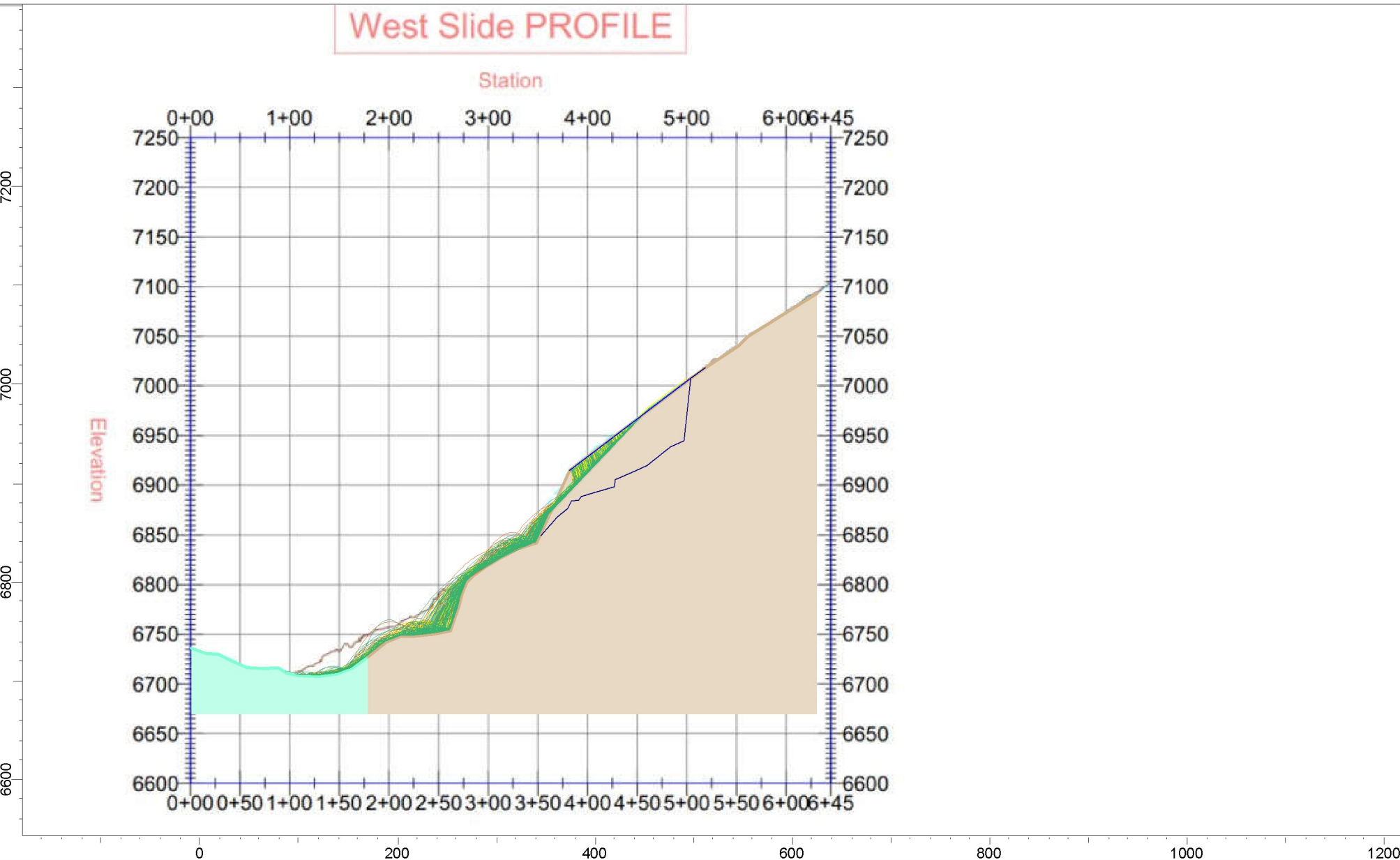


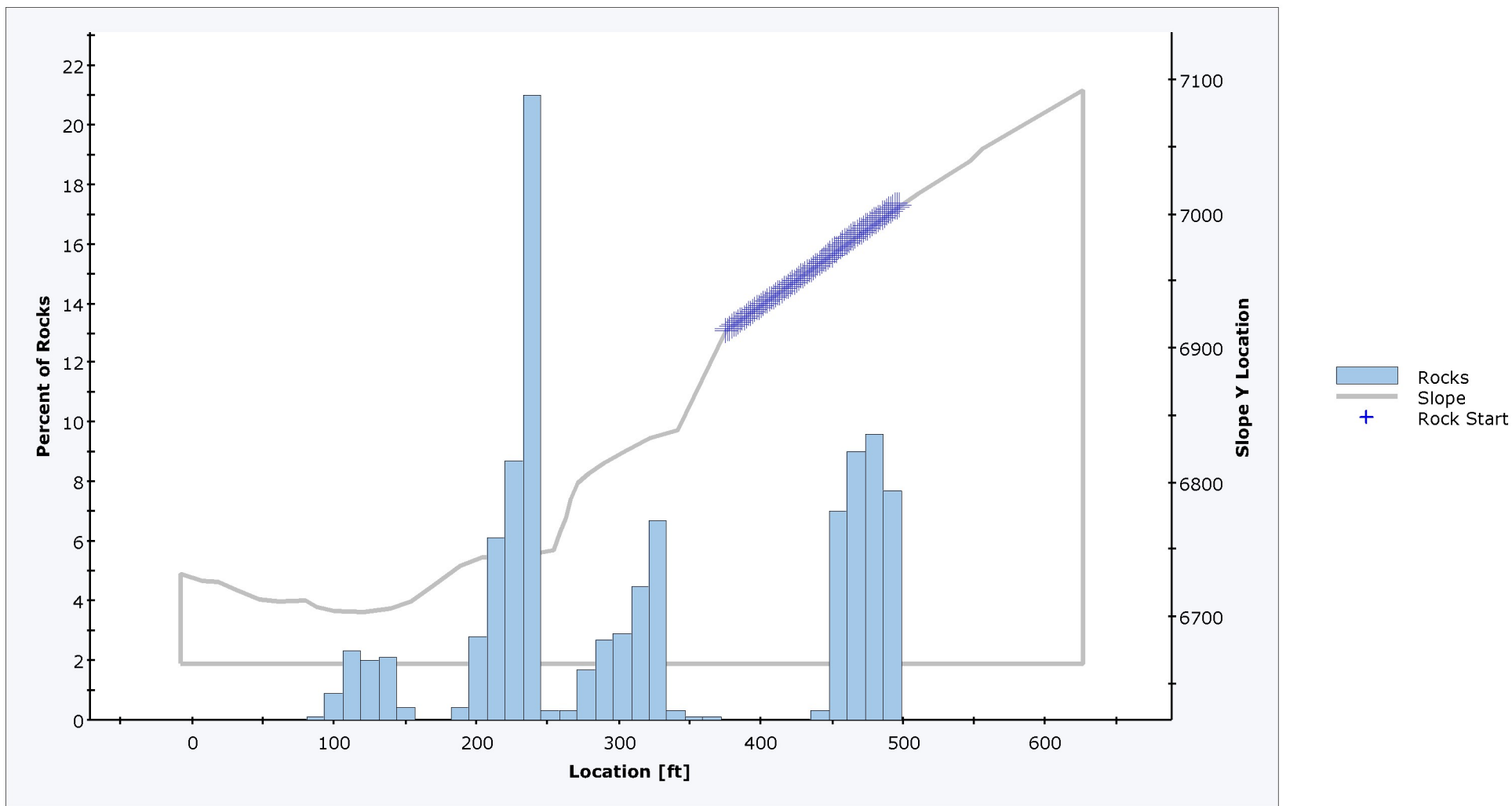
Appendix E

ROCKFALL MODELING RESULTS



	<i>Project</i>	Mid Continent Mine		
	<i>Analysis Description</i>	West Face Historic Topo		
	<i>Drawn By</i>	Sundermann	<i>Company</i>	Kilduff Underground Engineering
	<i>Date</i>	5/26/2023, 10:21:27 AM	<i>File Name</i>	WestFace_Historic_CrestLoss2.fal8

