APPENDIX C: CALCULATION PACKAGES - SUMMARIES AND RESULTS

Appendix C

Calculation Packages - Summaries and Results

CONTENTS

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Calculation No. 1

CALCULATION SUMMARY

Project: Reds Meadow Road Improvement Job No: 100062-002

Project Feature and Subject: Cross Sections and Material Properties Development

Calculation Purpose *(describe purpose/goal of calculation)*

To develop cross sections and determine soil properties for use in analysis of reinforced soil slope (RSS) and mechanically stabilized earth (MSE) walls.

General Approach/Assumptions *(please describe in general – can refer to calculation sheets for more information)*

Provided Plans:

- We were provided plan sheets (C-Sheets, dated 11/19/2018) and associated cross sections (dated 11/19/18, with updates provided on 11/26/18 and 11/27/18).

Subsurface Data:

- Hollow-stem exploratory borings were performed in May/June (labeled SW-B-3 through SW-B-21) and in October/November (labeled SW-B-44 through SW-B-51).
- Exploratory test pits (labeled TP-1 through TP-8) were performed in May.
- Geophysical exploration, consisting of seismic refraction lines (labeled S-1 through S-15), were performed in October.
- In general, the site consists of artificial fill (af), underlain by Quaternary Talus and Slopewash (Qts), further underlain by undifferentiated sedimentary rock (JTrc) and undifferentiated volcanic rocks (JTru), which will be referred to as bedrock.
- Results of the subsurface explorations are presented within the geotechnical report.

Development of Cross Sections:

- 19 cross sections were created to represent areas of proposed MSE walls and RSS zones.
- These cross sections were created using a combination of surficial geometry presented in the provided cross sections and soil units estimated using associated subsurface data.
- Table 1, presented on page 3, presents a summary of the cross section locations and the applicable exploration data used. The exploration data itself is not presented within this calc package; refer to the geotechnical report the exploration data.
- The cross sections used to determine the surficial geometry are provided on pages 27-46.

Development of Soil Parameters:

- Drained (effective stress) soil parameters were estimated using correlations from SPT blowcounts and typical values associated with soil type.
  - Effective friction angle, ϕ', was determined using the internal S&W spreadsheet "Deep Foundation Parameters vs. SPT Values" and based on the general soil type.
  - Unit weight, γ, was estimated based on the general soil type.
  - For all soil units, cohesion was assumed to be zero.
- Structural Fill:
  - Structural fill is assumed to consist of a unit weight of 125 pounds-per-cubic foot (pcf) and a friction angle of 34°.
- Artificial fill, af:
  - Artificial fill is assumed to consist of a unit weight of 120 pcf and a friction angle of 30°

CALCULATION SUMMARY

- Quaternary Talus and Slopewash, Qts:
  - Qts material is broken up into two main categories: non-pumice rich material and pumice rich material. Table 2 on page 4 presents a summary of the SPT blowcount material for both these categories.
  - In general, non-pumice rich Qts material had blowcounts between 10 and 40. Pumice-rich material had blowcounts between 2 and 10.
  - These values were used within the S&W "Parameters vs SPT Values" sheet to determine friction angle values; see page 5.
  - In general, I recommend non-pumice rich material to have a unit weight of 120 pcf and a friction angle of 32°; I recommend pumice-rich material to consist of a unit weight of 90 pcf and a friction angle of 30°.
    - For cross sections K and M, non-pumice rich Qts material was encountered, however the blowcounts within the borings for these area were lower than typical values. Therefore, I recommend using Qts material with a unit weight of 120 pcf and a friction angle of 30° for these two cross sections.
- Bedrock was assumed to consist of impenetrable material.

Sources of Data and Equations *(please describe in general – can refer to calculation sheets for more information – if other calculations are referenced, please include)*

Shannon & Wilson, Inc., Internal Spreadsheet, Deep Foundation Parameters vs. SPT Values

Proposed Plan Sheets, C-Sheets (C01 to C12), dated 11/19/2018

Proposed Cross Sections (X01 to X68), dated 11/19/2018.

Updated Cross Sections, provided on 11/26/2018 (cross sections every 50 feet from station 14+00 to 21+00) and 11/27/2018 (cross sections every 50 feet from station 130+00 to 133+00).

Summary and Conclusions *(please describe general conclusions – do not only refer to calculation sheets, but include conclusion here)*

Recommended cross section models are presented on pages 7-26.

Recommended soil parameters per cross section are presented on Table 3, on page 6.

PM Check of Assumptions and Input Properties

Rev No.	Calculation By	Date	Checked By	Date	No. of Pages*
0	Brian Trott	12/14/18	Steve Diem	12/19/18	180
1	Brian Trott	1/11/19	Steve Diem	1/18/19	47
PM Review of Assumptions and Input Properties			by: _____ on _____		
NOTES:					

* Number of pages is the total number of pages including the cover sheet.

Table 3. Recommended Soil Parameters for RSS and MSE Sections

Section Letter	Soil Parameters			
	Soil Unit	Unit Weight, γ (pcf)	Friction Angle, φ' (deg)	Cohesion, C' (psf)
A	af	120	30	0
	Qts	120	32	0
B	af	120	30	0
	Qts	120	32	0
C	af	120	30	0
	Qts	90	30	0
D	af	120	30	0
	Qts	120	32	0
E	af	120	30	0
	Qts	120	32	0
F	af	120	30	0
	Qts	120	32	0
G	af	120	30	0
	Qts	90	30	0
H	af	120	30	0
	Qts	90	30	0
I	af	120	30	0
	Qts	90	30	0
J	af	120	30	0
	Qts	90	30	0
K	af	120	30	0
	Qts	120	30[1]	0
L	af	120	30	0
	Qts	90	30	0
M	af	120	30	0
	Qts	120	30[1]	0
N	af	120	30	0
	Qts	90	30	0
O	af	120	30	0
	Qts (1)	90	30	0
	Qts (2)	120	32	0
P	af	120	30	0
	Qts	120	32	0
Q	af	120	30	0
	Qts	90	30	0
R	af	120	30	0
	Qts	90	30	0
S	af	120	30	0
	Qts	90	30	0

[1]The Qts encountered within Sections K and M did not consist of pumice gravel, however consisted of lower blowcounts than typical Qts encountered within other areas. Thus a phi angle of 30° was chosed instead of 32°.

SHANNON & WILSON, INC.
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Calculation No. 5

CALCULATION SUMMARY

Project: Reds Meadow Road Improvement Job No: 100062-002

Project Feature and Subject: Fill Slope Global Stability

Calculation Purpose *(describe purpose/goal of calculation)*

Perform global stability analysis for the proposed fill slopes.

General Approach/Assumptions *(please describe in general – can refer to calculation sheets for more information)*

Provided Plans:

- We were provided plan sheets (C-sheets, dated 11/19/2018) and associated cross sections (dated 11/19/2018, with updates provided on 11/26/18 and 11/27/18).

Design Guidance Documents:

- The primary design guidance is the Federal Lands Highway's Project Development and Design Manual (PDDM), specifically sections 6.4.6.5 and 6.4.7 for fill slopes.
- The PDDM refers to the Technical Guidance Manual (TGM).
- Sections 6.4.6.5 references TGM Section 4.6.5.
- Section 6.4.7.1 references TGM Section 4.7.1
- Design Guidance reference sheets are provided on pages 9-18.

Design Guidance Requirements:

- For fill slopes, the recommend minimum factor of safety is 1.3 for static stability.
- The provided plan sheets and cross sections do not show any proposed non-rock cut slopes, thus this calc package does not consider cut slopes.
- Seismic stability analysis was not performed as part of this calc package, per Section 6.4.11 of the PDDM; see page 13.

Soil Properties:

- Soil properties represent the properties determined within Calc Package 1 *Development of Cross Sections for RSS and MSE Analysis.*
- Structural fill has the following properties:
- Friction Angle, $\phi' = 34°$
- Cohesion, C = 0 psf
- Unit Weight, γ = 125 pcf
- Artificial Fill (af) has the following properties:
- Friction Angle, $\phi' = 30°$
- Cohesion, C = 0 psf
- Unit Weight, γ = 120 psf
- Qts (non-pumice) has the following properties:
- Friction Angle, $\phi' = 32°$
- Cohesion, C = 0 psf
- Unit Weight, γ = 120 pcf
- Qts (pumice) has the following properties:
- Friction Angle, $\phi' = 30°$
- Cohesion, C = 0 psf
- Unit Weight, γ = 90 pcf
- Bedrock is assumed to consist of impenetrable material

CALCULATION SUMMARY

Fill Slope Model:

- The provided plans show multiple locations for proposed fill slopes. Approximate proposed fill slope locations are presented on Table 1, shown on page 3. These locations are based on the provided C-sheets. All fill slopes are proposed at a gradient of 1V:2H.
- Two general models were created to analyze fill slopes, the first model considering the tallest slope with non-pumice conditions and the second model considering the tallest slope with pumice condition.
- The non-pumice fill slope model is based on the proposed section 124+50.
- The pumice fill slope model is based on the proposed section 121+00.
- For both models, the following assumptions were made:
- Initially start with a 10'-width key at the base of the proposed slope. If the minimum factor of safety is not met, extend the key width by an additional 5'.
- Assume a 10'-width fill placement at the top of the fill slope.

General Approach:

- The GeoStudio software SLOPE/W was used to calculate the factor of safety of the proposed fill and cut slope models.
- The Morgenstern-Price limit-equilibrium search method was chosen.
- I included a 250 psf traffic surcharge into the analyses.
- I limited the search below the toe of the fill slope, to the height of the fill slope.

Sources of Data and Equations *(please describe in general – can refer to calculation sheets for more information – if other calculations are referenced, please include)*

Federal Highway Administration (FHWA), 2007, Geotechnical Technical Guidance Manual (DRAFT), U.S. Department of Transportation, Federal Highway Administration, May 2007.

Federal Lands Highway, 2012, Project Development and Design Manual, U.S. Department of Transportation, Federal Highway Administration.

Previous Calc Packages Referenced:
Calculation No. 1, Development of Cross Sections for RSS and MSE Analysis

Summary and Conclusions *(please describe general conclusions – do not only refer to calculation sheets, but include conclusion here)*

A summary of the slope stability analysis is shown on Table 2 on page 4. Graphical results are presented on pages 5-8.

PM Check of Assumptions and Input Properties

Rev No.	Calculation By	Date	Checked By	Date	No. of Pages*
0	Brian Trott	1/13/19	Steve Diem	1/18/19	18
1	Brian Trott	1/22/19	Steve Diem	1/22/19	15
PM Review of Assumptions and Input Properties			by: _____ on _____		
NOTES:					

* Number of pages is the total number of pages including the cover sheet.

Table 2. Summary of Fill Slope Stability Analysis

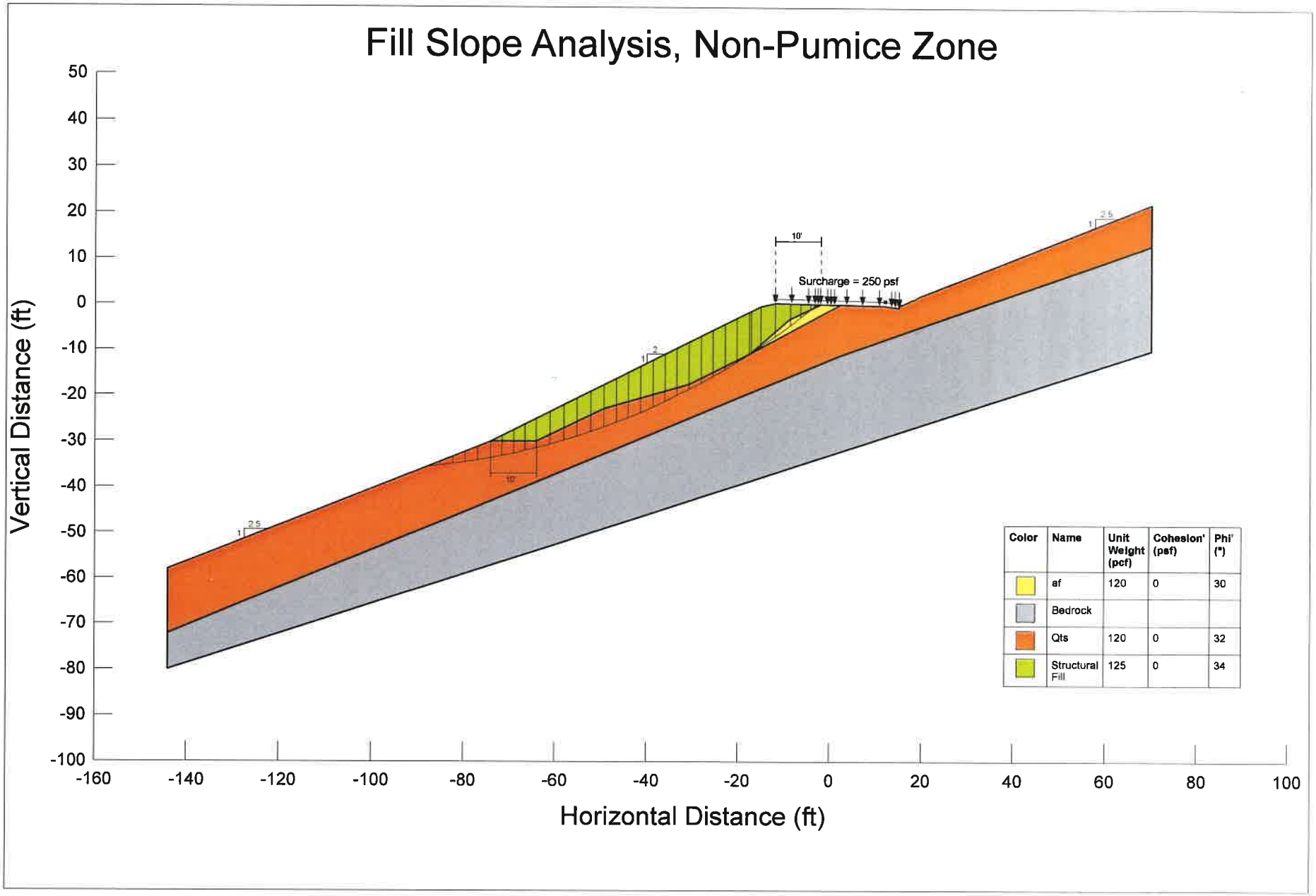
Section Analyzed	Base Key Width	Slope Stability Critical FOS[1]	Approximate Fill Slope Height (ft)
Fill Slopes Non-Pumice Zones	10'	1.39	30
Fill Slopes Pumice Zones	10'	1.28	23
	15'	1.31	

[1]Factor of Safety (FOS) values shown for critical failure surface as determined by GeoStudio. Per the Project Development and Design Manual, required FOS value is 1.3 for static analysis. Calculated FOS values that do not meet this requirement are presented in red.

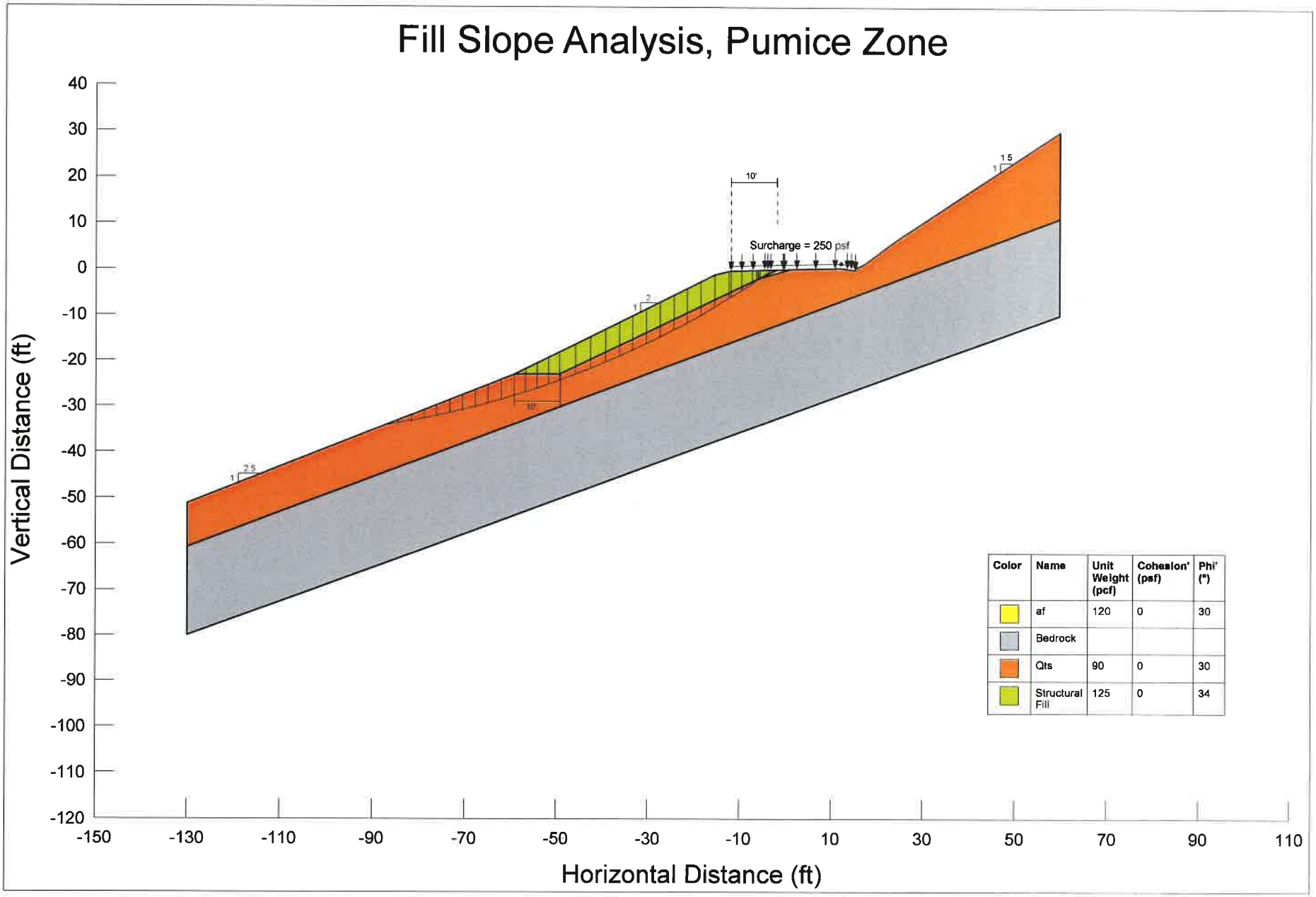
SLOPE/W

SLOPE STABILITY RESULTS

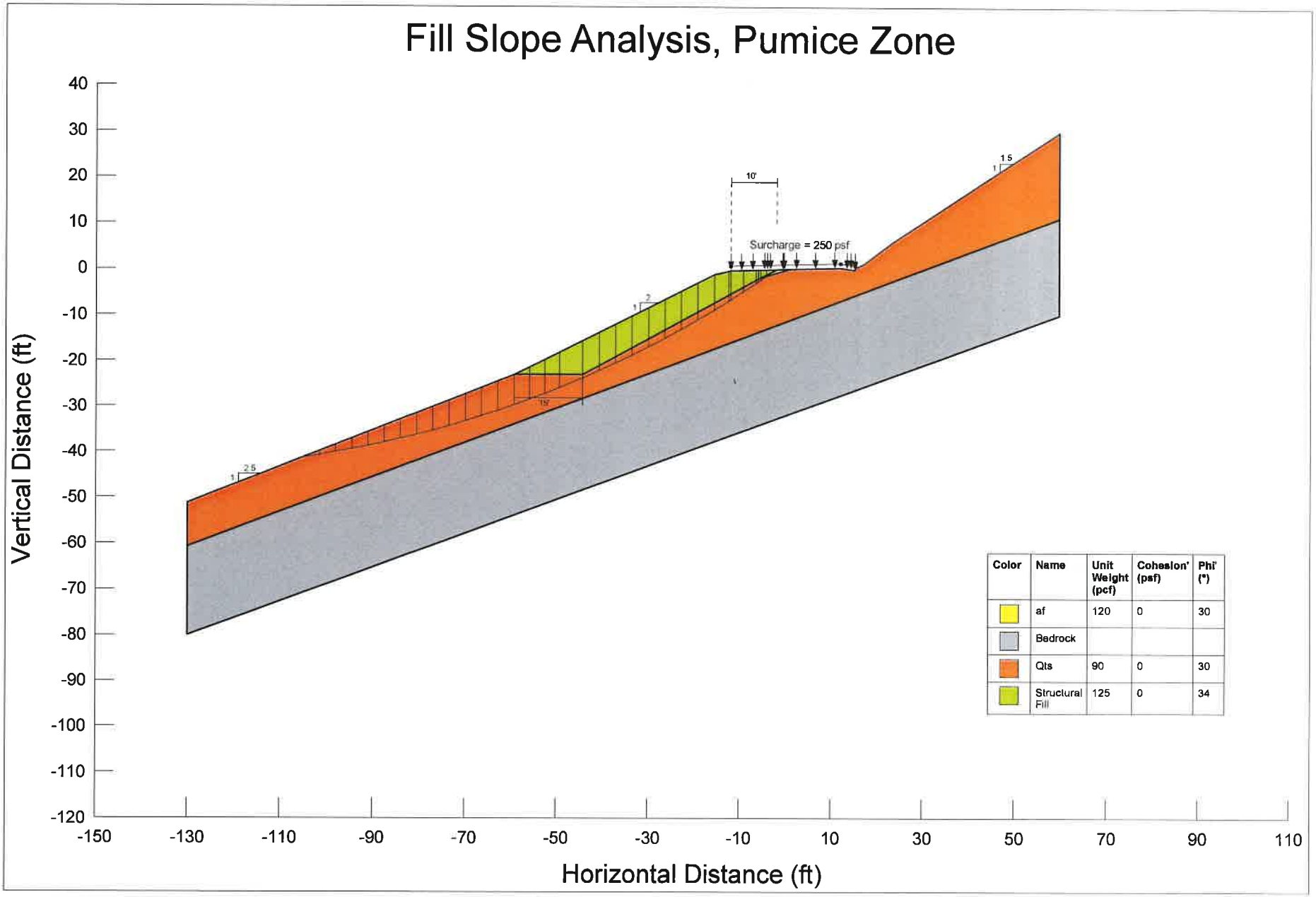
Factor of Safety = 1.39



Factor of Safety = 1.28



Factor of Safety = 1.31



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Calculation No. 6

CALCULATION SUMMARY

Project: Reds Meadow Road Improvement Job No: 100062-002

Project Feature and Subject: Flexible Pavement Section Design

Calculation Purpose *(describe purpose/goal of calculation)*

Provided recommended flexible pavement section thickness for proposed road improvement.

The purpose of Revision #2 is to incorporate review comments presented by the CFL pavement engineer, Robert Norick.

- Backfill subexcavations with Unclassified Borrow material and assume average CBR for design.
- Do not recommend full-depth HACP pavement sections due to level of uncertainty.
- Change binder type to PG64-28M.

General Approach/Assumptions *(please describe in general – can refer to calculation sheets for more information)*

DESIGN GUIDANCE:

- The primary design is the Federal Lands Highway's Project Development and Design Manual (PDDM), specifically chapter 11. Excerpts from the PDDM are presented on pages 7-13.
- We understand that the upper 2.5 miles of the project is (4R) and the lower 5.8 miles is (3R).
  - Per PDDM, recommend a 25-year design life for the upper 2.5 miles; see page 8.
  - Per PDDM, recommend a 20-year design life for lower 5.8 miles; see page 8.

TRAFFIC LOADING:

- Based on conversation with CH2M (as shown on page 5), we understand the design traffic loading shall consist of:
  - Average Daily Traffic (ADT) = 445
    - Shuttle bus = 13.5%
    - Passenger cars = 26.5%
    - Pickup vans = 60%
  - Per PDDM, recommend the following equivalency factors (see page 9):
    - Shuttle bus: 1.25
    - Passenger cars: 0.0006
    - Pickup vans: 0.0022
  - Consider a 20-year design life for the lower 5.8 miles, and 25-year design life for upper 2.5 miles.
  - Predicted annual growth is 0%.
- The road will be open for approximately 5 months each year (June through October). Estimate this to be 152 days open.
- Based on email with Jacobs, assume a directional distribution of 50%; see page 4.
- Based on the PDDM, recommend a traffic lane factor of 100%; see page 10.

PAVEMENT DESIGN VARIABLES:

- Pavement design variables were taken from the PDDM, chapter 11. The following design values were used within the design:
  - Initial serviceability, p_0, of 4.2; see page 8.
  - Terminal serviceability, p_t, of 2.0; see page 8.
  - Layer Coefficients (see page 11):
    - HACP = 0.42
    - Crushed aggregate base (CAB) = 0.13

CALCULATION SUMMARY

        - Full-Depth Reclamation (FDR) = 0.11
    - For drainage, assume drainage coefficients (m_i) of 1.0 for each sublayer.
    - Reliability, R = 75 percent; see page 13.
    - Design Standard Deviation, S_o = 0.49; see page 13.

MODELED LAYERS:

- The pavement section in the upper 2.5 miles will be a new section.
- We understand the pavement section in the lower 5.8 miles will include a 6-inch thick FDR layer. However, in areas where severe rutting was observed during the 30-percent field review, we recommend a subexcavation, in accordance with PDDM 11.3.2.1.2 (subex), to mitigate the poor subgrade conditions. The subexcavations should be backfilled with Unclassified Borrow material with a CBR ≥ Design CBR. We tabulated the subex locations on page 6.
- The pavement design section alternatives consist of:
    - Upper 2.5 miles
        - HACP over CAB over subgrade
        - HACP over subgrade
    - Lower 5.8 miles
        - HACP over FDR over subgrade
        - HACP over CAB over subgrade (in subex locations, see below)
        - HACP over subgrade (in subex location, see below)
- CBR laboratory tests were performed on 6 samples, resulting in values of 8, 28, 34, 38, 48, and 54.
    - CBR at 0.1" penetration.
    - These values assume 95% relative compaction.
    - Average CBR = Design CBR = 35.
    - CBR value of 8 corresponds to pumice-rich/poor subgrade zones.
    - CBR lab results are presented in Laboratory Test Results appendix.

GENERAL APPROACH:

- The "Flexible Pavement 18-kip Equivalent Single-Axle Loading (ESAL) Worksheet" was used to estimate the design ESAL value based on the recommended traffic loading and project design life.
    - The 20-year design life resulted with a design ESAL of 116,000
    - The 25-year design life resulted with a design ESAL of 144,000
- The "Flexible Pavement Design Worksheet" was used to calculated section thicknesses. This worksheet follows the AASHTO 1993 procedure using the pavement design variables and traffic loading conditions mentioned above.

BINDER:

- The software LTPPBind Online was used to determine the binder grade.
    - Assumed a base HT PG of 70
    - Assumed a target rutting depth of 16.5 mm
- The input values and results are presented on page 23.

FROST DEPTH:

- Reds Meadow Road is adjacent to the town of Mammoth Lakes, CA. The Minimum Design Standards of Mammoth Lakes states that the frost line shall be considered a minimum of 24" below grade; see pages 25-26.
- The US Frost Depth Map shows the frost depth between 5" and 10", see page 27. Recommend interpreting a frost depth of 8" based on this figure.

CALCULATION SUMMARY

Sources of Data and Equations *(please describe in general – can refer to calculation sheets for more information – if other calculations are referenced, please include)*

Federal Lands Highway, 2012, Project Development and Design Manual, U.S. Department of Transportation, Federal Highway Administration.

American Association of State Highway and Transportation Officials (AASHTO), 1993, AASHTO Guide for Design of Pavement Structures, Published by the American Association of State Highway and Transportation Officials, 444 N. Capitol Street, N.W., Suite 249, Washington D.C., 20001.

Summary and Conclusions *(please describe general conclusions – do not only refer to calculation sheets, but include conclusion here)*

For the upper 2.5 miles (25-year design life), **recommend** the following pavement sections:

- 3" **HACP** over 4" **CAB**
- 3.5" **HACP** over subgrade

For the lower 5.8 miles (20-year design life), recommend the following pavement sections:

- 3" **HACP** over 6" **FDR**
- 3" **HACP** over 4" **CAB** (if roadway alignment or width need to be adjusted)

CFL does not recommend using a full-depth HACP section; see CFL Comment Resolution table from review of S&W draft report dated January 22, 2019. Do not include full-depth HACP sections in the final report.

We recommend using a frost depth of 8 inches below the finished roadway grade.

The recommended binder grade is presented on page 23. CFL pavement engineer and project manager both requested we specify PG 64-28M.

PM Check of Assumptions and Input Properties

Rev No.	Calculation By	Date	Checked By	Date	No. of Pages*
0	Brian Trott	12/21/18	Steve Diem	1/10/19	36
1	Brian Trott	1/14/19	Steve Diem	1/14/19	33
2	Steve Diem	5/16/19	Brian Trott	5/16/19	27
PM Review of Assumptions and Input Properties			by: _____ on _____		
NOTES:					

* Number of pages is the total number of pages including the cover sheet.

ANALYSIS RESULTS

20-YEAR DESIGN LIFE (LOWER 5.8 MILES)

Flexible Pavement 18-kip Equivalent Single-Axle Loading (ESAL) Worksheet

Location: Madera County, California
Comment: Analysis based on Table D.21 of the 1993 AASHTO Guide for the Design of Pavement Structures
Reds Meadow Road

Paving Year:	2019	
Pavement Design Life (D):	20	years[3]
2019 Average Daily Traffic (ADT)[1]:	445	vehicles per day
2020 Average Daily Traffic (ADT)[1]:	445	
Estimated 2039 ADT[1]:	445	vehicles per day
Growth Rate (r):	0.00	%
Number of days Road Open:	152	

Equations
b = 2019 ADT * (a/100)
c = b * number of days road open
d = $[(1+r/100)^{25}-1]/(r/100)$
e = c * d
g = e * f
j = g * h * i

FHWA Vehical Classification and Description	a Traffic[1] Percentage	b 2019 ADT	c Total 2019 Traffic	d Growth Factors	e Design Traffic Volume (total two-way volume)	f Flexible[2] Pavement Equivalency Factor	g Roadway Design 18k ESAL	h Directional[4] Distribution Factor	i Traffic[4] Lane Factor	j Design Lane 18k ESAL
1) Motorcycles	0	0	0	20.00	0	0	0	0.50	1.0	0
2) Passenger Cars	26.5	118	17,925	20.00	358,492	0.0006	215	0.50	1.0	108
3) Pickups, Vans	60	267	40,584	20.00	811,681	0.0022	1,786	0.50	1.0	893
4) Buses	13.5	60	9,131	20.00	182,628	1.25	228,285	0.50	1.0	114,143
5) 2-Axle, 6-Tire Single Unit Trucks	0	0	0	20.00	0	0.50	0	0.50	1.0	0
RV Truck; PDDM midpoint Truck Factor Range	0	0	0	20.00	0	0.50	0	0.50	1.0	0
6) 3-Axle, Single Unit Trucks	0	0	0	20.00	0	1.0	0	0.50	1.0	0
Pickup Truck with RV Trailer (S&W Calculated)	0	0	0	20.00	0	0.0900	0	0.50	1.0	0
7) 4-Axle or More, Single Unit Trucks	0	0	0	20.00	0	1.50	0	0.50	1.0	0
8) 4-Axle or Less, Single Trailer Trucks	0	0	0	20.00	0	1.75	0	0.50	1.0	0
9) 5-Axle Single Trailer Trucks	0	0	0	20.00	0	2.15	0	0.50	1.0	0
10) 6 or More Axle Single Trailer Trucks	0	0	0	20.00	0	2.15	0	0.50	1.0	0
11) 5 or Less Axle Multi-Trailer Truck	0	0	0	20.00	0	3.0	0	0.50	1.0	0
12) 6-Axle Multi-Trailer Trucks	0	0	0	20.00	0	3.0	0	0.50	1.0	0
13) 7 or More Axle Multi-Trailer Trucks	0	0	0	20.00	0	3.0	0	0.50	1.0	0
All Vehicles	100	445			1,352,801		230,286			**115,144**

Design ESAL	**116,000**

Notes

1) The current and projected ADT were based on traffic data provided by CH2M.
2) Exhibit 11.2-A of the 2008 Federal Lands Highway Project Development and Design Manual provides common truck factor ranges for each FHWA vehicle classification. The average value was assumed in our analysis for passenger cars, pickup trucks, and vans.
3) The minimum design life for a reconstruction project (3R) is 20 years based on the 2008 Federal Lands Highway Project Development and Design Manual.
4) Assume 0% Growth Rate.

Flexible Pavement Design Worksheet

Location: Madera County, California
Comment: Design procedures based on 1993 AASHTO Guide For Design of Pavement Structures
New pavement design Reds Meadow Road
Resilient Modulus = 24865 psi, 20 year Design Life, 116000 ESALs

1. Pavement Design Life: 20 years

Traffic Loading (W_{18}): 18k ELDA = 15.9 — 18k ESALs: 1.16E+05 per lane

3. Serviceability:
   - p_0: 4.2 (PDDM for flexible pavement)
   - p_t: 2.0 (PDDM for ADT < 500 vehicles per day)
   - ΔPSI: 2.2

4. Subgrade Resilient Modulus (M_R):
   - CBR 35 (Based on CBR tests from AP Engineering)
   - 8
   - 5440
   - M_R: 24,865 psi

5. Reliability:
   - R: 75 %
   - Z_R: -0.674

6. Design Standard Deviation (S_o):
   - S_o: 0.49 (PDDM for flexible pavement design)

7. Requred Structural Numbers (SN): [Figure 3.1 of 1993 AASHTO Guide for Design of Pavement Structures

Req. SN: **1.350**

$$\log_{10}(W_{18}) = Z_R\, S_o + 9.36\, \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\, \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization:

Material	Structural Layer Coefficients	R_{Value} Requirements	Drainage Coefficients
HACP	a_1: 0.42	-	-
CAB	a_2: 0.13	-	m_2: 1.00
FDR	a_3: 0.10	-	m_3: 1.00

9. Solutions for thicknesses: $SN = a_1D_1 + a_2D_2m_2 + a_3D_3m_3$

Recommended Thicknesses		
Material	Layer	Thickness
HACP	D_1	3.0 inches
CAB	D_2	0.0 inches
FDR	D_3	6.0 inches
	D_4	inches

Minimum thickness considered = 3 inches.

Pavement Section SN: **1.860**

Note: Required SN <= Pavement SN, Design is Acceptable

Flexible Pavement Design Worksheet

Location: Madera County, California
Comment: Design procedures based on 1993 AASHTO Guide For Design of Pavement Structures
New pavement design Reds Meadow Road
Resilient Modulus = 24865 psi, 20 year Design Life, 116000 ESALs

1. Pavement Design Life: 20 years

Traffic Loading (W_{18}): 18k ELDA = 15.9 — 18k ESALs: 1.16E+05 per lane

3. Serviceability:
   - p_o: 4.2 (PDDM for flexible pavement)
   - p_t: 2.0 (PDDM for ADT < 500 vehicles per day)
   - ΔPSI: 2.2

4. Subgrade Resilient Modulus (M_R):
   - CBR 35 (Based on CBR tests from AP Engineering)
   - 8
   - 5440
   - M_R: 24,865 psi

5. Reliability:
   - R: 75 %
   - Z_R: -0.674

6. Design Standard Deviation (S_o):
   - S_o: 0.49 (PDDM for flexible pavement design)

7. Requred Structural Numbers (SN): [Figure 3.1 of 1993 AASHTO Guide for Design of Pavement Structures

Req. SN: **1.350**

$$\log_{10}(W_{18}) = Z_R\, S_o + 9.36\, \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\, \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization:

Material	Structural Layer Coefficients	R_{Value} Requirements	Drainage Coefficients
HACP	a_1: 0.42	-	-
CAB	a_2: 0.13	-	m_2: 1.00
FDR	a_3: 0.10	-	m_3: 1.00

9. Solutions for thicknesses: $SN = a_1D_1 + a_2D_2m_2 + a_3D_3m_3$

Recommended Thicknesses			
Material	Layer	Thickness	
HACP	D_1	3.0 inches	Minimum thickness considered = 3 inches.
CAB	D_2	4.0 inches	PDDM minimum CAB thickness = 4 inches.
FDR	D_3	0.0 inches	
	D_4	inches	

Pavement Section SN: **1.780**

Note: Required SN <= Pavement SN, Design is Acceptable

ANALYSIS RESULTS

25-YEAR DESIGN LIFE (UPPER 2.5 MILES)

Flexible Pavement 18-kip Equivalent Single-Axle Loading (ESAL) Worksheet

Location: Madera County, California
Comment: Analysis based on Table D.21 of the 1993 AASHTO Guide for the Design of Pavement Structures
Reds Meadow Road

Paving Year:	2019	
Pavement Design Life (D):	25	years[3]
2019 Average Daily Traffic (ADT)[1]:	445	vehicles per day
2020 Average Daily Traffic (ADT)[1]:	445	
Estimated 2039 ADT[1]:	445	vehicles per day
Growth Rate (r):	0.00	%
Number of days Road Open:	152	

Equations
b = 2019 ADT * (a/100)
c = b * number of days road open
d = $[(1+r/100)^{25}-1]/(r/100)$
e = c * d
g = e * f
j = g * h * i

FHWA Vehical Classification and Description	a Traffic[1] Percentage	b 2019 ADT	c Total 2019 Traffic	d Growth Factors	e Design Traffic Volume (total two-way volume)	f Flexible[2] Pavement Equivalency Factor	g Roadway Design 18k ESAL	h Directional[4] Distribution Factor	i Traffic[4] Lane Factor	j Design Lane 18k ESAL
1) Motorcycles	0	0	0	25.00	0	0	0	0.50	1.0	0
2) Passenger Cars	26.5	118	17,925	25.00	448,116	0.0006	269	0.50	1.0	135
3) Pickups, Vans	60	267	40,584	25.00	1,014,601	0.0022	2,232	0.50	1.0	1,116
4) Buses	13.5	60	9,131	25.00	228,285	1.25	285,357	0.50	1.0	142,679
5) 2-Axle, 6-Tire Single Unit Trucks	0	0	0	25.00	0	0.50	0	0.50	1.0	0
RV Truck; PDDM midpoint Truck Factor Range	0	0	0	25.00	0	0.50	0	0.50	1.0	0
6) 3-Axle, Single Unit Trucks	0	0	0	25.00	0	1.0	0	0.50	1.0	0
Pickup Truck with RV Trailer (S&W Calculated)	0	0	0	25.00	0	0.0900	0	0.50	1.0	0
7) 4-Axle or More, Single Unit Trucks	0	0	0	25.00	0	1.50	0	0.50	1.0	0
8) 4-Axle or Less, Single Trailer Trucks	0	0	0	25.00	0	1.75	0	0.50	1.0	0
9) 5-Axle Single Trailer Trucks	0	0	0	25.00	0	2.15	0	0.50	1.0	0
10) 6 or More Axle Single Trailer Trucks	0	0	0	25.00	0	2.15	0	0.50	1.0	0
11) 5 or Less Axle Multi-Trailer Truck	0	0	0	25.00	0	3.0	0	0.50	1.0	0
12) 6-Axle Multi-Trailer Trucks	0	0	0	25.00	0	3.0	0	0.50	1.0	0
13) 7 or More Axle Multi-Trailer Trucks	0	0	0	25.00	0	3.0	0	0.50	1.0	0
All Vehicles	100	445			1,691,002		287,858			**143,930**

Design ESAL	**144,000**

Notes
1) The current and projected ADT were based on traffic data provided by CH2M.
2) Exhibit 11.2-A of the 2008 Federal Lands Highway Project Development and Design Manual provides common truck factor ranges for each FHWA vehicle classification. The average value was assumed in our analysis for passenger cars, pickup trucks, and vans.
3) The minimum design life for a reconstruction project (4R) is 25 years based on the 2008 Federal Lands Highway Project Development and Design Manual.
4) Assume 0% Growth Rate.

Flexible Pavement Design Worksheet

Location: Madera County, California
Comment: Design procedures based on 1993 AASHTO Guide For Design of Pavement Structures
New pavement design Reds Meadow Road
Resilient Modulus = 24865 psi, 25 year Design Life, 144000 ESALs

1. Pavement Design Life: 25 years

Traffic Loading (W_{18}): 18k ELDA = 15.8 — 18k ESALs: 1.44E+05 per lane

3. Serviceability:
   - p_0: 4.2 (PDDM for flexible pavement)
   - p_t: 2.0 (PDDM for ADT < 500 vehicles per day)
   - ΔPSI: 2.2

4. Subgrade Resilient Modulus (M_R):
   - CBR 35 (Based on CBR tests from AP Engineering)
   - 8
   - 5440
   - M_R: 24.865 psi

5. Reliability:
   - R: 75 %
   - (PDDM for ADT < 2500 vehicles per day)
   - Z_R: -0.674

6. Design Standard Deviation (S_o):
   - S_o: 0.49
   - (PDDM for flexible pavement design)

7. Requred Structural Numbers (SN): [Figure 3.1 of 1993 AASHTO Guide for Design of Pavement Structures

Req. SN: **1.406**

$$\log_{10}(W_{18}) = Z_R S_o + 9.36 \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization:

Material	Structural Layer Coefficients	R_{Value} Requirements	Drainage Coefficients
HACP	a_1: 0.42	-	-
CAB	a_2: 0.13	-	m_2: 1.00
FDR	a_3: 0.11	-	m_3: 1.00

9. Solutions for thicknesses: $SN = a_1D_1 + a_2D_2m_2 + a_3D_3m_3$

Recommended Thicknesses		
Material	Layer	Thickness
HACP	D_1	3.0 inches
CAB	D_2	4.0 inches
FDR	D_3	0.0 inches
	D_4	inches

PDDM minimum CAB thickness = 4 inches.

Pavement Section SN: **1.780**

Note: Required SN <= Pavement SN, Design is Acceptable

Flexible Pavement Design Worksheet

Location: Madera County, California

Comment: Design procedures based on 1993 AASHTO Guide For Design of Pavement Structures

New pavement design Reds Meadow Road

Resilient Modulus = 24865 psi, 25 year Design Life, 144000 ESALs

1. Pavement Design Life: 25 years

Traffic Loading (W_{18}): 18k ELDA = 15.8 — 18k ESALs: 1.44E+05 per lane

3. Serviceability:

p_0: 4.2 (PDDM for flexible pavement) — ΔPSI: 2.2

p_t: 2.0 (PDDM for ADT < 500 vehicles per day)

4. Subgrade Resilient Modulus (M_R):

CBR 35 (Based on CBR tests from AP Engineering)

8

5440

M_R: 24.865 psi

5. Reliability:

R: 75 % (PDDM for ADT < 2500 vehicles per day) — Z_R: -0.674

6. Design Standard Deviation (S_o):

S_o: 0.49 (PDDM for flexible pavement design)

7. Requred Structural Numbers (SN): [Figure 3.1 of 1993 AASHTO Guide for Design of Pavement Structures

Req. SN: **1.406**

$$\log_{10}(W_{18}) = Z_R\, S_o + 9.36\, \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2-1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32\, \log_{10}(M_R) - 8.07$$

Layer Analysis

8. Pavement Materials Characterization:

Material	Structural Layer Coefficients	R_{Value} Requirements	Drainage Coefficients
HACP	a_1: 0.42	-	-
CAB	a_2: 0.13	-	m_2: 1.00
FDR	a_3: 0.11	-	m_3: 1.00

9. Solutions for thicknesses: $SN = a_1D_1 + a_2D_2m_2 + a_3D_3m_3$

Recommended Thicknesses		
Material	Layer	Thickness
HACP	D_1	3.5 inches
CAB	D_2	0.0 inches
FDR	D_3	0.0 inches
	D_4	inches

Pavement Section SN: **1.470**

Note: Required SN <= Pavement SN, Design is Acceptable

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Calculation No. 8

CALCULATION SUMMARY

Project: Reds Meadow
Job No: 100062
Feature and Subject: Rock Slopes

Calculation Purpose *(describe purpose/goal of calculation)*

Evaluate discontinuity data collected by Shannon & Wilson in May and October 2018 for proposed rock cut slope inclinations and excavatibility at 5 proposed rock cut slopes. Provide ditch recommendations for rockfall using slope charts.

General Approach/Assumptions *(please describe in general – can refer to calculation sheets for more information)*

1. Rock Mass Rating (RMR) and Geological Strength Index (GSI)
    a. Developed following Bieniawski 1989.
    b. Used mapping data from May 2018 that included field estimates of rock strength, weathering, type, fabric, discontinuity spacing, general discontinuity conditions, and general water conditions.
    c. Based on the relationship from Hoek and Bray (1997), GSI = RMR_{89} -5 for dry conditions.
2. Kinematic Analysis:
    a. Convert discontinuity data from strike/dip as measured in the field to dip/dip direction. Add declination measured as 12.8 degrees according to NOAA at the time of the October 2018 mapping. Use the Dips program to evaluate stereonets.
    b. Select pole clusters to represent major plane orientations.
    c. Perform initial kinematic analysis varying the friction angle from 20 (lowest friction angle from FHWA) to 40 (highest friction from FHWA) to observe change of percent probability of kinematically admissible failures.
    d. Present kinematic analysis assuming a friction angle of 34 degrees for meta-sedimentary and meta-volcanic rock walls (RW-1, RW-2A, RW-4, and RW-8). Assume friction angle of 27 degrees for meta-sedimentary phyllite at RW-2B. Friction angle is assumed based on the average values of published data (FHWA 1998) for medium to high friction rock types (meta-sedimentary, meta-volcanic, and igneous rock). Using joint roughness coefficient (JRC) values ranging from 4 to 20 from field mapping data, add 5 degrees to friction angle but still assume medium friction rock based on FHWA.
    e. Evaluate cut slope for a 0.5H:1V (63 degree) inclination at all slopes. Slope inclinations based on site visits with client, initial analysis, and 30% design documents with field notations.
    f. Slope RW-4 was separated into 3 windows based on observed changes in the field mapping data and photographs of the slopes. Windows 1 through 10 were combined as follows: 1 through 5, 6 and 7, 8 through 10.
    g. Kinematic plots are constructed according to Dips tutorial attached. See the tutorial pages for general labeling of kinematics construction lines.
    h. SWEDGE was used to evaluate if wedges noted as kinematically admissible failures

CALCULATION SUMMARY

from the stereonet analysis form given the actual slope dimensions, slope orientation, and scaling the discontinuities based on field mapping data.

