XR: 255.29 YR: 4770.61

Centre: XC: 229.61 YC: 4875.00 Radius: R: 107.50

Distributed Loads (2 loads)

Load	X-Left	Pressure	X-Right	Pressure
1	30.00	100.0	75.00	100.0
2	75.00	100.0	174.00	100.0

RESULTS: Analysis 1 - Section E

Bishop Simplified Method of Analysis - Circular Failure Surface

Factor of Safety: 2.62

Slice Geometry and Properties (38 slices)

Slice		X-S	Base						PoreWater	Normal	Test
	X-Left	Area	Angle	Width	Length	Matl	Cohesion	Phi	Weight	Force	Stress	Factor
1	174.00	1.07	30.0	1.92	2.22	1	0.00	22.0	112.02	0.00	53.49	1.06
2	175.92	3.20	30.0	1.92	2.22	1	0.00	22.0	335.97	0.00	160.43	1.06
3	177.85	5.38	27.6	1.97	2.22	1	0.00	22.0	564.62	0.00	265.56	1.04
4	179.81	7.40	27.6	1.97	2.22	1	0.00	22.0	777.06	0.00	365.49	1.04
5	181.78	9.54	25.2	2.01	2.22	1	0.00	22.0	1001.49	0.00	464.88	1.03
6	183.79	11.44	25.2	2.01	2.22	1	0.00	22.0	1201.24	0.00	557.61	1.03
7	185.80	13.50	22.9	2.05	2.22	1	0.00	22.0	1417.87	0.00	650.77	1.02
8	187.84	15.27	22.9	2.05	2.22	1	0.00	22.0	1603.31	0.00	735.89	1.02
9	189.89	17.23	20.5	2.08	2.22	1	0.00	22.0	1808.99	0.00	822.44	1.01
10	191.97	18.85	20.5	2.08	2.22	1	0.00	22.0	1978.73	0.00	899.62	1.01
11	194.05	20.67	18.1	2.11	2.22	1	0.00	22.0	2170.44	0.00	979.22	1.00
12	196.16	22.13	18.1	2.11	2.22	1	0.00	22.0	2323.51	0.00	1048.25	1.00
13	198.27	19.16	15.8	1.73	1.80	1	0.00	22.0	2012.25	0.00	1114.63	1.00
14	200.00	28.98	15.8	2.54	2.64	1	0.00	22.0	3043.30	0.00	1146.64	1.00
15	202.54	24.81	13.4	2.16	2.22	1	0.00	22.0	2604.64	0.00	1163.21	0.99
16	204.70	24.87	13.4	2.16	2.22	1	0.00	22.0	2611.49	0.00	1166.27	0.99
17	206.86	25.06	11.0	2.18	2.22	1	0.00	22.0	2631.12	0.00	1172.14	0.99