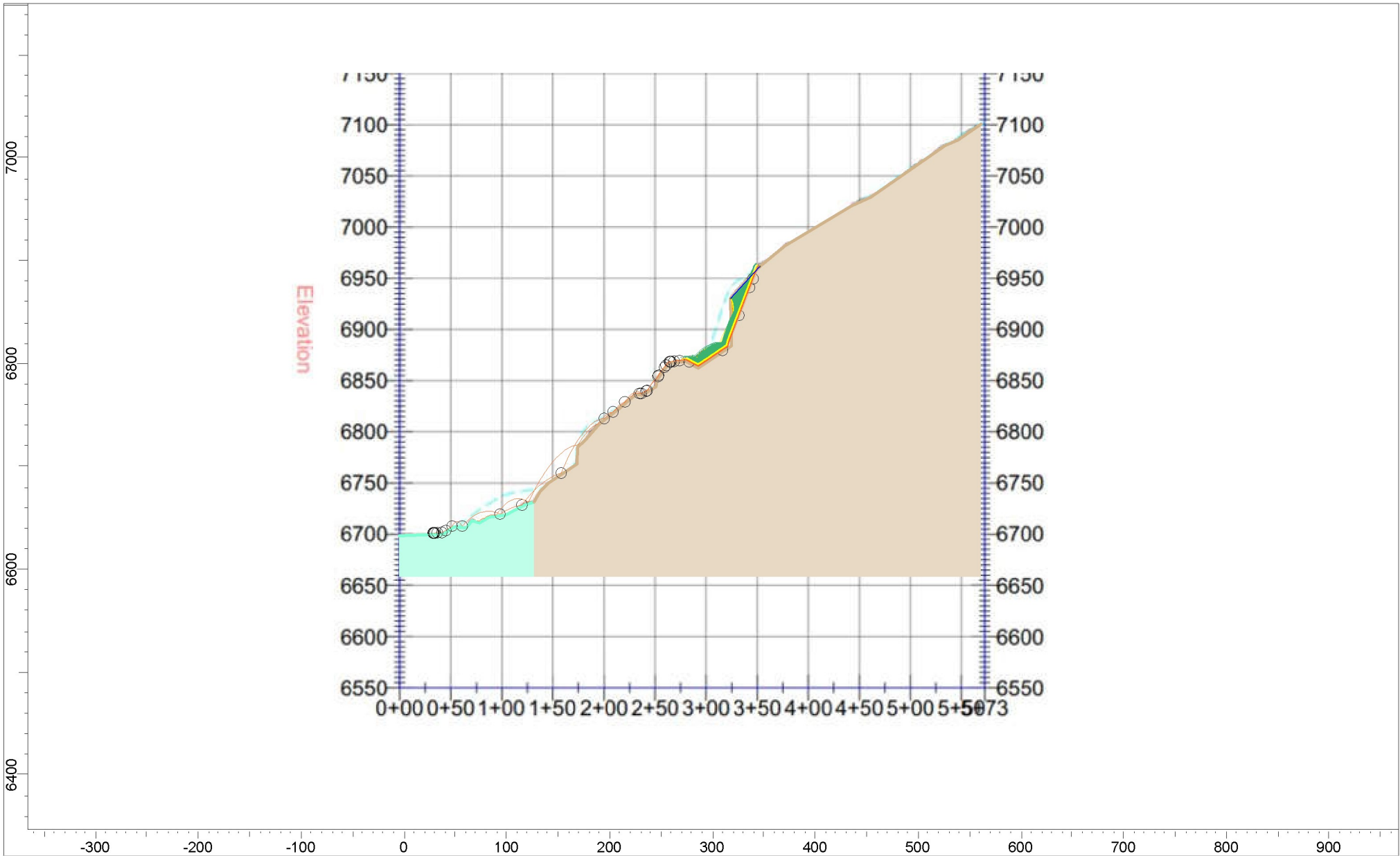
Distribution of Rock Path End Locations




Total number of rock paths: 1000

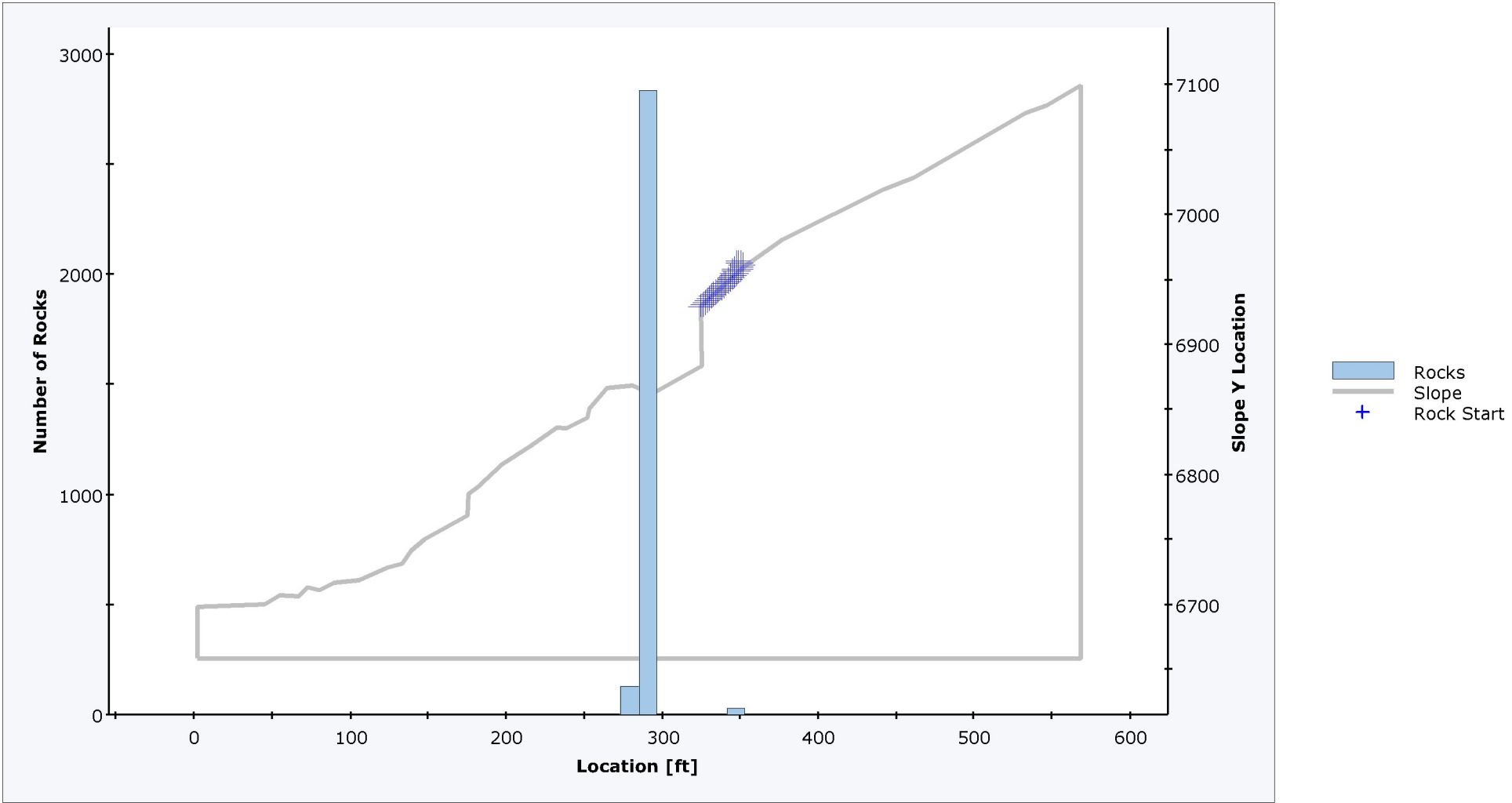


<i>Project</i>	Mid Continent Mine		
<i>Analysis Description</i>	West Face Historic Topo		
<i>Drawn By</i>	Sundermann	<i>Company</i>	Kilduff Underground Engineering
<i>Date</i>	5/26/2023, 10:21:27 AM	<i>File Name</i>	WestFace_Historic_CrestLoss2.fal8