3. Global Stability
    a. Using Slide, evaluate global stability at the maximum cut slope at Station 83+00 (Slope RW-4) for an inclination of 0.5H:1V. The section was developed using general parameters and materials provided in Shannon & Wilson Calculation No. 1 for Development of Cross Sections for RSS and MSE analysis dated 12/14/18.
    b. The rock mass was modeled with Generalized Hoek-Brown. A planar failure was modeled using Generalized Anisotropic Strength. The failure surface was modeled using a non-circular surface type and forced to be deeper than 5 feet. Small surficial failures were observed without forcing the failure plane deeper.
    c. Site specific PGA was evaluated as 0.257g (0.1285g modeled) based on the Shannon & Wilson calculation package No.1 for Seismic dated 8/3/18.
4. Rockfall Catchment
    a. Using FHWA's Rockfall Catchment Area Design Guide, evaluate for 80% catchment.
    b. The design guide begins their slope charts at a 40-foot height, it was assumed that the ditch sizes from the slope charts could be reduced by 25% to relate to a 10-foot high slope.
    c. Evaluate slope charts for 0.25H:1V (76 degrees), 0.5H:1V (63 degrees), 0.75H:1V (53 degree), 1H:1V (45 degrees), and Vertical (80 degrees).
5. Excavatability of materials:
    a. Point Load (Rock Strength) versus Fracture Spacing (Fracture Density) Method using the excavation plot provided in NAVFAC 7.2 (1986) developed by Broch and Franklin (1972).
    b. Point Load Strength from Rock Strength Descriptors:

    The rock strength was assessed in the field using the simple means test and rock grade descriptors published by the International Society of Rock Mechanics (ISRM, 1978). Using the descriptors, we estimated an average or mode strength value (whichever is appropriate) based on the range provided by ISRM for each descriptor. The rock strength is then converted to a Corrected Point Load Index ($I_{s(50)}$) by using a factor of 1/24 as recommended by the ASTM D5731 Suggested Method. The modal values assumed from the rock strength descriptions are summarized in Table 1.

CALCULATION SUMMARY

Table 1: Point Load Strength from Rock Grade

	Uniaxial Compressive Strength (UCS)			Point Load $I_{s(50)}$		
	LOW	HIGH	MODE	LOW	HIGH	MODE
DESCRIPTOR	Psi			tsf		
R0	50	150	100	0.15	0.45	**0.3**
R0-R1	X	X	150	X	X	**0.5**
R1	150	750	450	0.45	2.25	**1.4**
R1-R2	X	X	750	X	X	**2.3**
R2	750	3500	2125	2.25	10.5	**6.4**
R2-R3	X	X	3500	X	X	**10.5**
R3	3500	7500	5500	10.5	22.5	**16.5**
R3-R4	X	X	7500	X	X	**22.5**
R4	7500	15000	11250	22.5	45	**33.8**
R4-R5	X	X	15000	X	X	**45.0**
R5	15000	35000	25000	45	105	**75.0**
R5-R6	X	X	35000	X	X	**105.0**
R6	35000	60000	47500	105	180	**142.5**

Fracture Spacing:

Similarly, the fracture spacing is assumed using the modal value for the fracture density spacing descriptors and the rock core data as shown in Table 2.

Table 2: Fracture Spacing from Fracture Density

DESCRIPTOR	FRACTURE DENSITY				
	LOW	HIGH	LOW	HIGH	MODE
	Inches		Feet		
IF	0	2	0.00	0.17	0.08
IF-HF	X	X	X	X	0.17
HF	2	8	0.17	0.67	0.42
HF-MF	X	8	X	X	0.67
MF	8	24	0.67	2.00	1.33
MF-SF	X	X	X	X	2.00
SF	24	72	2.00	6.00	4.00
SF-UF	X	72	X	X	6.00
UF	72	240	6.00	20.00	10.00

The correlated data are plotted onto the excavation chart developed by Broch and Franklin (1972).

CALCULATION SUMMARY

c. Excavatibility was also interpreted using Primary "P" Wave (seismic) Velocity and interpreted by Geovision in their report using the excavation plot provided by Caterpillar (2014) for a D8 bulldozer.

d. Excavatability for the 4 cut slopes were evaluated using p-wave velocities from geophysical surveys provided by Geovision. The following seismic lines were placed for evaluating each slope:

   i. RW-2A: S-2, S-3 and S-13

   ii. RW-2B: S-4 and S-5

   iii. RW-4: S-8 and S-9

   iv. RW-8: S-12

e. Geovision summarized their data assuming that rock that the site would be rippable below a seismic velocity of 6250 ft/s, marginally rippable between 6250 and 8250 ft/s if the rock is sufficiently jointed and fractured.

f. The Geovision report is not included as part of this calculation package since it will be included in the main Geotechnical Report.

Sources of Data and Equations *(please describe in general – can refer to calculation sheets for more information – if other calculations are referenced, please include)*

1. Discontinuity field measurements by Shannon & Wilson, Inc., May and October 2018.
2. Rock mass rating measurements by Shannon & Wilson, Inc., May 2018.
3. Z.T. Bieniawski, 1989, Engineering rock mass classifications, N. Y., Wiley.
4. Hoek, E. and Bray, J., 1997, Practical estimates of rock mass strength. International Journal of Rock Mechanics and Mining Sciences, Vol 34, No 8, p. 1165-1186.
5. FHWA, 1998, Rock Slopes Reference Manual. NHI Course No. 13235 – Module 5, Publication No. FHWA HI-99-007.
6. https://www.ngdc.noaa.gov/geomag/calculators/magcalc.shtml#declination
7. Rocscience, Inc., 2014, Dips (v. 6.016): Toronto, Ontario, Rocscience, Inc.
8. Rocscience, Inc., 2015, Slide (v. 6.034): Toronto, Ontario, Rocscience, Inc.
9. Rocscience, Inc., 2009, Swedge (v. 5.0): Toronto, Ontario, Rocscience, Inc.
10. Shannon & Wilson Calculation No. 1 for Seismicity dated 8/3/18 (previous phase work)
11. Shannon & Wilson Calculation No. 1 for Development of Cross Sections for RSS and MSE analysis dated 12/14/18.
12. FHWA, 2001, Rockfall Catchment Area Design Guide. FHWA-OR-RD-02-04
13. Broch, E. and Franklin, J.A. (1972). "The Point-load Strength Test," International Journal of Rock Mechanics and Mining Science, Vol. 9.
14. Naval Facilities Engineering Command (NAVFAC). (1986). Foundations and Earth Structures Design Manual 2.02, Revalidated September.

CALCULATION SUMMARY

15. International Society of Rock Mechanics, 1978
16. Geovision Report
17. Caterpillar Handbook of Ripping, 2014

Summary and Conclusions *(please describe general conclusions – do not only refer to calculation sheets, but include conclusion here)*

Attachments:

1. Plan sheets and cross sections of site (12 sheets)
2. Rock Field Mapping Sheets (56 sheets)
3. Magnetic declination (2 sheets)
4. Discontinuity Data Converted from Strike/Dip to Dip/Dip Direction (11 sheets)
5. Rock unit weight and friction angle reference (4 sheets)
6. Rock Mass Rating Sheets based on May 2018 data (5 sheets)
7. Dips Kinematic Analysis Tutorial Reference – select pages (8 sheets)
8. Summary of Kinematic Analysis (1 sheet)
9. Summary of Friction Angle Variation in Dips (1 sheet)
10. Slope Cross Sections, Dips stereonet plots, and SWEDGE plots (137 sheets)
11. Global Stability Evaluation (3 sheets)
12. Rockfall Slope Charts (9 sheets)
13. Excavatibility (1 sheet)

Summary:

Kinematic Analysis

There is potential for kinematically admissible failures to occur at the slopes mapped. The summary table (attachment 8) provides information regarding slope numbering, stationing, proposed cut slope height, existing slope inclinations estimated in the field, the evaluated slope inclination and dip directions, percent probability of kinematically admissible failures, and if wedges were formed when evaluated in SWEDGE. The percent probability of failure is not a statistical evaluation, but a way to provide the percentage of points within a kinematically admissible critical zone for failure. This provides a numerical representation that the potential for kinematically admissible failures are present and should be further evaluated.

The rock cut slope inclination of 0.5H:1V does not remove all kinematically admissible failure types. The inclinations were selected if a failure mode was observed as having the same percentage of dip vectors fall within a critical zone at a lower inclination (i.e., 53 degrees) value as the steeper inclination value (i.e., 63 degrees).

For all slopes there is potential for planar failures to occur. Slope RW-4 was modeled using the Rocscience program Slide (2015) for a 17-foot-tall rock cut at a 0.5H:1V inclination. Within the program, anisotropic strengths were used to model a planar failure that may occur out of the slope. The program indicated that the factor of safety was less than 1.0 for a large, planar failure through the rock slope. Given the moderately to highly fractured nature of the slopes however, a planar failure is still likely, but the scale of a planar feature would be limited to the fracture spacing and likely produce

CALCULATION SUMMARY

rocks about 1 to 5 feet in dimension as was observed during our field geological mapping.

Wedge type kinematically admissible failures identified on the stereonets were further evaluated in the Rocscience program SWEDGE (2009). SWEDGE allows the user to evaluate two specific joints in relation to the cut slope dip and dip direction. Evaluation of the two joints with the slope orientation provides an estimate if the wedge observed on the stereonet forms in real space. The program also allows for scaling of the joints. This feature is useful for modeling fractured rock slopes that have other discontinuities truncating the length of an observed feature. The SWEDGE modeling indicated that wedges are likely to form at slopes RW-1, RW-2A, RW-2B, and within the first portion of slope RW-4.

Toppling failures are likely to occur at all of the rock slopes except RW-1 and RW-8. Toppling was not observed as kinematically admissible on the stereonets for RW-1 and RW-8 and is therefore to have a low likelihood for toppling to occur. Toppling failures are the other slopes may occur and will likely be limited to the rock size of about 1 to 5 feet as observed during our field geological mapping.

Global Stability

Global stability cross sections were developed using nearby sections developed in Calculation No. 1 for Development of Cross Sections for RSS and MSE analysis dated 12/14/18. It was assumed that little to no colluvium/slope wash would be present on the slopes after construction was completed. Slope failures modeling an anisotropic strength for plane shear failures indicated that plane shear failures have a factor of safety less than 1 (see discussion of plane shear under Kinematic Analysis). A global stability failure through the rock mass is assumed to not be the main failure mode at the rock cut slopes. Failures will likely be along discontinuities daylighting in the cut slope face.

Rockfall Catchment

Rockfall catchment was based on developed slope charts and are not reflective of actual expected slope height in the field. For a 10-foot-tall slope at a 0.5H:1V slope inclination with a 4H:1V ditch configuration, a ditch width of 2.25 feet is anticipated to contain approximately 80 percent of rockfall.

Rippability

Rippability of the slopes is summarized by Geovision in their report as well as noted on the attached plot. Overall, it is anticipated that ripping can be performed at Slope RW-2B, while blasting will likely be required at the other slopes.

PM Check of Assumptions and Input Properties

Rev No.	Calculation By	Date	Checked By	Date
0	KDD	12/20/2018	RAW	
1	KDD	1/10/2019	RAW	1-21-2019

Table C-2
Reds Meadow Rock Mass Rating Summary Table

Slope	Rock Type	Weathering	Rock Grade	Rock Strength[1] (Mpa)	Rock Strength (psi)	RQD	RMR[2]	GSI[3]
RW 1	Meta-Sedimentary	Moderately	R3	38	5,438	89	68	63
RW 2A	Meta-Sedimentary	Moderately	R3	38	5,510	85	93	88
RW 4	Meta-Volcanic	Moderately	R4	75	10,875	100	100	95
RW 8	Volcanic	Moderately	R4	75	10,875	95	74	69

GSI	
≥76	Very Good
75-56	Good
55-46	Fair
45-16	Poor
≤16	Very Poor

Notes:

1: Rock Strength based on ISRM.

2: Rock Mass Ratings (RMR) assumes no slope rating (Bieniawski, 1989)

3: Geologic Strength Index (GSI) estimated from relationship with RMR (Hoek, 1997)

Geomechanics Classification of Rock Masses

After Z.T. Bieniawski, 1989

General Information

Project:	Reds Meadow Road	**Location:**	RW 1		
Date:	05/16/18	**Depth(ft):**	Begin: N/A	End: N/A	**Photograph?** Yes
Proj. No.:	100062				
Field Personnel	BLC	**Run:**	N/A		**Elev.** N/A

Slope:	**Length**	**Height**	**Dip Direction**	**Dip**
	20.00	12.00	100	80

Rock Material Information

Type:	meta-sedimentary	**Color:**	light reddish brown
Grain Size:	fine	**Strength Vaildity:**	Assessed

Rock Mass Information

Strength of Intact Rock		**RQD, %**		**Discontinuity Spacing, mm**	
Field Description	R3	**Field Remarks**	**Field X** 3	**Low**	200
Mpa	38		**Field Y** 2	**Field Range High**	600
Point Load ?	Y		**Field Z** 3	**Discontinuity Spacing, mm**	400
Uniaxial Compressive ?	N		**RQD, %** 89		
Bieniawski Rating	15	Bieniawski Rating	18	Bieniawski Rating	10

Conditions of Discontinuitites	**Rating**
1. Very rough surfaces, not continuous, no separation, and unweathered rock walls.	**30**
2. Slightly rough surfaces, separation < 1 mm, and slightly weathered walls.	**25**
3. Slightly rough surface, separation < 1 mm, and highly weathered walls.	**20**
4. Slickenslided surfaces -or- gouge (infilling), 1-5 mm thick -or- separation 1-5 mm and continuous.	**10**
5. Soft gouge > 5 mm -or- separation > 5 mm and continuous.	**0**
Bieniawski Rating?	10

Groundwater Conditions	**Rating**
Conditions include:	
A. Inflow per 10 m of tunnel length (L/m).	
B. Ratio of joint water pressure to s_1.	
C. General conditions.	
1. No inflow -or- 0 ratio -or- completely dry.	**15**
2. < 10 L/min -or- < 10 ratio -or- damp.	**10**
3. 10-25 L/min inflow -or- 0.1-0.2 ratio -or- wet.	**7**
4. 22-125 L/min inflow -or- 0.2-0.5 ratio -or- dripping.	**4**
5. > 125 L/min inflow -or- > 0.5 ratio -or- flowing.	**0**
Bieniawski Rating?	15

Rock Mass Rating

Overall RMR	**68**	
Class	**II**	**Good Rock**
GSI	**63**	

This rock exhibits an average standup time of 1 year for a 10 meter horizontal span, 300-400 kPa rock mass cohesion, and a friction angle between 35 and 45 degrees.

Additional Information

		Block Size (feet)		**# of Discontinuity Sets**
Fabric:	Blocky	**Field X**	1	3
Weathering:	moderately	**Field Y**	2	
		Field Z	1	

Geomechanics Classification of Rock Masses

After Z.T. Bieniawski, 1989

General Information

Project:	Reds Meadow Road		**Location:**	RW 2A			
Date:	05/16/18		**Depth(ft):**	Begin	End	**Photograph?**	
Proj. No.:	100062			N/A	N/A	Yes	
Field Personnel	BLC		**Run:**	N/A		**Elev.**	N/A
	Slope:	**Length**	**Height**	**Dip Direction**		**Dip**	
		20.00	10.00	255		76	

Rock Material Information

Type:	meta-sedimentary	**Color:**	light yellowish brown
Grain Size:	fine	**Strength Vaildity:**	Assessed

Rock Mass Information

Strength of Intact Rock		**RQD, %**			**Discontinuity Spacing, mm**	
Field Description	R3	**Field Remarks**	**Field X**	3	**Low**	600
Mpa	38		**Field Y**	4	**Field Range High**	6000
Point Load ?	Y		**Field Z**	2	**Discontinuity Spacing, mm**	3300
Uniaxial Compressive ?	N		**RQD, %**	85		
Bieniawski Rating	15	Bieniawski Rating		17	Bieniawski Rating	36

Conditions of Discontinuitites	**Rating**
1. Very rough surfaces, not continuous, no separation, and unweathered rock walls.	**30**
2. Slightly rough surfaces, separation < 1 mm, and slightly weathered walls.	**25**
3. Slightly rough surface, separation < 1 mm, and highly weathered walls.	**20**
4. Slickenslided surfaces -or- gouge (infilling), 1-5 mm thick -or- separation 1-5 mm and continuous.	**10**
5. Soft gouge > 5 mm -or- separation > 5 mm and continuous.	**0**
Bieniawski Rating?	**10**

Groundwater Conditions	**Rating**
Conditions include:	
A. Inflow per 10 m of tunnel length (L/m).	
B. Ratio of joint water pressure to s_1.	
C. General conditions.	
1. No inflow -or- 0 ratio -or- completely dry.	**15**
2. < 10 L/min -or- < 10 ratio -or- damp.	**10**
3. 10-25 L/min inflow -or- 0.1-0.2 ratio -or- wet.	**7**
4. 22-125 L/min inflow -or- 0.2-0.5 ratio -or- dripping.	**4**
5. > 125 L/min inflow -or- > 0.5 ratio -or- flowing.	**0**
Bieniawski Rating?	**15**

Rock Mass Rating

Overall RMR	**93**	
Class	**I**	**Very Good Rock**
GSI	**88**	

This rock exhibits an average standup time of 20 years for a 15 meter horizontal span, greater than 400 kPa rock mass cohesion, and friction angle greater than 45 degrees.

Additional Information

		Block Size (feet)		**# of Discontinuity Sets**
Fabric:	Blocky	**Field X**	3.5	3
Weathering:	moderately	**Field Y**	4	
		Field Z	1.5	

Geomechanics Classification of Rock Masses

After Z.T. Bieniawski, 1989

General Information

Project:	Reds Meadow Road	**Location:**	RW 4		
Date:	05/16/18	**Depth(ft):**	Begin: N/A	End: N/A	**Photograph?** Yes
Proj. No.:	100062				
Field Personnel	CLZ	**Run:**	N/A		**Elev.** N/A
Slope:	**Length** 40.00	**Height**	**Dip Direction** 225		**Dip** 66

Rock Material Information

Type:	meta-volcanic	**Color:**	light reddish yellow
Grain Size:	medium	**Strength Vaildity:**	Assessed

Rock Mass Information

Strength of Intact Rock		**RQD, %**		**Discontinuity Spacing, mm**	
Field Description	R4	**Field Remarks**	**Field X** 1	**Low**	2000
Mpa	75		**Field Y** 0	**Field Range High**	6000
Point Load ?	Y		**Field Z** 1	**Discontinuity Spacing, mm**	4000
Uniaxial Compressive ?	N		**RQD, %** 100		
Bieniawski Rating	15	Bieniawski Rating	20	Bieniawski Rating	81

Conditions of Discontinuitites	**Rating**
1. Very rough surfaces, not continuous, no separation, and unweathered rock walls.	**30**
2. Slightly rough surfaces, separation < 1 mm, and slightly weathered walls.	**25**
3. Slightly rough surface, separation < 1 mm, and highly weathered walls.	**20**
4. Slickenslided surfaces -or- gouge (infilling), 1-5 mm thick -or- separation 1-5 mm and continuous.	**10**
5. Soft gouge > 5 mm -or- separation > 5 mm and continuous.	**0**
Bieniawski Rating?	10

Groundwater Conditions	**Rating**
Conditions include:	
A. Inflow per 10 m of tunnel length (L/m),	
B. Ratio of joint water pressure to s_1,	
C. General conditions.	
1. No inflow -or- 0 ratio -or- completely dry.	**15**
2. < 10 L/min -or- < 10 ratio -or- damp.	**10**
3. 10-25 L/min inflow -or- 0.1-0.2 ratio -or- wet.	**7**
4. 22-125 L/min inflow -or- 0.2-0.5 ratio -or- dripping.	**4**
5. > 125 L/min inflow -or- > 0.5 ratio -or- flowing.	**0**
Bieniawski Rating?	8

Rock Mass Rating

Overall RMR	100	
Class	I	Very Good Rock
GSI	95	

This rock exhibits an average standup time of 20 years for a 15 meter horizontal span, greater than 400 kPa rock mass cohesion, and friction angle greater than 45 degrees.

Additional Information

		Block Size (feet)		**# of Discontinuity Sets**
Fabric:	Blocky	**Field X**	6	5
Weathering:	moderately	**Field Y**	6	
		Field Z	3	

Geomechanics Classification of Rock Masses

After Z.T. Bieniawski, 1989

General Information

Project:	Reds Meadow Road	**Location:**	RW 8		
Date:	05/16/18	**Depth(ft):**	Begin	End	**Photograph?**
Proj. No.:	100062		N/A	N/A	Yes
Field Personnel	CLZ	**Run:**	N/A		**Elev.** N/A

Slope:	**Length**	**Height**	**Dip Direction**	**Dip**
	40.00	20.00	230	73

Rock Material Information

Type:	volcanic	**Color:**	light bluish grey
Grain Size:	medium to fine	**Strength Vaildity:**	Assessed

Rock Mass Information

Strength of Intact Rock		**RQD, %**		**Discontinuity Spacing, mm**	
Field Description	R4	**Field Remarks**	**Field X** 4	**Low**	200
Mpa	75		**Field Y** 1	**Field Range High**	2000
Point Load ?	Y		**Field Z** 1	**Discontinuity Spacing, mm**	1100
Uniaxial Compressive ?	N		**RQD, %** 95		
Bieniawski Rating	15	Bieniawski Rating	19	Bieniawski Rating	15

Conditions of Discontinuitites	**Rating**
1. Very rough surfaces, not continuous, no separation, and unweathered rock walls.	**30**
2. Slightly rough surfaces, separation < 1 mm, and slightly weathered walls.	**25**
3. Slightly rough surface, separation < 1 mm, and highly weathered walls.	**20**
4. Slickenslided surfaces -or- gouge (infilling), 1-5 mm thick -or- separation 1-5 mm and continuous.	**10**
5. Soft gouge > 5 mm -or- separation > 5 mm and continuous.	**0**
Bieniawski Rating?	10

Groundwater Conditions	**Rating**
Conditions include: A. Inflow per 10 m of tunnel length (L/m). B. Ratio of joint water pressure to s_1, C. General conditions.	
j	**15**
2. < 10 L/min -or- < 10 ratio -or- damp.	**10**
3. 10-25 L/min inflow -or- 0.1-0.2 ratio -or- wet.	**7**
4. 22-125 L/min inflow -or- 0.2-0.5 ratio -or- dripping.	**4**
5. > 125 L/min inflow -or- > 0.5 ratio -or- flowing.	**0**
Bieniawski Rating?	15

Rock Mass Rating

Overall RMR	74	
Class	II	Good Rock
GSI	69	

This rock exhibits an average standup time of 1 year for a 10 meter horizontal span, 300-400 kPa rock mass cohesion, and a friction angle between 35 and 45 degrees.

Additional Information

		Block Size (feet)		**# of Discontinuity Sets**
Fabric:	Blocky	**Field X**	2-Jan	4
Weathering:	moderately	**Field Y**	1.5	
		Field Z	1	

Kinematic Analysis

1/8/2018
KDD

0.5H:1V Slope Inclination

Slope	Approximate Station Range	Maximum Slope Height (ft)	Existing Slope Inclination (degrees)	Combined Windows	Dip Direction (degrees)	% Probability of Failure (All Planes)[1] Planar[2]	Wedge[3]	Toppling	Wedge Formed (Yes/No)	Joints Forming Wedge	FOS from SWEDGE	Joints Forming Wedge	FOS from SWEDGE	Joints Forming Wedge	FOS from SWEDGE	Joints Forming Wedge	FOS from SWEDGE	Joints Forming Wedge	FOS from SWEDGE	Joints Forming Wedge	FOS from SWEDGE	Joints Forming Wedge	FOS from SWEDGE	Joints Forming Wedge	FOS from SWEDGE	Joints Forming Wedge	FOS from SWEDGE
RW 1	15+15 to 16+50	6	63		157	4.76	16.67	0.00	Yes	j1 &j4	0.7																
RW 2A	38+20 to 40+50	4	76		207	6.06	10.00	12.12	Yes	j1 & j3	1.19																
RW 2B	41+40 to 47+10	8	70 84		263	3.23	10.00	15.15	No																		
					257	4.84	10.00	8.06	Yes	j4 &j5	1.44																
RW 4	80+20 to 84+25 and 86+40 to 90+10	17	60-78	1 thru 5	223	13.64	21.43	18.18		j1&j2	0.59	j1&j3	1.32	j1&j4	NA	j1&j5	1.4	j1&j8	0.59	j2&j8	0.88						
					228	14.77	25.00	18.18		j1&j2	0.59	j1&j3	1.32	j1&j4	NA	j1&j5	1.4	j1&j7	0.59	j1&j8	0.59	j2&j8	0.88				
					243	15.91	28.57	14.77		j1&j2	1.65	j1&j3	0.59	j1&j4	NA	j1&j5	0.59	j1&j7	2.17	j1&j8	0.82	j2&j8	0.88	j7&j8	NA		
				6 and 7	243	17.39	26.67	17.39		j1&j3	1	j1&j5	1	j1&j5	1	j3&j6	1.61										
					253	15.22	26.67	4.35		j1&j3	1	j1&j5	1	j1&j5	1	j3&j6	1.61										
				8 thru 10	239	5.08	0.00	11.86																			
					246	5.08	0.00	10.17																			
					263	5.08	0.00	5.08																			
RW 8	132+23 to 135+12	18	70-85		253	10.81	0.00	0.00																			
					233	13.51	0.00	0.00																			

Notes:

1. Percent Probability of Failure assumes the number of poles within the critical zone is divided by the total number of poles within the data set and gives a percentage. For example, a data set with 20 poles in the critical zone has a 13.33% probability of failure if there are a total of 150 poles in the data set. This is NOT a statistical analysis of the data, but an indication that kinematically admissable failures are possible within the critical zone identified.

2. Planar analysis assumes lateral limits to be 20 degrees based on direction from Rocscience Dips and Goodman, 1980.

3. Flexural toppling analysis assumes lateral limits to be 30 degrees based on direction from Rocscience Dips and Goodman, 1980.

Reds Meadow
Kinematic Analysis Friction Angle Variation Summary

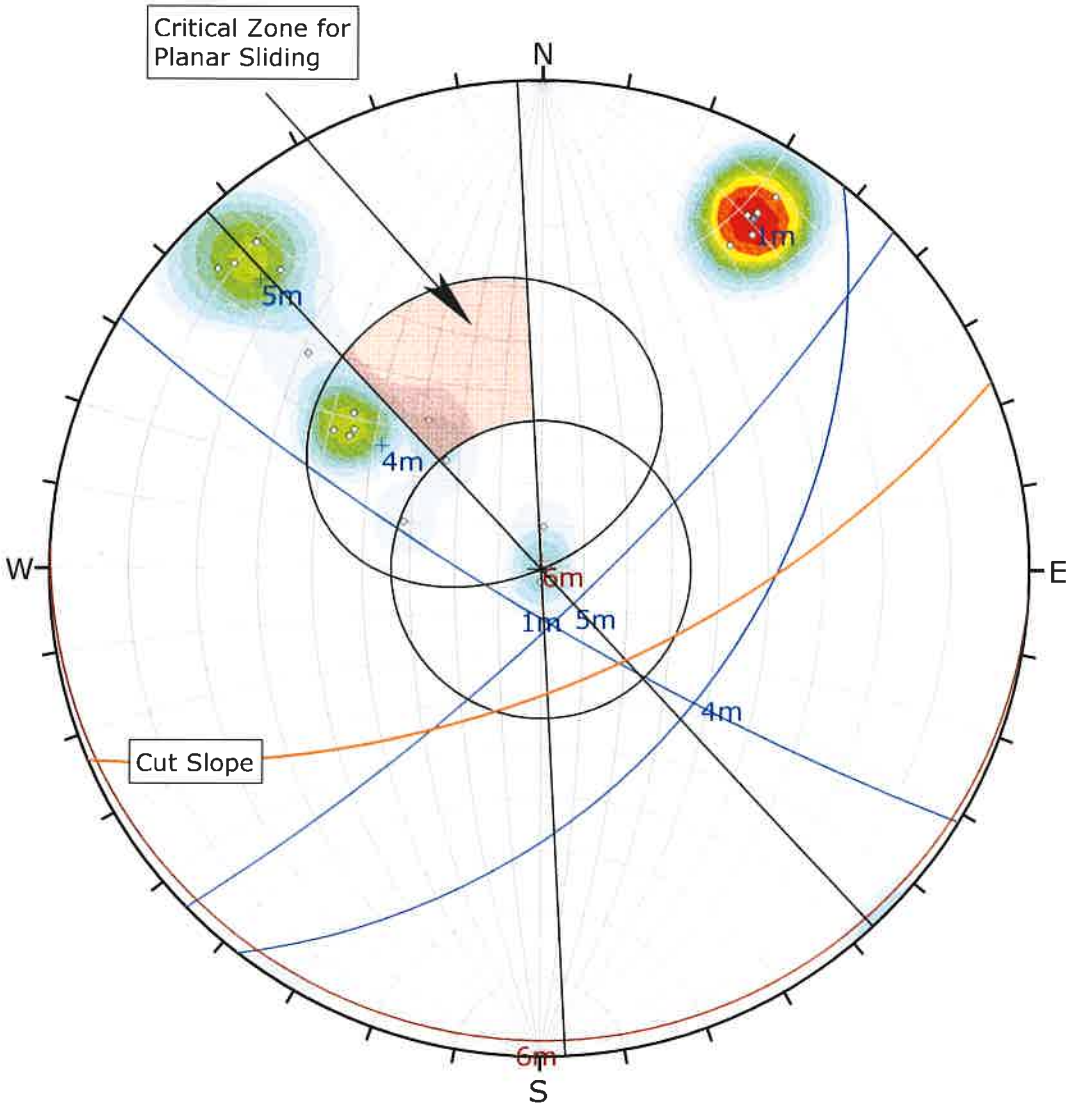
1/7/2019
KDD

Slope	Approximate Station Range	Maximum Slope Height (ft)	Proposed Slope Inclincation (degrees)	Combined Windows	Dip Direction (degrees)	20 degree friction angle % Probability of Failure (All Planes)[1]			34 degree friction angle % Probability of Failure (All Planes)[1]			40 degree friction angle % Probability of Failure (All Planes)[1]			Largest difference		
						Planar[2]	Wedge[3]	Toppling	Planar[2]	Wedge[3]	Toppling	Planar[2]	Wedge[3]	Toppling	Planar[2]	Wedge[3]	Toppling
RW 1	15+15 to 16+50	6	63		157	9.52	16.67	0.00	4.76	16.67	0.00	4.76	16.67	0.00	4.76	0.00	0.00
RW 2A	38+20 to 40+50	4	63		207	6.06	10.00	18.18	6.06	10.00	12.12	6.06	10.00	15.15	0.00	0.00	3.03
RW 2B[4]	41+40 to 47+10	8	63		263	6.45	20.00	8.06	3.23	10.00	8.06	1.61	0.00	8.06	4.84	20.00	0.00
					257	9.68	20.00	8.06	4.84	10.00	8.06	1.61	0.00	8.06	8.07	20.00	0.00
RW 4	80+20 to 84+25 and 86+40 to 90+10	17	63	1 thru 5	223	15.91	35.71	19.32	13.64	21.43	18.18	9.09	17.86	14.77	6.82	17.85	4.55
					228	17.05	39.29	19.32	14.77	25.00	18.18	10.23	21.43	14.77	6.82	17.86	4.55
					243	17.05	46.43	14.77	15.91	28.57	14.77	12.50	28.57	10.23	4.55	17.86	4.54
				6 and 7	243	26.09	46.67	17.39	17.39	26.67	17.39	13.04	0.00	13.04	13.05	46.67	4.35
					253	21.74	40.00	4.35	15.22	26.67	4.35	10.87	0.00	2.17	10.87	40.00	2.18
				8 thru 10	239	16.95	50.00	11.86	5.08	0.00	11.86	0.00	0.00	10.17	16.95	50.00	1.69
					246	16.95	50.00	10.17	5.08	0.00	10.17	0.00	0.00	8.47	16.95	50.00	1.70
					263	16.95	66.67	5.08	5.08	0.00	5.08	0.00	0.00	3.39	16.95	66.67	1.69
RW 8	132+23 to 135+12	18	53		253	18.92	50.00	0.00	10.81	0.00	0.00	2.70	0.00	0.00	16.22	50.00	0.00
					233	16.22	50.00	8.11	13.51	0.00	0.00	5.41	0.00	0.00	10.81	50.00	8.11

Notes:

1. Percent Probability of Failure assumes the number of poles within the critical zone is divided by the total number of poles within the data set and gives a percentage. For example, a data set with 20 poles in the critical zone has a 13.33% probability of failure if there are a total of 150 poles in the data set.
2. Planar analysis assumes lateral limits to be 20 degrees based on direction from Rocscience Dips and Goodman, 1980.
3. Flexural toppling analysis assumes lateral limits to be 30 degrees based on direction from Rocscience Dips and Goodman, 1980.
4. A phi angle of 27 degrees was used for this slope.

Slope RW-1



Symbol	Feature
◇	Pole Vectors

Color	Density Concentrations
	0.00 - 2.80
	2.80 - 5.60
	5.60 - 8.40
	8.40 - 11.20
	11.20 - 14.00
	14.00 - 16.80
	16.80 - 19.60
	19.60 - 22.40
	22.40 - 25.20
	25.20 - 28.00

Contour Data	Pole Vectors
Maximum Density	27.43%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Planar Sliding
Slope Dip	63
Slope Dip Direction	157
Friction Angle	34°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	1	21	4.76%
Planar Sliding (Set 4)	1	7	14.29%

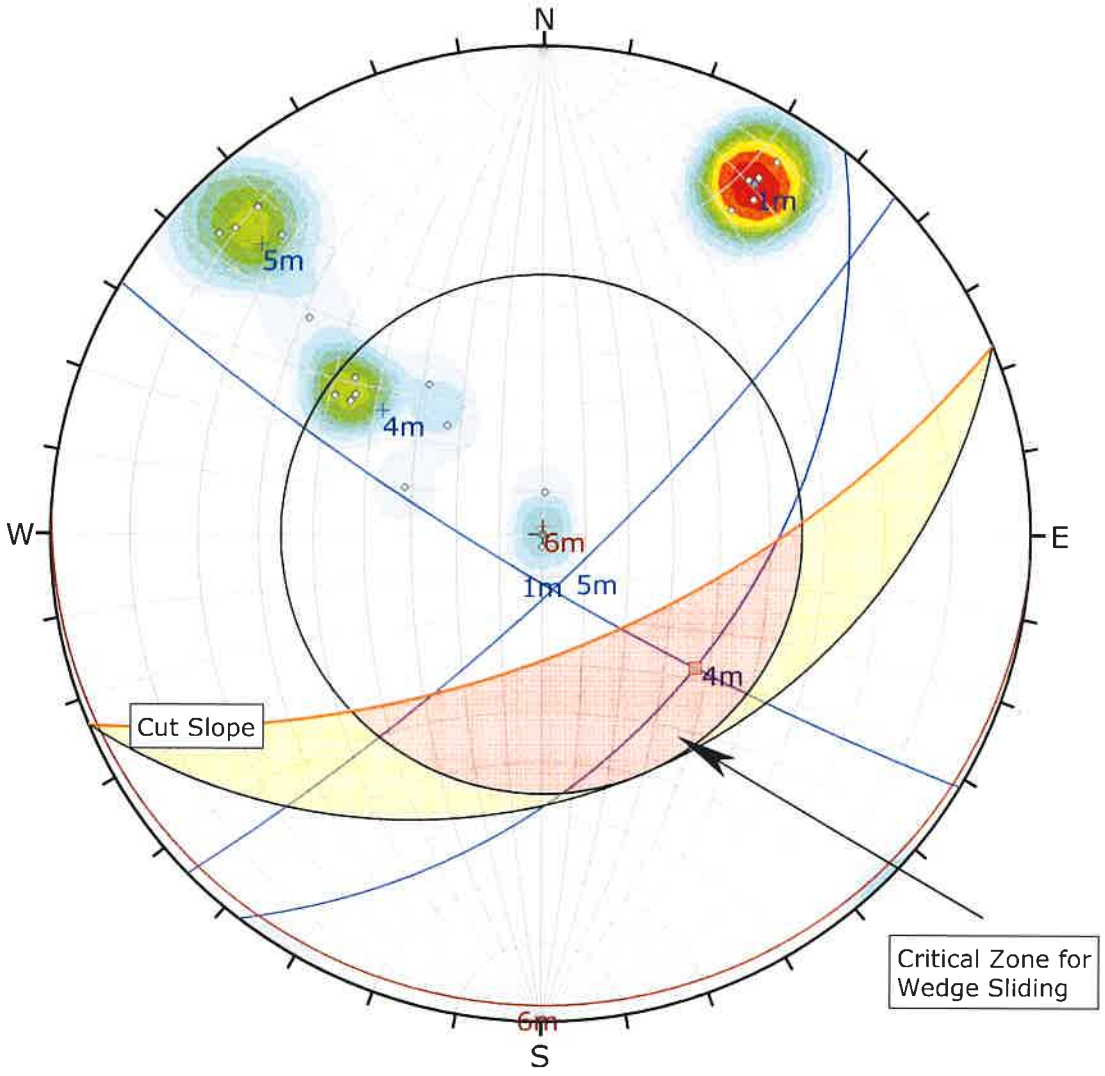
	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		80	211	
4m		45	128	
5m		79	136	
6m		2	183	

Plot Mode	Pole Vectors
Vector Count	21 (21 Entries)
Hemisphere	Lower
Projection	Equal Angle

rocscience

DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic Analysis		
Drawn By	KDD	*Company*	Shannon & Wilson
Date	1/10/2019	*File Name*	Slope RW1_70 percent_.dips7



Symbol	Feature
◇	Pole Vectors
▭	Critical Intersection

Color	Density Concentrations
	0.00 - 2.80
	2.80 - 5.60
	5.60 - 8.40
	8.40 - 11.20
	11.20 - 14.00
	14.00 - 16.80
	16.80 - 19.60
	19.60 - 22.40
	22.40 - 25.20
	25.20 - 28.00

Contour Data	Pole Vectors
Maximum Density	27.43%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Wedge Sliding
Slope Dip	63
Slope Dip Direction	157
Friction Angle	34°

	Critical	Total	%
Wedge Sliding	1	6	16.67%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		80	211	
4m		45	128	
5m		79	136	
6m		2	183	

Plot Mode	Pole Vectors
Vector Count	21 (21 Entries)
Intersection Mode	User and Mean Set Planes
Intersections Count	6
Hemisphere	Lower
Projection	Equal Angle

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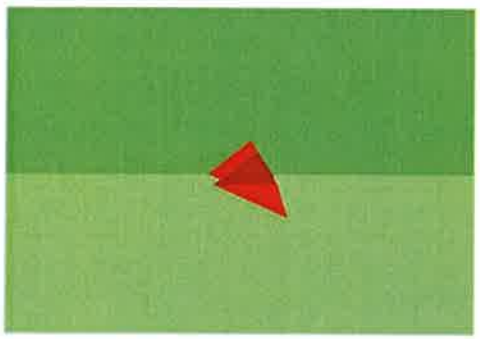
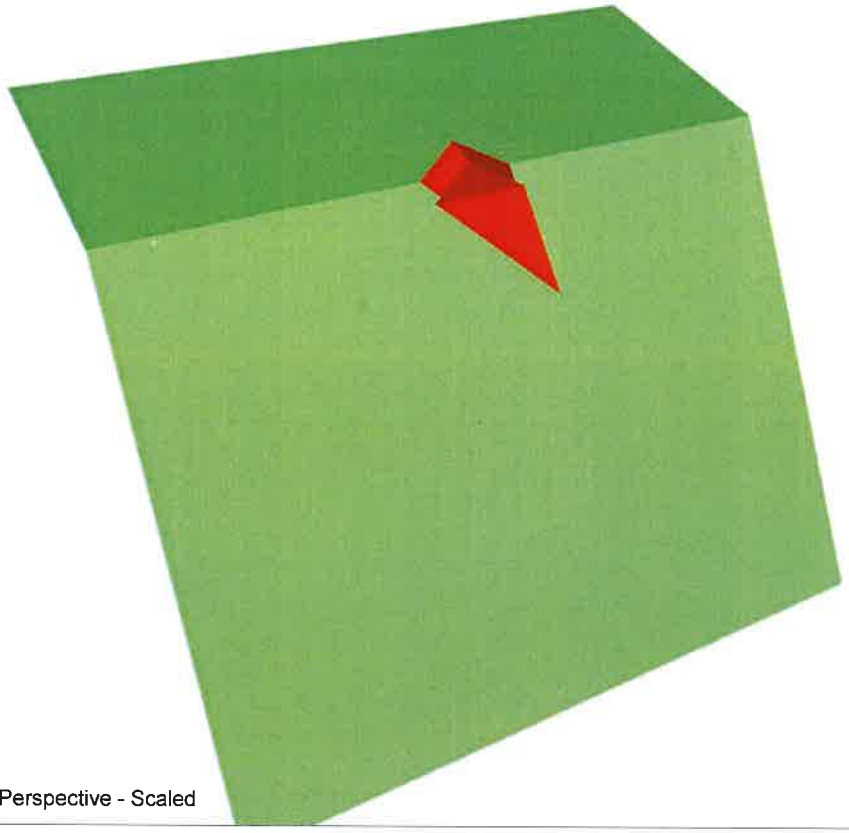
DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic Analysis		
Drawn By	KDD	*Company*	Shannon & Wilson
Date	1/10/2019	*File Name*	Slope RW1_70 percent_.dips7

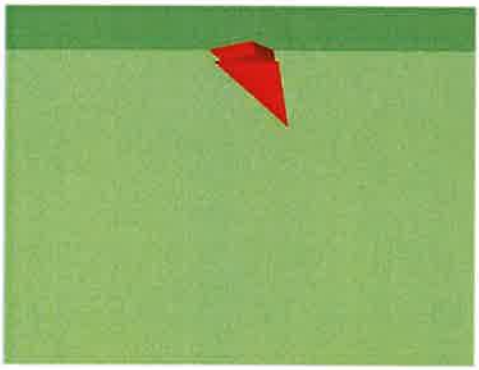
Factor of Safety: 0.70



Top - Scaled



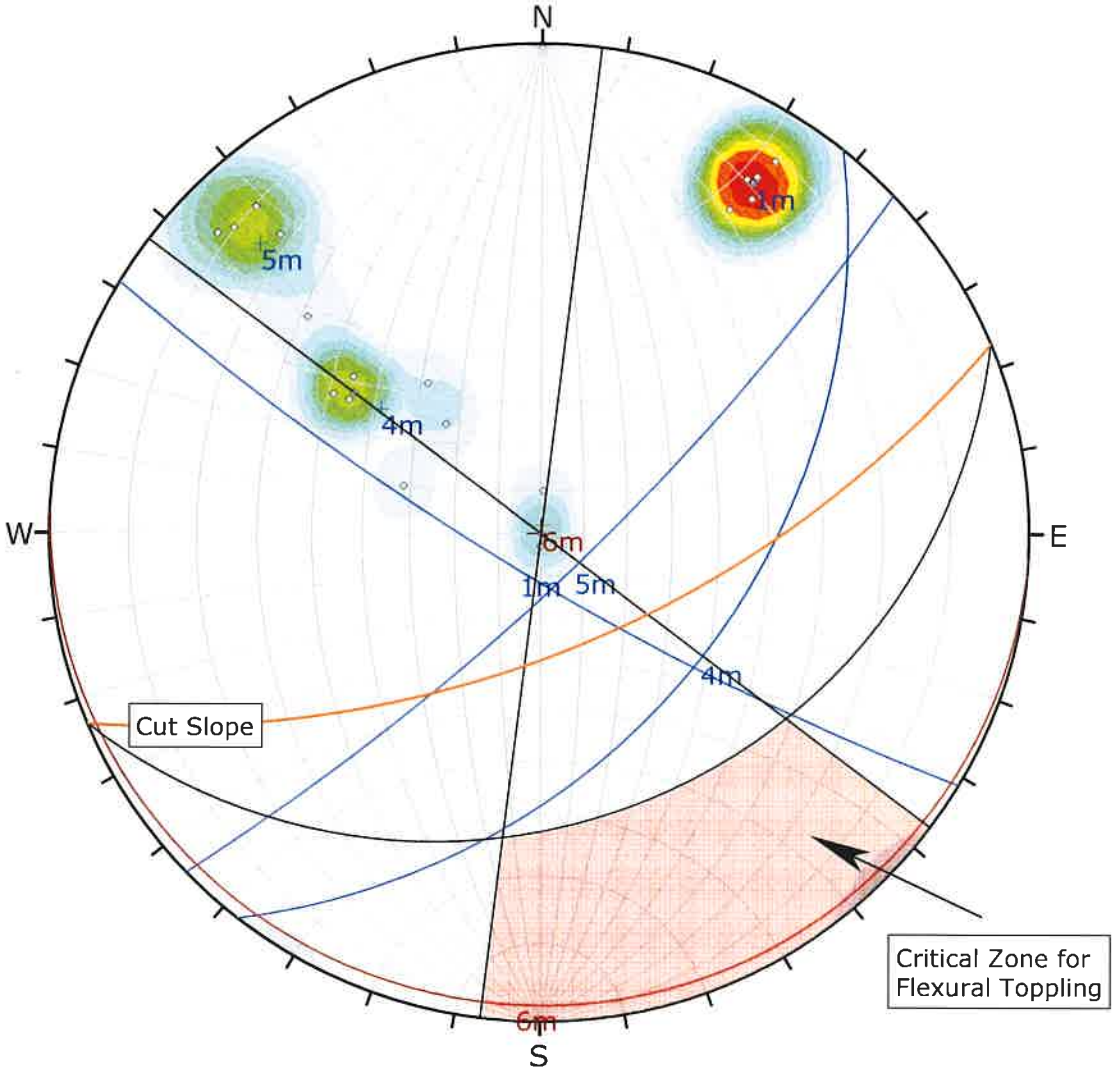
Perspective - Scaled



Front - Scaled

Side - Scaled

rocscience	Project	Reds Meadow	
	Analysis Description	SWEDGE - Surface Wedge Stability Analysis	
	Drawn By	KDD	Company: Shannon & Wilson
SWEDGE 6.018	Date	1/10/2019, 2:03:10 PM	File Name: Swedge_RW 1_j1&j4.swd