18	209.04	24.92	11.0	2.18	2.22	1	0.00	22.0	2616.73	0.00	1165.68	0.99
19	211.22	24.86	8.7	2.19	2.22	1	0.00	22.0	2610.05	0.00	1161.82	0.99
20	213.42	24.51	8.7	2.19	2.22	1	0.00	22.0	2573.80	0.00	1145.69	0.99
21	215.61	24.19	6.3	2.21	2.22	1	0.00	22.0	2540.38	0.00	1131.85	0.99
22	217.82	23.64	6.3	2.21	2.22	1	0.00	22.0	2482.24	0.00	1105.94	0.99
23	220.03	23.07	3.9	2.22	2.22	1	0.00	22.0	2422.28	0.00	1082.06	0.99
24	222.24	22.31	3.9	2.22	2.22	1	0.00	22.0	2342.23	0.00	1046.30	0.99
25	224.46	21.49	1.6	2.22	2.22	1	0.00	22.0	2255.94	0.00	1012.16	1.00
26	226.68	20.52	1.6	2.22	2.22	1	0.00	22.0	2154.21	0.00	966.49	1.00
27	228.89	19.45	-0.8	2.22	2.22	1	0.00	22.0	2042.24	0.00	921.85	1.00
28	231.11	18.28	-0.8	2.22	2.22	1	0.00	22.0	1919.10	0.00	866.28	1.00
29	233.34	16.98	-3.2	2.22	2.22	1	0.00	22.0	1782.55	0.00	810.97	1.01
30	235.55	15.60	-3.2	2.22	2.22	1	0.00	22.0	1638.41	0.00	745.40	1.01
31	237.77	14.09	-5.5	2.21	2.22	1	0.00	22.0	1479.20	0.00	679.45	1.02
32	239.98	12.52	-5.5	2.21	2.22	1	0.00	22.0	1314.46	0.00	603.80	1.02
33	242.19	10.80	-7.9	2.20	2.22	1	0.00	22.0	1133.97	0.00	526.88	1.03
34	244.39	9.05	-7.9	2.20	2.22	1	0.00	22.0	949.73	0.00	441.29	1.03
35	246.59	7.15	-10.3	2.18	2.22	1	0.00	22.0	750.27	0.00	353.27	1.05
36	248.77	5.21	-10.3	2.18	2.22	1	0.00	22.0	547.07	0.00	257.58	1.05
37	250.96	3.16	-12.6	2.17	2.22	1	0.00	22.0	331.45	0.00	158.46	1.06
38	253.12	1.05	-12.6	2.17	2.22	1	0.00	22.0	110.41	0.00	52.79	1.06
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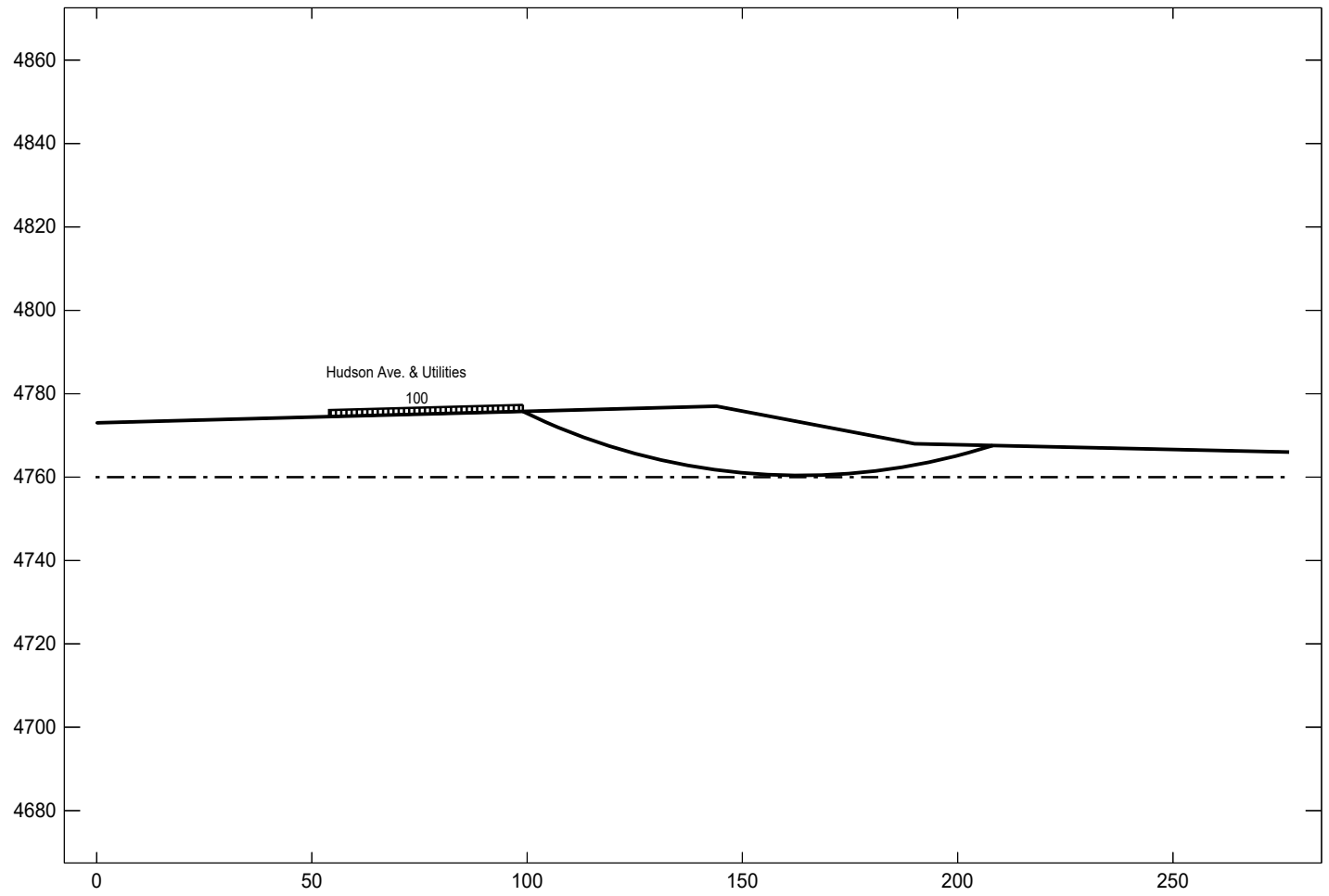
X-S Area: 611.38 Path Length: 84.37 X-S Weight: 64194.78