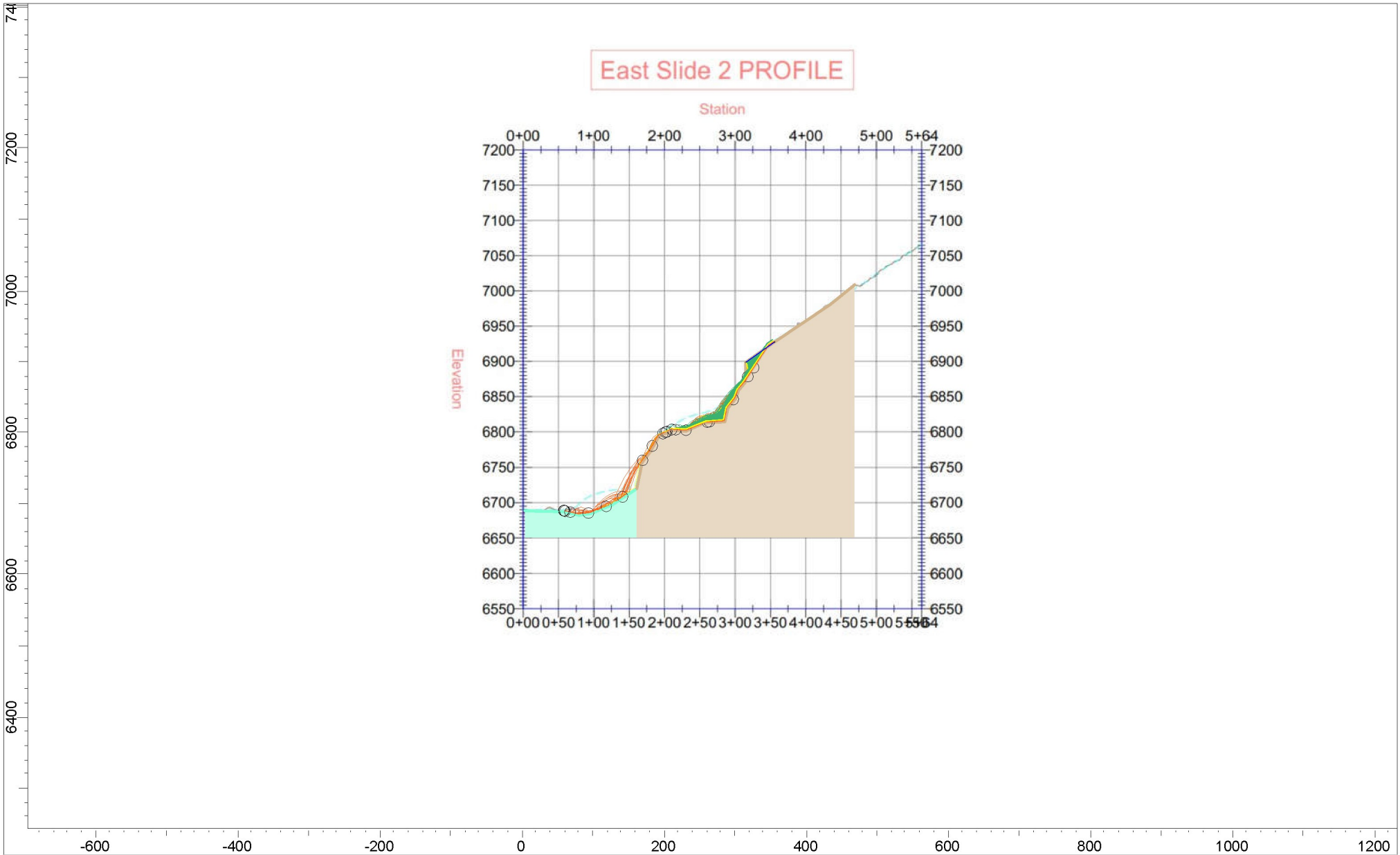
	<i>Project</i> Mid Continent Mine	
	<i>Analysis Description</i> East Face 1 - West Trend - Runout	
	<i>Drawn By</i> Sundermann	<i>Company</i> Kilduff Underground Engineering
	<i>Date</i> 5/26/2023, 12:24:29 PM	<i>File Name</i> EastFace1_West_Runout.fal8