Symbol	Feature
◦	Pole Vectors

Color	Density Concentrations
	0.00 - 2.80
	2.80 - 5.60
	5.60 - 8.40
	8.40 - 11.20
	11.20 - 14.00
	14.00 - 16.80
	16.80 - 19.60
	19.60 - 22.40
	22.40 - 25.20
	25.20 - 28.00

Contour Data	Pole Vectors
Maximum Density	27.43%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Flexural Toppling
Slope Dip	63
Slope Dip Direction	157
Friction Angle	34°
Lateral Limits	30°

	Critical	Total	%
Flexural Toppling (All)	0	21	0.00%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		80	211	
4m		45	128	
5m		79	136	
6m		2	183	

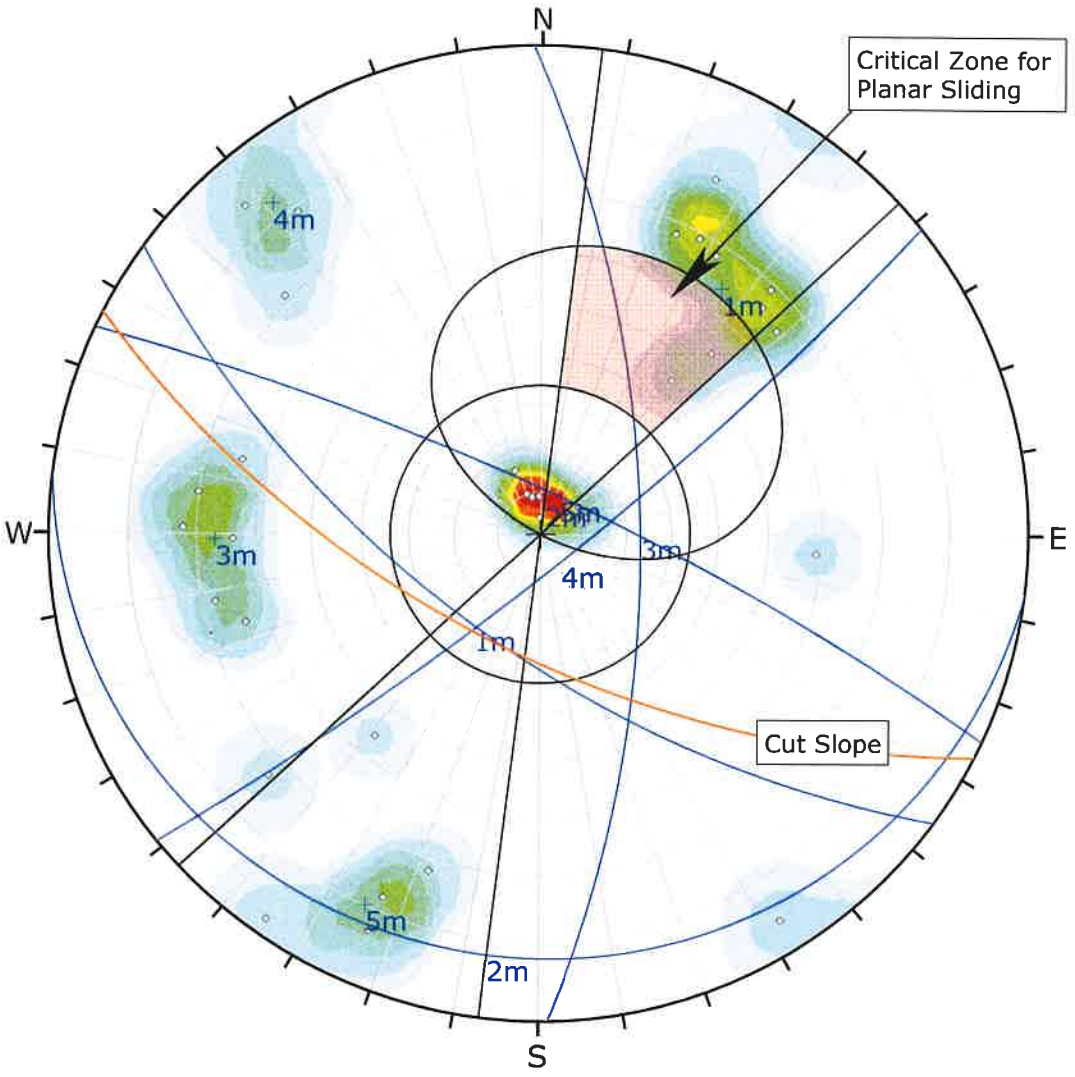
Plot Mode	Pole Vectors
Vector Count	21 (21 Entries)
Hemisphere	Lower
Projection	Equal Angle

rocscience

DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic Analysis		
Drawn By	KDD	*Company*	Shannon & Wilson
Date	1/10/2019	*File Name*	Slope RW1_70 percent_.dips7

Slope RW-2A



Symbol	Feature
◇	Pole Vectors

Color	Density Concentrations
	0.00 - 1.40
	1.40 - 2.80
	2.80 - 4.20
	4.20 - 5.60
	5.60 - 7.00
	7.00 - 8.40
	8.40 - 9.80
	9.80 - 11.20
	11.20 - 12.60
	12.60 - 14.00

Contour Data	Pole Vectors
Maximum Density	13.55%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Planar Sliding
Slope Dip	63
Slope Dip Direction	207
Friction Angle	34°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	2	33	6.06%
Planar Sliding (Set 1)	2	9	22.22%

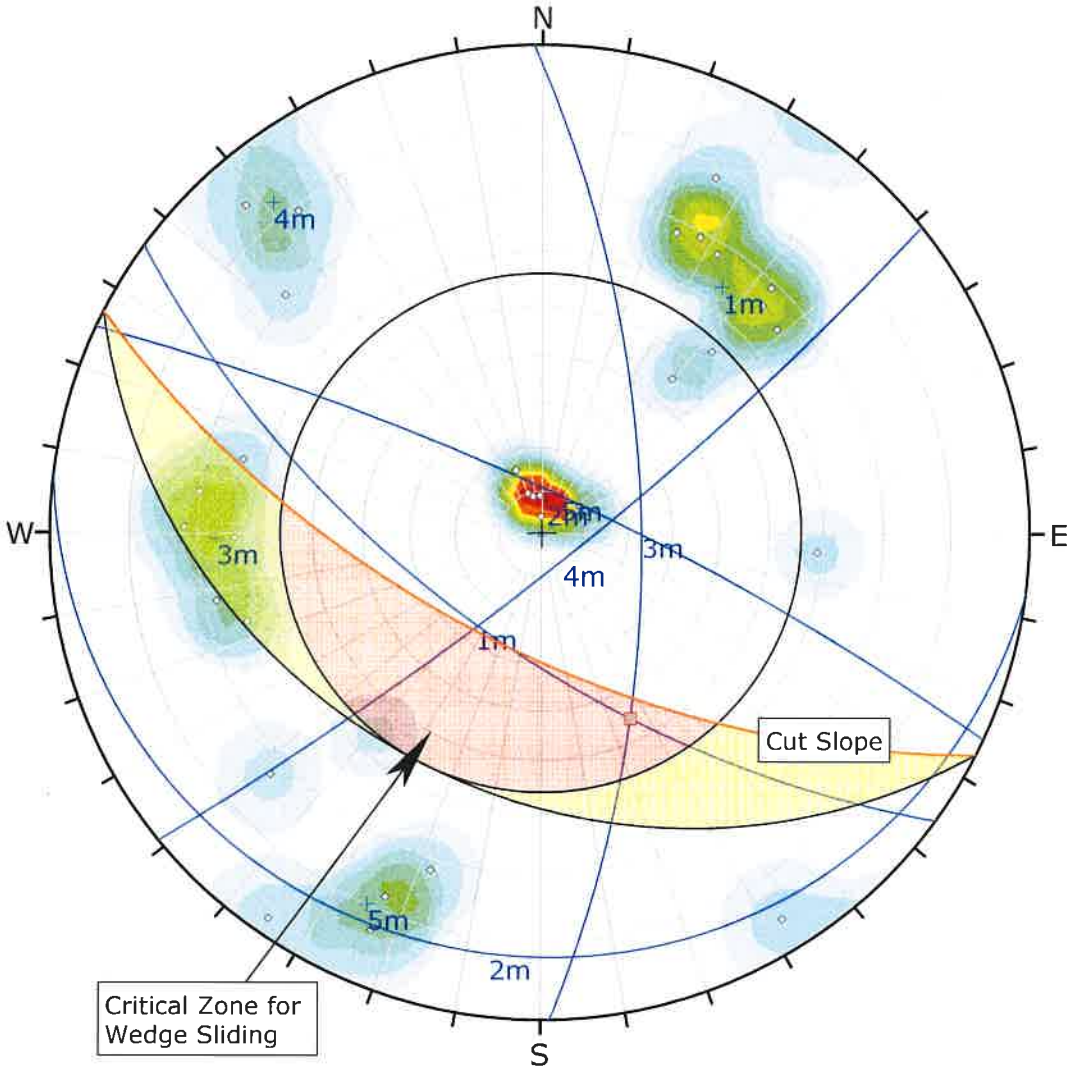
	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		64	216	
2m		8	187	
3m		67	89	
4m		82	141	
5m		80	25	

Plot Mode	Pole Vectors
Vector Count	33 (33 Entries)
Hemisphere	Lower
Projection	Equal Angle

rocscience

DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic Analysis		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/10/2019	*File Name*	Slope RW 2a_70 percent_.dips7



Symbol	Feature
◇	Pole Vectors
▒	Critical Intersection

Color	Density Concentrations
	0.00 - 1.40
	1.40 - 2.80
	2.80 - 4.20
	4.20 - 5.60
	5.60 - 7.00
	7.00 - 8.40
	8.40 - 9.80
	9.80 - 11.20
	11.20 - 12.60
	12.60 - 14.00

Contour Data	Pole Vectors
Maximum Density	13.55%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Wedge Sliding
Slope Dip	63
Slope Dip Direction	207
Friction Angle	34°

	Critical	Total	%
Wedge Sliding	1	10	10.00%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		64	216	
2m		8	187	
3m		67	89	
4m		82	141	
5m		80	25	

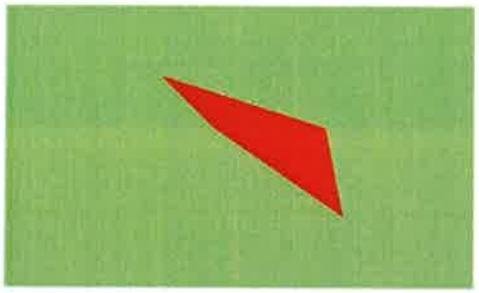
Plot Mode	Pole Vectors
Vector Count	33 (33 Entries)
Intersection Mode	User and Mean Set Planes
Intersections Count	10
Hemisphere	Lower
Projection	Equal Angle

rocscience

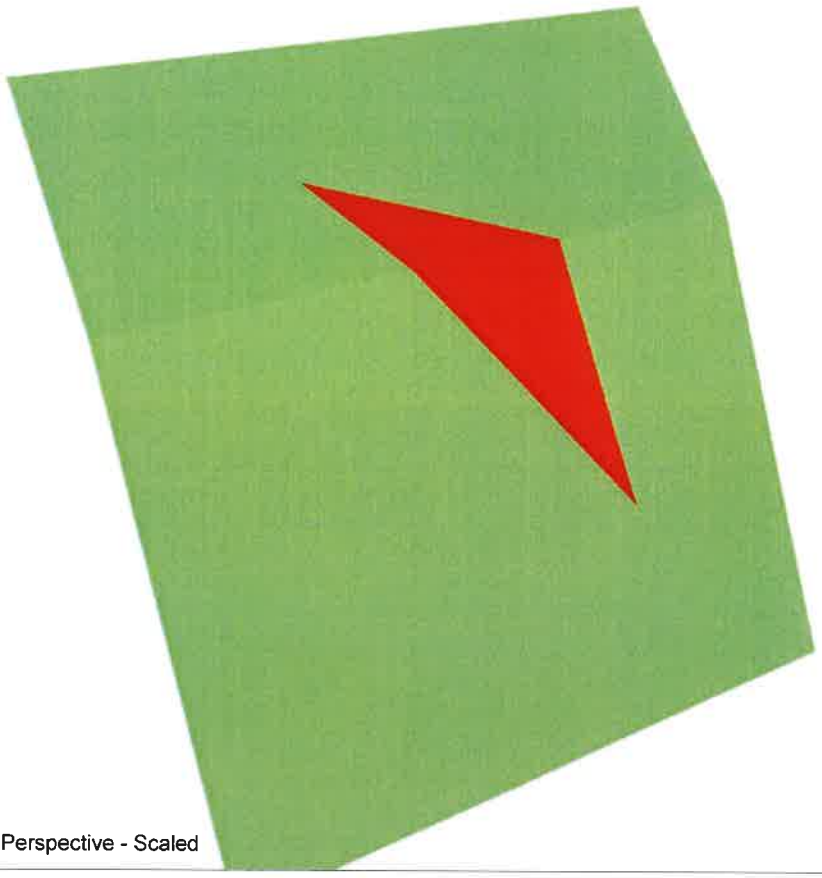
DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic Analysis		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/10/2019	*File Name*	Slope RW 2a_70 percent_.dips7

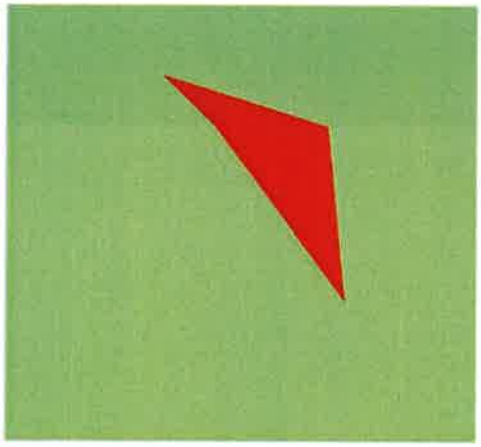
Factor of Safety: 1.19



Top - Scaled



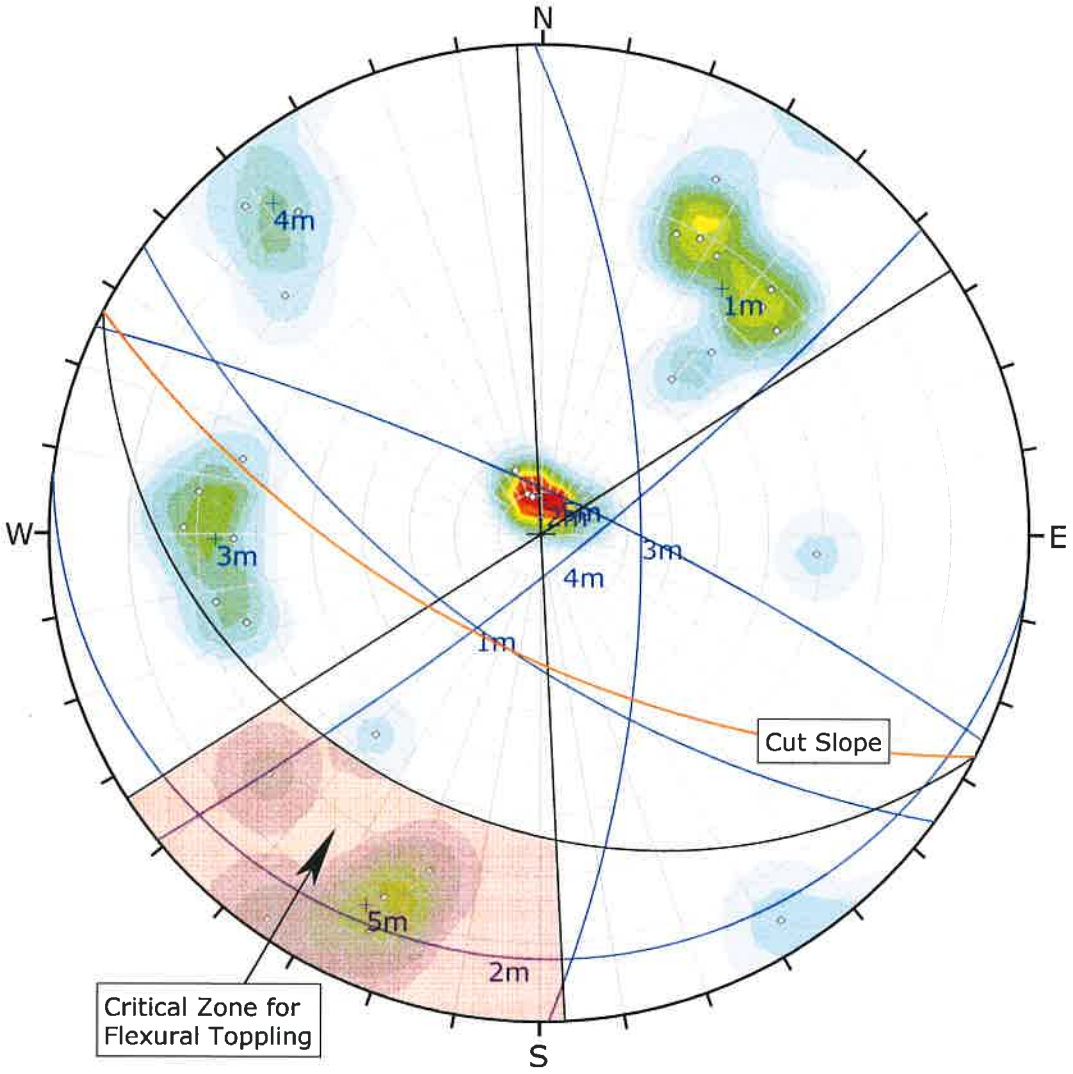
Perspective - Scaled



Front - Scaled

Side - Scaled

rocscience	Project	Reds Meadow	
	Analysis Description	SWEDGE - Surface Wedge Stability Analysis	
	Drawn By	KDD	Company: Shannon & Wilson Inc
SWEDGE 6.018	Date	1/10/2019, 3:28:47 PM	File Name: Swedge_RW 2A_j1&j3.swd



Symbol	Feature
◇	Pole Vectors

Color	Density Concentrations
	0.00 - 1.40
	1.40 - 2.80
	2.80 - 4.20
	4.20 - 5.60
	5.60 - 7.00
	7.00 - 8.40
	8.40 - 9.80
	9.80 - 11.20
	11.20 - 12.60
	12.60 - 14.00

Contour Data	Pole Vectors
Maximum Density	13.55%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Flexural Toppling
Slope Dip	63
Slope Dip Direction	207
Friction Angle	34°
Lateral Limits	30°

	Critical	Total	%
Flexural Toppling (All)	5	33	15.15%
Flexural Toppling (Set 5)	4	4	100.00%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		64	216	
2m		8	187	
3m		67	89	
4m		82	141	
5m		80	25	

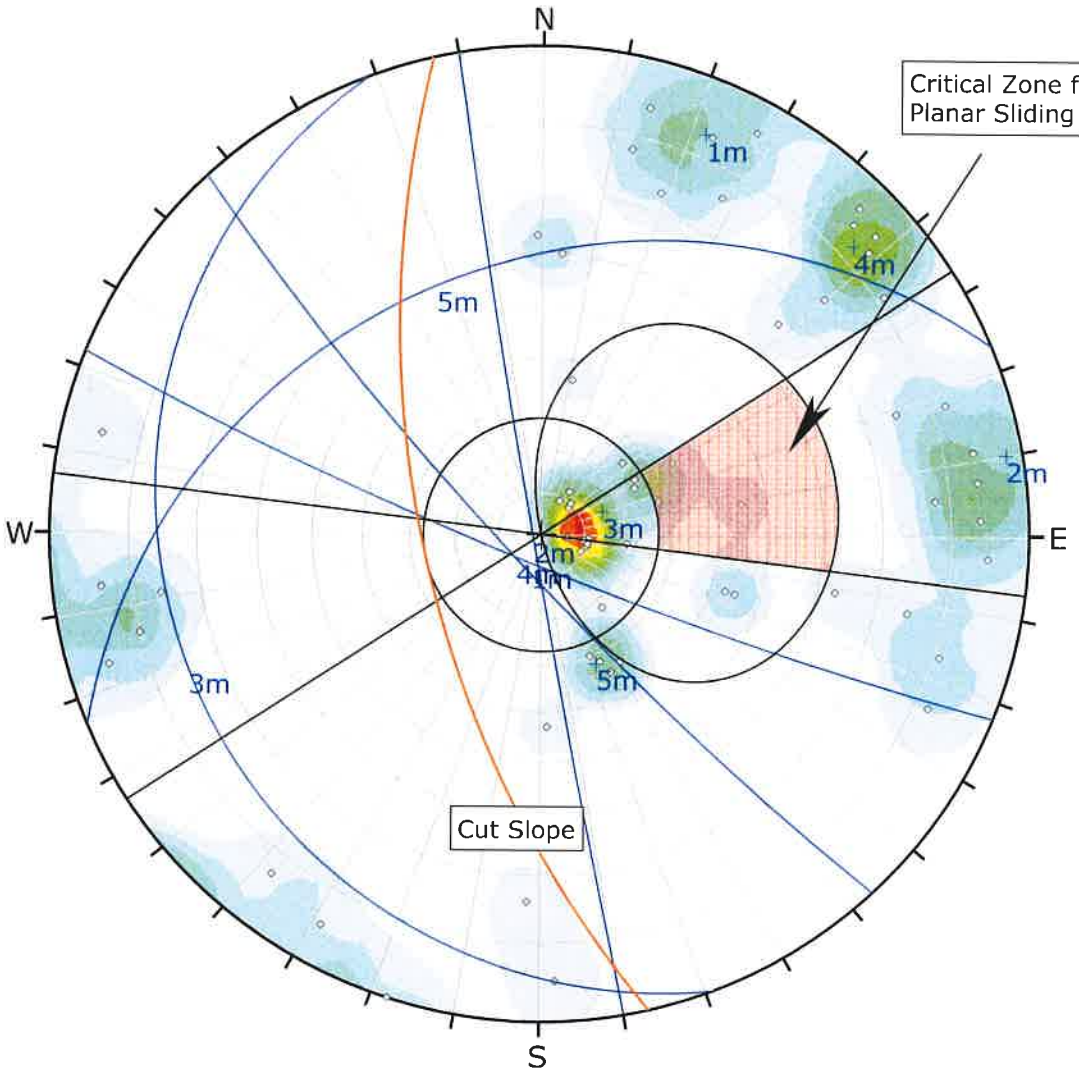
Plot Mode	Pole Vectors
Vector Count	33 (33 Entries)
Hemisphere	Lower
Projection	Equal Angle

rocscience

DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic Analysis		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/10/2019	*File Name*	Slope RW 2a_70 percent_.dips7

Slope RW-2B



Symbol	Feature
○	Pole Vectors

Color	Density Concentrations
	0.00 - 1.30
	1.30 - 2.60
	2.60 - 3.90
	3.90 - 5.20
	5.20 - 6.50
	6.50 - 7.80
	7.80 - 9.10
	9.10 - 10.40
	10.40 - 11.70
	11.70 - 13.00

Contour Data	Pole Vectors
Maximum Density	12.44%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Planar Sliding
Slope Dip	63
Slope Dip Direction	257
Friction Angle	27°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	3	62	4.84%
Planar Sliding (Set 3)	2	16	12.50%

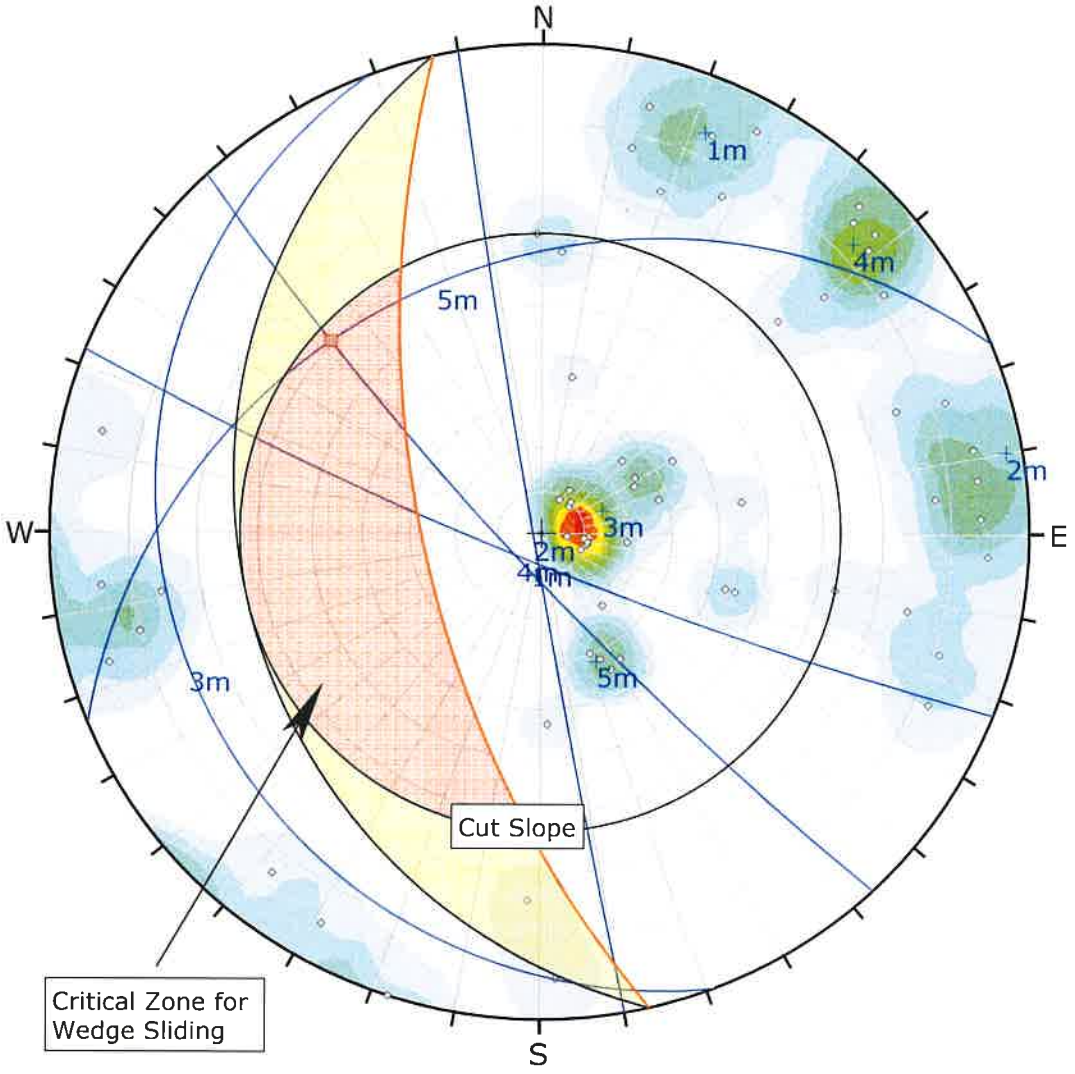
	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		83	202	
2m		88	260	
3m		15	249	
4m		82	227	
5m		32	337	

Plot Mode	Pole Vectors
Vector Count	62 (62 Entries)
Hemisphere	Lower
Projection	Equal Angle

rocscience

DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic Analysis		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/10/2019	*File Name*	Slope RW 2b_70 percent_DD 257.dips7



Symbol	Feature
○	Pole Vectors
▒	Critical Intersection

Color	Density Concentrations
	0.00 - 1.30
	1.30 - 2.60
	2.60 - 3.90
	3.90 - 5.20
	5.20 - 6.50
	6.50 - 7.80
	7.80 - 9.10
	9.10 - 10.40
	10.40 - 11.70
	11.70 - 13.00

Contour Data	Pole Vectors
Maximum Density	12.44%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Wedge Sliding
Slope Dip	63
Slope Dip Direction	257
Friction Angle	27°

	Critical	Total	%
Wedge Sliding	1	10	10.00%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		83	202	
2m		88	260	
3m		15	249	
4m		82	227	
5m		32	337	

Plot Mode	Pole Vectors
Vector Count	62 (62 Entries)
Intersection Mode	User and Mean Set Planes
Intersections Count	10
Hemisphere	Lower
Projection	Equal Angle

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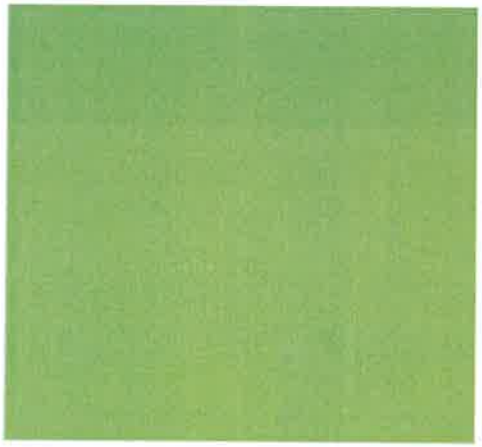
DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic Analysis		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/10/2019	*File Name*	Slope RW 2b_70 percent_DD 257.dips7

Top - Scaled

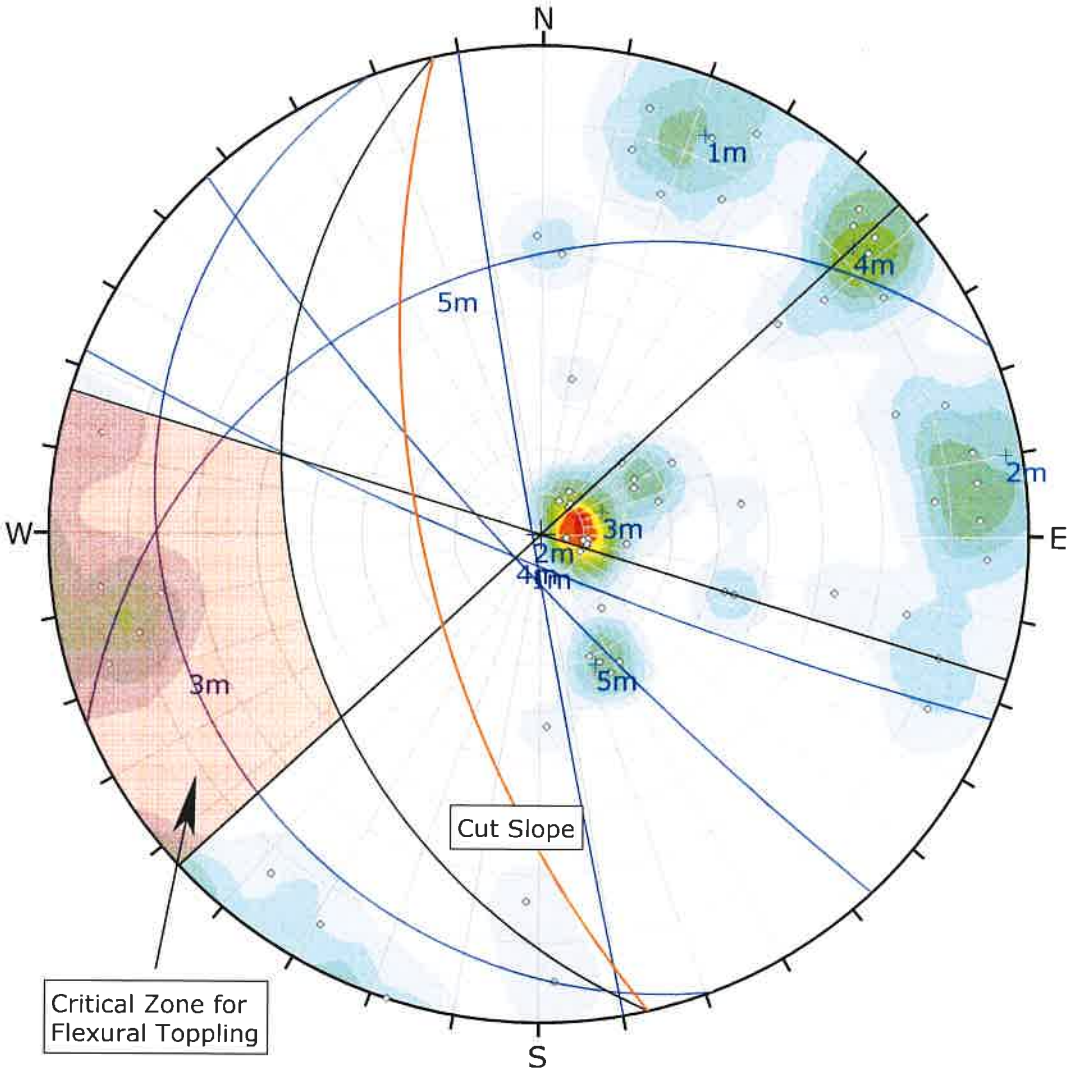
Perspective - Scaled



Front - Scaled

Side - Scaled

rocscience	Project	Reds Meadow	
	Analysis Description	SWEDGE - Surface Wedge Stability Analysis	
	Drawn By	KDD	Company: Shannon & Wilson, Inc.
SWEDGE 6.018	Date	1/10/2019, 3:32:27 PM	File Name: Swedge_RW 2B_DD263_j4 &j5.swd



Symbol	Feature
○	Pole Vectors

Color	Density Concentrations
	0.00 - 1.30
	1.30 - 2.60
	2.60 - 3.90
	3.90 - 5.20
	5.20 - 6.50
	6.50 - 7.80
	7.80 - 9.10
	9.10 - 10.40
	10.40 - 11.70
	11.70 - 13.00

Contour Data	Pole Vectors
Maximum Density	12.44%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Flexural Toppling
Slope Dip	63
Slope Dip Direction	257
Friction Angle	27°
Lateral Limits	30°

	Critical	Total	%
Flexural Toppling (All)	5	62	8.06%
Flexural Toppling (Set 2)	4	11	36.36%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		83	202	
2m		88	260	
3m		15	249	
4m		82	227	
5m		32	337	

Plot Mode	Pole Vectors
Vector Count	62 (62 Entries)
Hemisphere	Lower
Projection	Equal Angle

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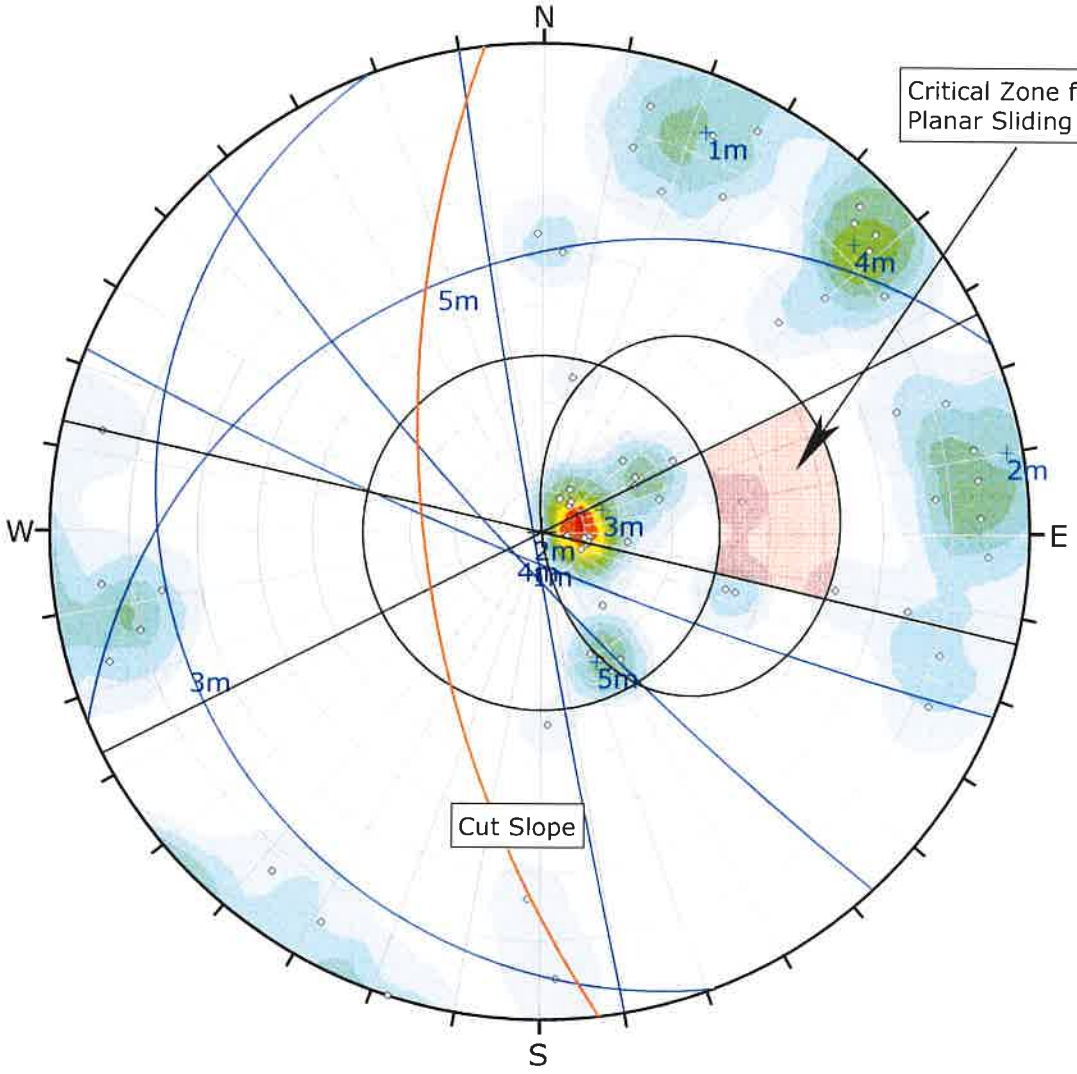
DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic Analysis		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/10/2019	*File Name*	Slope RW 2b_70 percent_DD 257.dips7



Symbol	Feature
○	Pole Vectors

Color	Density Concentrations
	0.00 - 1.30
	1.30 - 2.60
	2.60 - 3.90
	3.90 - 5.20
	5.20 - 6.50
	6.50 - 7.80
	7.80 - 9.10
	9.10 - 10.40
	10.40 - 11.70
	11.70 - 13.00

Contour Data	Pole Vectors
Maximum Density	12.44%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Planar Sliding
Slope Dip	63
Slope Dip Direction	263
Friction Angle	40°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	1	62	1.61%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		83	202	
2m		88	260	
3m		15	249	
4m		82	227	
5m		32	337	

Plot Mode	Pole Vectors
Vector Count	62 (62 Entries)
Hemisphere	Lower
Projection	Equal Angle

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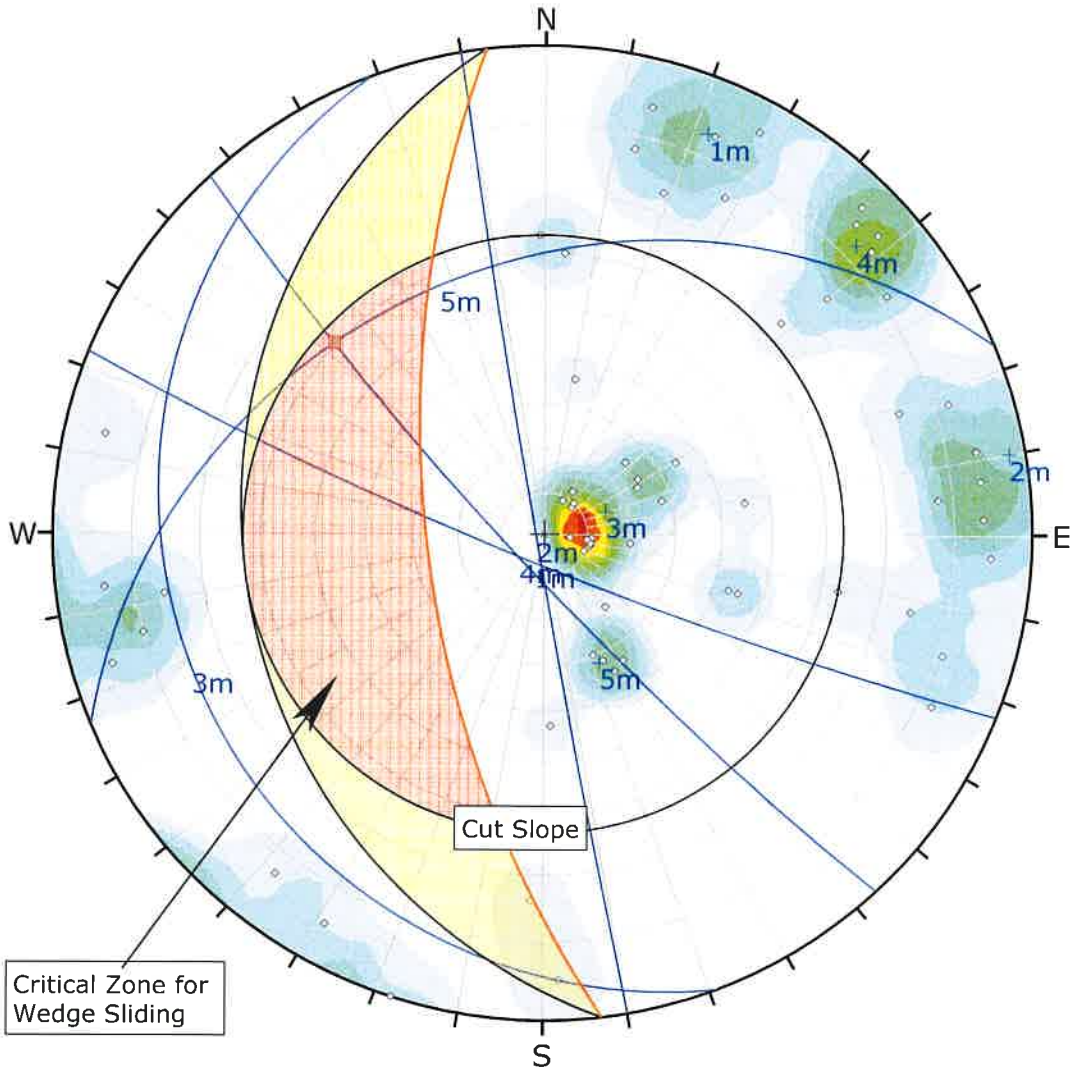
DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic Analysis		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/10/2019	*File Name*	Slope RW 2b_70 percent_263.dips7



Symbol	Feature
◦	Pole Vectors
	Critical Intersection

Color	Density Concentrations
	0.00 - 1.30
	1.30 - 2.60
	2.60 - 3.90
	3.90 - 5.20
	5.20 - 6.50
	6.50 - 7.80
	7.80 - 9.10
	9.10 - 10.40
	10.40 - 11.70
	11.70 - 13.00

Contour Data	Pole Vectors
Maximum Density	12.44%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Wedge Sliding
Slope Dip	63
Slope Dip Direction	263
Friction Angle	27°

	Critical	Total	%
Wedge Sliding	1	10	10.00%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		83	202	
2m		88	260	
3m		15	249	
4m		82	227	
5m		32	337	

Plot Mode	Pole Vectors
Vector Count	62 (62 Entries)
Intersection Mode	User and Mean Set Planes
Intersections Count	10
Hemisphere	Lower
Projection	Equal Angle