GALENA Version 7.2

Project Native/Pierre Mine
Section F

File: G:\My Drive\1 - My Projects Google\8 Galena - Stability Analysis Models\NativePierre\Section F.gmf

Analysis 1
Single Stability Analysis
Method: Bishop Simplified
Surface: Circular

Results
Factor of Safety: 4.51

Edited: 5 Jan 2021 *Processed:* 5 Jan 2021

Dept of the Interior - Office of Surface Mining

GALENA 7.2 Analysis Results Version: 7.20.2.01 Licensee: Dept of the Interior - Office of Surface Mining

Project: Native/Pierre Mine
File: G:\My Drive\1 - My Projects Google\8 Galena - Stability Analysis Models\NativePierre\Section F.gmf
Processed: 05 Jan 2021 08:29:24

DATA: Analysis 1 - Section F

Material Properties (2 materials)

Material: 1 (Mohr-Coulomb Isotropic) - Clay

Cohesion	Phi	UnitWeight	Ru
0.00	22.0	105.00	Auto

Material: 2 (Mohr-Coulomb Isotropic) - Pierre Shale

Cohesion	Phi	UnitWeight	Ru
600.00	26.0	122.00	Auto

Water Properties

Unit weight of water: 62.400 Unit weight of water/medium above ground: 62.400

Material Profiles (2 profiles)

Profile: 1 (2 points) Material beneath: 1 - Clay

0.00	4780.00	277.00	4780.00

Profile: 2 (2 points) Material beneath: 2 - Pierre Shale

0.00	4760.00	277.00	4760.00

Slope Surface (4 points)

0.00	4773.00	144.00	4777.00	190.00	4768.00	277.00	4766.00

Phreatic Surface (2 points)

0.00	4628.00	500.00	4630.00

Failure Surface

Circular surface defined by: XL,XR,R

Intersects:	XL:	99.00	YL:	4775.75	XR:	208.17	YR: 4767.58
Centre:	XC:	163.44	YC:	4903.41		Radius: R:	143.00

Distributed Loads (1 load)

Load	X-Left	Pressure	X-Right	Pressure
1	54.00	100.0	99.00	100.0

RESULTS: Analysis 1 - Section F

Bishop Simplified Method of Analysis - Circular Failure Surface

Factor of Safety: 4.51

Slice Geometry and Properties (39 slices)