Distribution of Rock Path End Locations



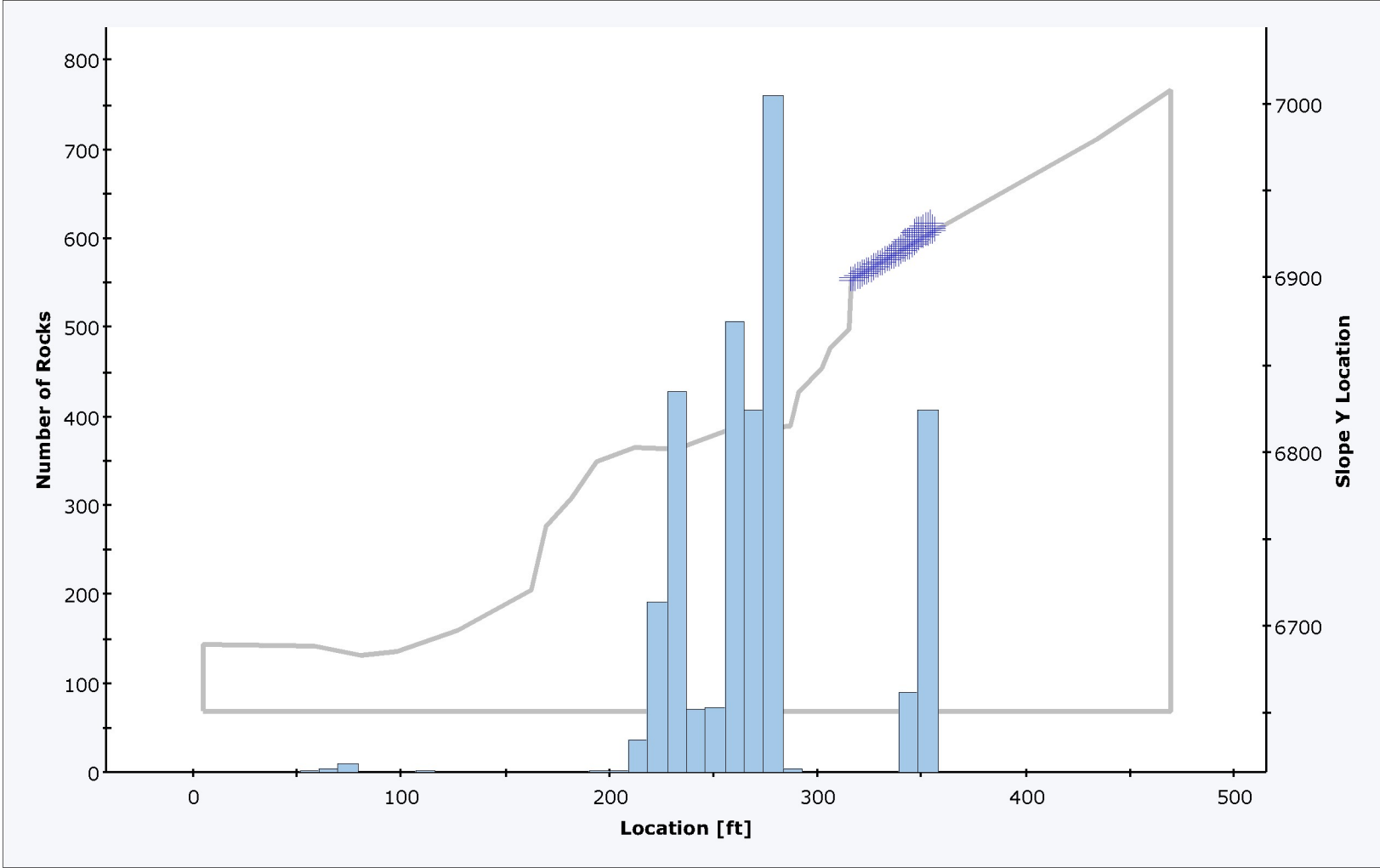
Total number of rock paths: 3000

	Project		Mid Continent Mine	
	Analysis Description		East Face 1 - West Trend - Runout	
	Drawn By	Sundermann	Company	Kilduff Underground Engineering
	Date	5/26/2023, 12:24:29 PM	File Name	EastFace1_West_Runout.fal8