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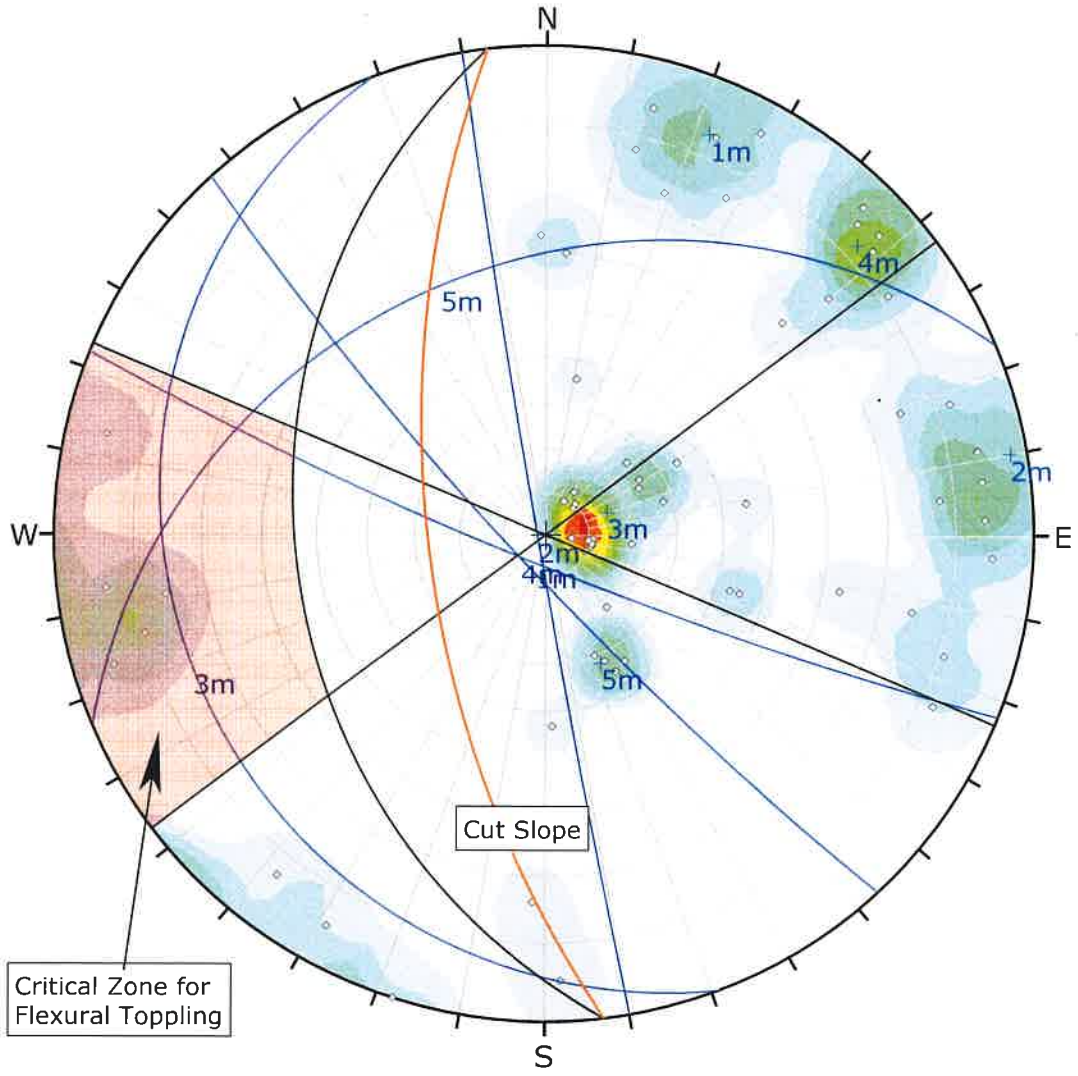
DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic Analysis		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/10/2019	*File Name*	Slope RW 2b_70 percent_263.dips7



Symbol	Feature
○	Pole Vectors

Color	Density Concentrations
	0.00 - 1.30
	1.30 - 2.60
	2.60 - 3.90
	3.90 - 5.20
	5.20 - 6.50
	6.50 - 7.80
	7.80 - 9.10
	9.10 - 10.40
	10.40 - 11.70
	11.70 - 13.00

Contour Data	Pole Vectors
Maximum Density	12.44%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Flexural Toppling
Slope Dip	63
Slope Dip Direction	263
Friction Angle	27°
Lateral Limits	30°

	Critical	Total	%
Flexural Toppling (All)	5	62	8.06%
Flexural Toppling (Set 2)	4	11	36.36%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		83	202	
2m		88	260	
3m		15	249	
4m		82	227	
5m		32	337	

Plot Mode	Pole Vectors
Vector Count	62 (62 Entries)
Hemisphere	Lower
Projection	Equal Angle

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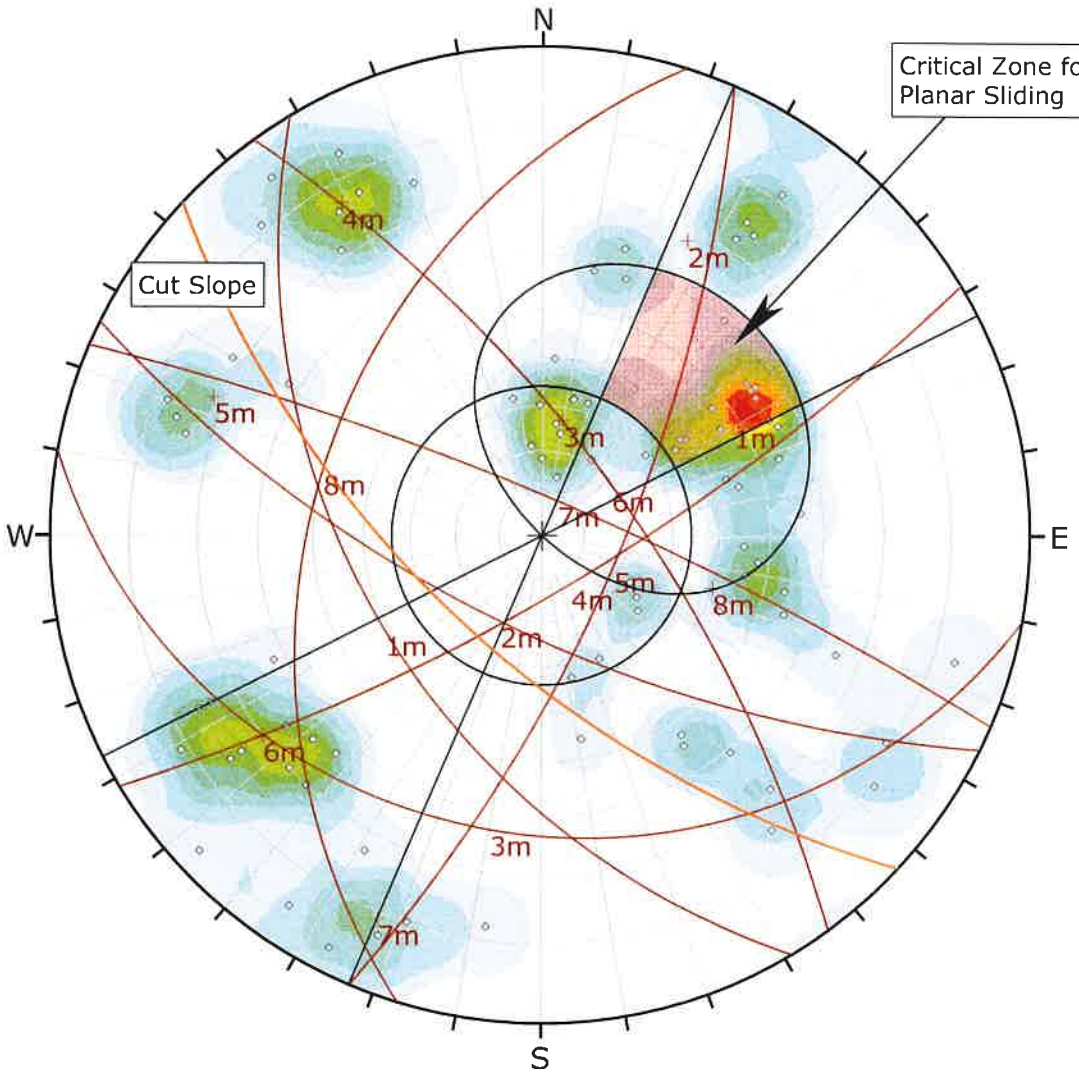
DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic Analysis		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/10/2019	*File Name*	Slope RW 2b_70 percent_263.dips7

Slope RW-4

Windows 1 through 5



Symbol	Feature
○	Pole Vectors

Color	Density Concentrations
	0.00 - 0.80
	0.80 - 1.60
	1.60 - 2.40
	2.40 - 3.20
	3.20 - 4.00
	4.00 - 4.80
	4.80 - 5.60
	5.60 - 6.40
	6.40 - 7.20
	7.20 - 8.00

Contour Data	Pole Vectors
Maximum Density	7.42%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Planar Sliding
Slope Dip	63
Slope Dip Direction	223
Friction Angle	34°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	12	88	13.64%
Planar Sliding (Set 1)	11	15	73.33%
Planar Sliding (Set 3)	1	12	8.33%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		49	239	
2m		68	206	
3m		27	190	
4m		77	149	
5m		72	113	
6m		70	54	
7m		81	23	
8m		40	287	

Plot Mode	Pole Vectors
Vector Count	88 (88 Entries)

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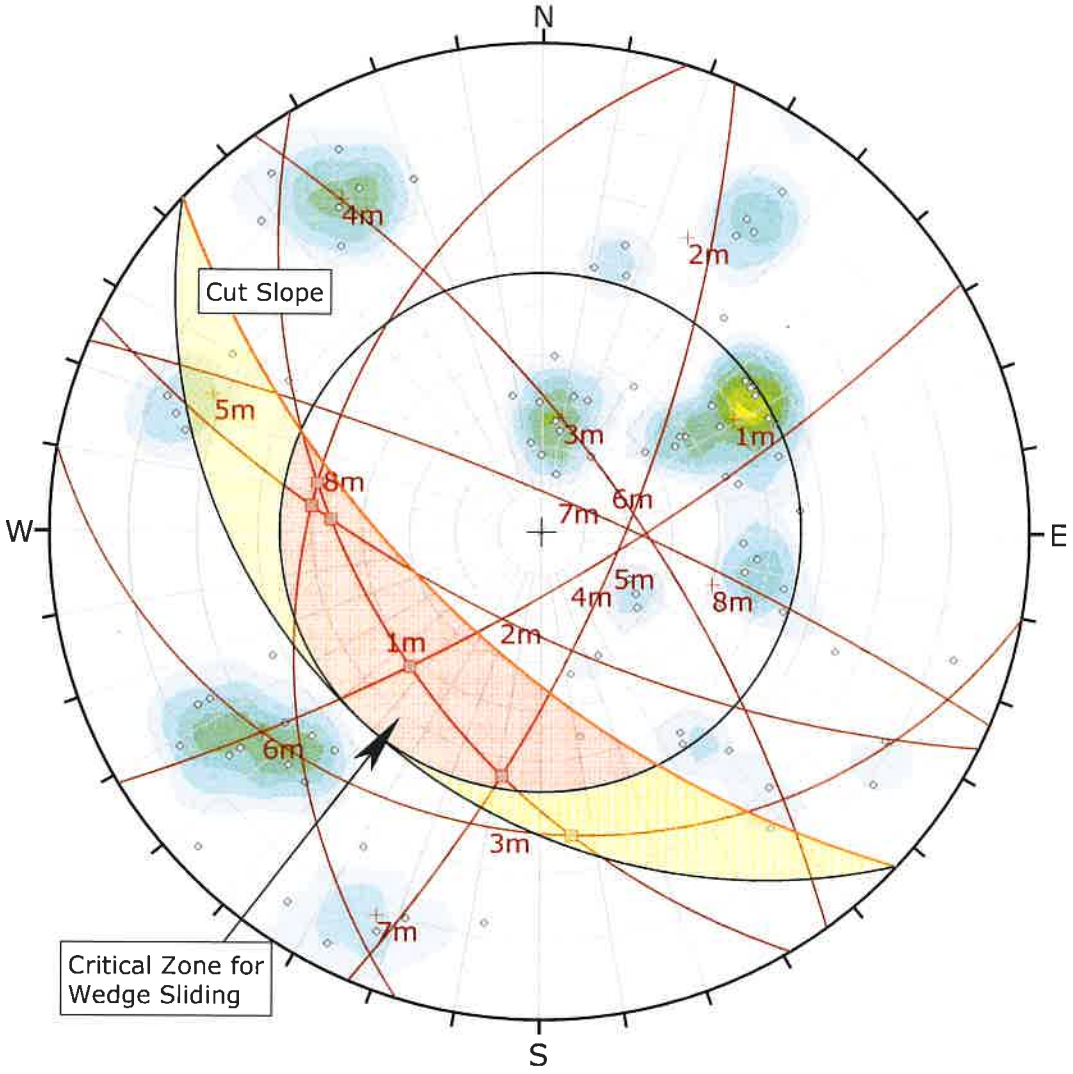
DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 10:58:06 AM	*File Name*	RW4 -1 thru 5.dips7



Symbol	Feature
○	Pole Vectors
▒	Critical Intersection

Color	Density Concentrations
	< 1.90
	1.90 - 2.80
	2.80 - 3.70
	3.70 - 4.60
	4.60 - 5.50
	5.50 - 6.40
	6.40 - 7.30
	7.30 - 8.20
	8.20 - 9.10
	9.10 <

Contour Data	Pole Vectors
Maximum Density	7.42%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Wedge Sliding
Slope Dip	63
Slope Dip Direction	223
Friction Angle	34°

	Critical	Total	%
Wedge Sliding	6	28	21.43%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		49	239	
2m		68	206	
3m		27	190	
4m		77	149	
5m		72	113	
6m		70	54	
7m		81	23	
8m		40	287	

Plot Mode	Pole Vectors
Vector Count	88 (88 Entries)
Intersection Mode	User and Mean Set Planes
Intersections Count	28

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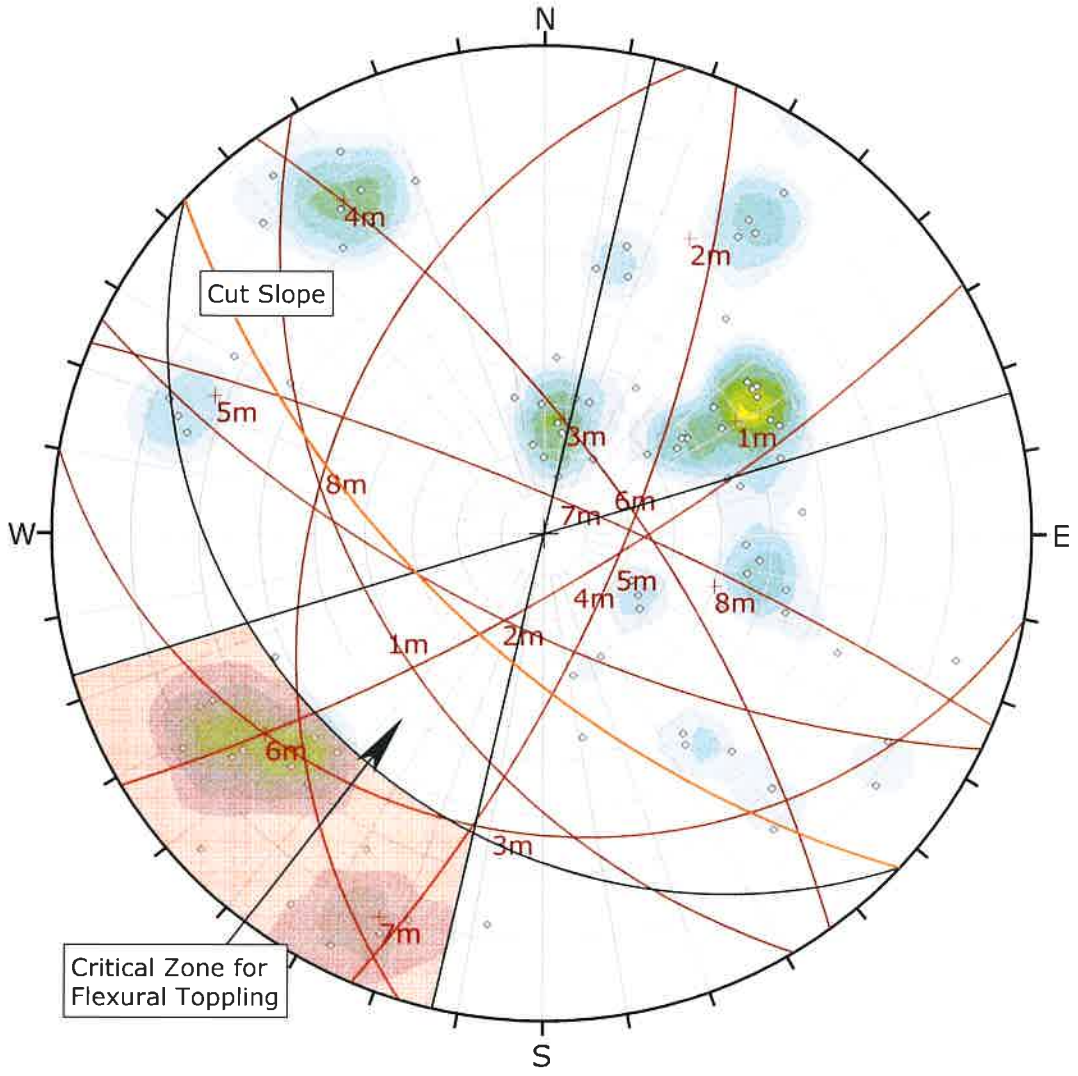
DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 10:58:06 AM	*File Name*	RW4 -1 thru 5.dips7



Symbol	Feature
○	Pole Vectors

Color	Density Concentrations
	< 1.90
	1.90 - 2.80
	2.80 - 3.70
	3.70 - 4.60
	4.60 - 5.50
	5.50 - 6.40
	6.40 - 7.30
	7.30 - 8.20
	8.20 - 9.10
	9.10 <

Contour Data	Pole Vectors
Maximum Density	7.42%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Flexural Toppling
Slope Dip	63
Slope Dip Direction	223
Friction Angle	34°
Lateral Limits	30°

	Critical	Total	%
Flexural Toppling (All)	16	88	18.18%
Flexural Toppling (Set 6)	10	11	90.91%
Flexural Toppling (Set 7)	5	6	83.33%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		49	239	
2m		68	206	
3m		27	190	
4m		77	149	
5m		72	113	
6m		70	54	
7m		81	23	
8m		40	287	

Plot Mode	Pole Vectors
Vector Count	88 (88 Entries)

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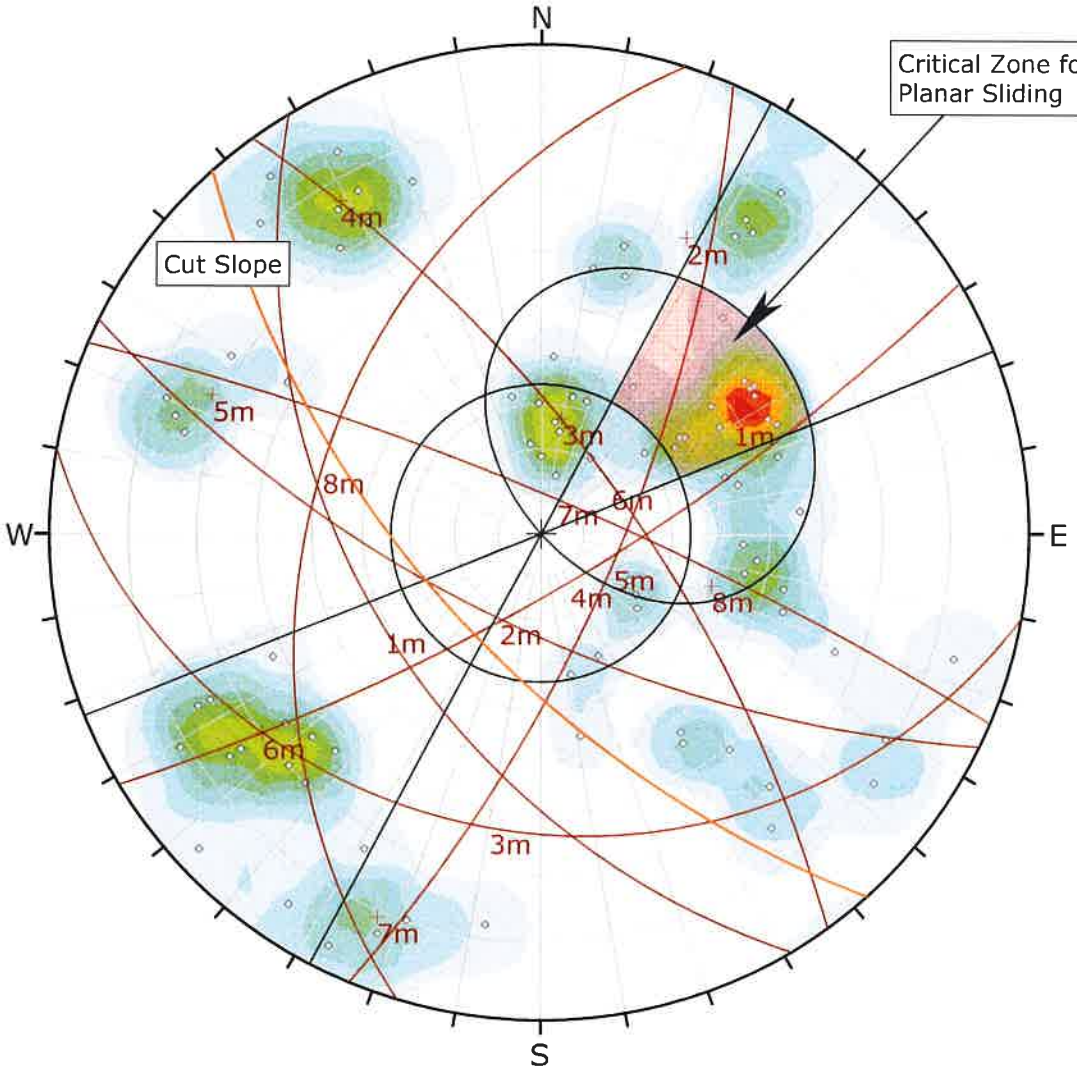
DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 10:58:06 AM	*File Name*	RW4 -1 thru 5.dips7



Symbol	Feature
○	Pole Vectors

Color	Density Concentrations
	0.00 - 0.80
	0.80 - 1.60
	1.60 - 2.40
	2.40 - 3.20
	3.20 - 4.00
	4.00 - 4.80
	4.80 - 5.60
	5.60 - 6.40
	6.40 - 7.20
	7.20 - 8.00

Contour Data	Pole Vectors
Maximum Density	7.42%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Planar Sliding
Slope Dip	63
Slope Dip Direction	228
Friction Angle	34°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	13	88	14.77%
Planar Sliding (Set 1)	12	15	80.00%
Planar Sliding (Set 3)	1	12	8.33%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		49	239	
2m		68	206	
3m		27	190	
4m		77	149	
5m		72	113	
6m		70	54	
7m		81	23	
8m		40	287	

Plot Mode	Pole Vectors
Vector Count	88 (88 Entries)

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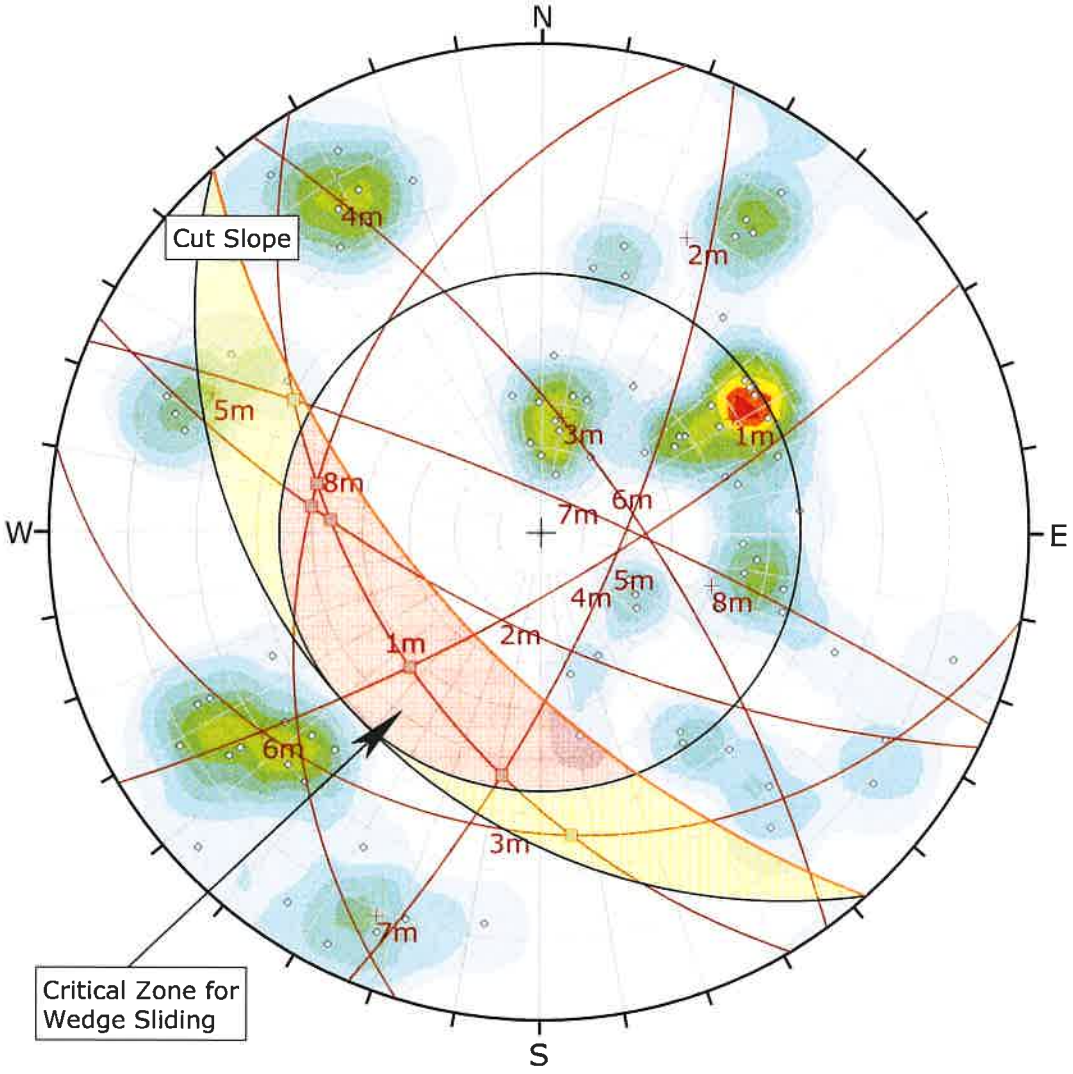
DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 10:58:06 AM	*File Name*	RW4 -1 thru 5_DD 228.dips7



Symbol	Feature
○	Pole Vectors
▩	Critical Intersection

Color	Density Concentrations
	0.00 - 0.80
	0.80 - 1.60
	1.60 - 2.40
	2.40 - 3.20
	3.20 - 4.00
	4.00 - 4.80
	4.80 - 5.60
	5.60 - 6.40
	6.40 - 7.20
	7.20 - 8.00

Contour Data	Pole Vectors
Maximum Density	7.42%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Wedge Sliding
Slope Dip	63
Slope Dip Direction	228
Friction Angle	34°

	Critical	Total	%
Wedge Sliding	7	28	25.00%

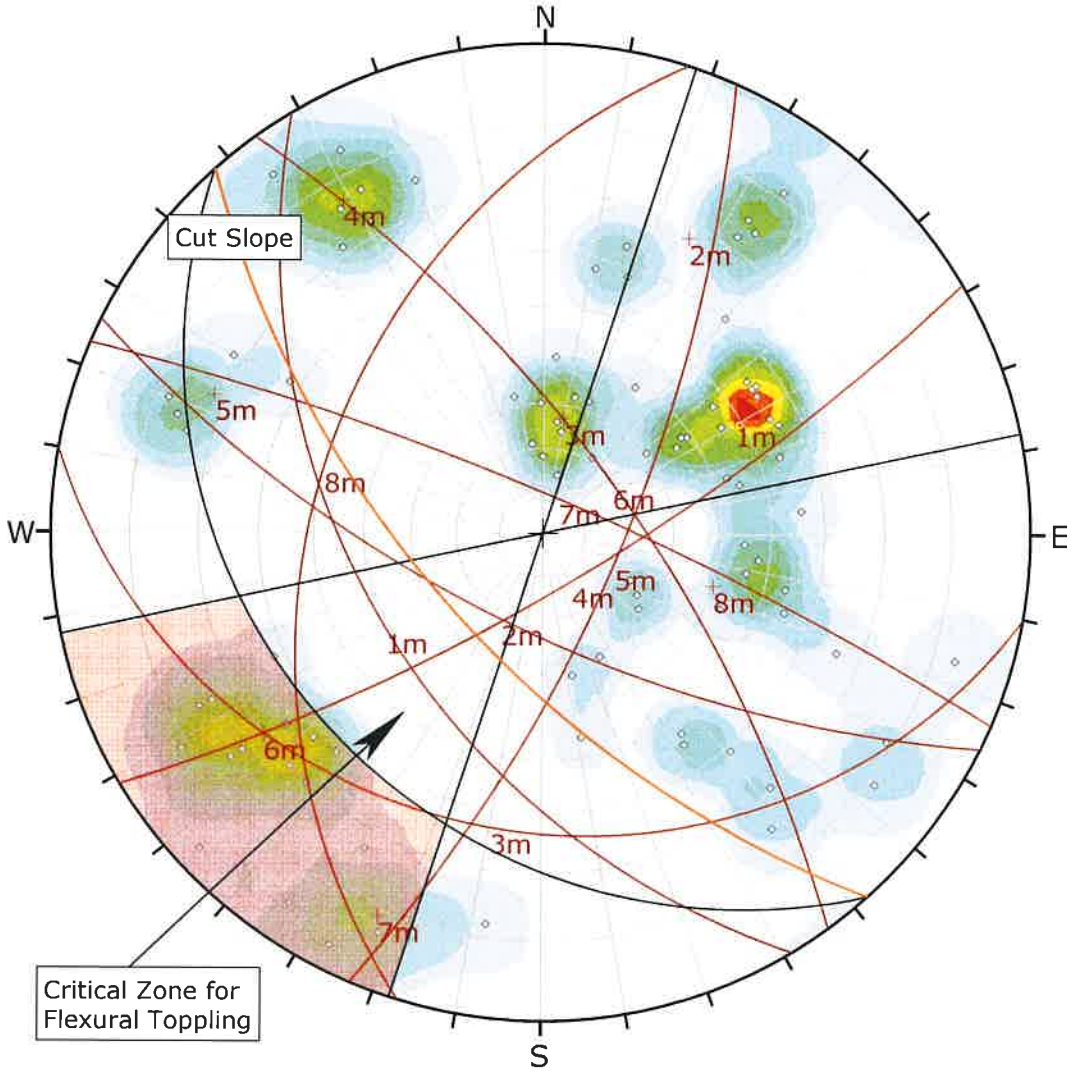
	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		49	239	
2m		68	206	
3m		27	190	
4m		77	149	
5m		72	113	
6m		70	54	
7m		81	23	
8m		40	287	

Plot Mode	Pole Vectors
Vector Count	88 (88 Entries)
Intersection Mode	User and Mean Set Planes
Intersections Count	28

rocscience

DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 10:58:06 AM	*File Name*	RW4 -1 thru 5_DD 228.dips7



Symbol	Feature
	Pole Vectors

Color	Density Concentrations
	0.00 - 0.80
	0.80 - 1.60
	1.60 - 2.40
	2.40 - 3.20
	3.20 - 4.00
	4.00 - 4.80
	4.80 - 5.60
	5.60 - 6.40
	6.40 - 7.20
	7.20 - 8.00

Contour Data	Pole Vectors
Maximum Density	7.42%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Flexural Toppling
Slope Dip	63
Slope Dip Direction	228
Friction Angle	34°
Lateral Limits	30°

	Critical	Total	%
Flexural Toppling (All)	16	88	18.18%
Flexural Toppling (Set 6)	10	11	90.91%
Flexural Toppling (Set 7)	5	6	83.33%

	Color	Dip	Dip Direction	Label
		Mean Set Planes		
1m		49	239	
2m		68	206	
3m		27	190	
4m		77	149	
5m		72	113	
6m		70	54	
7m		81	23	
8m		40	287	

Plot Mode	Pole Vectors
Vector Count	88 (88 Entries)

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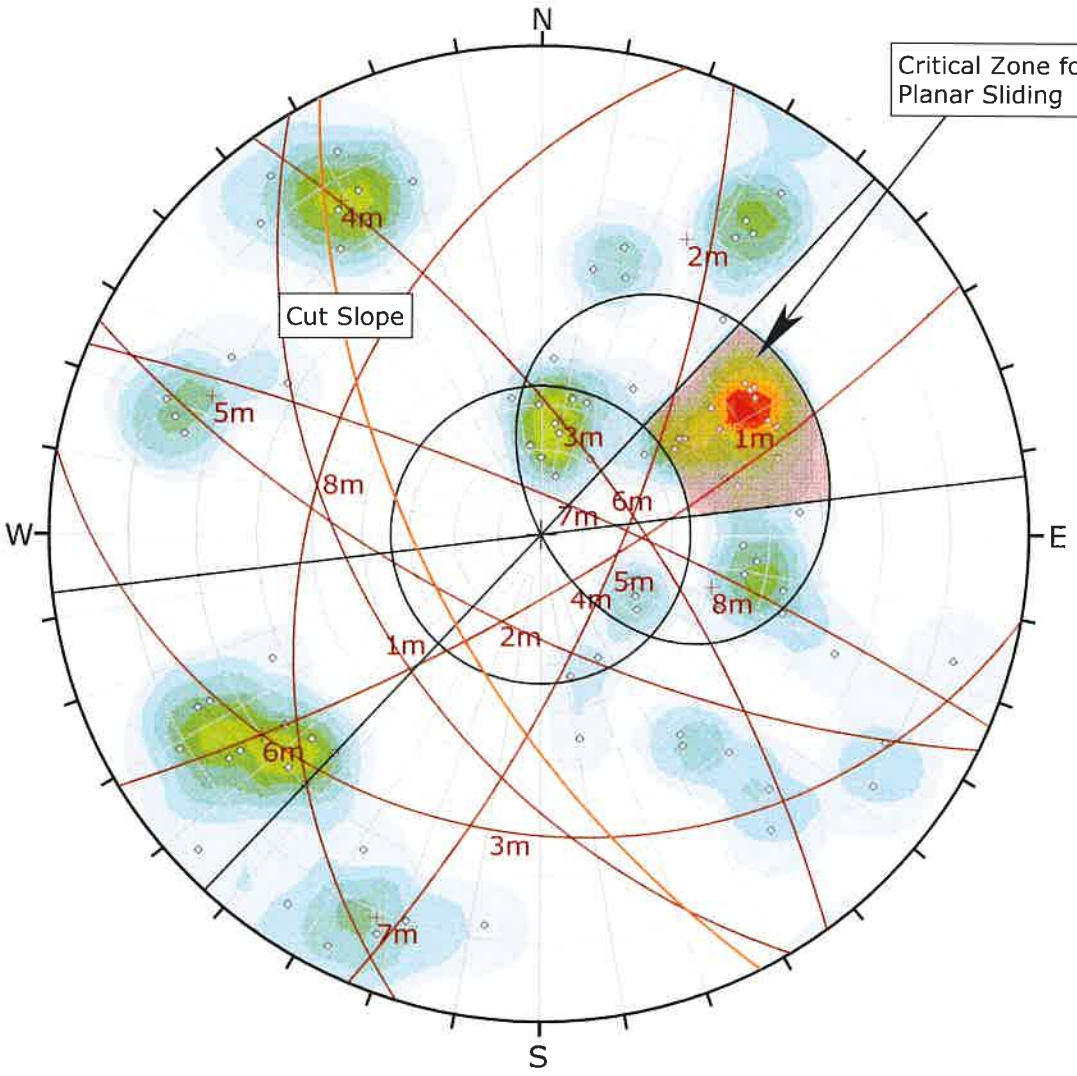
DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 10:58:06 AM	*File Name*	RW4 -1 thru 5_DD 228.dips7



Symbol	Feature
○	Pole Vectors

Color	Density Concentrations
	0.00 - 0.80
	0.80 - 1.60
	1.60 - 2.40
	2.40 - 3.20
	3.20 - 4.00
	4.00 - 4.80
	4.80 - 5.60
	5.60 - 6.40
	6.40 - 7.20
	7.20 - 8.00

Contour Data	Pole Vectors
Maximum Density	7.42%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Planar Sliding
Slope Dip	63
Slope Dip Direction	243
Friction Angle	34°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	14	88	15.91%
Planar Sliding (Set 1)	14	15	93.33%

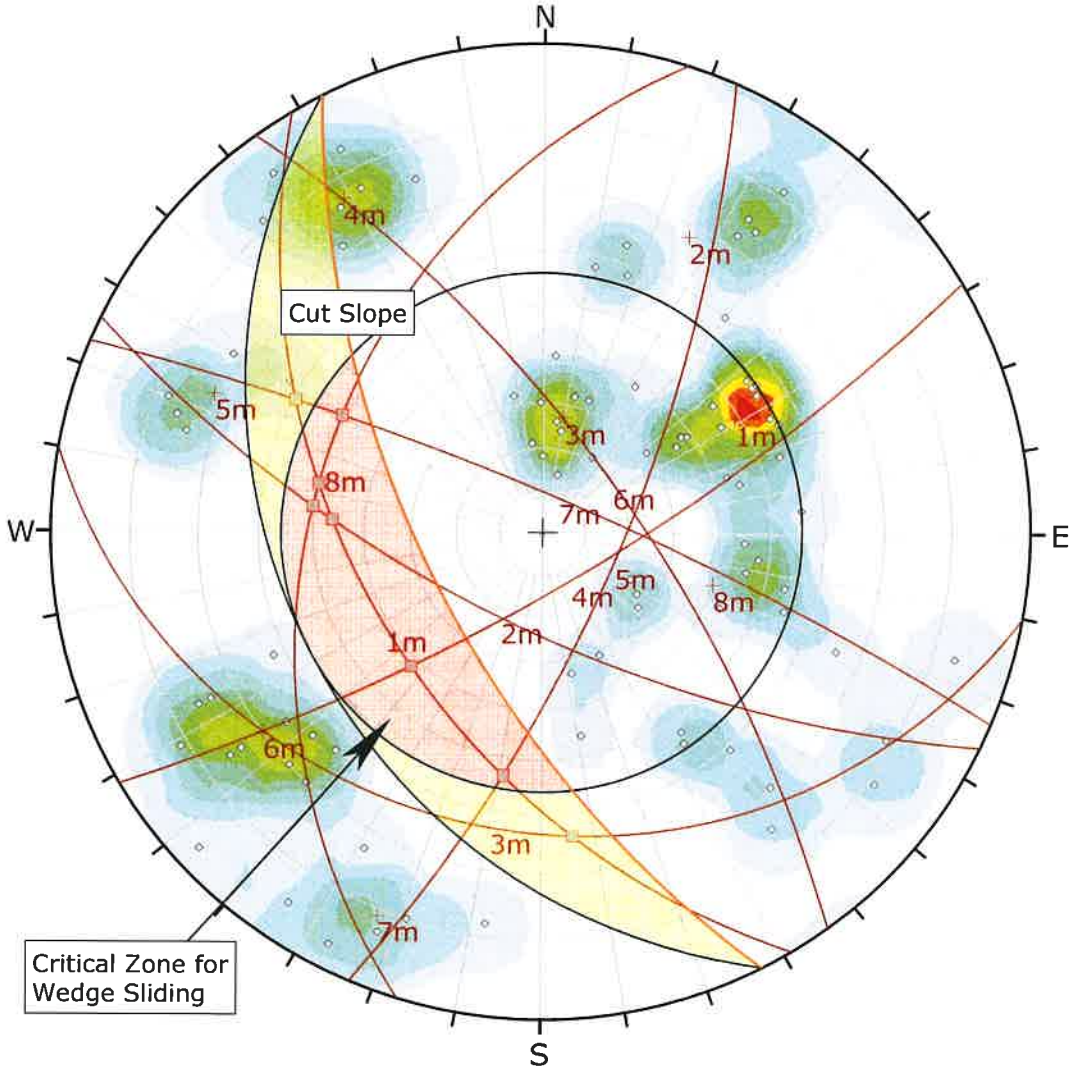
	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		49	239	
2m		68	206	
3m		27	190	
4m		77	149	
5m		72	113	
6m		70	54	
7m		81	23	
8m		40	287	

Plot Mode	Pole Vectors
Vector Count	88 (88 Entries)
Hemisphere	Lower

rocscience

DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 10:58:06 AM	*File Name*	RW4 -1 thru 5_DD 243.dips7



Symbol	Feature
◇	Pole Vectors
▩	Critical Intersection

Color	Density Concentrations
	0.00 - 0.80
	0.80 - 1.60
	1.60 - 2.40
	2.40 - 3.20
	3.20 - 4.00
	4.00 - 4.80
	4.80 - 5.60
	5.60 - 6.40
	6.40 - 7.20
	7.20 - 8.00

Contour Data	Pole Vectors
Maximum Density	7.42%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Wedge Sliding
Slope Dip	63
Slope Dip Direction	243
Friction Angle	34°

	Critical	Total	%
Wedge Sliding	8	28	28.57%

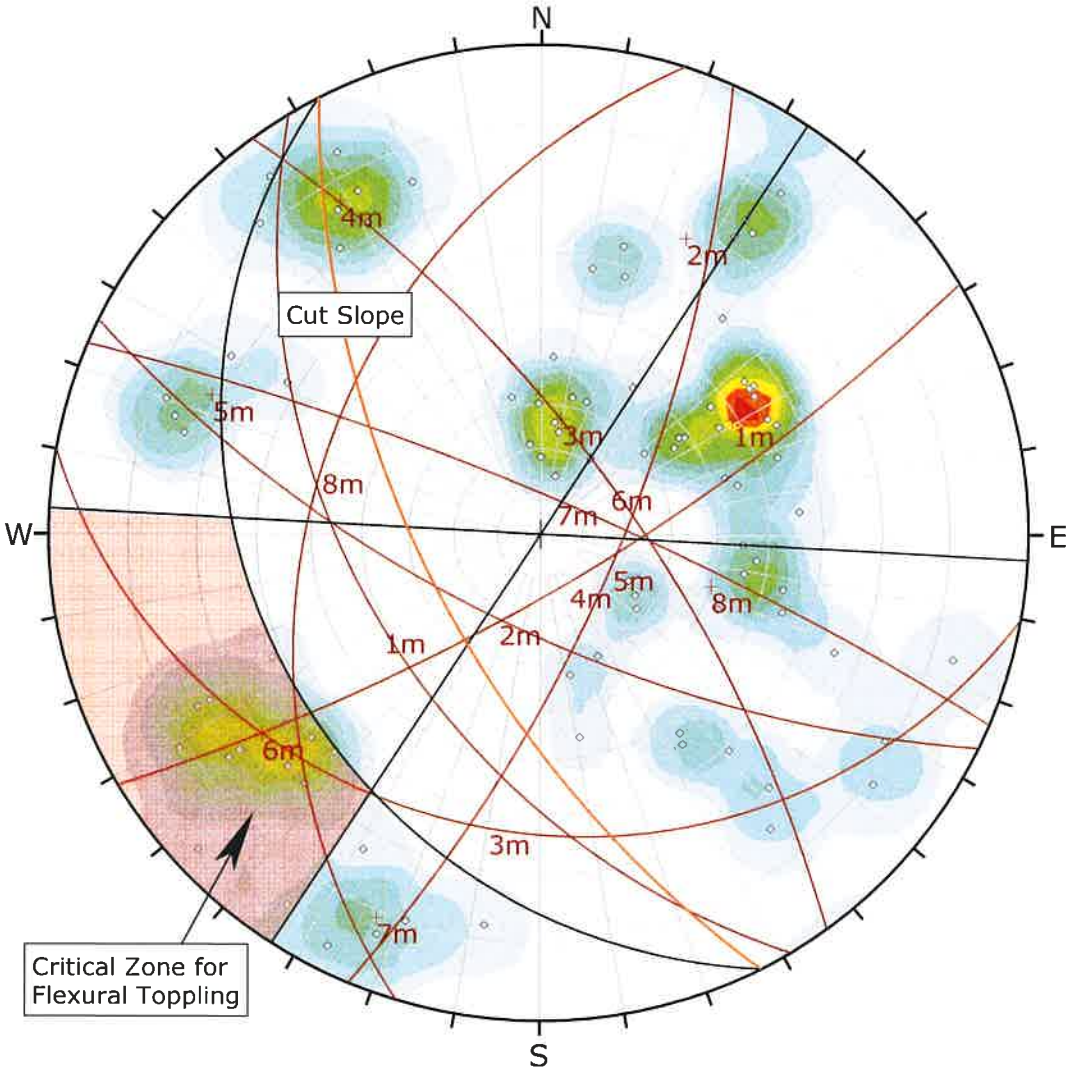
	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		49	239	
2m		68	206	
3m		27	190	
4m		77	149	
5m		72	113	
6m		70	54	
7m		81	23	
8m		40	287	

Plot Mode	Pole Vectors
Vector Count	88 (88 Entries)
Intersection Mode	User and Mean Set Planes
Intersections Count	28

rocscience

DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 10:58:06 AM	*File Name*	RW4 -1 thru 5_DD 243.dips7



Symbol	Feature
○	Pole Vectors

Color	Density Concentrations
	0.00 - 0.80
	0.80 - 1.60
	1.60 - 2.40
	2.40 - 3.20
	3.20 - 4.00
	4.00 - 4.80
	4.80 - 5.60
	5.60 - 6.40
	6.40 - 7.20
	7.20 - 8.00

Contour Data	Pole Vectors
Maximum Density	7.42%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Flexural Toppling
Slope Dip	63
Slope Dip Direction	243
Friction Angle	34°
Lateral Limits	30°

	Critical	Total	%
Flexural Toppling (All)	13	88	14.77%
Flexural Toppling (Set 6)	11	11	100.00%
Flexural Toppling (Set 7)	1	6	16.67%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		49	239	
2m		68	206	
3m		27	190	
4m		77	149	
5m		72	113	
6m		70	54	
7m		81	23	
8m		40	287	

Plot Mode	Pole Vectors
Vector Count	88 (88 Entries)