Slice		X-S	Base						PoreWater	Normal	Test
	X-Left	Area	Angle	Width	Length	Matl	Cohesion	Phi	Weight	Force	Stress	Factor
1	99.00	1.80	25.6	2.67	2.96	1	0.00	22.0	189.17	0.00	68.04	1.06
2	101.67	5.40	25.6	2.67	2.96	1	0.00	22.0	567.37	0.00	204.06	1.06
3	104.33	9.03	23.2	2.72	2.96	1	0.00	22.0	948.03	0.00	336.06	1.05
4	107.05	12.40	23.2	2.72	2.96	1	0.00	22.0	1302.07	0.00	461.56	1.05
5	109.76	15.88	20.9	2.76	2.96	1	0.00	22.0	1667.90	0.00	583.86	1.03
6	112.53	19.00	20.9	2.76	2.96	1	0.00	22.0	1995.48	0.00	698.53	1.03
7	115.29	22.29	18.5	2.80	2.96	1	0.00	22.0	2340.87	0.00	810.68	1.02
8	118.09	25.14	18.5	2.80	2.96	1	0.00	22.0	2639.85	0.00	914.22	1.02
9	120.90	28.19	16.1	2.84	2.96	1	0.00	22.0	2959.57	0.00	1015.83	1.01
10	123.74	30.74	16.1	2.84	2.96	1	0.00	22.0	3227.90	0.00	1107.95	1.01
11	126.58	33.50	13.8	2.87	2.96	1	0.00	22.0	3517.40	0.00	1198.70	1.01
12	129.45	35.75	13.8	2.87	2.96	1	0.00	22.0	3753.40	0.00	1279.10	1.01
13	132.32	38.17	11.4	2.90	2.96	1	0.00	22.0	4008.17	0.00	1358.58	1.00
14	135.22	40.10	11.4	2.90	2.96	1	0.00	22.0	4210.38	0.00	1427.12	1.00
15	138.12	42.16	9.0	2.92	2.96	1	0.00	22.0	4427.05	0.00	1495.03	1.00
16	141.03	43.75	9.0	2.92	2.96	1	0.00	22.0	4593.78	0.00	1551.35	1.00
17	143.95	44.49	6.6	2.94	2.96	1	0.00	22.0	4671.28	0.00	1574.45	1.00
18	146.89	43.81	6.6	2.94	2.96	1	0.00	22.0	4599.78	0.00	1550.34	1.00
19	149.83	43.11	4.3	2.95	2.96	1	0.00	22.0	4527.05	0.00	1525.46	1.00
20	152.77	42.06	4.3	2.95	2.96	1	0.00	22.0	4416.59	0.00	1488.21	1.00
21	155.72	40.92	1.9	2.95	2.96	1	0.00	22.0	4296.91	0.00	1450.02	1.00
22	158.68	39.51	1.9	2.95	2.96	1	0.00	22.0	4148.16	0.00	1399.83	1.00
23	161.63	37.93	-0.5	2.96	2.96	1	0.00	22.0	3982.60	0.00	1348.24	1.00
24	164.59	36.15	-0.5	2.96	2.96	1	0.00	22.0	3795.42	0.00	1284.87	1.00
25	167.54	34.15	-2.8	2.95	2.96	1	0.00	22.0	3585.63	0.00	1219.83	1.01
26	170.50	32.01	-2.8	2.95	2.96	1	0.00	22.0	3361.13	0.00	1143.44	1.01
27	173.45	29.61	-5.2	2.94	2.96	1	0.00	22.0	3109.33	0.00	1064.83	1.01
28	176.39	27.13	-5.2	2.94	2.96	1	0.00	22.0	2848.36	0.00	975.47	1.01
29	179.34	24.36	-7.6	2.93	2.96	1	0.00	22.0	2557.53	0.00	883.27	1.02
30	182.27	21.54	-7.6	2.93	2.96	1	0.00	22.0	2261.26	0.00	780.95	1.02
31	185.20	15.42	-9.9	2.40	2.44	1	0.00	22.0	1619.18	0.00	685.11	1.03
32	187.60	13.28	-9.9	2.40	2.44	1	0.00	22.0	1394.65	0.00	590.09	1.03
33	190.00	5.09	-10.0	1.02	1.04	1	0.00	22.0	534.68	0.00	531.82	1.03
34	191.02	13.10	-12.3	2.89	2.96	1	0.00	22.0	1375.65	0.00	485.79	1.04
35	193.91	11.09	-12.3	2.89	2.96	1	0.00	22.0	1164.49	0.00	411.22	1.04
36	196.80	8.82	-14.7	2.86	2.96	1	0.00	22.0	926.19	0.00	331.65	1.06
37	199.66	6.49	-14.7	2.86	2.96	1	0.00	22.0	681.63	0.00	244.08	1.06
38	202.52	3.95	-17.0	2.83	2.96	1	0.00	22.0	414.57	0.00	150.82	1.08
39	205.34	1.32	-17.0	2.83	2.96	1	0.00	22.0	138.09	0.00	50.24	1.08
		978.65			112.33				102758.55			

X-S Area: 978.65 Path Length: 112.33 X-S Weight: 102758.55