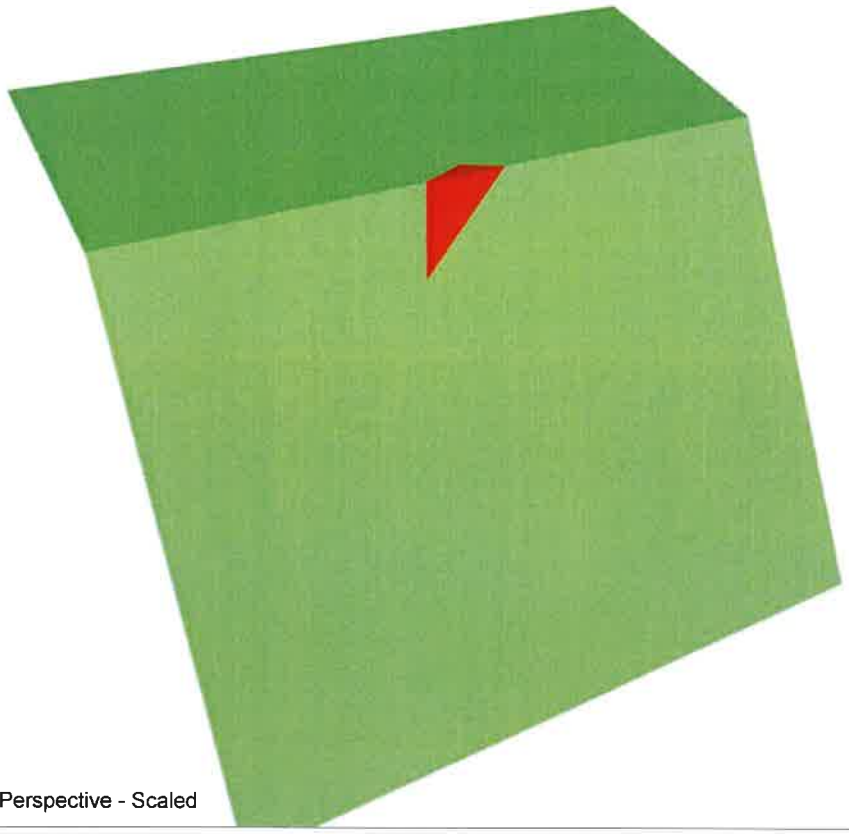
rocscience

DIPS 7.014

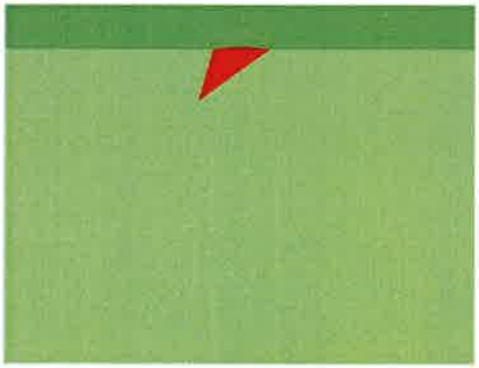
Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 10:58:06 AM	*File Name*	RW4 -1 thru 5_DD 243.dips7

Factor of Safety: 0.59

Top - Scaled



Perspective - Scaled



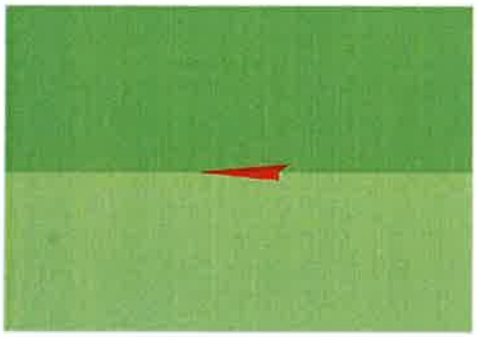
Front - Scaled

Side - Scaled

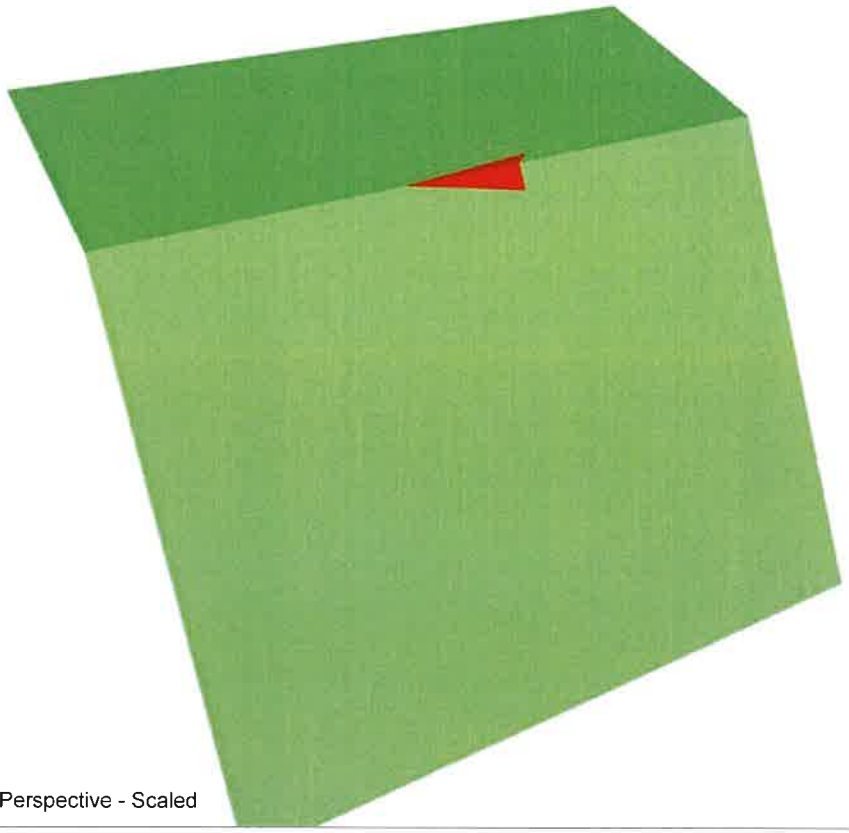
rocscience	Project	Reds Meadow	
	Analysis Description	SWEDGE - Surface Wedge Stability Analysis	
	Drawn By	KDD	Company: Shannon & Wilson, Inc
	Date	1/11/2019, 1:25:01 PM	File Name: RW-4 windows 1 thru 5_j1&j2.swd

SWEDGE 6.018

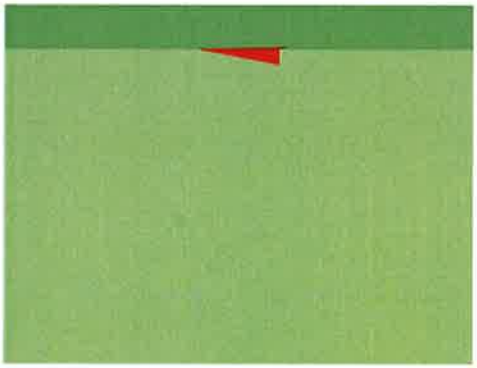
Factor of Safety: 1.65



Top - Scaled



Perspective - Scaled



Front - Scaled

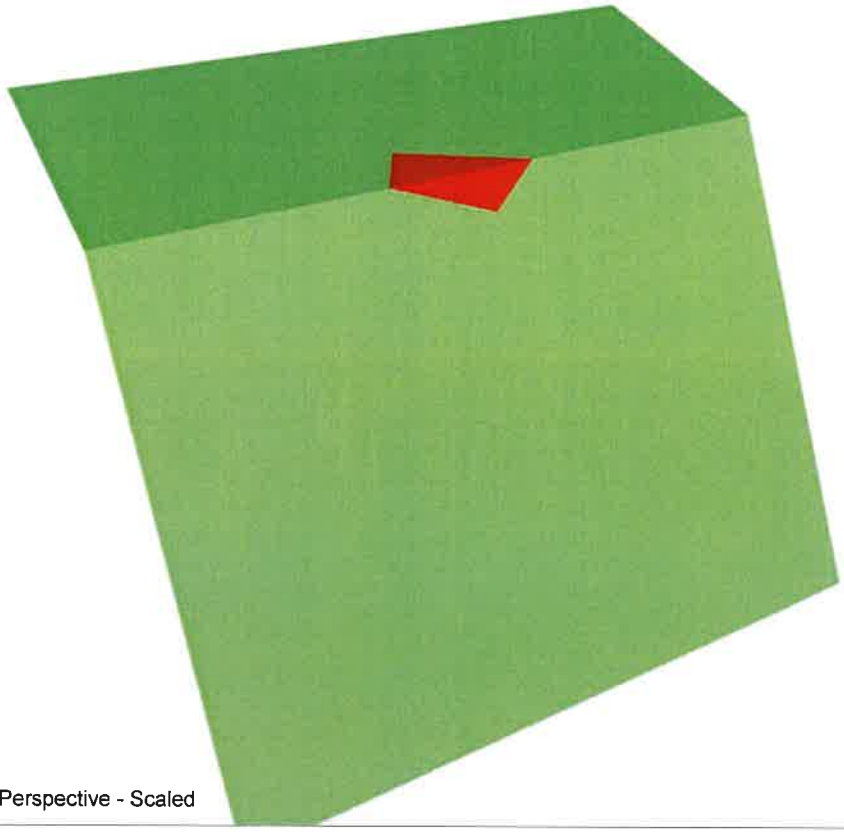
Side - Scaled

rocscience	Project	Reds Meadow	
	Analysis Description	SWEDGE - Surface Wedge Stability Analysis	
	Drawn By	KDD	Company: Shannon & Wilson, Inc
	Date	1/11/2019, 1:25:01 PM	File Name: RW-4 windows 1 thru 5_j1&j2.swd

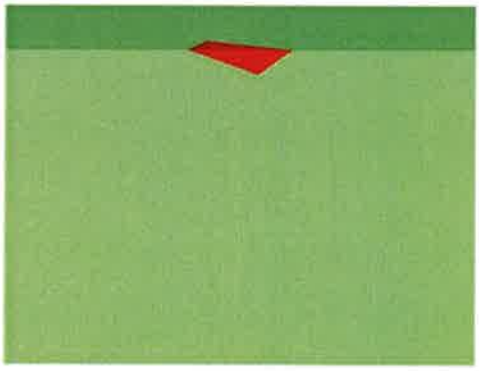
SWEDGE 6.018

Factor of Safety: 1.32

Top - Scaled



Perspective - Scaled



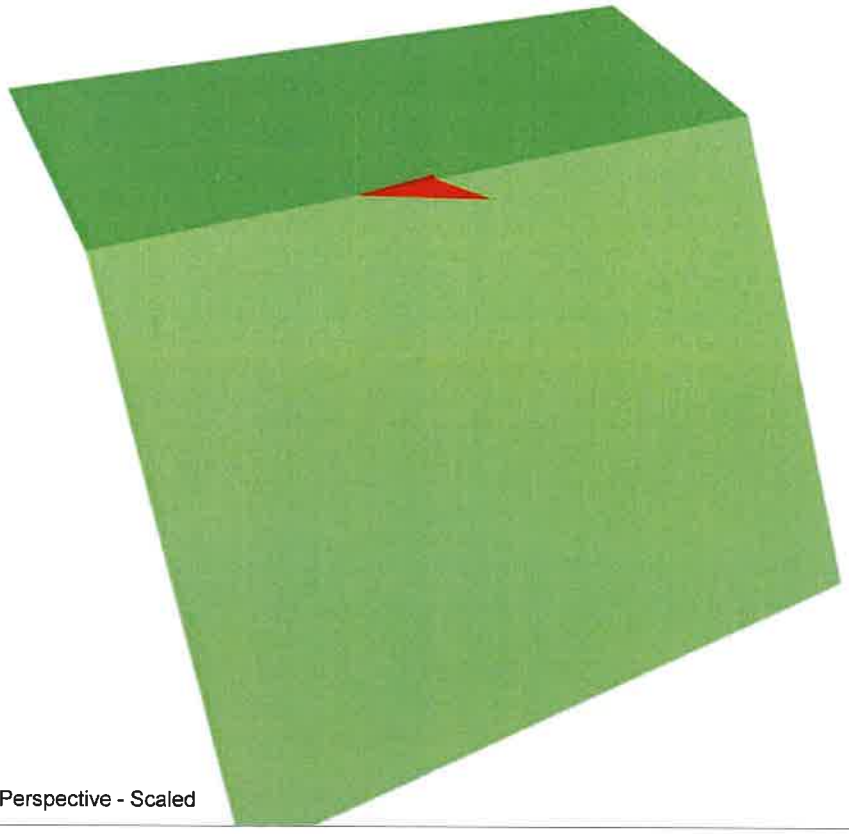
Front - Scaled

Side - Scaled

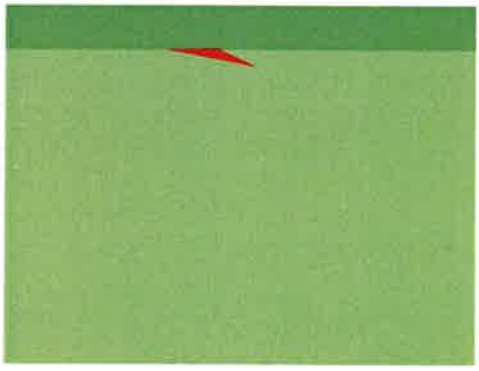
rocscience	Project	Reds Meadow	
	Analysis Description	SWEDGE - Surface Wedge Stability Analysis	
	Drawn By	KDD	Company: Shannon & Wilson, Inc
SWEDGE 6.018	Date	1/11/2019, 1:25:01 PM	File Name: RW-4 windows 1 thru 5_j1&j3.swd

Factor of Safety: 0.59

Top - Scaled



Perspective - Scaled

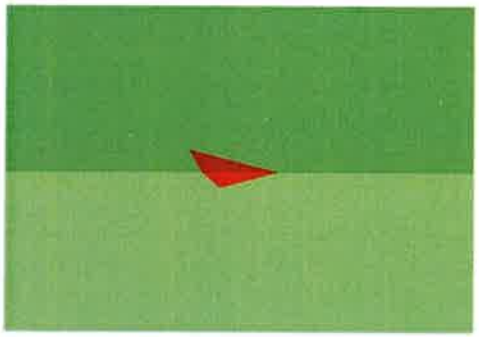


Front - Scaled

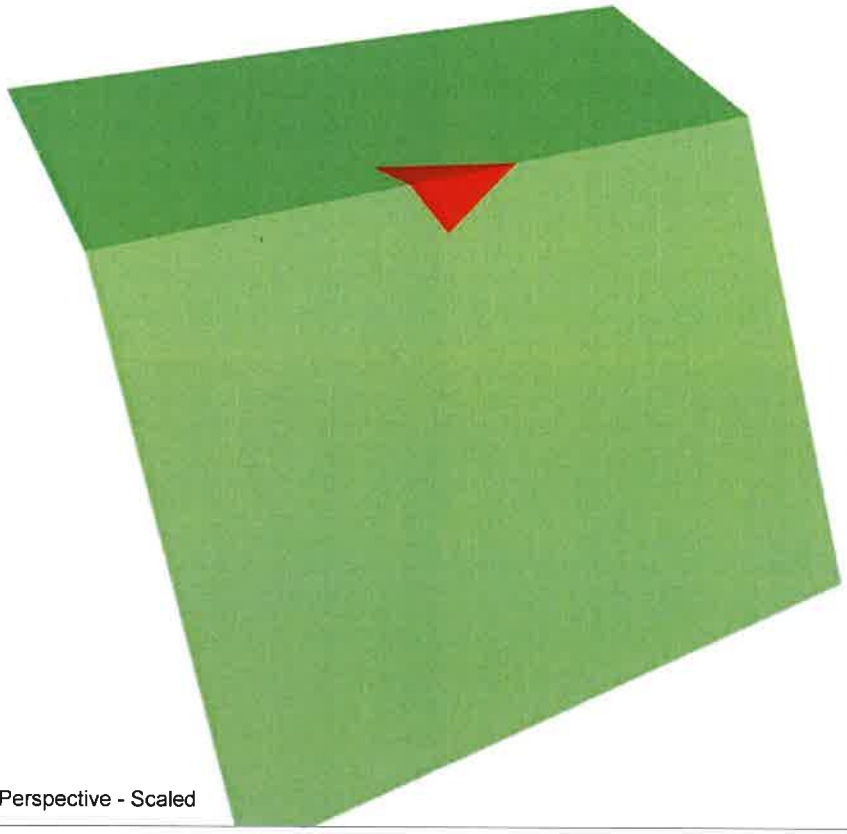
Side - Scaled

rocscience	Project	Reds Meadow	
	Analysis Description	SWEDGE - Surface Wedge Stability Analysis	
	Drawn By	KDD	Company: Shannon & Wilson, Inc
SWEDGE 6.018	Date	1/11/2019, 1:25:01 PM	File Name: RW-4 windows 1 thru 5_j1&j3.swd

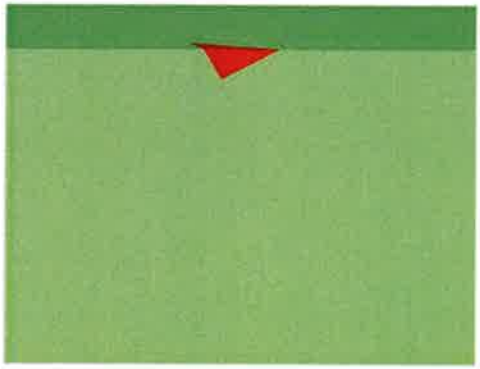
Factor of Safety: 1.40



Top - Scaled



Perspective - Scaled



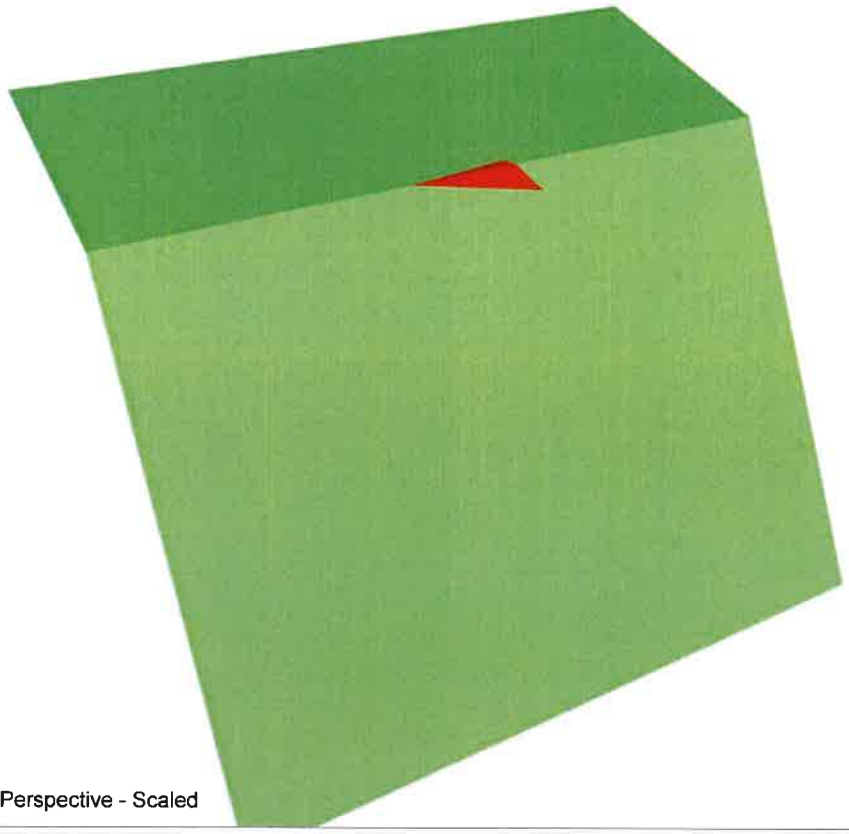
Front - Scaled

Side - Scaled

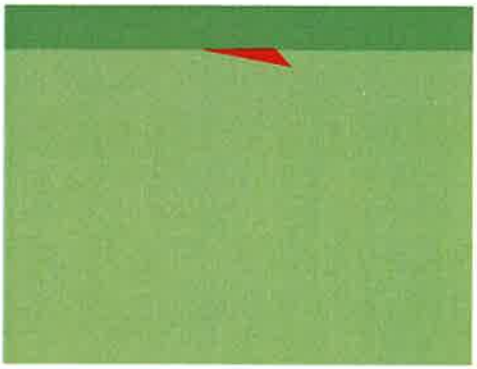
rocscience	Project	Reds Meadow	
	Analysis Description	SWEDGE - Surface Wedge Stability Analysis	
	Drawn By	KDD	Company: Shannon & Wilson, Inc
SWEDGE 6.018	Date	1/11/2019, 1:25:01 PM	File Name: RW-4 windows 1 thru 5_j1&j5.swd

Factor of Safety: 0.59

Top - Scaled



Perspective - Scaled



Front - Scaled

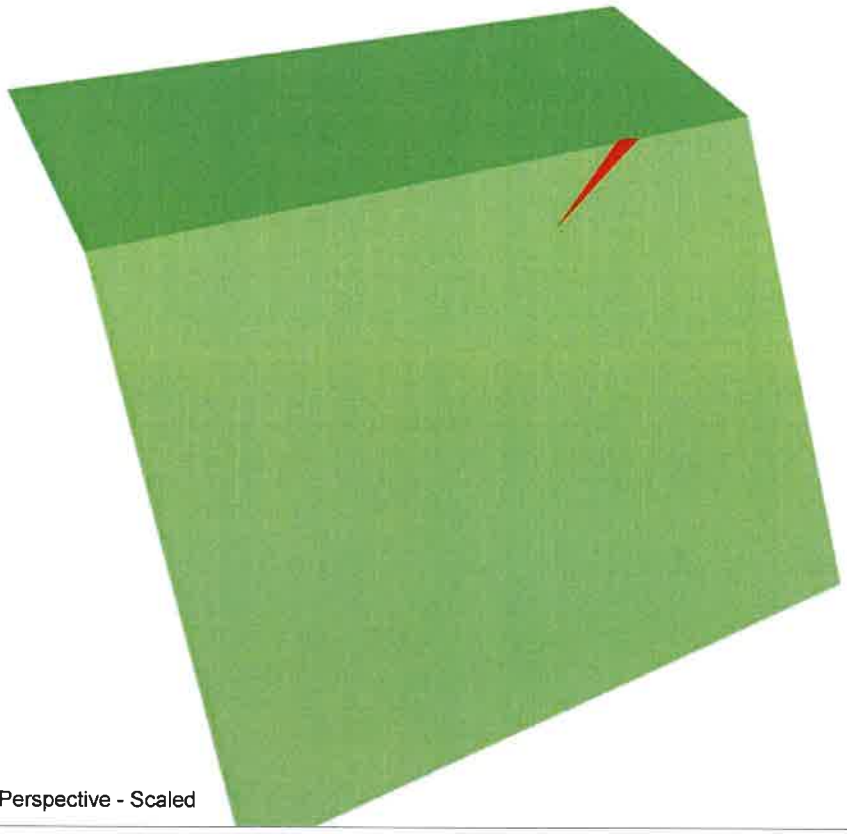
Side - Scaled

rocscience	Project	Reds Meadow	
	Analysis Description	SWEDGE - Surface Wedge Stability Analysis	
	Drawn By	KDD	Company: Shannon & Wilson, Inc
	Date	1/11/2019, 1:25:01 PM	File Name: RW-4 windows 1 thru 5_j1&j5.swd

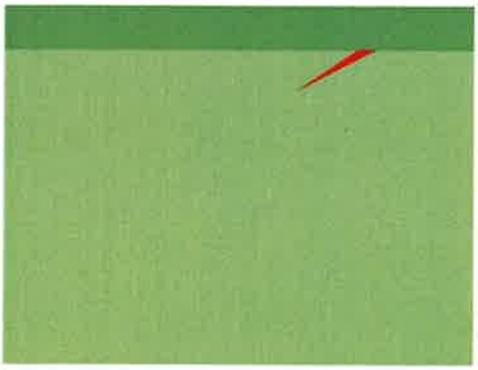
SWEDGE 6.018

Factor of Safety: 0.59

Top - Scaled



Perspective - Scaled

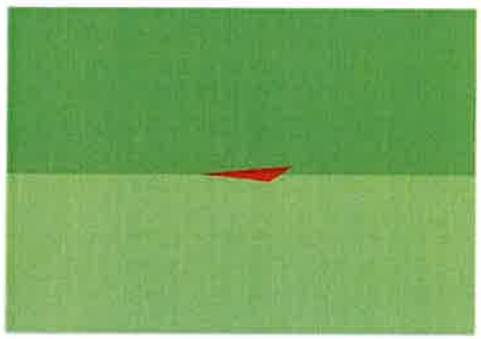


Front - Scaled

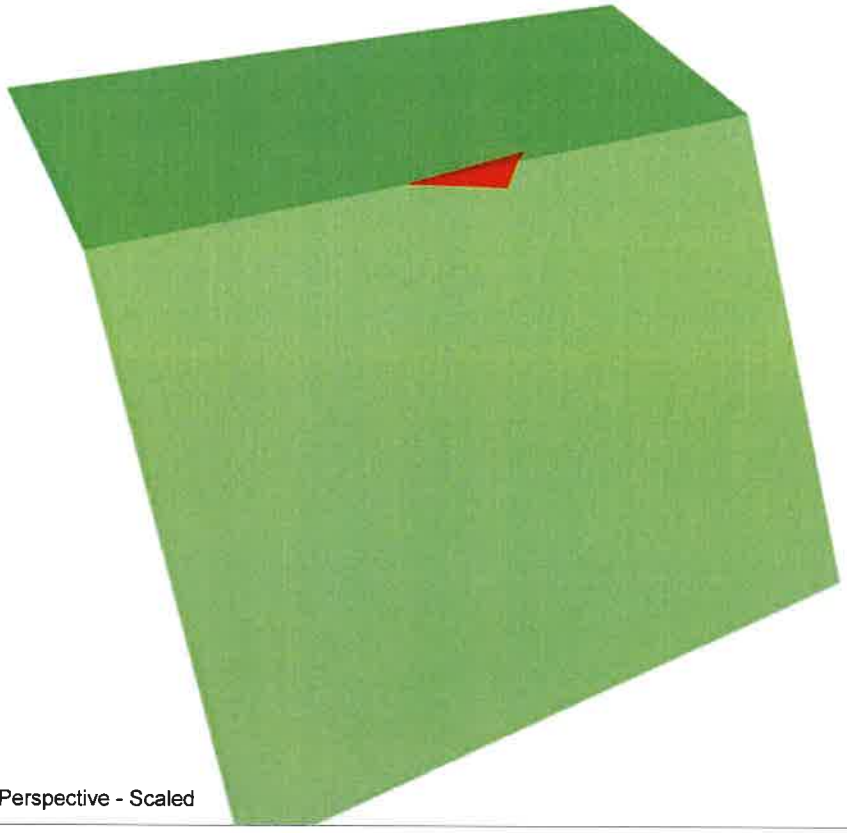
Side - Scaled

rocscience	Project	Reds Meadow	
	Analysis Description	SWEDGE - Surface Wedge Stability Analysis	
	Drawn By	KDD	Company: Shannon & Wilson, Inc
SWEDGE 6.018	Date	1/11/2019, 1:25:01 PM	File Name: RW-4 windows 1 thru 5_j1&j7.swd

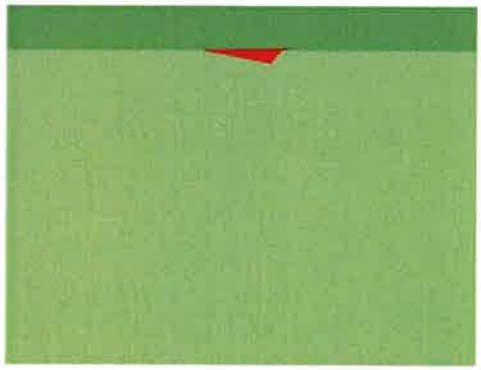
Factor of Safety: 2.17



Top - Scaled



Perspective - Scaled

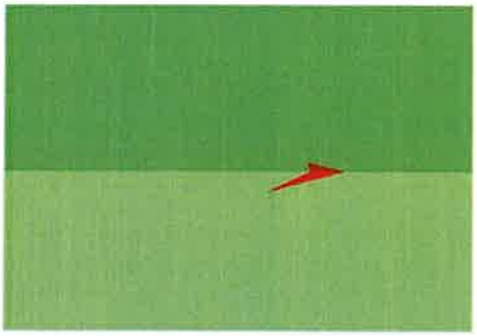


Front - Scaled

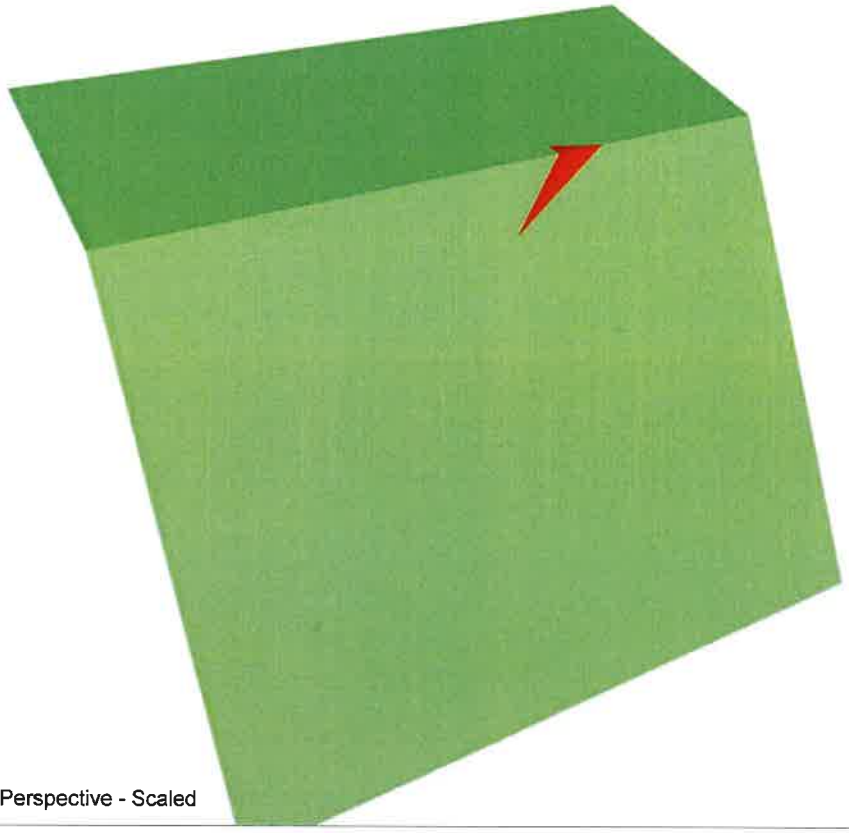
Side - Scaled

rocscience	Project	Reds Meadow	
	Analysis Description	SWEDGE - Surface Wedge Stability Analysis	
	Drawn By	KDD	Company: Shannon & Wilson, Inc
SWEDGE 6.018	Date	1/11/2019, 1:25:01 PM	File Name: RW-4 windows 1 thru 5_j1&j7.swd

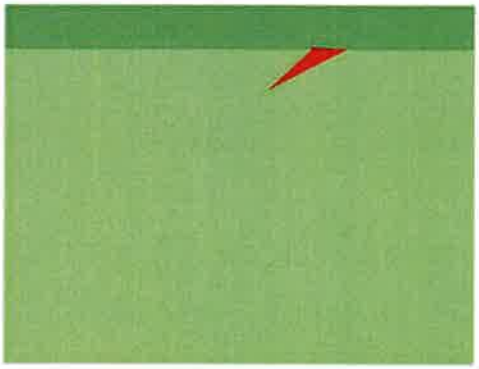
Factor of Safety: 0.59



Top - Scaled



Perspective - Scaled



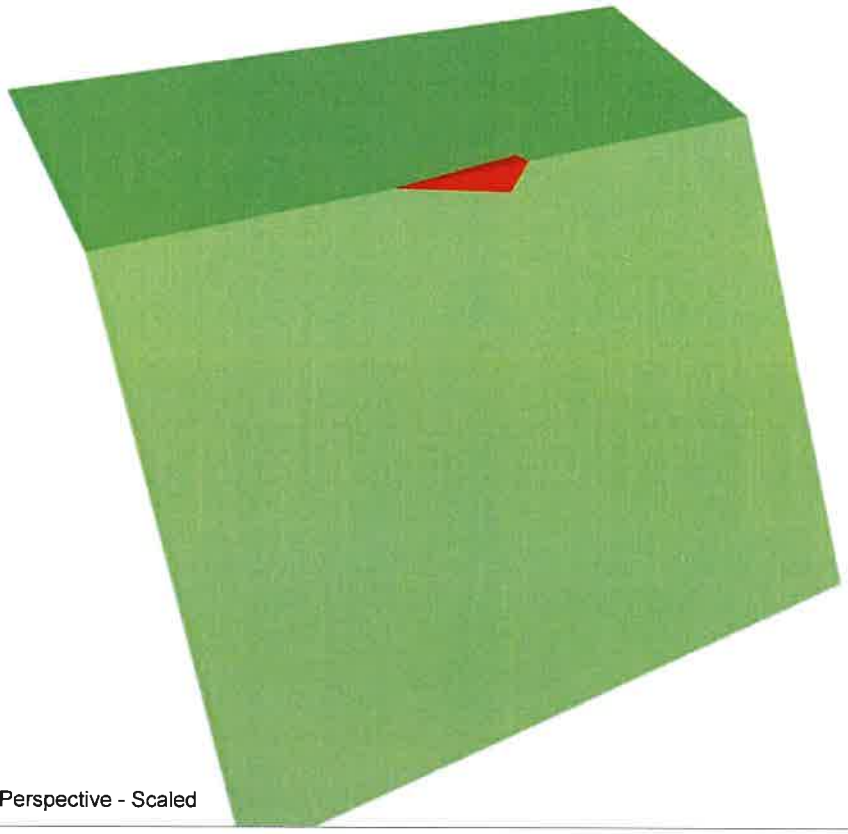
Front - Scaled

Side - Scaled

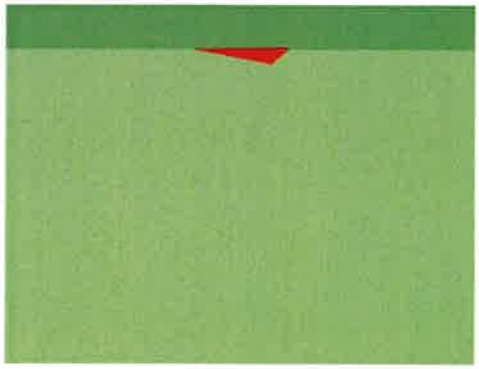
rocscience	Project	Reds Meadow	
	Analysis Description	SWEDGE - Surface Wedge Stability Analysis	
	Drawn By	KDD	Company: Shannon & Wilson, Inc
SWEDGE 6.018	Date	1/11/2019, 1:25:01 PM	File Name: RW-4 windows 1 thru 5_j1&j8.swd

Factor of Safety: 0.82

Top - Scaled



Perspective - Scaled



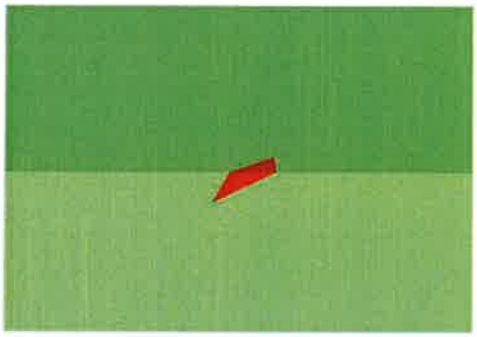
Front - Scaled

Side - Scaled

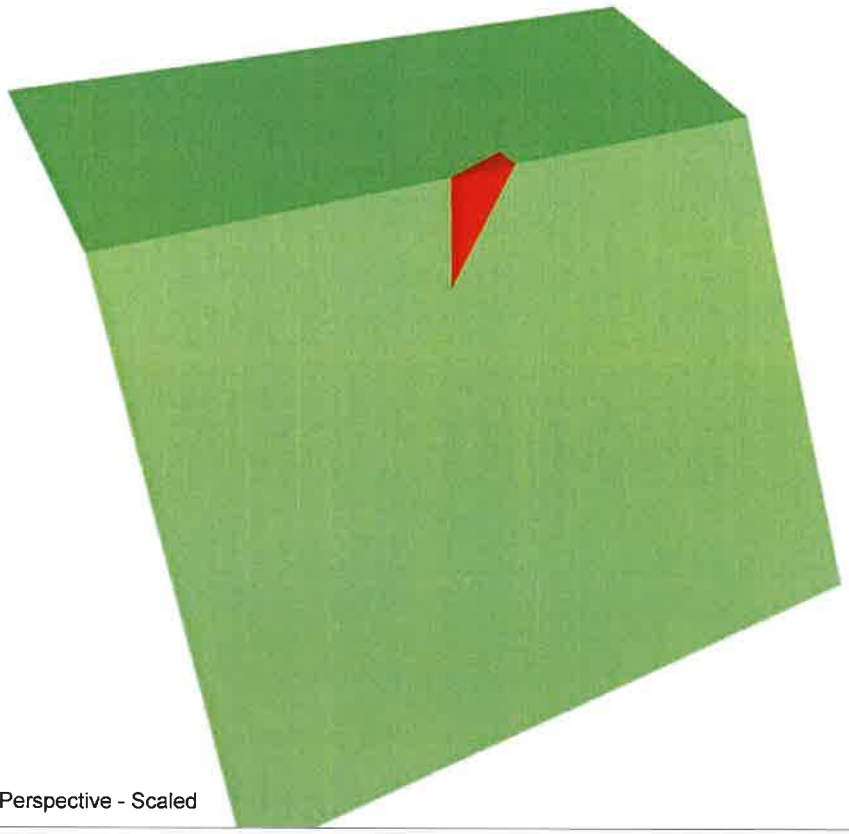
rocscience	Project	Reds Meadow	
	Analysis Description	SWEDGE - Surface Wedge Stability Analysis	
	Drawn By	KDD	Company: Shannon & Wilson, Inc
	Date	1/11/2019, 1:25:01 PM	File Name: RW-4 windows 1 thru 5_j1&j8.swd

SWEDGE 6.018

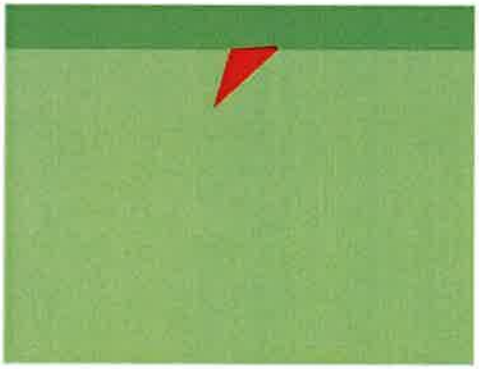
Factor of Safety: 0.88



Top - Scaled



Perspective - Scaled



Front - Scaled

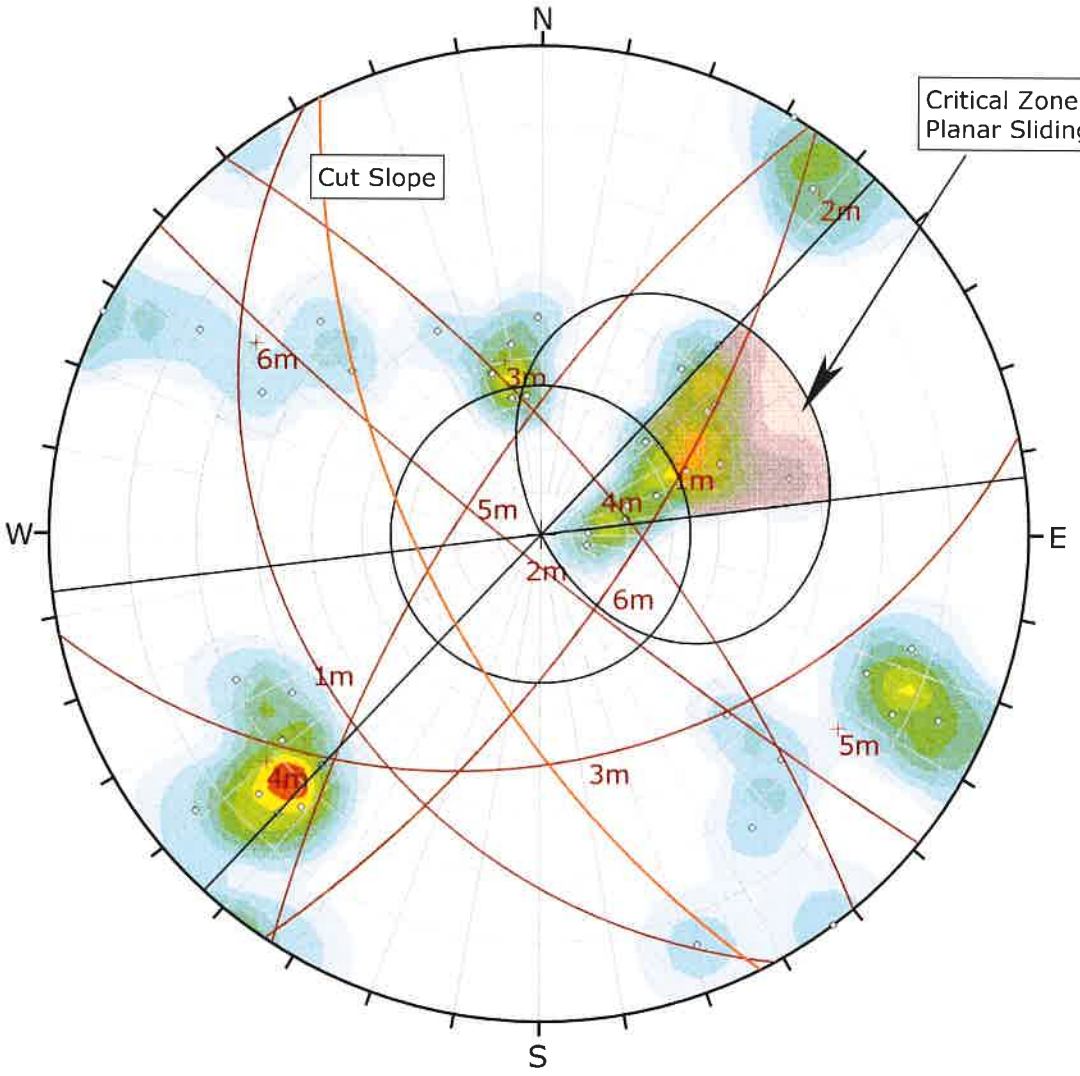
Side - Scaled

rocscience	Project	Reds Meadow	
	Analysis Description	SWEDGE - Surface Wedge Stability Analysis	
	Drawn By	KDD	Company: Shannon & Wilson, Inc
	Date	1/11/2019, 1:25:01 PM	File Name: RW-4 windows 1 thru 5_j2&j8.swd

SWEDGE 6.018

Slope RW-4

Windows 6 through 8



Symbol	Feature
◇	Pole Vectors

Color	Density Concentrations
	0.00 - 1.00
	1.00 - 2.00
	2.00 - 3.00
	3.00 - 4.00
	4.00 - 5.00
	5.00 - 6.00
	6.00 - 7.00
	7.00 - 8.00
	8.00 - 9.00
	9.00 - 10.00

Contour Data	Pole Vectors
Maximum Density	9.11%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Planar Sliding
Slope Dip	63
Slope Dip Direction	243
Friction Angle	34°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	8	46	17.39%
Planar Sliding (Set 1)	8	15	53.33%

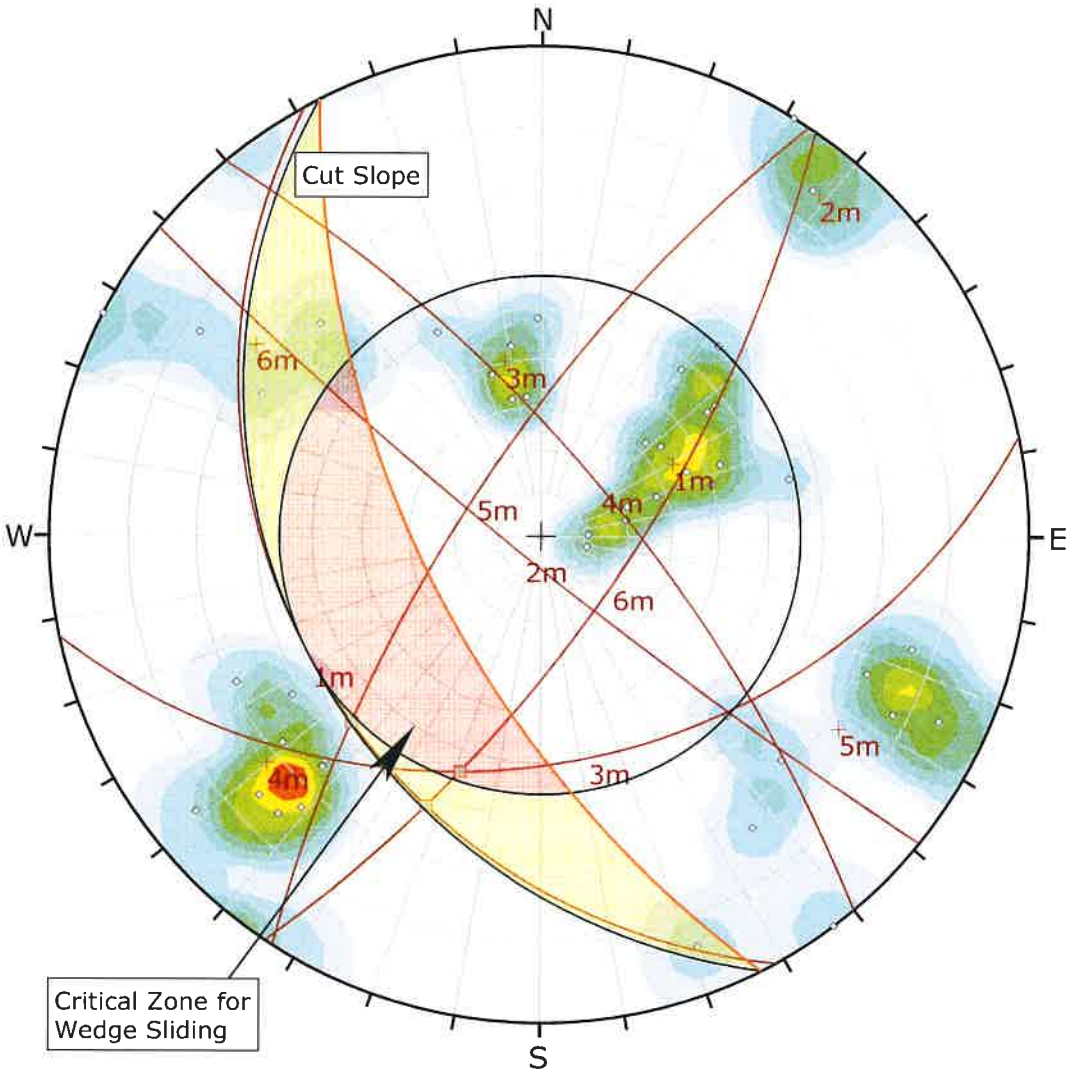
	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		34	241	
2m		84	219	
3m		40	168	
4m		72	50	
5m		72	303	
6m		70	124	

Plot Mode	Pole Vectors
Vector Count	46 (46 Entries)
Hemisphere	Lower
Projection	Equal Angle

rocscience

DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 11:05:00 AM	*File Name*	RW4 - 6 thru 7_DD 243.dips7



Symbol	Feature
○	Pole Vectors
▣	Critical Intersection

Color	Density Concentrations
	0.00 - 1.00
	1.00 - 2.00
	2.00 - 3.00
	3.00 - 4.00
	4.00 - 5.00
	5.00 - 6.00
	6.00 - 7.00
	7.00 - 8.00
	8.00 - 9.00
	9.00 - 10.00

Contour Data	Pole Vectors
Maximum Density	9.11%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Wedge Sliding
Slope Dip	63
Slope Dip Direction	243
Friction Angle	34°

	Critical	Total	%
Wedge Sliding	4	15	26.67%

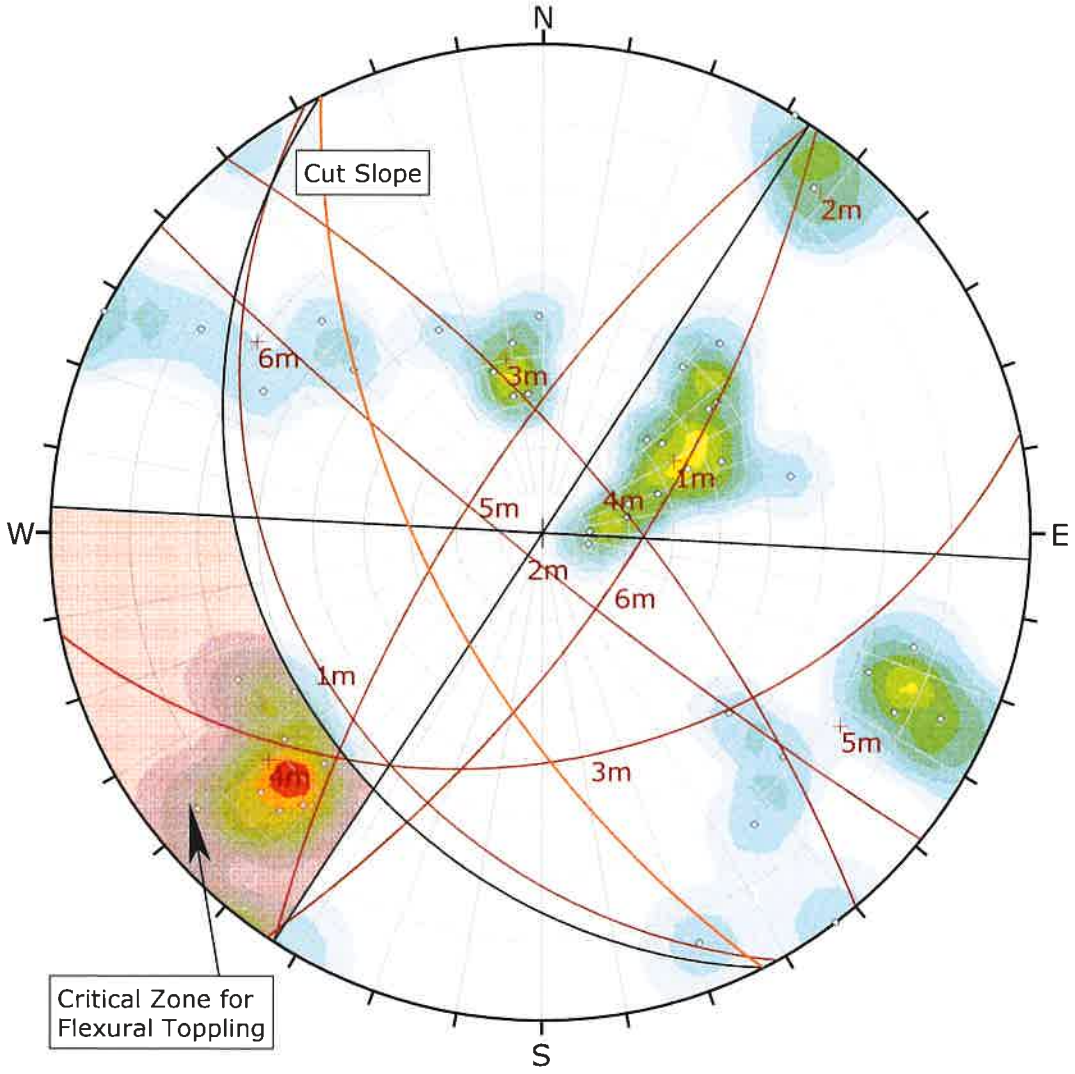
	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		34	241	
2m		84	219	
3m		40	168	
4m		72	50	
5m		72	303	
6m		70	124	

Plot Mode	Pole Vectors
Vector Count	46 (46 Entries)
Intersection Mode	User and Mean Set Planes
Intersections Count	15
Hemisphere	Lower
Projection	Equal Angle

rocscience

DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 11:05:00 AM	*File Name*	RW4 - 6 thru 7_DD 243.dips7



Symbol	Feature
◇	Pole Vectors

Color	Density Concentrations
	0.00 - 1.00
	1.00 - 2.00
	2.00 - 3.00
	3.00 - 4.00
	4.00 - 5.00
	5.00 - 6.00
	6.00 - 7.00
	7.00 - 8.00
	8.00 - 9.00
	9.00 - 10.00

Contour Data	Pole Vectors
Maximum Density	9.11%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Flexural Toppling
Slope Dip	63
Slope Dip Direction	243
Friction Angle	34°
Lateral Limits	30°

	Critical	Total	%
Flexural Toppling (All)	8	46	17.39%
Flexural Toppling (Set 4)	8	8	100.00%

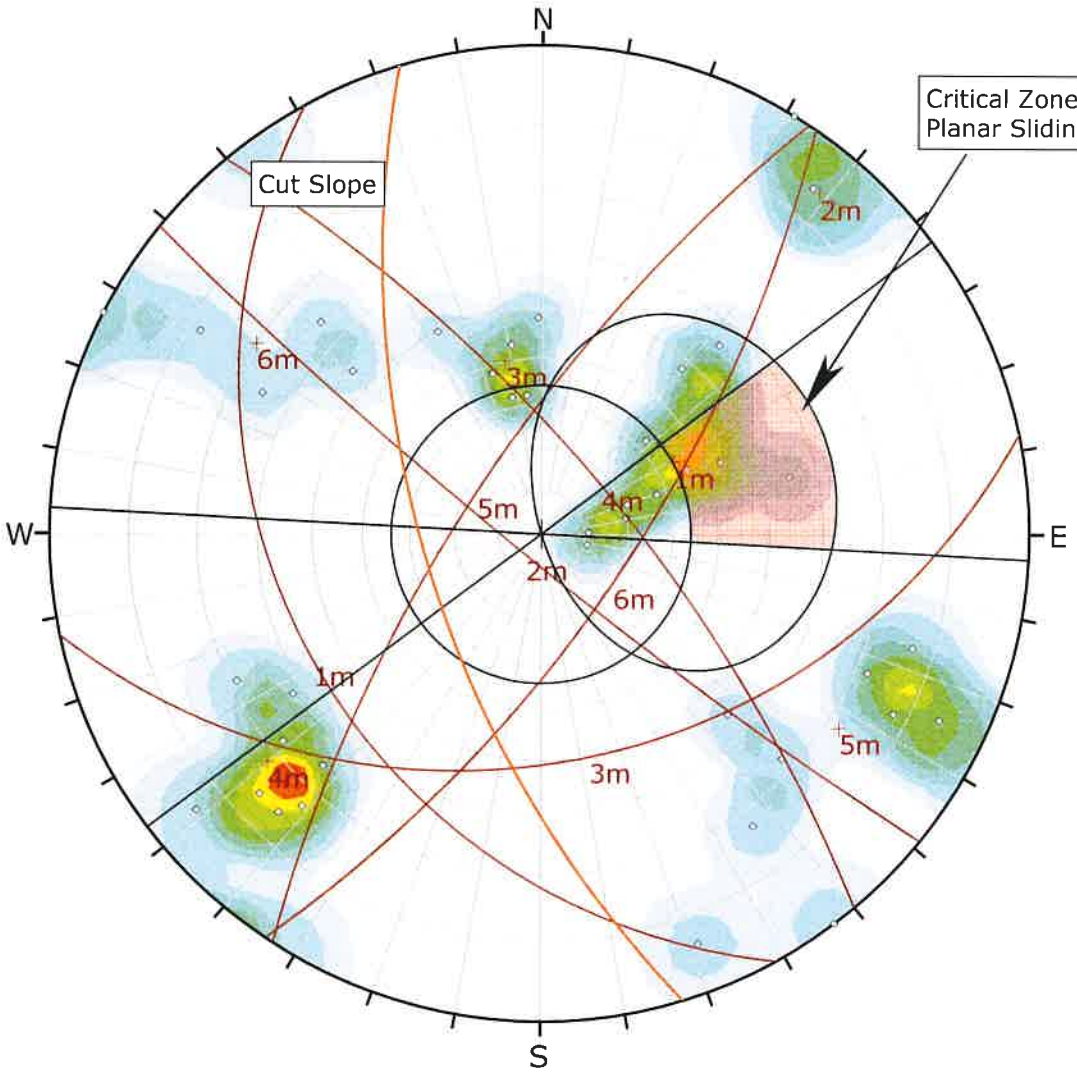
	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		34	241	
2m		84	219	
3m		40	168	
4m		72	50	
5m		72	303	
6m		70	124	

Plot Mode	Pole Vectors
Vector Count	46 (46 Entries)
Hemisphere	Lower
Projection	Equal Angle

rocscience

DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 11:05:00 AM	*File Name*	RW4 - 6 thru 7_DD 243.dips7



Symbol	Feature
○	Pole Vectors
+	Intersection

Color	Density Concentrations
	0.00 - 1.00
	1.00 - 2.00
	2.00 - 3.00
	3.00 - 4.00
	4.00 - 5.00
	5.00 - 6.00
	6.00 - 7.00
	7.00 - 8.00
	8.00 - 9.00
	9.00 - 10.00

Contour Data	Pole Vectors
Maximum Density	9.11%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Planar Sliding
Slope Dip	63
Slope Dip Direction	253
Friction Angle	34°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	7	46	15.22%
Planar Sliding (Set 1)	7	15	46.67%

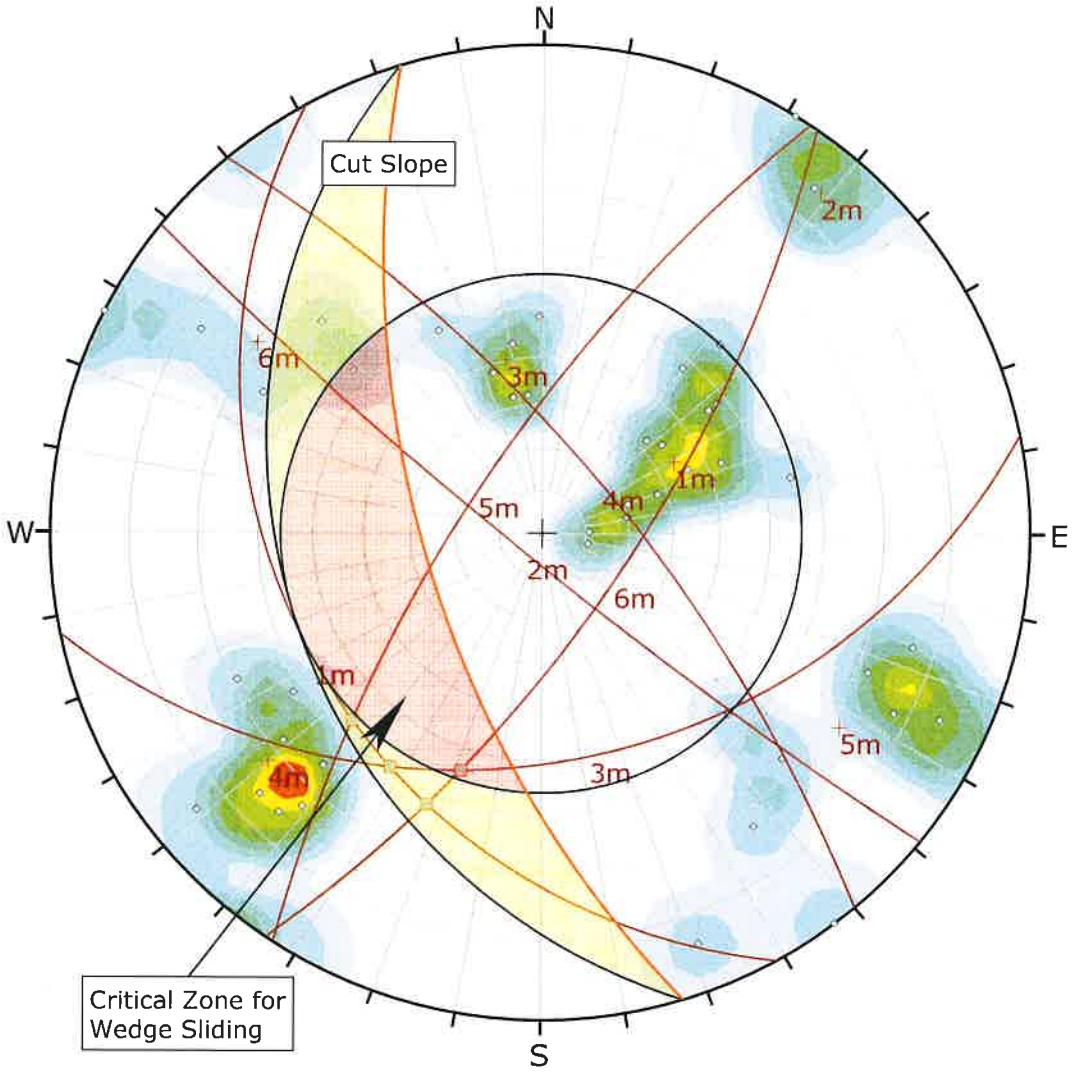
	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		34	241	
2m		84	219	
3m		40	168	
4m		72	50	
5m		72	303	
6m		70	124	

Plot Mode	Pole Vectors
Vector Count	46 (46 Entries)
Intersection Mode	Invalid Set vs Set Planes
Intersections Count	0

rocscience

DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 11:05:00 AM	*File Name*	RW4 - 6 thru 7_DD 253.dips7



Symbol	Feature
◇	Pole Vectors
▩	Critical Intersection

Color	Density Concentrations
	0.00 - 1.00
	1.00 - 2.00
	2.00 - 3.00
	3.00 - 4.00
	4.00 - 5.00
	5.00 - 6.00
	6.00 - 7.00
	7.00 - 8.00
	8.00 - 9.00
	9.00 - 10.00

Contour Data	Pole Vectors
Maximum Density	9.11%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Wedge Sliding
Slope Dip	63
Slope Dip Direction	253
Friction Angle	34°

	Critical	Total	%
Wedge Sliding	4	15	26.67%

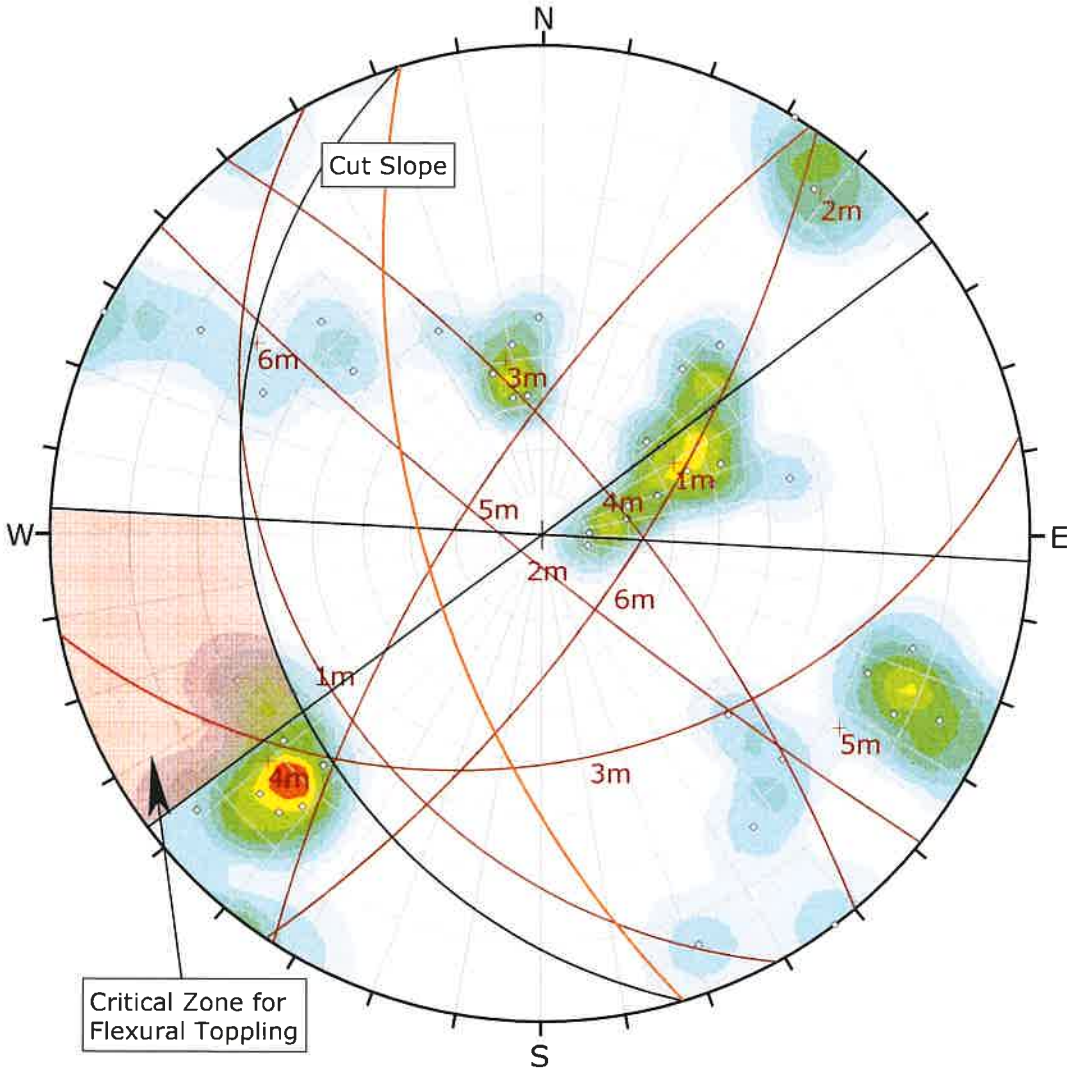
	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		34	241	
2m		84	219	
3m		40	168	
4m		72	50	
5m		72	303	
6m		70	124	

Plot Mode	Pole Vectors
Vector Count	46 (46 Entries)
Intersection Mode	User and Mean Set Planes
Intersections Count	15
Hemisphere	Lower
Projection	Equal Angle

rocscience

DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 11:05:00 AM	*File Name*	RW4 - 6 thru 7_DD 253.dips7



Symbol	Feature
◦	Pole Vectors

Color	Density Concentrations
	0.00 - 1.00
	1.00 - 2.00
	2.00 - 3.00
	3.00 - 4.00
	4.00 - 5.00
	5.00 - 6.00
	6.00 - 7.00
	7.00 - 8.00
	8.00 - 9.00
	9.00 - 10.00

Contour Data	Pole Vectors
Maximum Density	9.11%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Flexural Toppling
Slope Dip	63
Slope Dip Direction	253
Friction Angle	34°
Lateral Limits	20°

	Critical	Total	%
Flexural Toppling (All)	2	46	4.35%
Flexural Toppling (Set 4)	2	8	25.00%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		34	241	
2m		84	219	
3m		40	168	
4m		72	50	
5m		72	303	
6m		70	124	

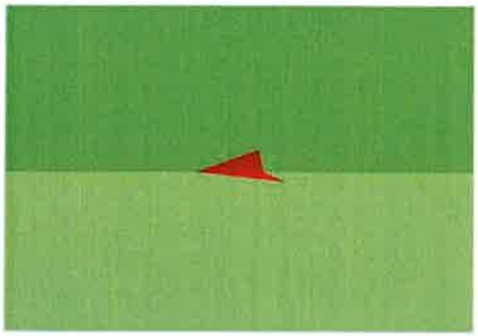
Plot Mode	Pole Vectors
Vector Count	46 (46 Entries)
Hemisphere	Lower
Projection	Equal Angle

rocscience

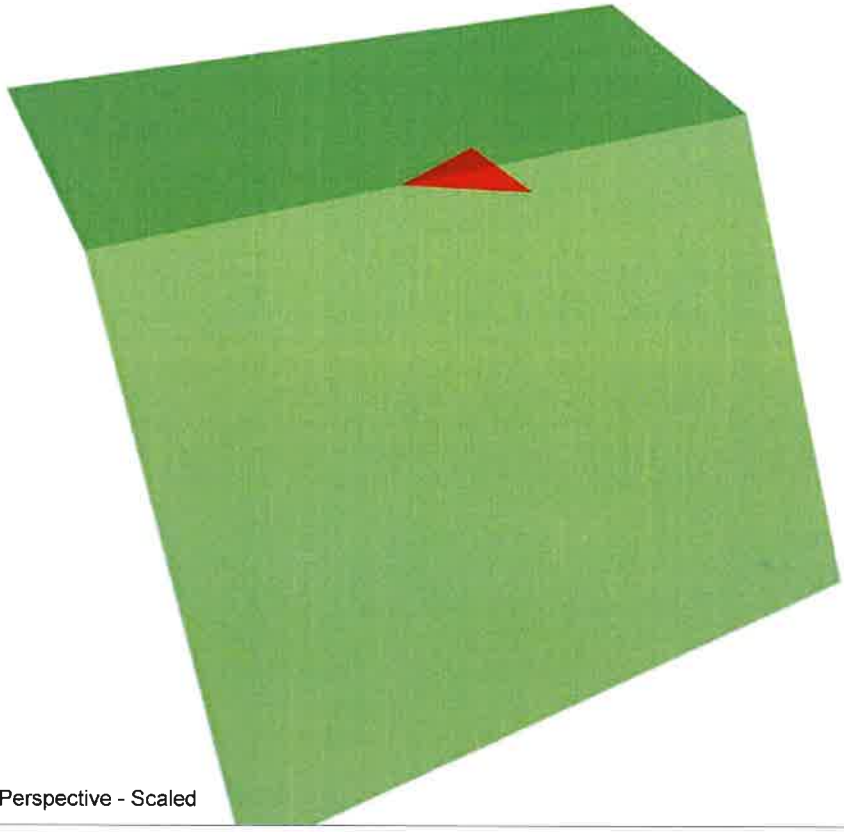
DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 11:05:00 AM	*File Name*	RW4 - 6 thru 7_DD 253.dips7

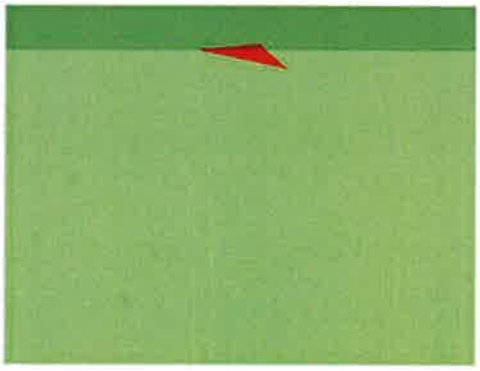
Factor of Safety: 1.00



Top - Scaled



Perspective - Scaled



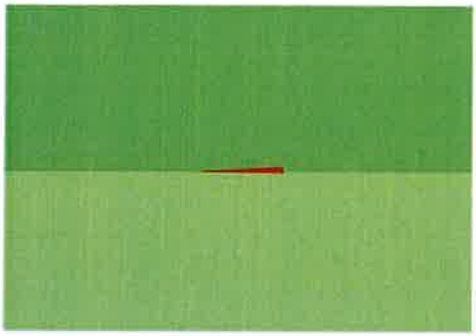
Front - Scaled

Side - Scaled

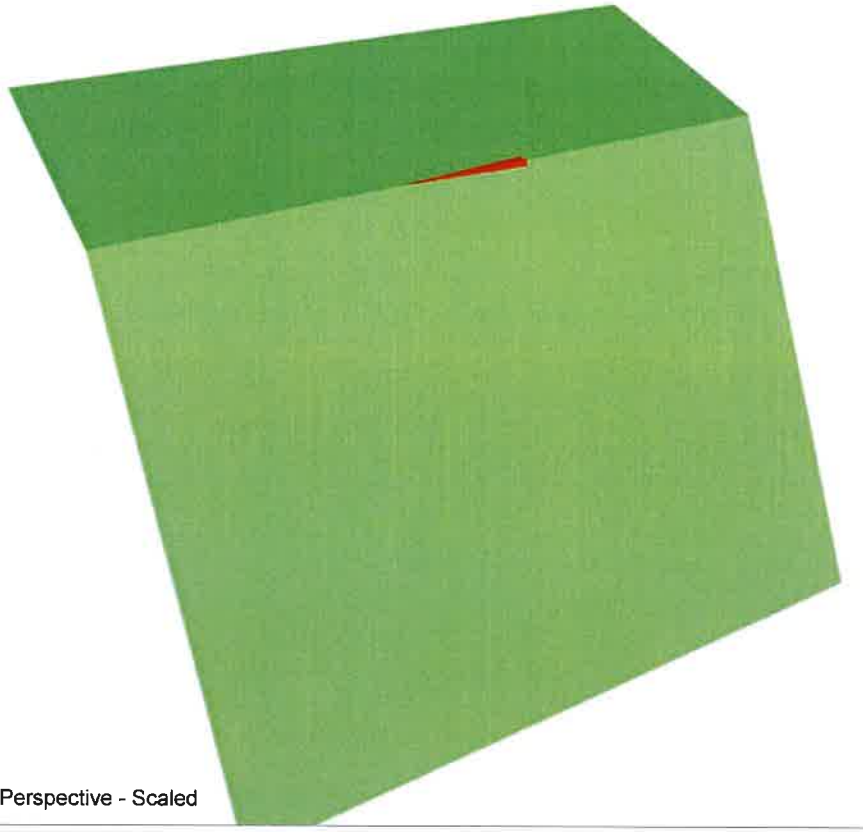
rocscience	Project	Reds Meadow	
	Analysis Description	SWEDGE - Surface Wedge Stability Analysis	
	Drawn By	KDD	Company: Shannon & Wilson, Inc
	Date	1/11/2019, 1:25:01 PM	File Name: RW-4 windows 6 and 7_j1&j3.swd

SWEDGE 6.018

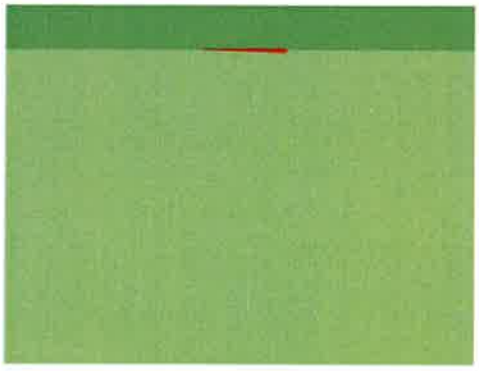
Factor of Safety: 1.00



Top - Scaled



Perspective - Scaled



Front - Scaled

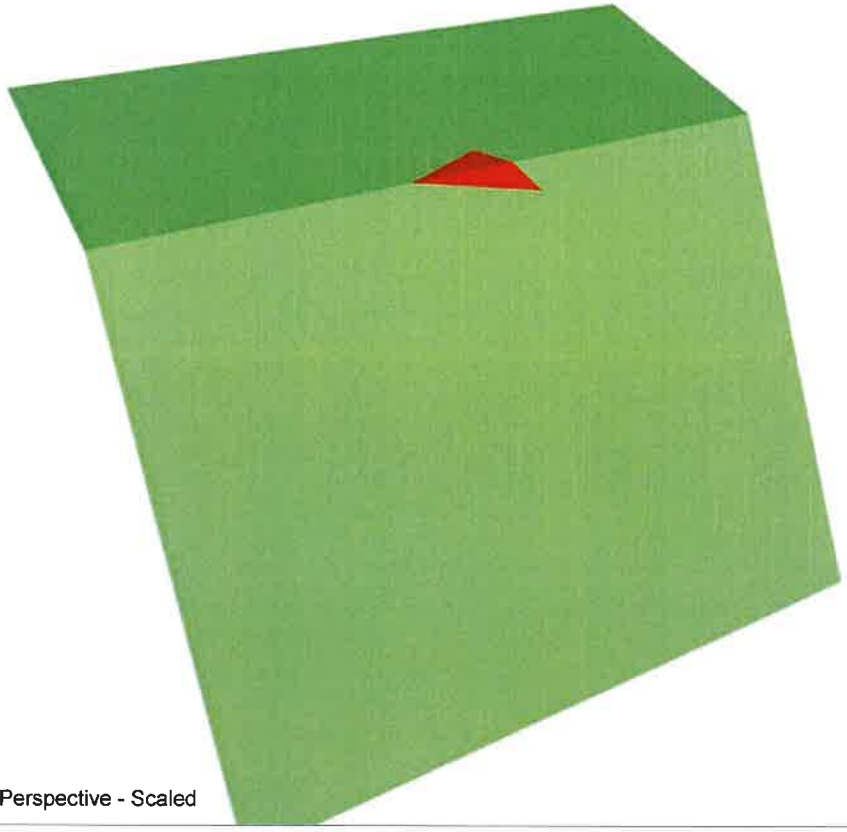
Side - Scaled

rocscience	Project	Reds Meadow	
	Analysis Description	SWEDGE - Surface Wedge Stability Analysis	
	Drawn By	KDD	Company: Shannon & Wilson, Inc
	Date	1/11/2019, 1:25:01 PM	File Name: RW-4 windows 6 and 7_j1&j5.swd

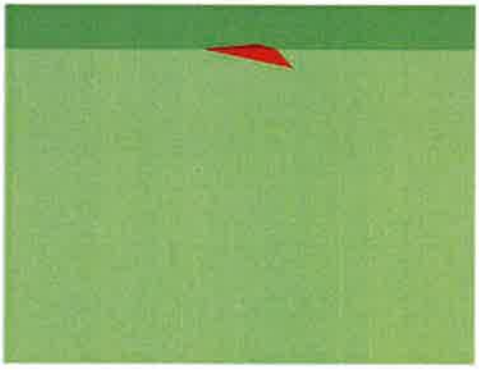
SWEDGE 6.018

Factor of Safety: 1.00

Top - Scaled



Perspective - Scaled



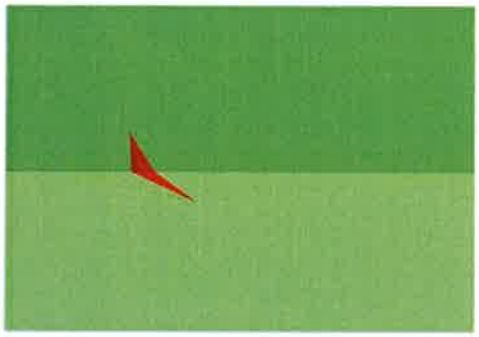
Front - Scaled

Side - Scaled

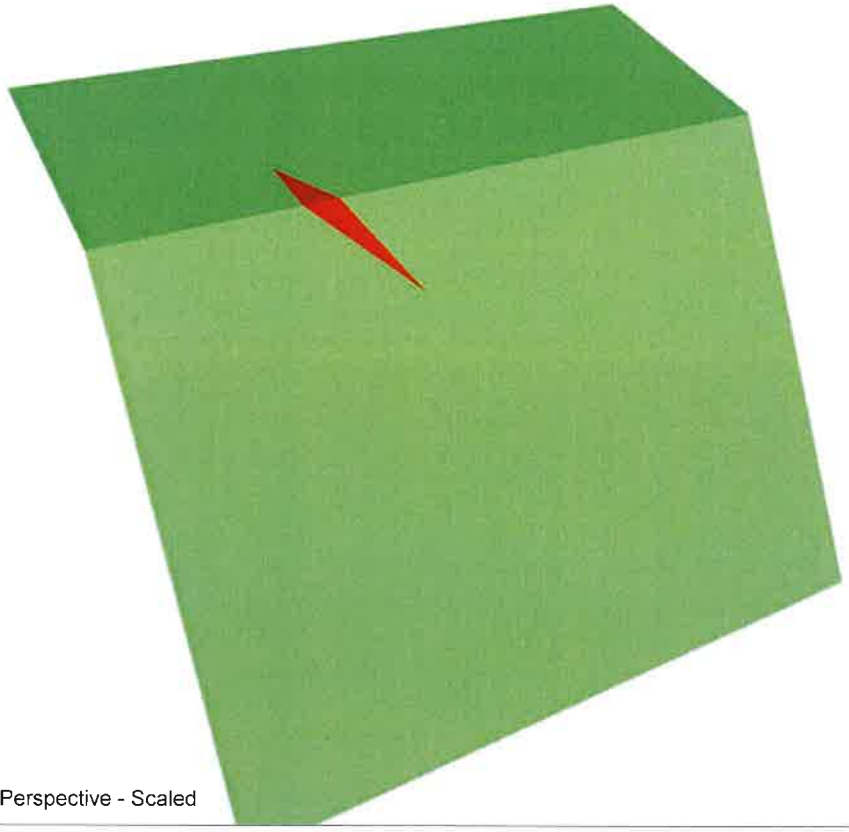
rocscience	Project	Reds Meadow	
	Analysis Description	SWEDGE - Surface Wedge Stability Analysis	
	Drawn By	KDD	Company: Shannon & Wilson, Inc
	Date	1/11/2019, 1:25:01 PM	File Name: RW-4 windows 6 and 7_j1&j6.swd

SWEDGE 6.018

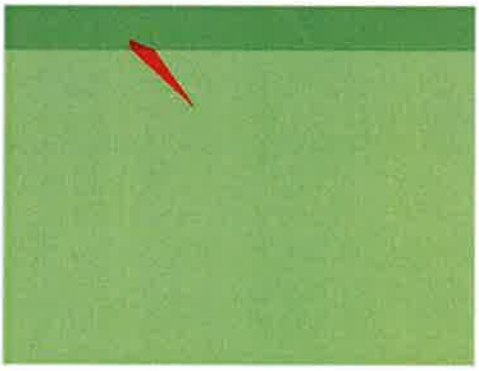
Factor of Safety: 1.61



Top - Scaled



Perspective - Scaled



Front - Scaled

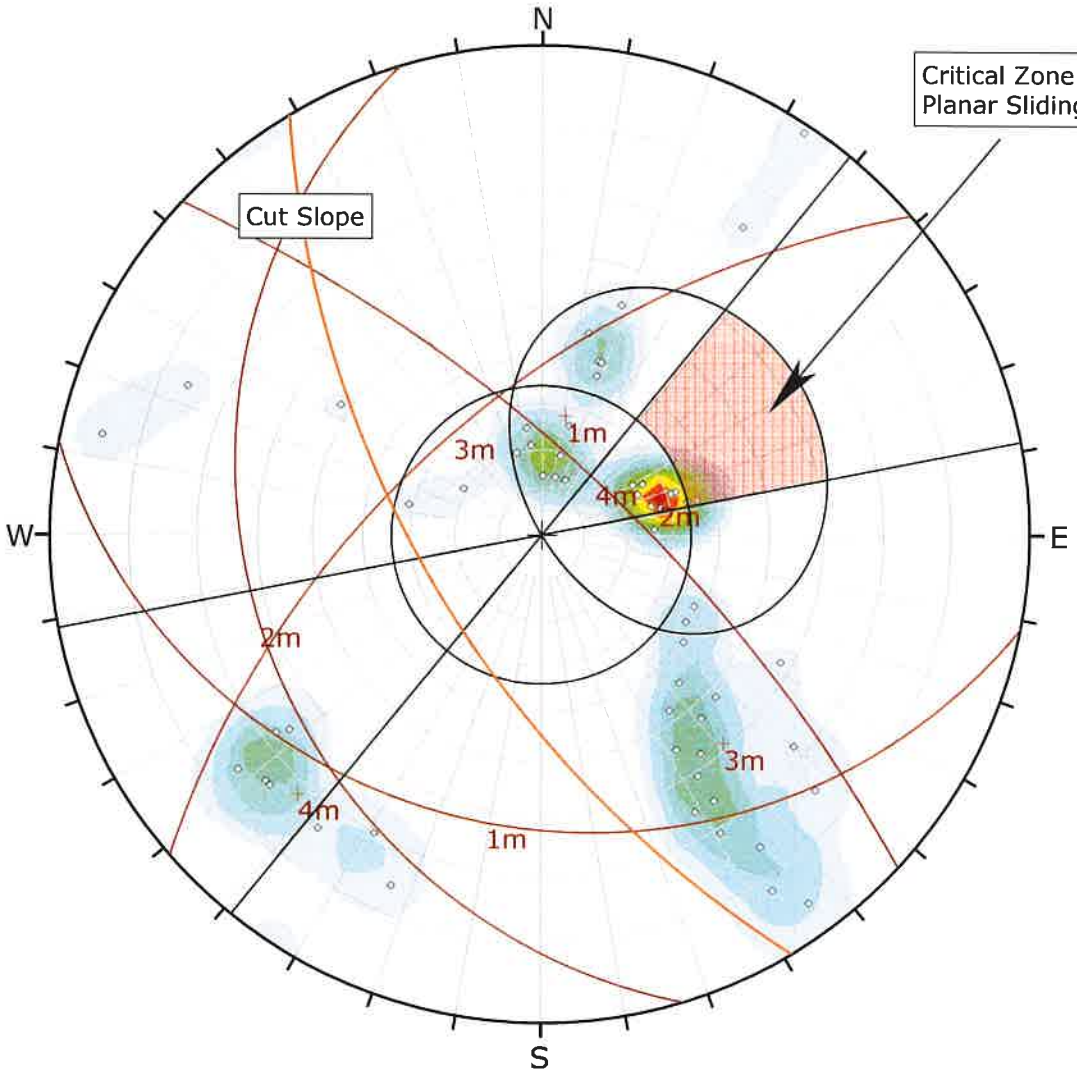
Side - Scaled

rocscience	Project	Reds Meadow	
	Analysis Description	SWEDGE - Surface Wedge Stability Analysis	
	Drawn By	KDD	Company: Shannon & Wilson, Inc
	Date	1/11/2019, 1:25:01 PM	File Name: RW-4 windows 6 and 7_j3&j6.swd

SWEDGE 6.018

Slope RW-4

Windows 9 and 10



Symbol	Feature
○	Pole Vectors

Color	Density Concentrations
	0.00 - 1.60
	1.60 - 3.20
	3.20 - 4.80
	4.80 - 6.40
	6.40 - 8.00
	8.00 - 9.60
	9.60 - 11.20
	11.20 - 12.80
	12.80 - 14.40
	14.40 - 16.00

Contour Data	Pole Vectors
Maximum Density	15.47%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Planar Sliding
Slope Dip	63
Slope Dip Direction	239
Friction Angle	34°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	3	59	5.08%
Planar Sliding (Set 2)	3	12	25.00%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		28	191	
2m		28	253	
3m		59	319	
4m		72	43	

Plot Mode	Pole Vectors
Vector Count	59 (59 Entries)
Hemisphere	Lower
Projection	Equal Angle

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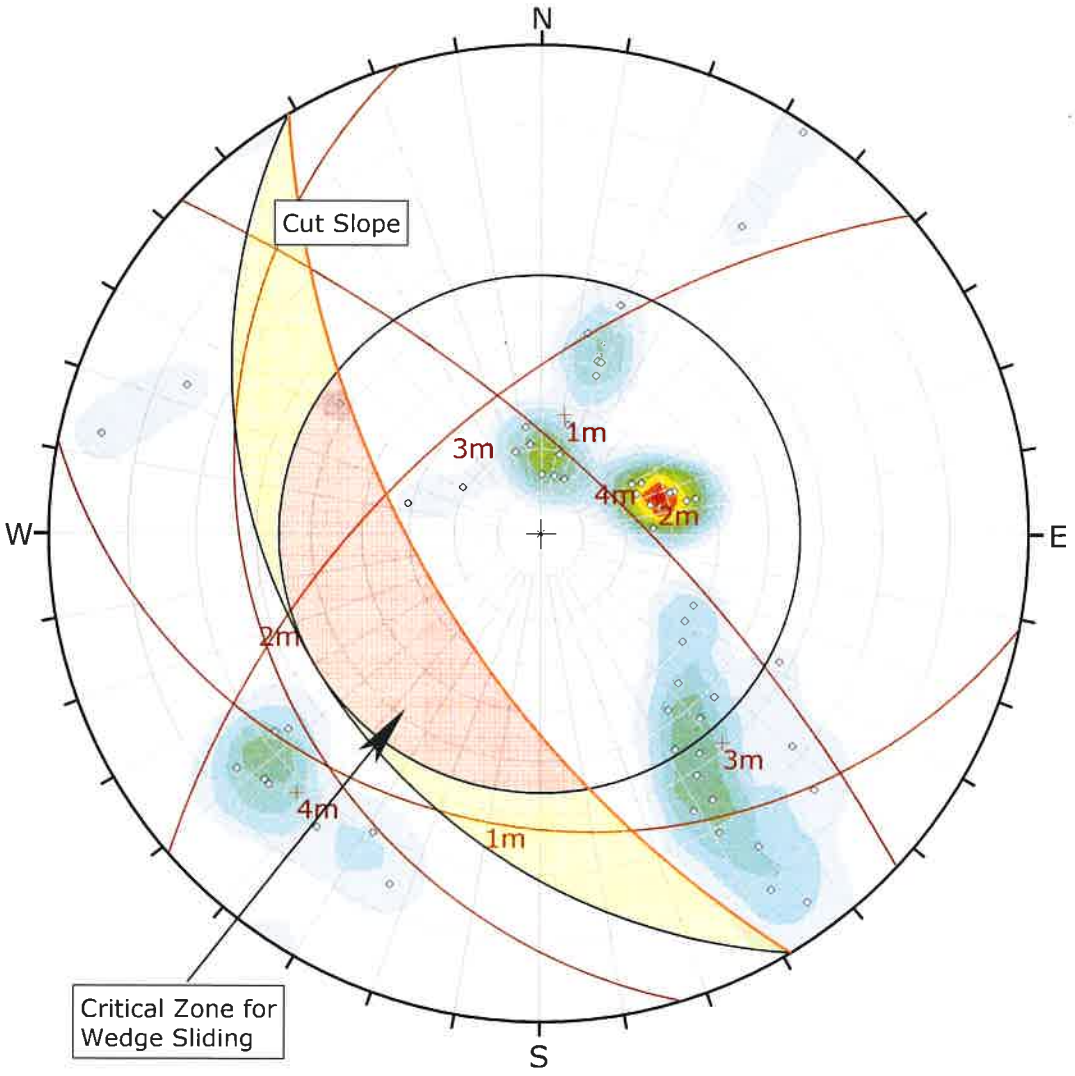
DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 11:09:39 AM	*File Name*	RW4 - 8 thru 10.dips7



Symbol	Feature
○	Pole Vectors
▒	Critical Intersection

Color	Density Concentrations
	0.00 - 1.60
	1.60 - 3.20
	3.20 - 4.80
	4.80 - 6.40
	6.40 - 8.00
	8.00 - 9.60
	9.60 - 11.20
	11.20 - 12.80
	12.80 - 14.40
	14.40 - 16.00

Contour Data	Pole Vectors
Maximum Density	15.47%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Wedge Sliding
Slope Dip	63
Slope Dip Direction	239
Friction Angle	34°

	Critical	Total	%
Wedge Sliding	0	6	0.00%

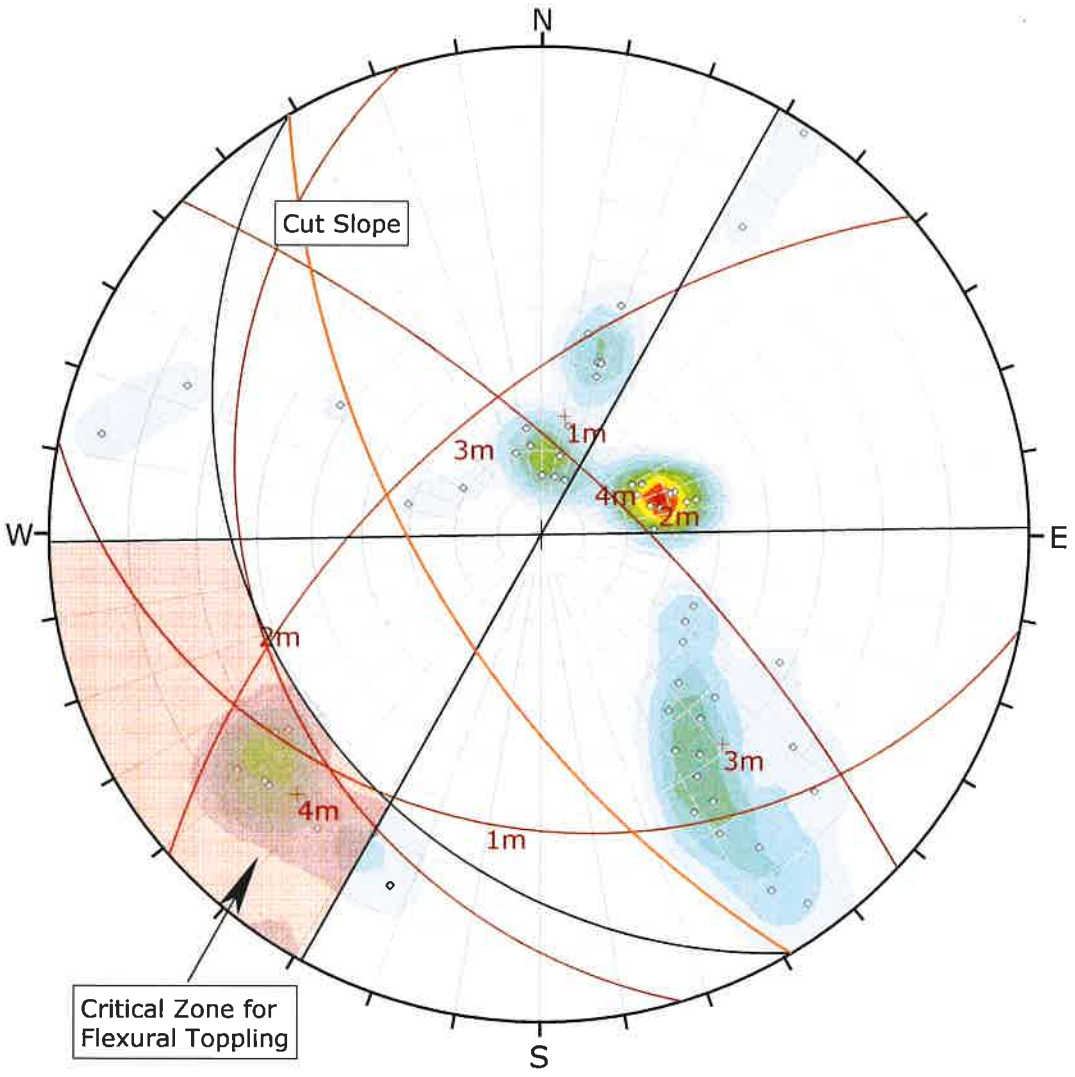
	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		28	191	
2m		28	253	
3m		59	319	
4m		72	43	

Plot Mode	Pole Vectors
Vector Count	59 (59 Entries)
Intersection Mode	User and Mean Set Planes
Intersections Count	6
Hemisphere	Lower
Projection	Equal Angle

rocscience

DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 11:09:39 AM	*File Name*	RW4 - 8 thru 10.dips7



Symbol	Feature
◦	Pole Vectors

Color	Density Concentrations
	0.00 - 1.60
	1.60 - 3.20
	3.20 - 4.80
	4.80 - 6.40
	6.40 - 8.00
	8.00 - 9.60
	9.60 - 11.20
	11.20 - 12.80
	12.80 - 14.40
	14.40 - 16.00

Contour Data	Pole Vectors
Maximum Density	15.47%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Flexural Toppling
Slope Dip	63
Slope Dip Direction	239
Friction Angle	34°
Lateral Limits	30°

	Critical	Total	%
Flexural Toppling (All)	7	59	11.86%
Flexural Toppling (Set 4)	7	8	87.50%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		28	191	
2m		28	253	
3m		59	319	
4m		72	43	

Plot Mode	Pole Vectors
Vector Count	59 (59 Entries)
Hemisphere	Lower
Projection	Equal Angle

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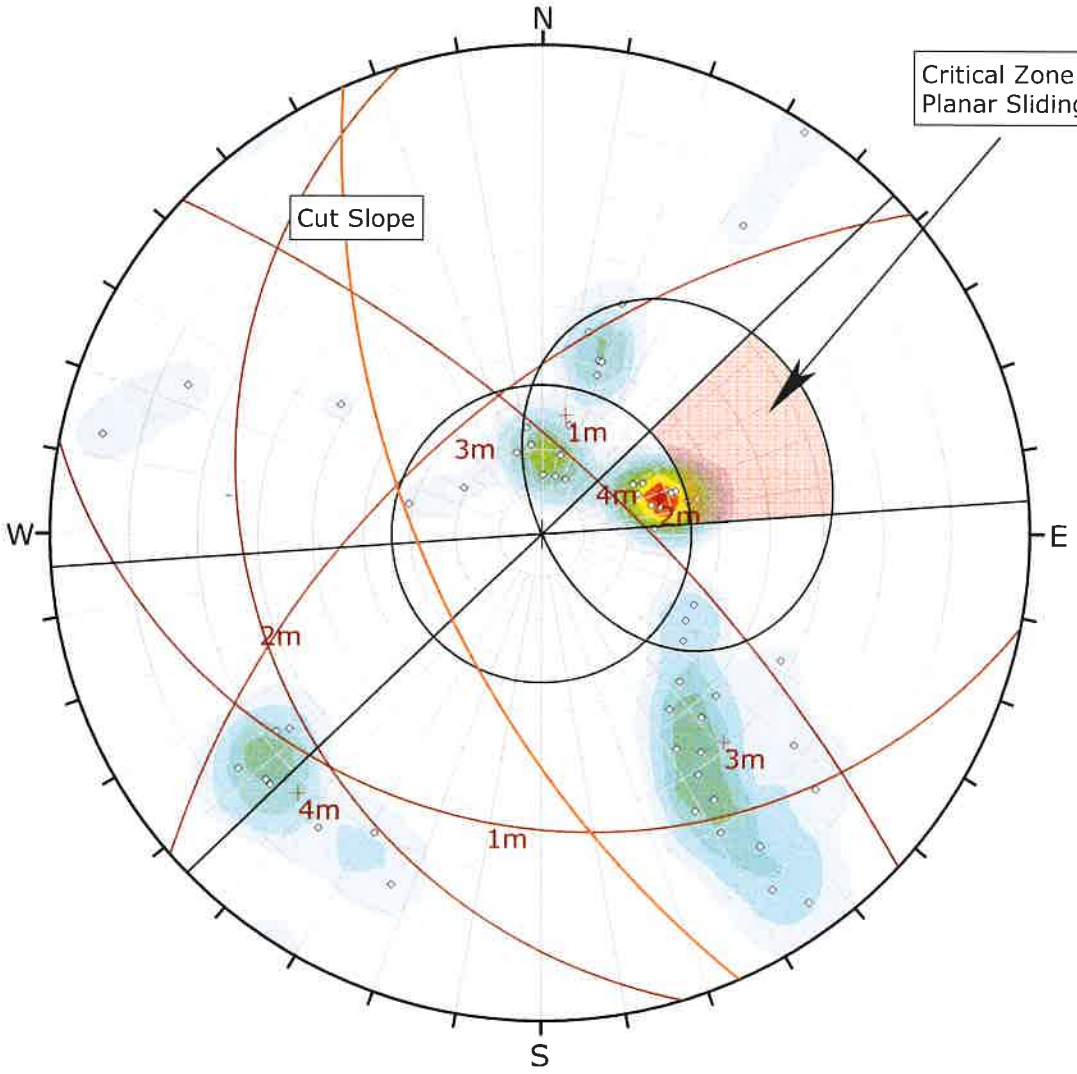
DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 11:09:39 AM	*File Name*	RW4 - 8 thru 10.dips7



Symbol	Feature
◦	Pole Vectors

Color	Density Concentrations
	0.00 - 1.60
	1.60 - 3.20
	3.20 - 4.80
	4.80 - 6.40
	6.40 - 8.00
	8.00 - 9.60
	9.60 - 11.20
	11.20 - 12.80
	12.80 - 14.40
	14.40 - 16.00

Contour Data	Pole Vectors
Maximum Density	15.47%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Planar Sliding
Slope Dip	63
Slope Dip Direction	246
Friction Angle	34°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	3	59	5.08%
Planar Sliding (Set 2)	3	12	25.00%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		28	191	
2m		28	253	
3m		59	319	
4m		72	43	

Plot Mode	Pole Vectors
Vector Count	59 (59 Entries)
Hemisphere	Lower
Projection	Equal Angle

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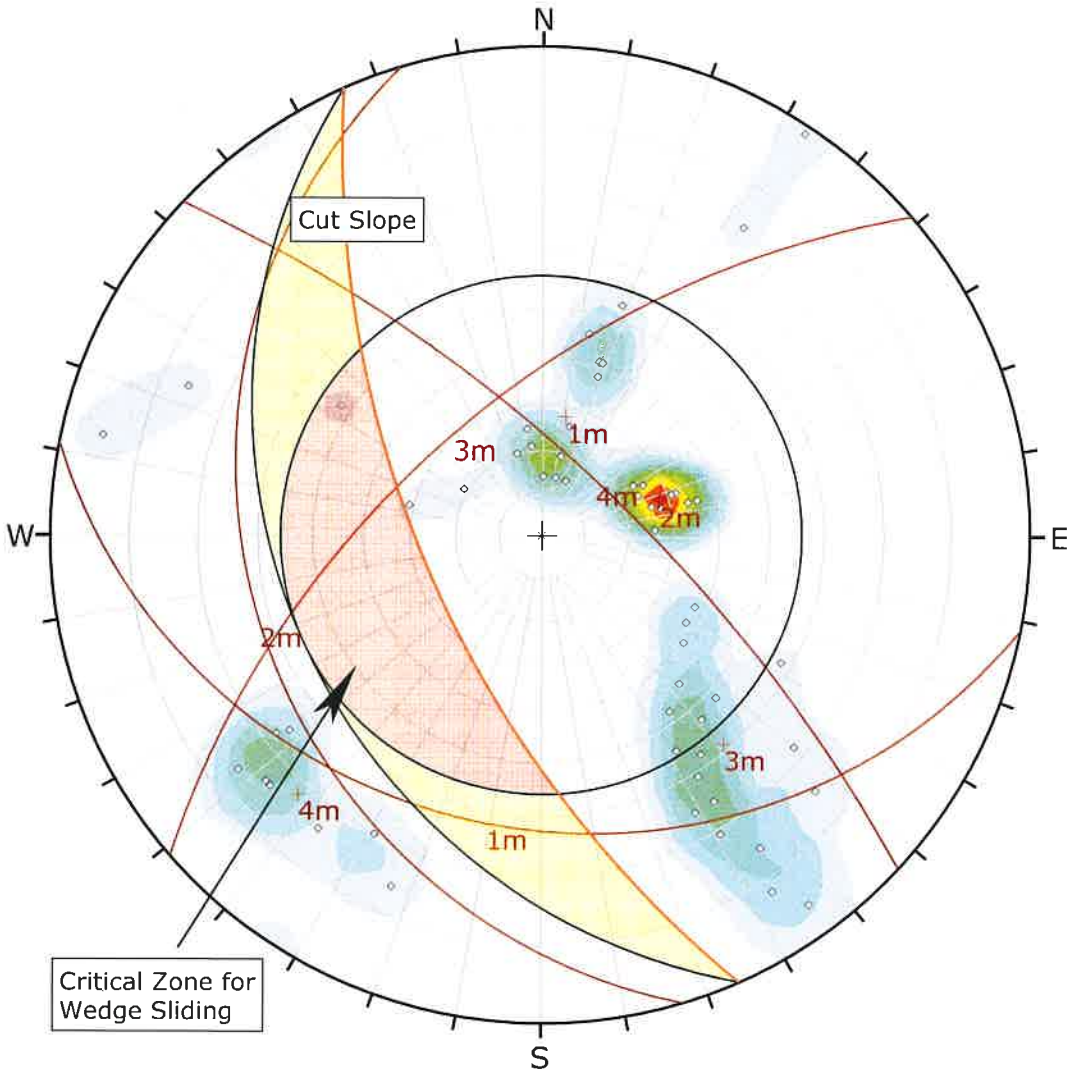
DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 11:09:39 AM	*File Name*	RW4 - 8 thru 10_DD 246.dips7



Symbol	Feature
◇	Pole Vectors
▭	Critical Intersection

Color	Density Concentrations
	0.00 - 1.60
	1.60 - 3.20
	3.20 - 4.80
	4.80 - 6.40
	6.40 - 8.00
	8.00 - 9.60
	9.60 - 11.20
	11.20 - 12.80
	12.80 - 14.40
	14.40 - 16.00

Contour Data	Pole Vectors
Maximum Density	15.47%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Wedge Sliding
Slope Dip	63
Slope Dip Direction	246
Friction Angle	34°

	Critical	Total	%
Wedge Sliding	0	6	0.00%

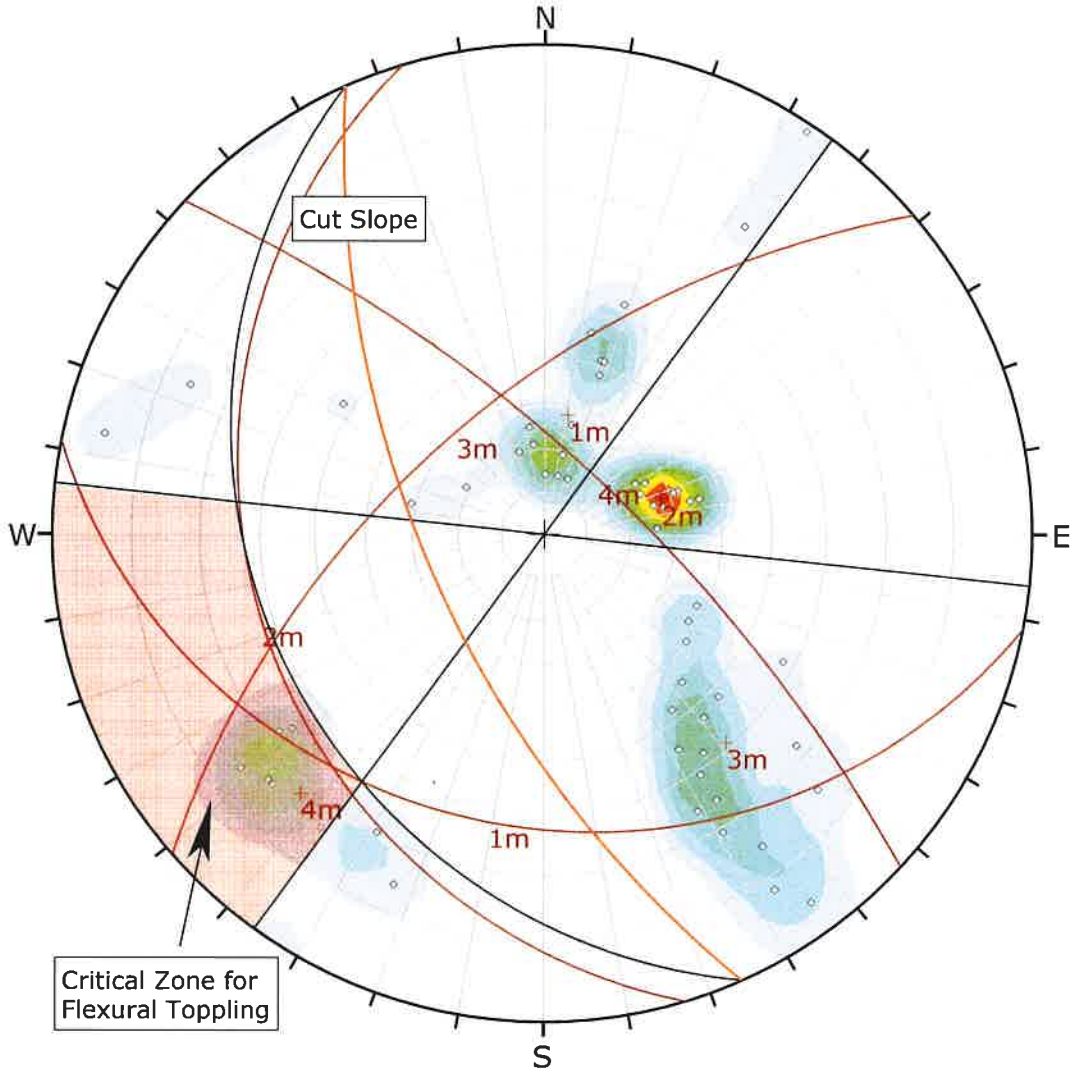
	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		28	191	
2m		28	253	
3m		59	319	
4m		72	43	

Plot Mode	Pole Vectors
Vector Count	59 (59 Entries)
Intersection Mode	User and Mean Set Planes
Intersections Count	6
Hemisphere	Lower
Projection	Equal Angle

rocscience

DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 11:09:39 AM	*File Name*	RW4 - 8 thru 10_DD 246.dips7



Symbol	Feature
◦	Pole Vectors

Color	Density Concentrations
	0.00 - 1.60
	1.60 - 3.20
	3.20 - 4.80
	4.80 - 6.40
	6.40 - 8.00
	8.00 - 9.60
	9.60 - 11.20
	11.20 - 12.80
	12.80 - 14.40
	14.40 - 16.00

Contour Data	Pole Vectors
Maximum Density	15.47%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Flexural Toppling
Slope Dip	63
Slope Dip Direction	246
Friction Angle	34°
Lateral Limits	30°

	Critical	Total	%
Flexural Toppling (All)	6	59	10.17%
Flexural Toppling (Set 4)	6	8	75.00%

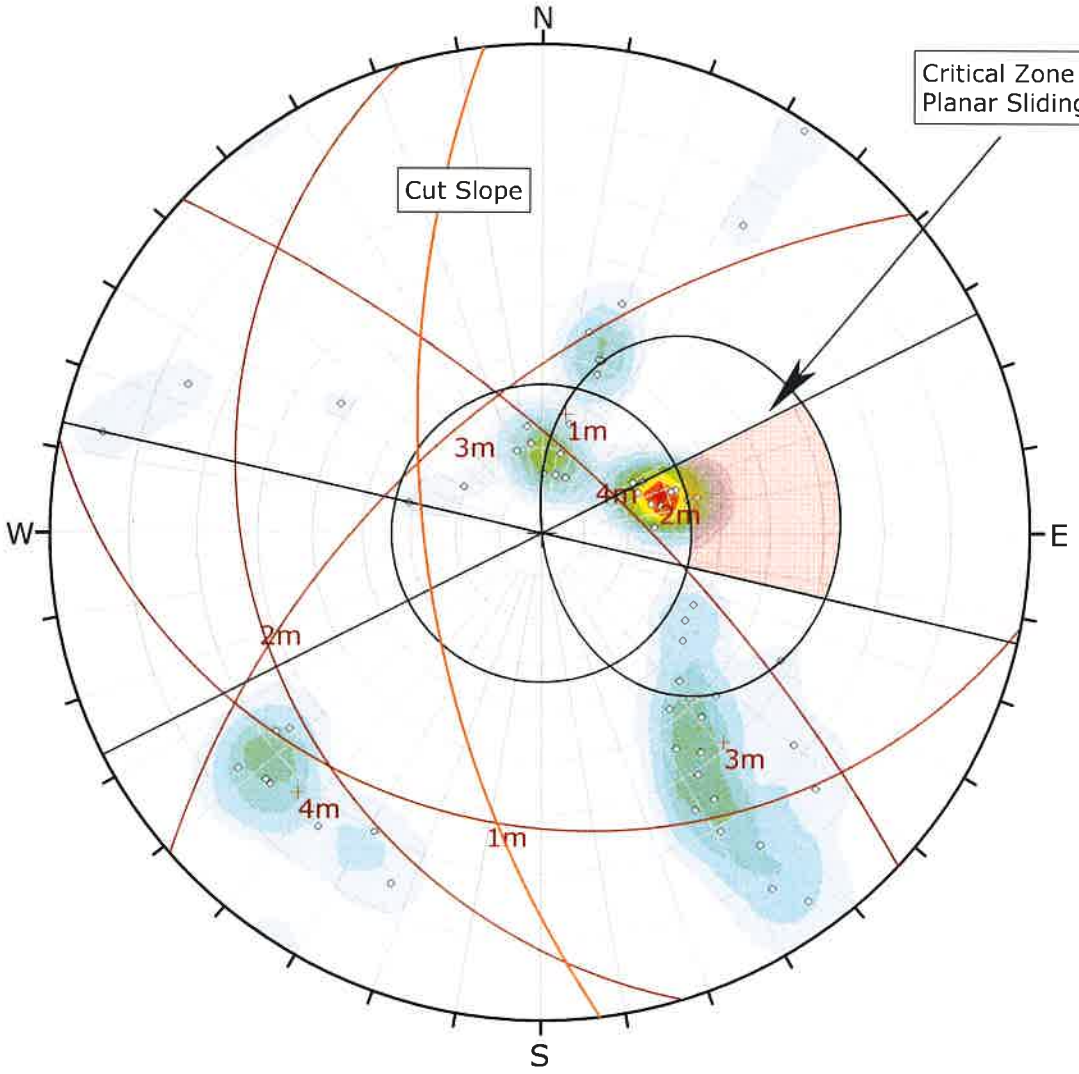
	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		28	191	
2m		28	253	
3m		59	319	
4m		72	43	

Plot Mode	Pole Vectors
Vector Count	59 (59 Entries)
Hemisphere	Lower
Projection	Equal Angle

rocscience

DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 11:09:39 AM	*File Name*	RW4 - 8 thru 10_DD 246.dips7



Symbol	Feature
○	Pole Vectors

Color	Density Concentrations
	0.00 - 1.60
	1.60 - 3.20
	3.20 - 4.80
	4.80 - 6.40
	6.40 - 8.00
	8.00 - 9.60
	9.60 - 11.20
	11.20 - 12.80
	12.80 - 14.40
	14.40 - 16.00

Contour Data	Pole Vectors
Maximum Density	15.47%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Planar Sliding
Slope Dip	63
Slope Dip Direction	263
Friction Angle	34°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	3	59	5.08%
Planar Sliding (Set 2)	3	12	25.00%

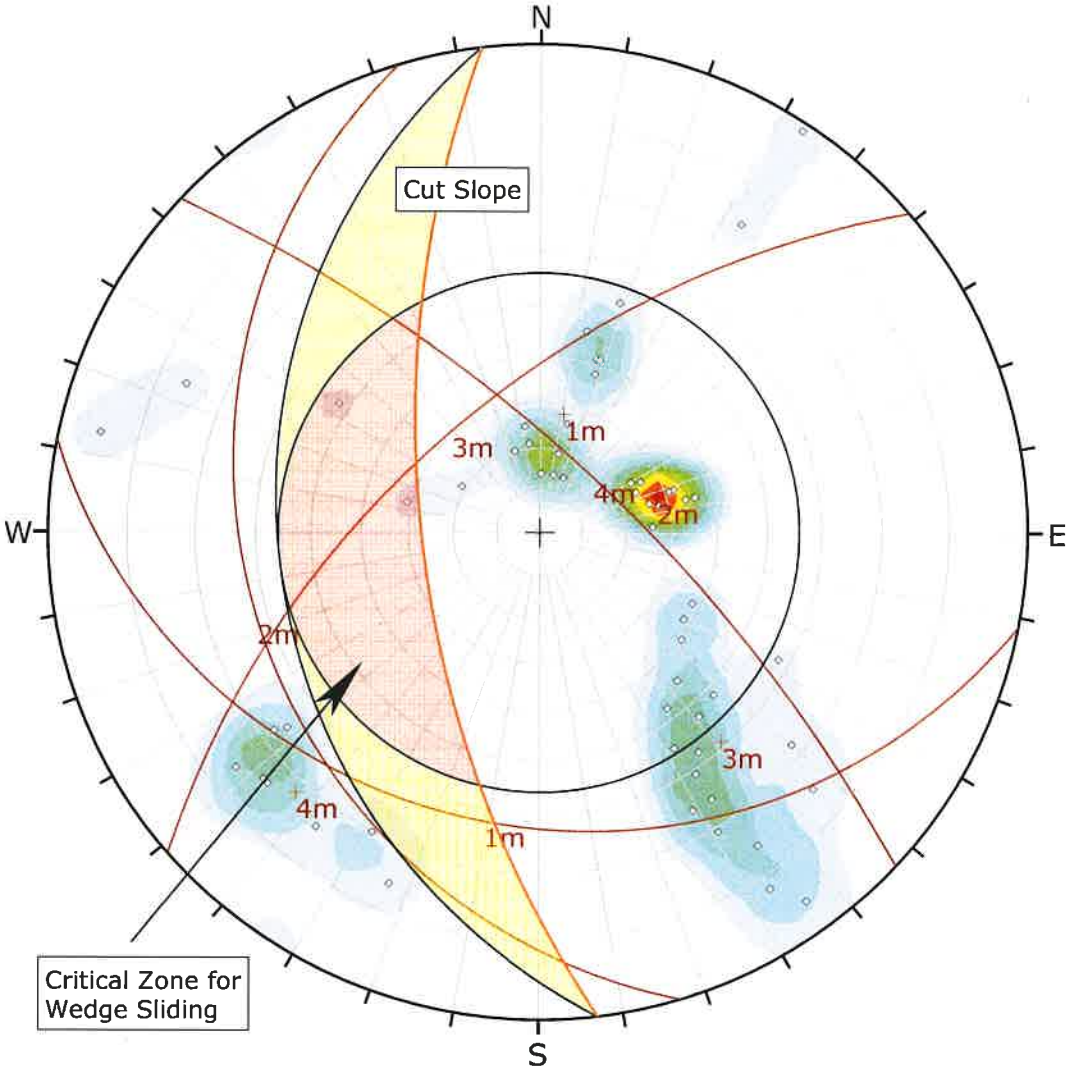
	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		28	191	
2m		28	253	
3m		59	319	
4m		72	43	

Plot Mode	Pole Vectors
Vector Count	59 (59 Entries)
Hemisphere	Lower
Projection	Equal Angle

rocscience

DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 11:09:39 AM	*File Name*	RW4 - 8 thru 10_DD 263.dips7



Symbol	Feature
◇	Pole Vectors
▦	Critical Intersection

Color	Density Concentrations
	0.00 - 1.60
	1.60 - 3.20
	3.20 - 4.80
	4.80 - 6.40
	6.40 - 8.00
	8.00 - 9.60
	9.60 - 11.20
	11.20 - 12.80
	12.80 - 14.40
	14.40 - 16.00

Contour Data	Pole Vectors
Maximum Density	15.47%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Wedge Sliding
Slope Dip	63
Slope Dip Direction	263
Friction Angle	34°

	Critical	Total	%
Wedge Sliding	0	6	0.00%

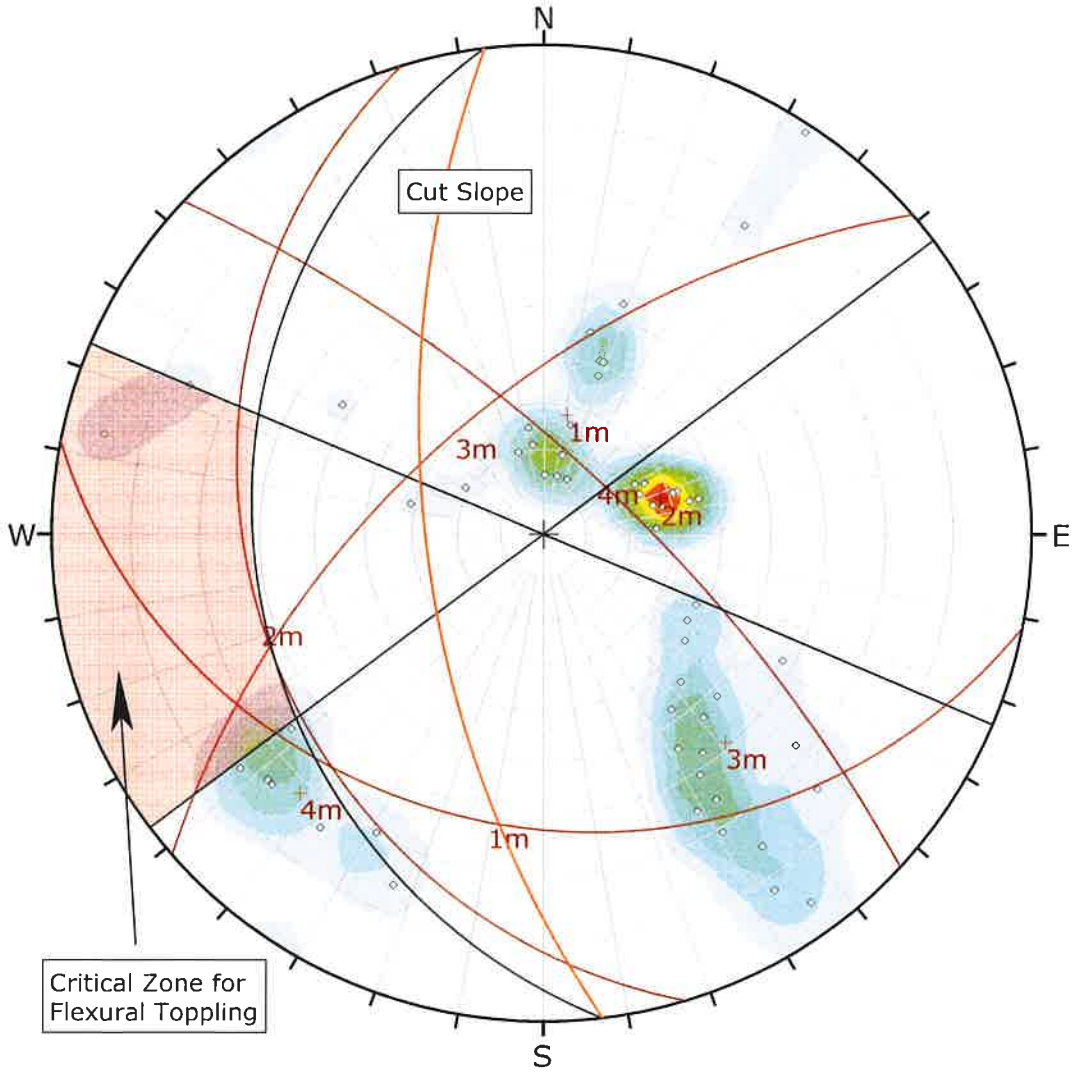
	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		28	191	
2m		28	253	
3m		59	319	
4m		72	43	

Plot Mode	Pole Vectors
Vector Count	59 (59 Entries)
Intersection Mode	User and Mean Set Planes
Intersections Count	6
Hemisphere	Lower
Projection	Equal Angle

rocscience

DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 11:09:39 AM	*File Name*	RW4 - 8 thru 10_DD 263.dips7



Symbol	Feature
○	Pole Vectors

Color	Density Concentrations
	0.00 - 1.60
	1.60 - 3.20
	3.20 - 4.80
	4.80 - 6.40
	6.40 - 8.00
	8.00 - 9.60
	9.60 - 11.20
	11.20 - 12.80
	12.80 - 14.40
	14.40 - 16.00

Contour Data	Pole Vectors
Maximum Density	15.47%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Flexural Toppling
Slope Dip	63
Slope Dip Direction	263
Friction Angle	34°
Lateral Limits	30°

	Critical	Total	%
Flexural Toppling (All)	3	59	5.08%
Flexural Toppling (Set 4)	1	8	12.50%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		28	191	
2m		28	253	
3m		59	319	
4m		72	43	

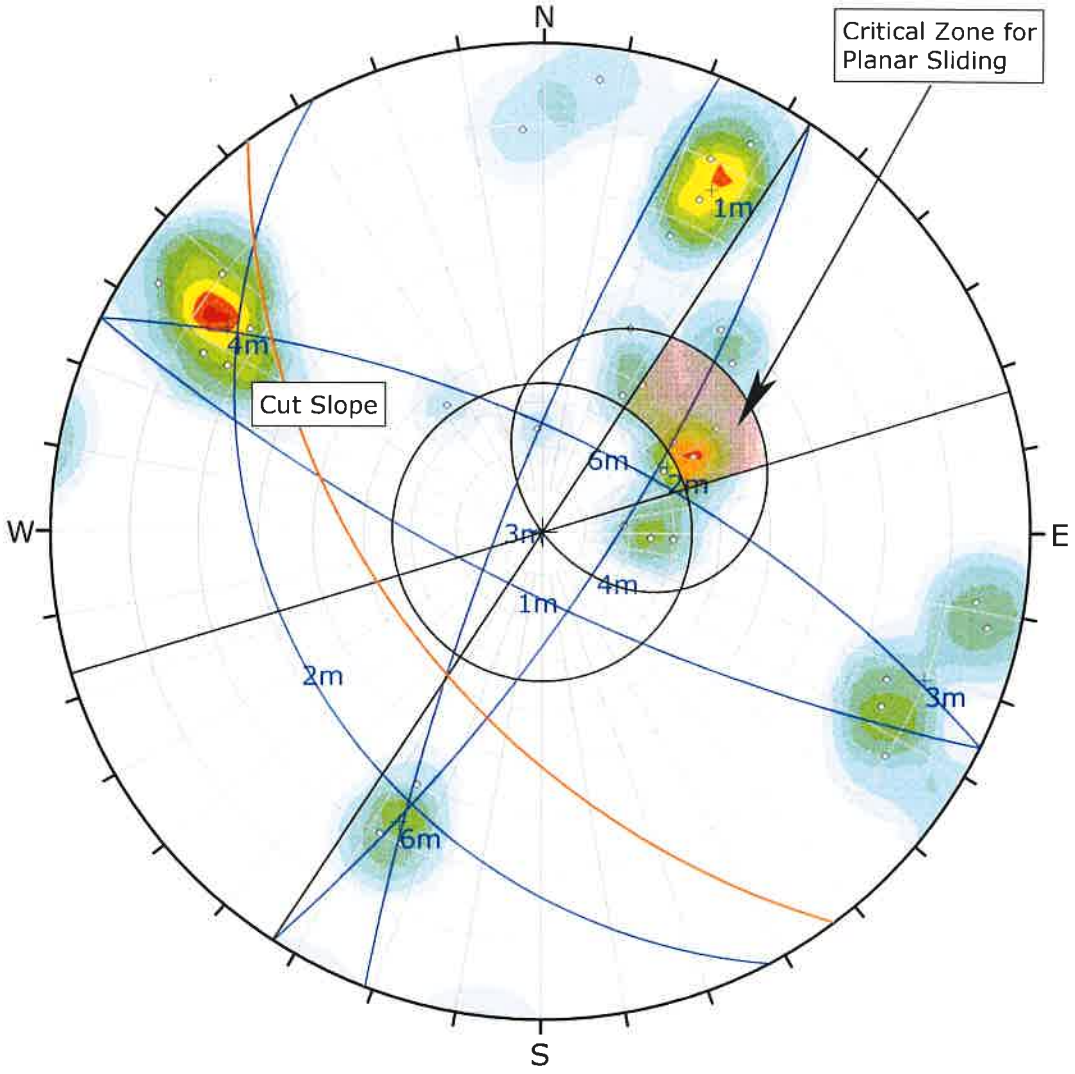
Plot Mode	Pole Vectors
Vector Count	59 (59 Entries)
Hemisphere	Lower
Projection	Equal Angle

rocscience

DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/11/2019, 11:09:39 AM	*File Name*	RW4 - 8 thru 10_DD 263.dips7

Slope RW-8



Symbol	Feature
○	Pole Vectors

Color	Density Concentrations
	0.00 - 1.20
	1.20 - 2.40
	2.40 - 3.60
	3.60 - 4.80
	4.80 - 6.00
	6.00 - 7.20
	7.20 - 8.40
	8.40 - 9.60
	9.60 - 10.80
	10.80 - 12.00

Contour Data	Pole Vectors
Maximum Density	11.55%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Planar Sliding
Slope Dip	53
Slope Dip Direction	233
Friction Angle	34°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	5	37	13.51%
Planar Sliding (Set 2)	5	10	50.00%

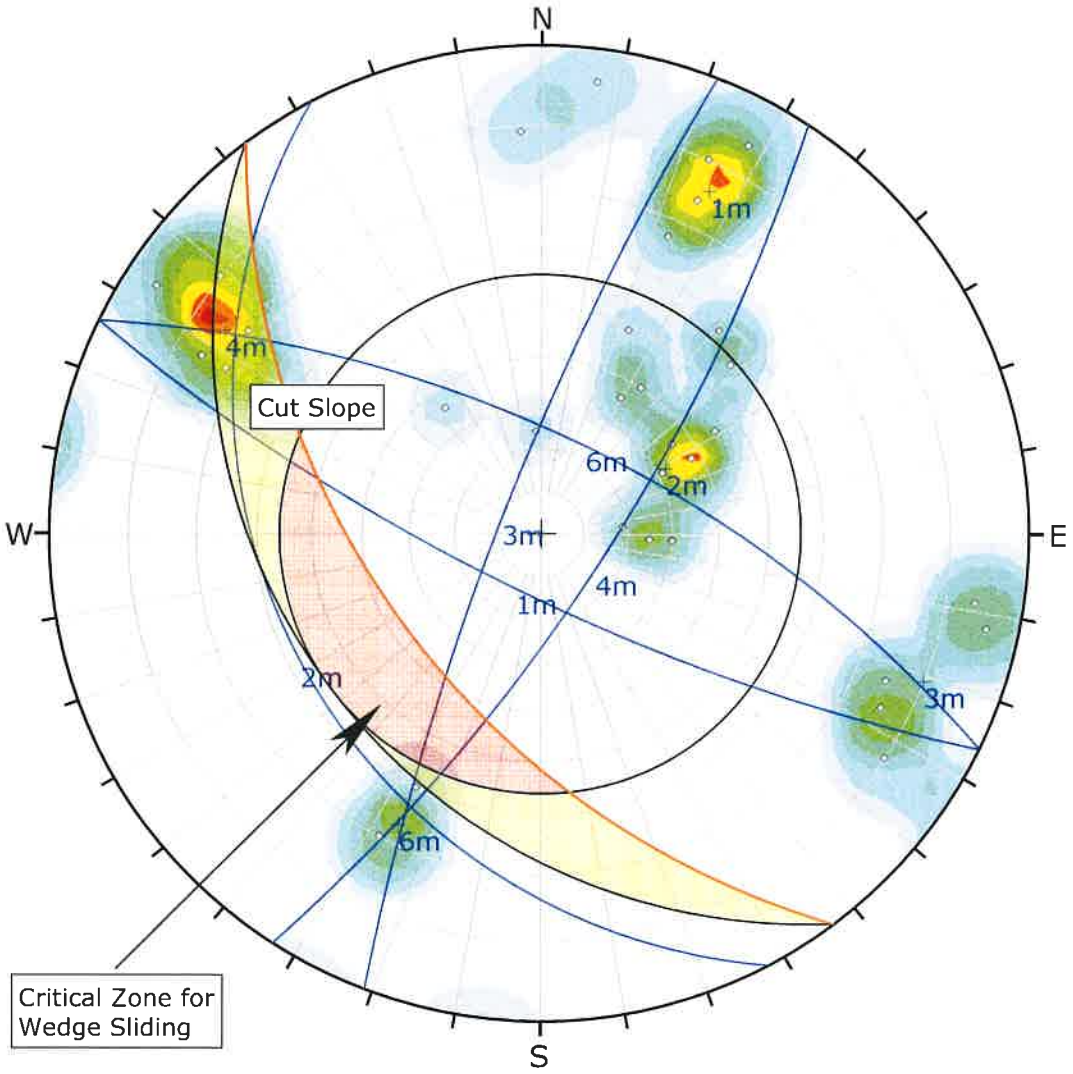
	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		76	206	
2m		32	242	
3m		80	291	
4m		75	123	
6m		67	26	

Plot Mode	Pole Vectors
Vector Count	37 (37 Entries)
Hemisphere	Lower
Projection	Equal Angle

rocscience

DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic Analysis		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/10/2019	*File Name*	Slope RW 8_70 percent_233.dips7



Symbol	Feature
○	Pole Vectors
▭	Critical Intersection

Color	Density Concentrations
	0.00 - 1.20
	1.20 - 2.40
	2.40 - 3.60
	3.60 - 4.80
	4.80 - 6.00
	6.00 - 7.20
	7.20 - 8.40
	8.40 - 9.60
	9.60 - 10.80
	10.80 - 12.00

Contour Data	Pole Vectors
Maximum Density	11.55%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Wedge Sliding
Slope Dip	53
Slope Dip Direction	233
Friction Angle	34°

	Critical	Total	%
Wedge Sliding	0	10	0.00%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		76	206	
2m		32	242	
3m		80	291	
4m		75	123	
6m		67	26	

Plot Mode	Pole Vectors
Vector Count	37 (37 Entries)
Intersection Mode	User and Mean Set Planes
Intersections Count	10
Hemisphere	Lower
Projection	Equal Angle

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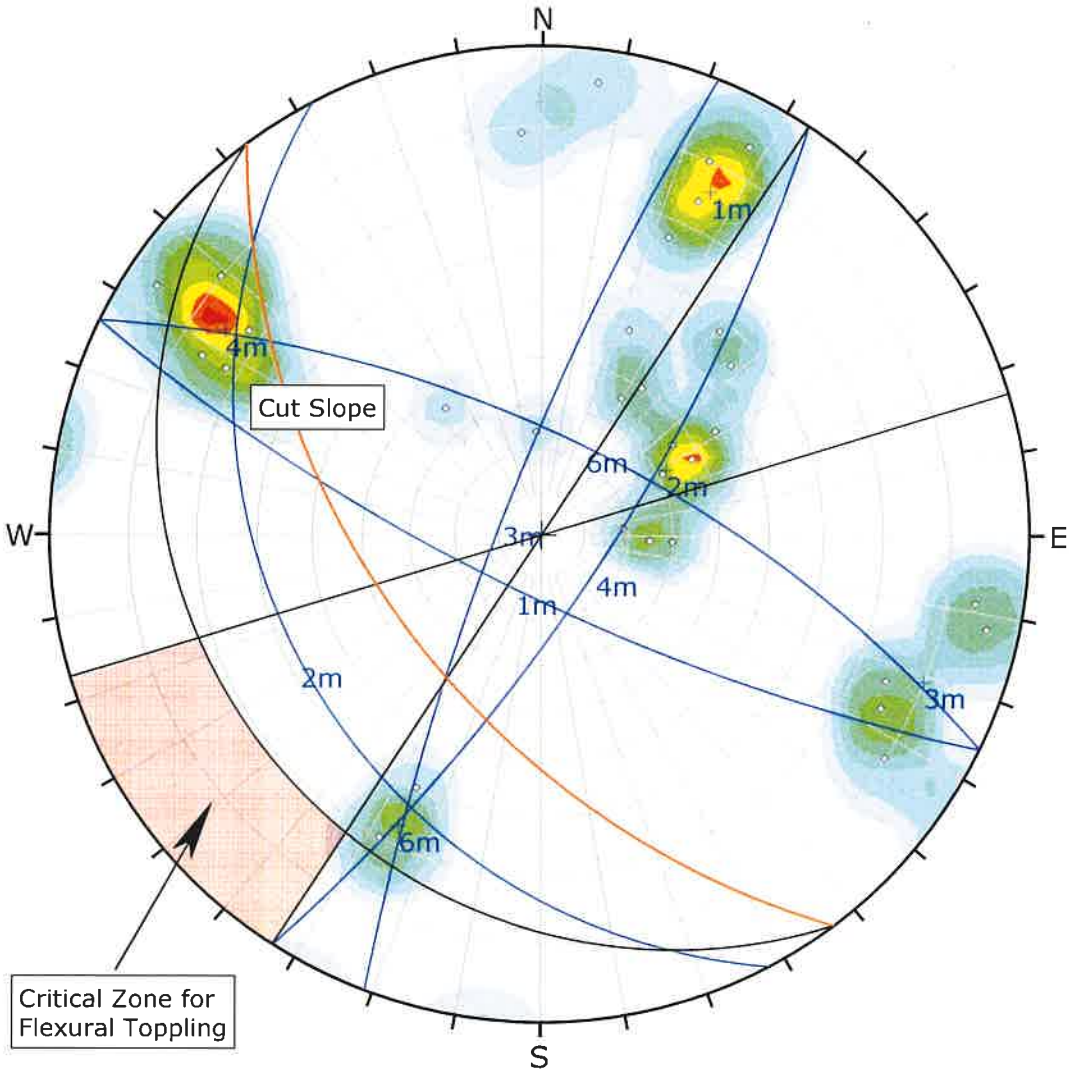
DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic Analysis		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/10/2019	*File Name*	Slope RW 8_70 percent_233.dips7



Symbol	Feature
○	Pole Vectors

Color	Density Concentrations
	0.00 - 1.20
	1.20 - 2.40
	2.40 - 3.60
	3.60 - 4.80
	4.80 - 6.00
	6.00 - 7.20
	7.20 - 8.40
	8.40 - 9.60
	9.60 - 10.80
	10.80 - 12.00

Contour Data	Pole Vectors
Maximum Density	11.55%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Flexural Toppling
Slope Dip	53
Slope Dip Direction	233
Friction Angle	34°
Lateral Limits	20°

	Critical	Total	%
Flexural Toppling (All)	0	37	0.00%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		76	206	
2m		32	242	
3m		80	291	
4m		75	123	
6m		67	26	

Plot Mode	Pole Vectors
Vector Count	37 (37 Entries)
Hemisphere	Lower
Projection	Equal Angle

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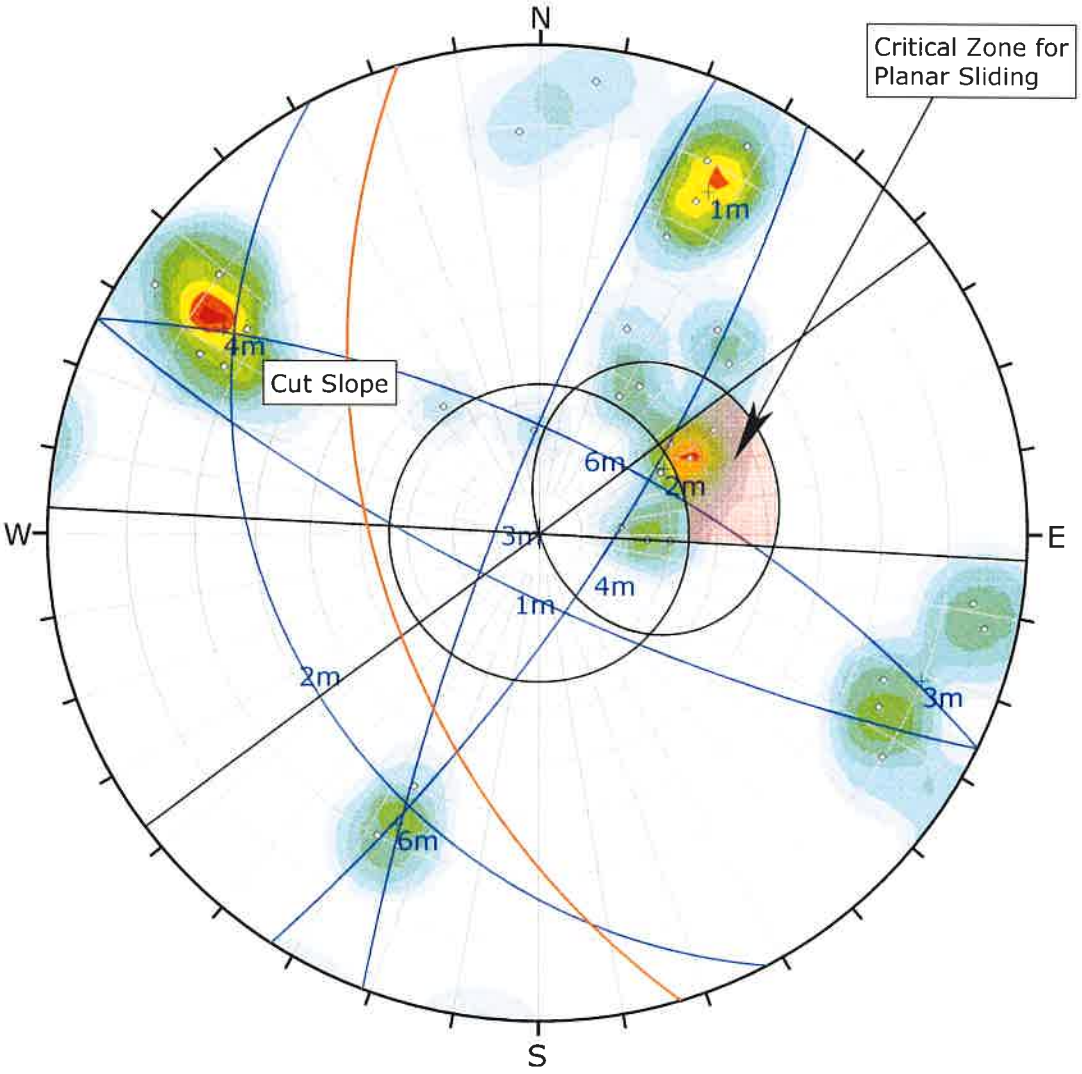
DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic Analysis		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/10/2019	*File Name*	Slope RW 8_70 percent_233.dips7



Symbol	Feature
◇	Pole Vectors

Color	Density Concentrations
	0.00 - 1.20
	1.20 - 2.40
	2.40 - 3.60
	3.60 - 4.80
	4.80 - 6.00
	6.00 - 7.20
	7.20 - 8.40
	8.40 - 9.60
	9.60 - 10.80
	10.80 - 12.00

Contour Data	Pole Vectors
Maximum Density	11.55%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Planar Sliding
Slope Dip	53
Slope Dip Direction	253
Friction Angle	34°
Lateral Limits	20°

	Critical	Total	%
Planar Sliding (All)	4	37	10.81%
Planar Sliding (Set 2)	4	10	40.00%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		76	206	
2m		32	242	
3m		80	291	
4m		75	123	
6m		67	26	

Plot Mode	Pole Vectors
Vector Count	37 (37 Entries)
Hemisphere	Lower
Projection	Equal Angle

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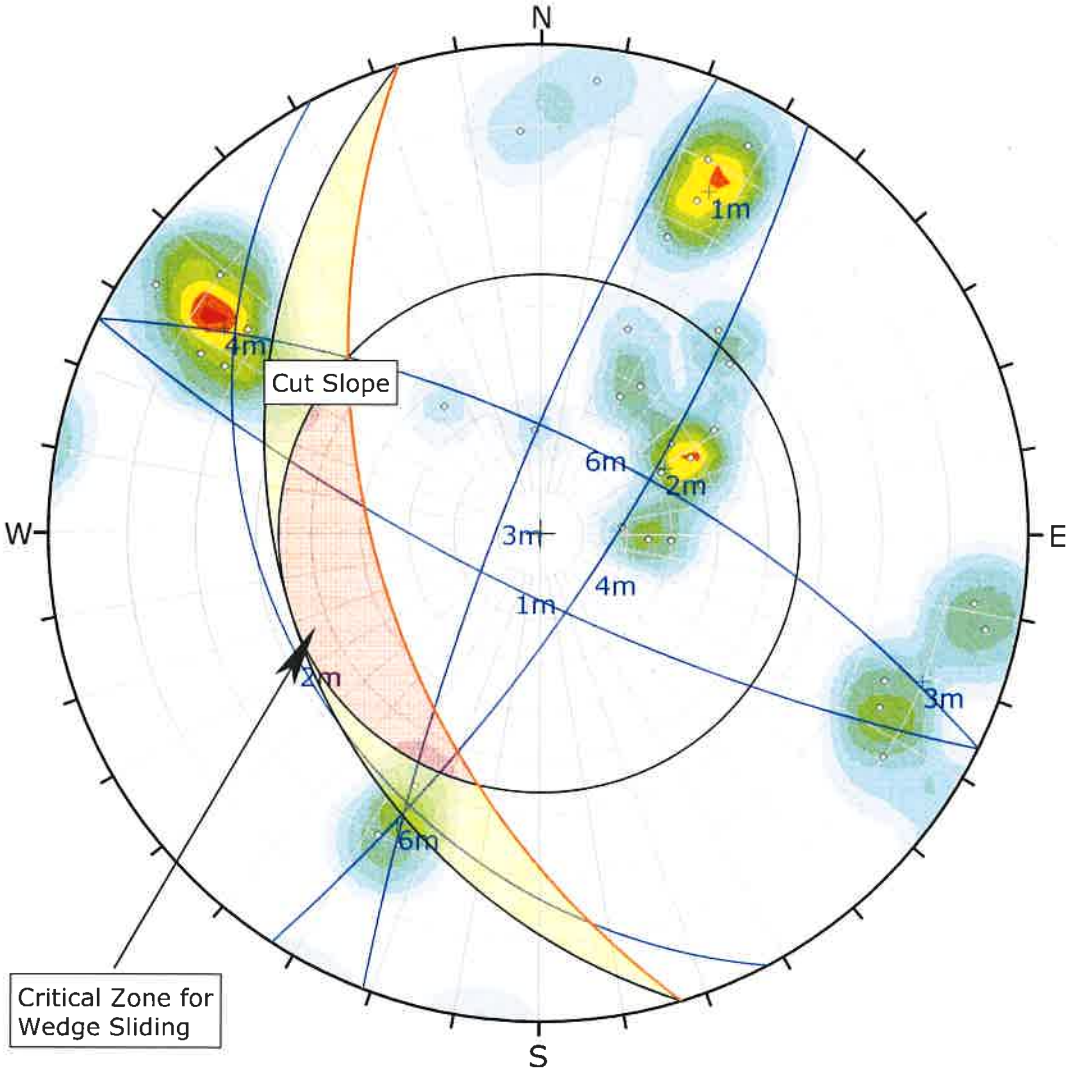
DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic Analysis		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/10/2019	*File Name*	Slope RW 8_70 percent_.dips7



Symbol	Feature
○	Pole Vectors
▒	Critical Intersection

Color	Density Concentrations
	0.00 - 1.20
	1.20 - 2.40
	2.40 - 3.60
	3.60 - 4.80
	4.80 - 6.00
	6.00 - 7.20
	7.20 - 8.40
	8.40 - 9.60
	9.60 - 10.80
	10.80 - 12.00

Contour Data	Pole Vectors
Maximum Density	11.55%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Wedge Sliding
Slope Dip	53
Slope Dip Direction	253
Friction Angle	34°

	Critical	Total	%
Wedge Sliding	0	10	0.00%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		76	206	
2m		32	242	
3m		80	291	
4m		75	123	
6m		67	26	

Plot Mode	Pole Vectors
Vector Count	37 (37 Entries)
Intersection Mode	User and Mean Set Planes
Intersections Count	10
Hemisphere	Lower
Projection	Equal Angle

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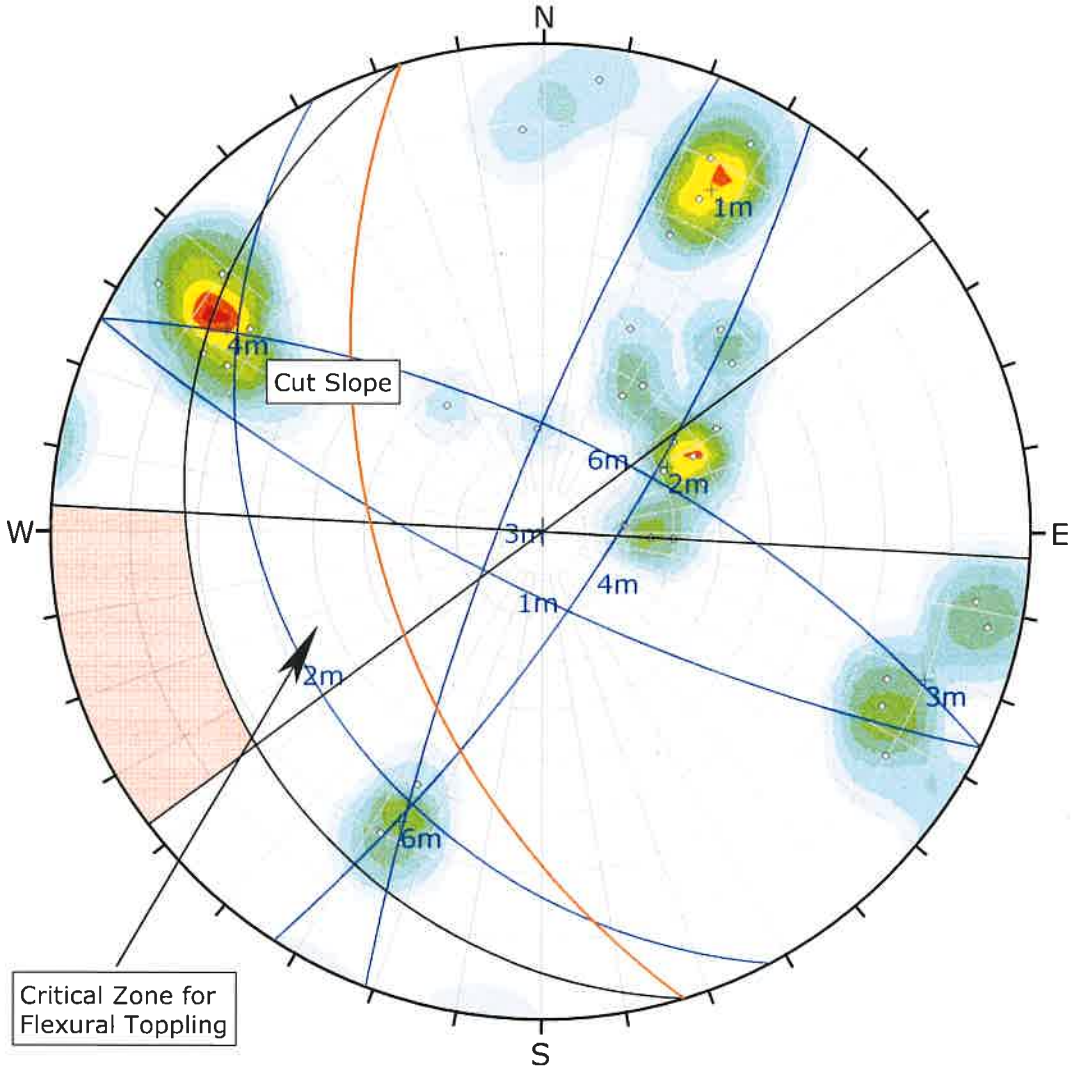
DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic Analysis		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/10/2019	*File Name*	Slope RW 8_70 percent_.dips7



Symbol	Feature
○	Pole Vectors

Color	Density Concentrations
	0.00 - 1.20
	1.20 - 2.40
	2.40 - 3.60
	3.60 - 4.80
	4.80 - 6.00
	6.00 - 7.20
	7.20 - 8.40
	8.40 - 9.60
	9.60 - 10.80
	10.80 - 12.00

Contour Data	Pole Vectors
Maximum Density	11.55%
Contour Distribution	Fisher
Counting Circle Size	1.0%

Kinematic Analysis	Flexural Toppling
Slope Dip	53
Slope Dip Direction	253
Friction Angle	34°
Lateral Limits	20°

	Critical	Total	%
Flexural Toppling (All)	0	37	0.00%

	Color	Dip	Dip Direction	Label
Mean Set Planes				
1m		76	206	
2m		32	242	
3m		80	291	
4m		75	123	
6m		67	26	

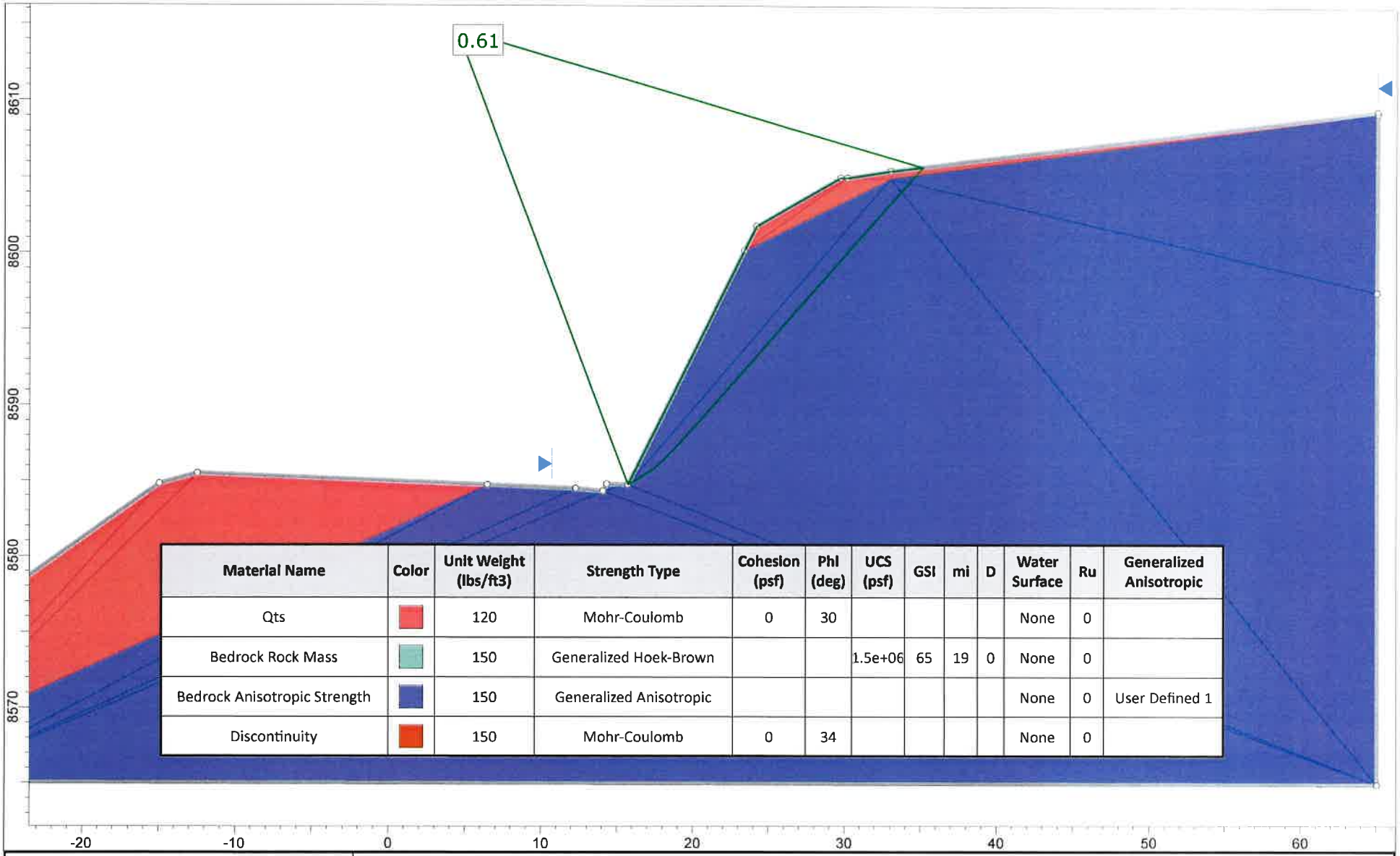
Plot Mode	Pole Vectors
Vector Count	37 (37 Entries)
Hemisphere	Lower
Projection	Equal Angle

rocscience

DIPS 7.014

Project	Reds Meadow		
Analysis Description	Kinematic Analysis		
Drawn By	KDD	*Company*	Shannon & Wilson, Inc
Date	1/10/2019	*File Name*	Slope RW 8_70 percent_.dips7

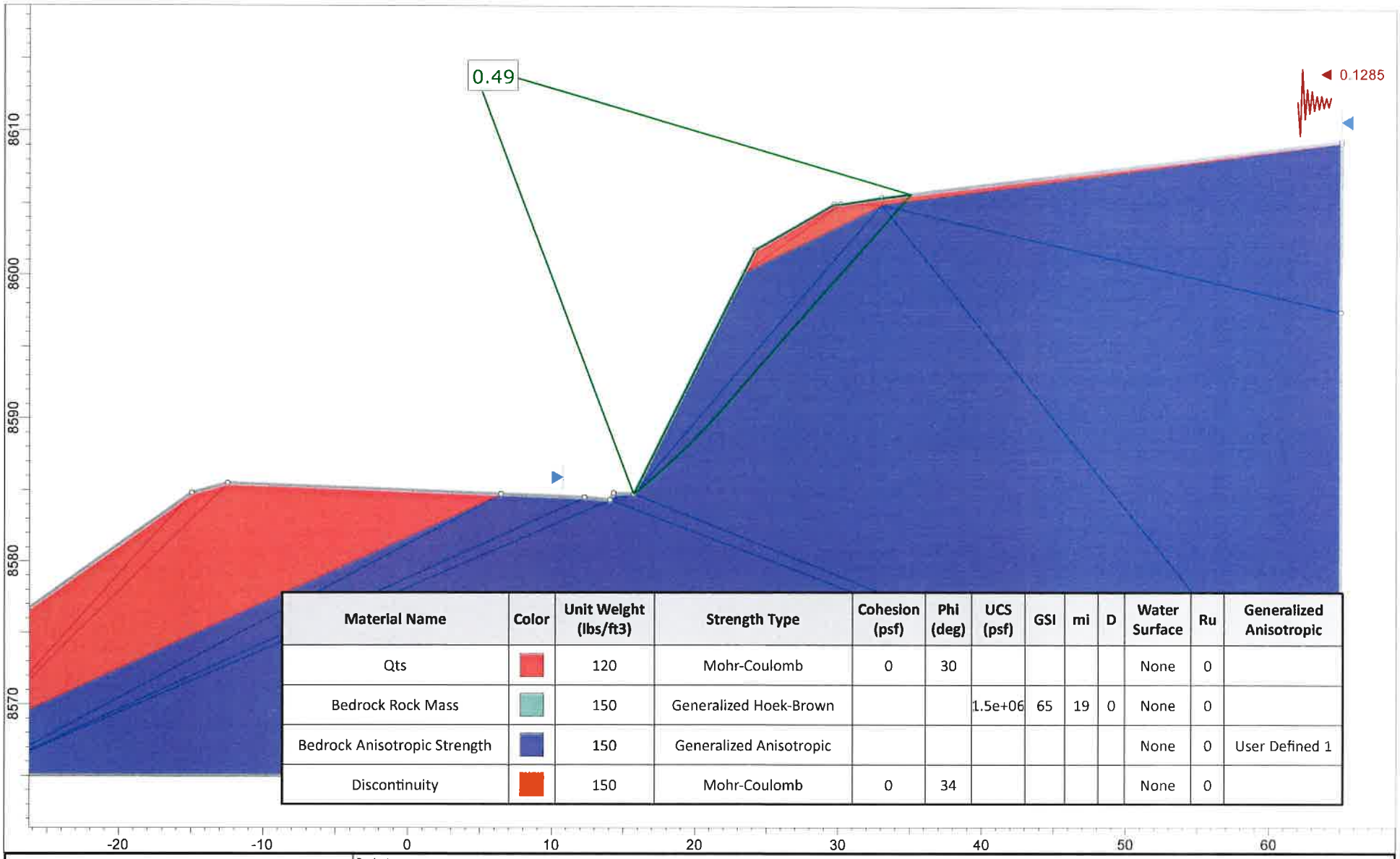
Slide



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	UCS (psf)	GSI	mi	D	Water Surface	Ru	Generalized Anisotropic
Qts		120	Mohr-Coulomb	0	30					None	0	
Bedrock Rock Mass		150	Generalized Hoek-Brown			1.5e+06	65	19	0	None	0	
Bedrock Anisotropic Strength		150	Generalized Anisotropic							None	0	User Defined 1
Discontinuity		150	Mohr-Coulomb	0	34					None	0	

SLIDEINTERPRET 8.016

Project	Reds Meadow			
Analysis Description	Global Stability Station 83+00			
Drawn By	KDD	Scale	1:105	Company: Shannon & Wilson, Inc
Date	1/4/2019, 2:01:39 PM			File Name: Slide_Station 83+00.slmd

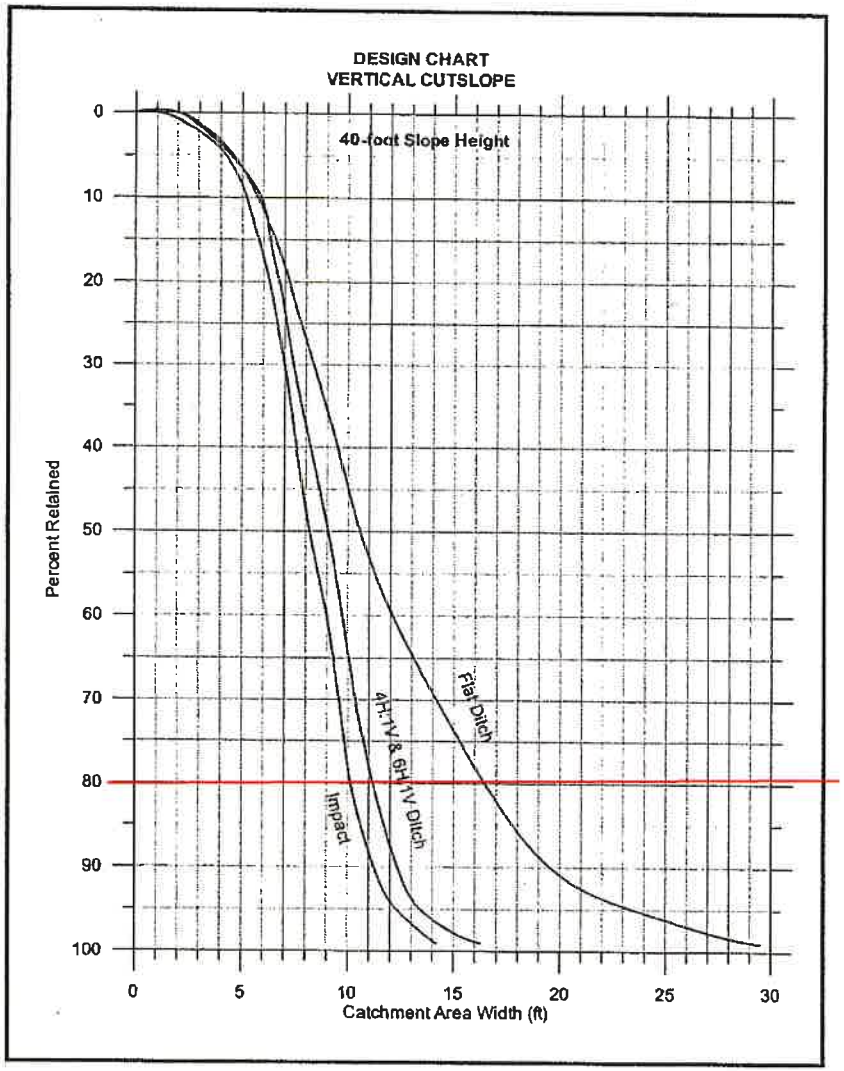


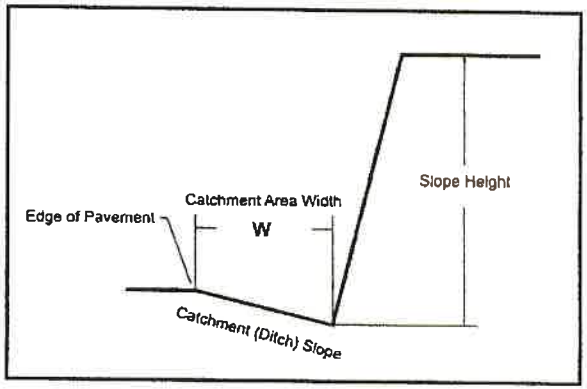
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	UCS (psf)	GSI	mi	D	Water Surface	Ru	Generalized Anisotropic
Qts		120	Mohr-Coulomb	0	30					None	0	
Bedrock Rock Mass		150	Generalized Hoek-Brown			1.5e+06	65	19	0	None	0	
Bedrock Anisotropic Strength		150	Generalized Anisotropic							None	0	User Defined 1
Discontinuity		150	Mohr-Coulomb	0	34					None	0	

SLIDEINTERPRET 8.016

Project	Reds Meadow		
Analysis Description	Global Stability Station 83+00		
Drawn By	KDD	Scale	1:111
Company	Shannon & Wilson, Inc		
Date	1/4/2019, 2:01:39 PM	File Name	Slide_Station 83+00.slmd

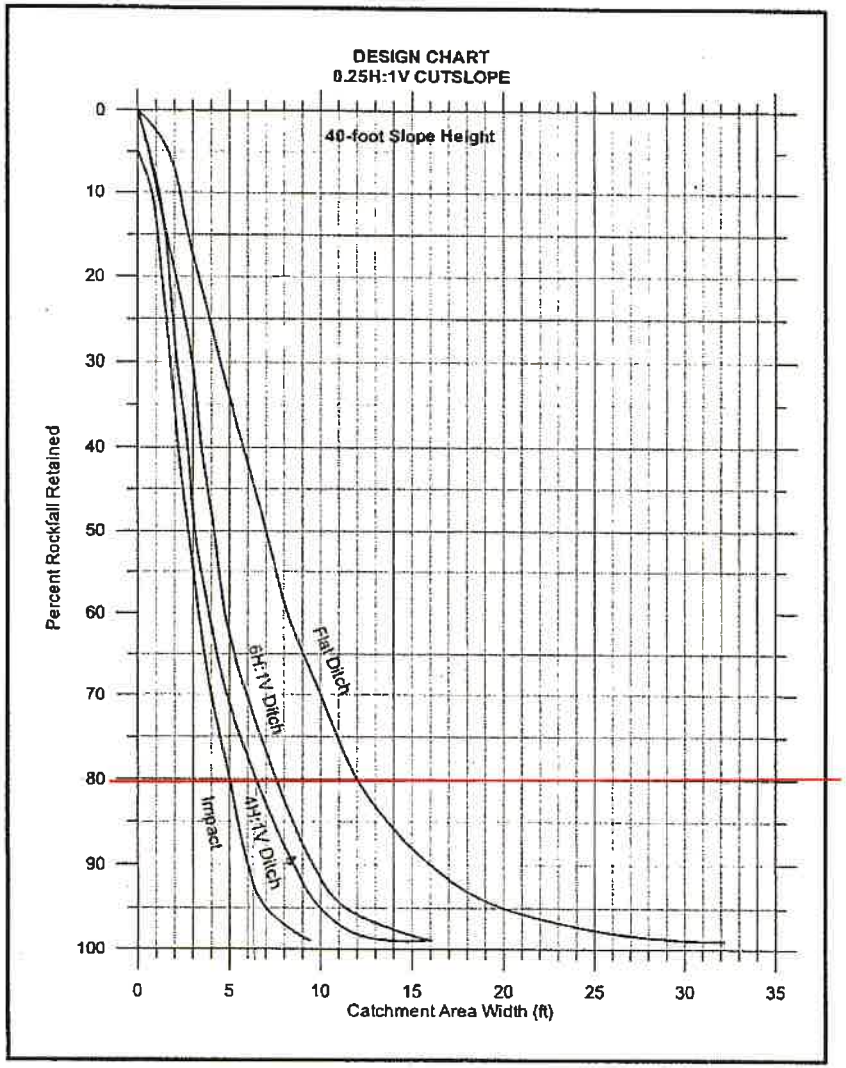
Rockfall Slope Charts

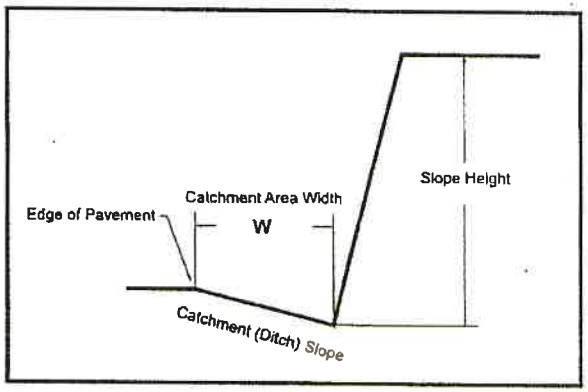




Quick Reference - 40-Ft Slope Catchment Area Width - **W**				
Percent Rockfall Retained	Impact	Catchment Area Slope		
		4H:1V	6H:1V	Flat
	W (ft)	**W** (ft)	**W** (ft)	**W** (ft)
50%	8	9	9	11
75%	10	11	11	15
80%	10	11	11	16
85%	11	12	12	18
90%	11	12	12	20
95%	12	13	13	24
99%	14	16	16	30

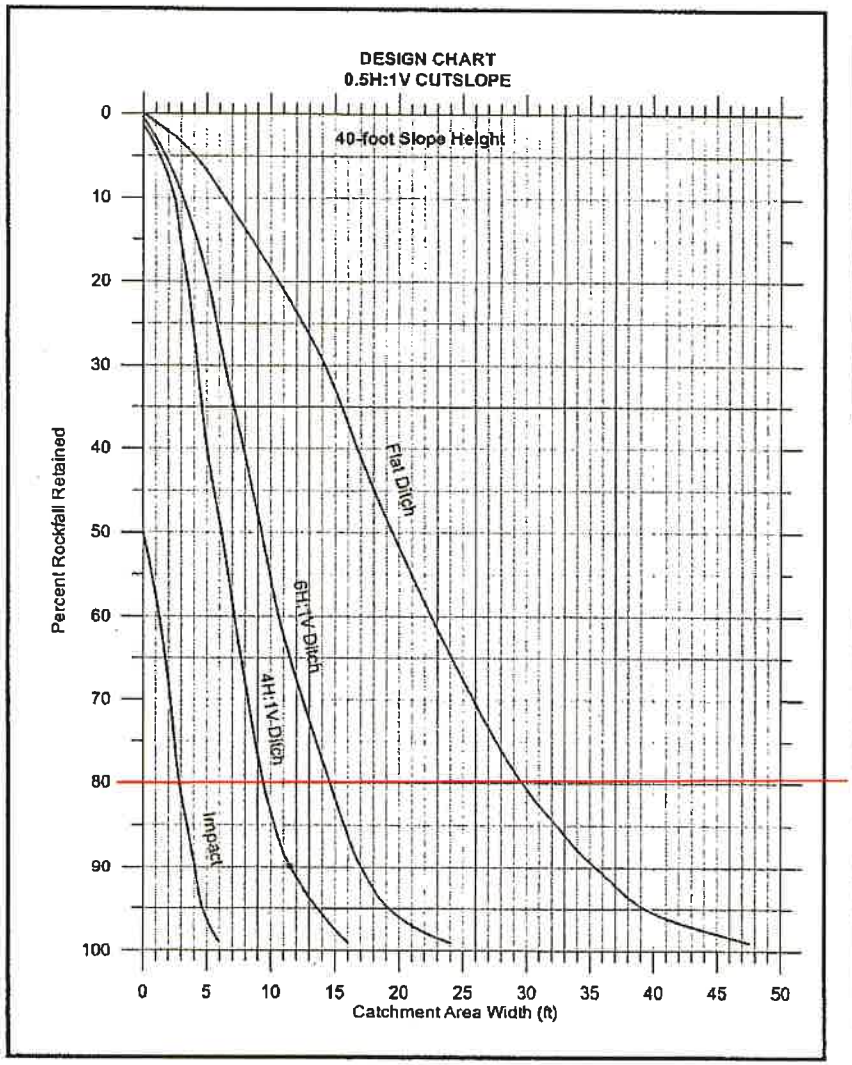
Figure 5.1: Design chart for 40-foot high vertical cutslopes

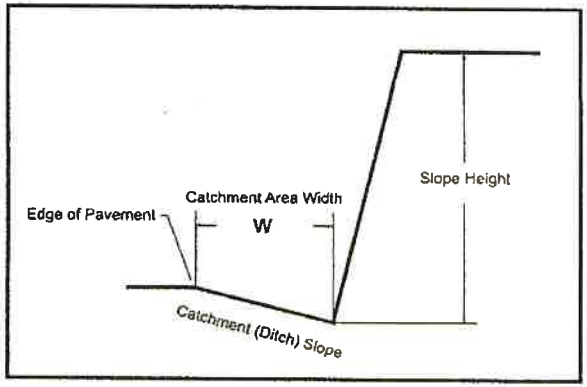




Quick Reference - 40-Ft Slope Catchment Area Width - **W**				
Percent Rockfall Retained	Impact	Catchment Area Slope		
		4H:1V	6H:1V	Flat
	W (ft)	**W** (ft)	**W** (ft)	**W** (ft)
50%	3	3	4	7
75%	4	6	7	11
80%	5	6	8	12
85%	5	7	8	14
90%	6	9	10	16
95%	7	10	11	20
99%	9	16	16	32

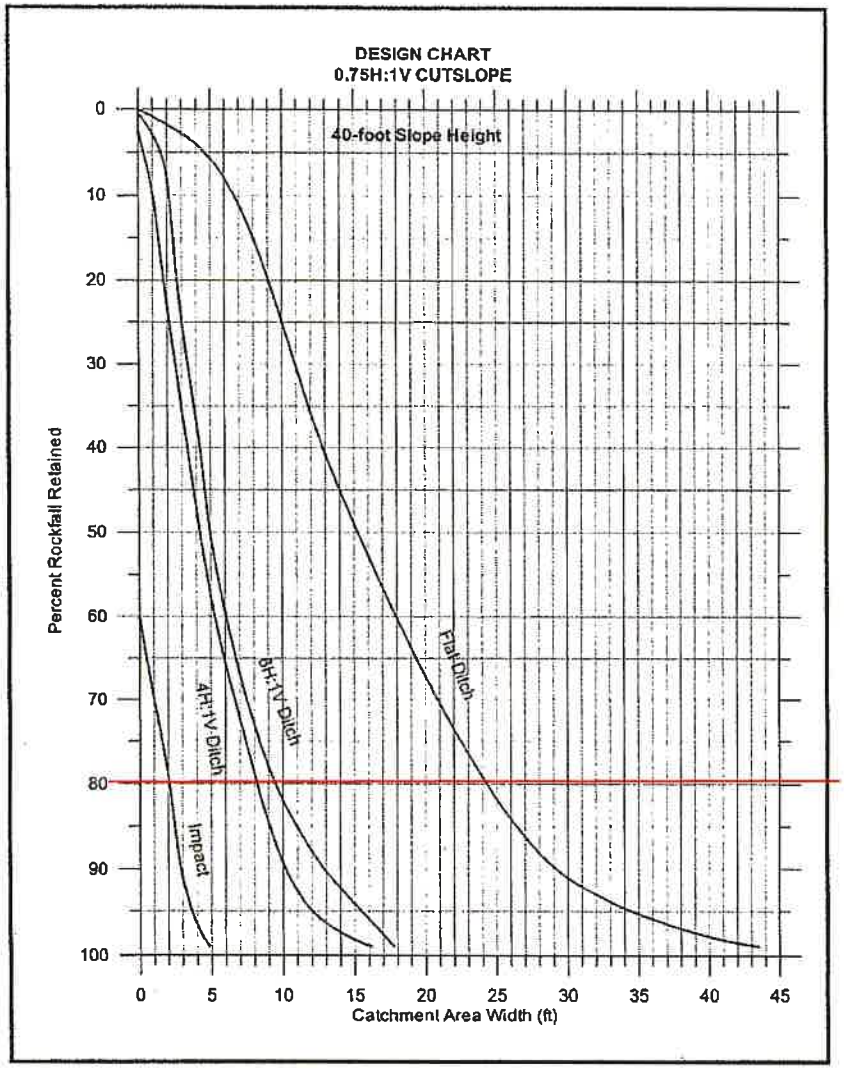
Figure 5.6: Design chart for 40-foot high 0.25H:1V cutslopes

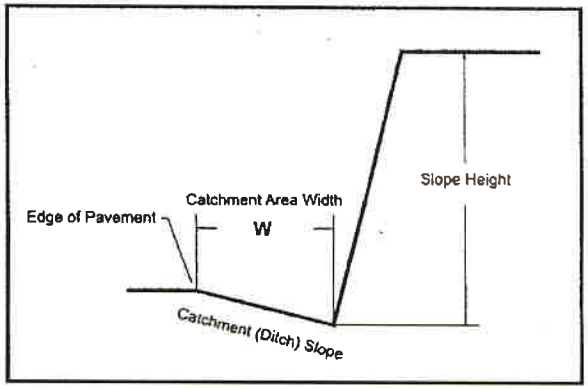




Quick Reference - 40-Ft Slope Catchment Area Width - **W**				
Percent Rockfall Retained	Impact	Catchment Area Slope		
		4H:1V	6H:1V	Flat
	W (ft)	**W** (ft)	**W** (ft)	**W** (ft)
50%	0	6	9	19
75%	2	9	14	28
80%	3	9	15	30
85%	3	10	16	32
90%	4	11	17	35
95%	5	14	19	39
99%	6	16	24	48

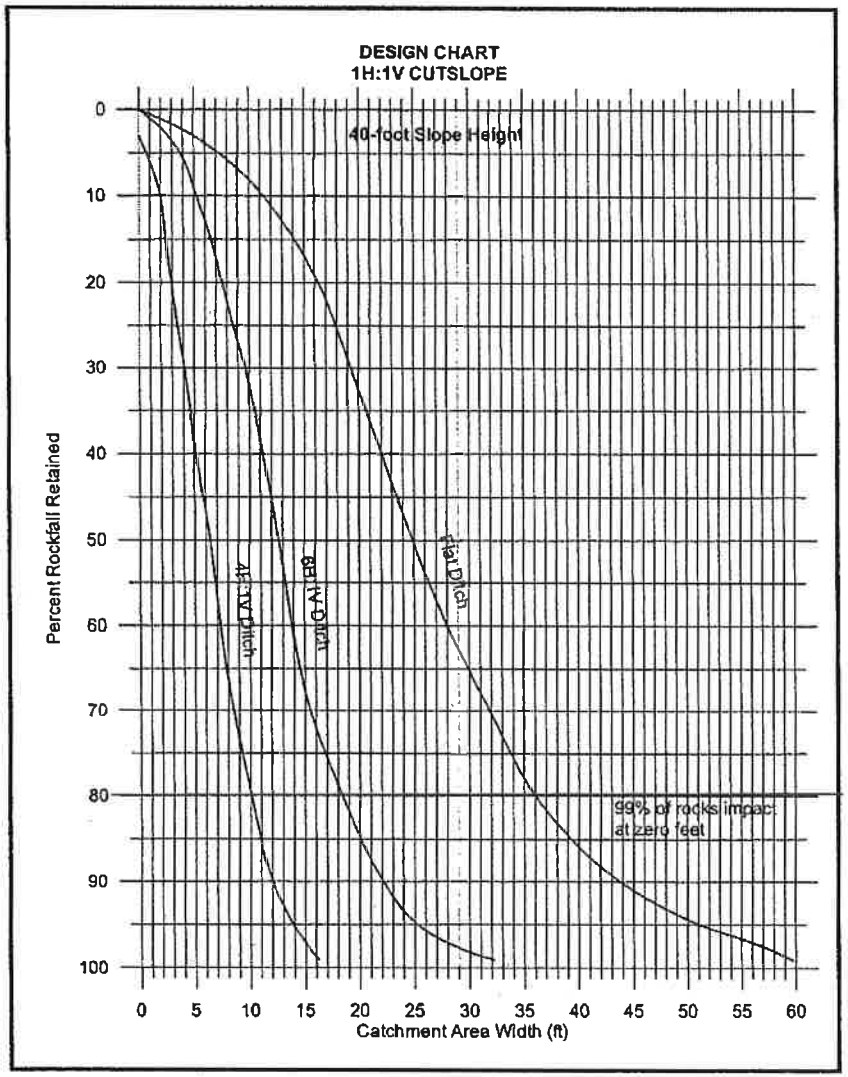
Figure 5.11: Design chart for 40-foot high 0.5H:1V cutslopes

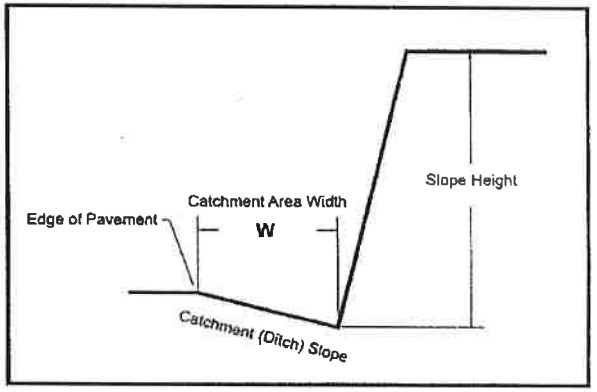




Quick Reference - 40-Ft Slope Catchment Area Width - **W**				
Percent Rockfall Retained	Impact	Catchment Area Slope		
		4H:1V	6H:1V	Flat
	W (ft)	**W** (ft)	**W** (ft)	**W** (ft)
50%	0	4	5	15
75%	2	7	8	23
80%	2	8	9	24
85%	2	9	11	26
90%	3	10	13	29
95%	4	12	15	35
99%	5	16	18	44

Figure 5.16: Design chart for 40-foot high 0.75H:1V cutslopes





Quick Reference - 40-Ft Slope Catchment Area Width - **W**				
Percent Rockfall Retained	Impact	Catchment Area Slope		
		4H:1V	6H:1V	Flat
	W (ft)	**W** (ft)	**W** (ft)	**W** (ft)
50%	0	6	13	25
75%	0	9	17	34
80%	0	10	18	36
85%	0	11	20	39
90%	0	12	22	44
95%	0	14	25	51
99%	0	16	32	60

Figure 5.21: Design chart for 40-foot high 1H:1V cutslopes

7/25/2018
KDD

Slope Inclination	Ditch Configuration Width for 80% Catchment Based on FHWA Slope Charts[1]			Ditch Configuration Width for 80% Catchment Based on Reduction of Slope Height[2]		
	4H:1V	6H:1V	Flat	4H:1V	6H:1V	Flat
Vertical	11	11	16	2.75	2.75	4
0.25H:1V	6	8	12	1.5	2	3
0.5H:1V	9	15	30	2.25	3.75	7.5
0.75H:1V	8	9	24	2	2.25	6
1H:1V	10	18	36	2.5	4.5	9

Notes:

1. Ditch Width Values assume rock is falling from a 40-foot high slope.

2. Adjusted Ditch Width Values assume a reduction in ditch width of 25% from a 40-foot high slope to a 10-foot high slope.