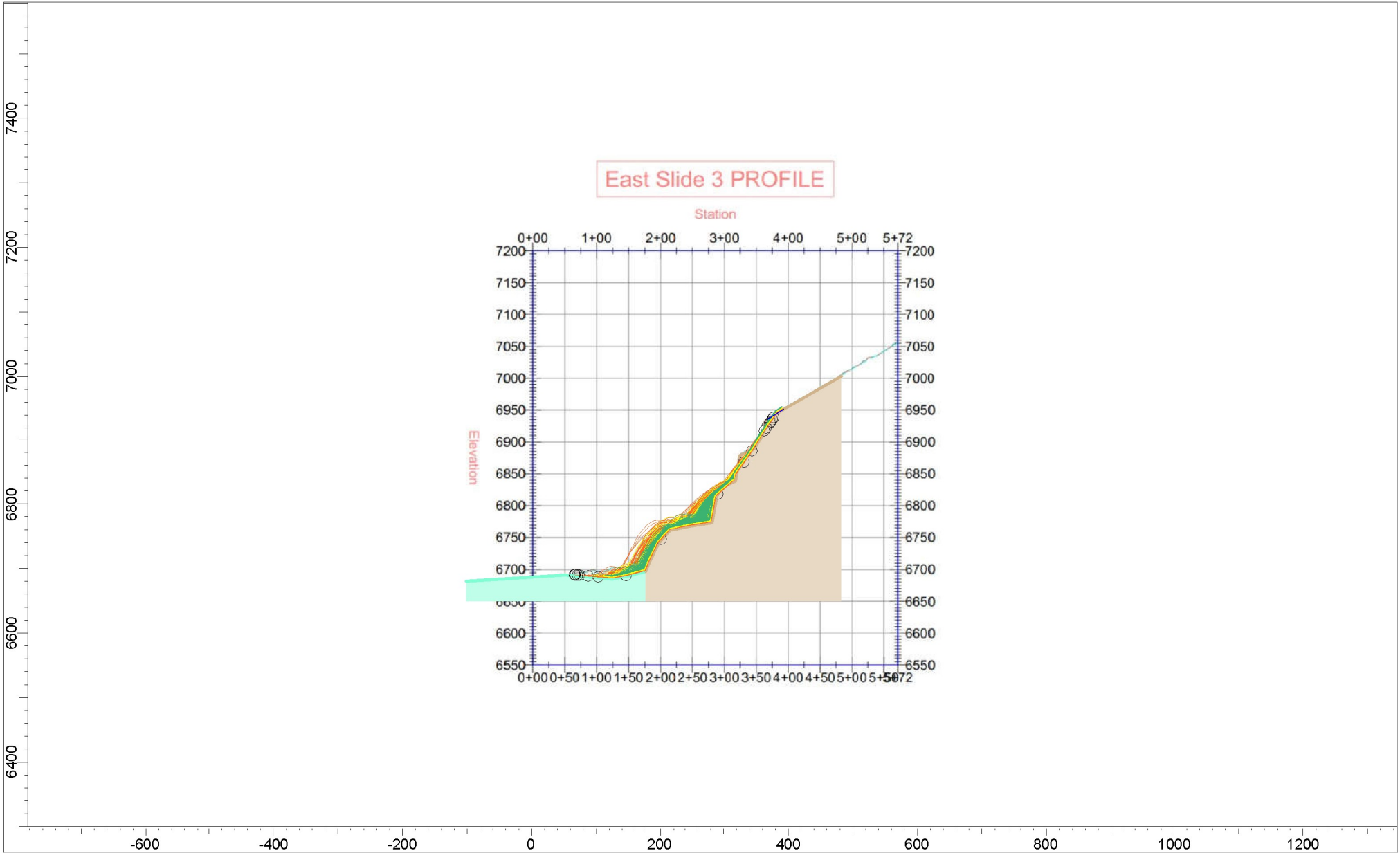
	Project			Mid Continent Mine		
	Analysis Description			East Face 2 - Center Trend - Runout		
	Drawn By		Sundermann	Company		Kilduff Underground Engineering
	Date		5/26/2023, 12:24:29 PM	File Name		EastFace2_Center_Runout.fal8


Distribution of Rock Path End Locations



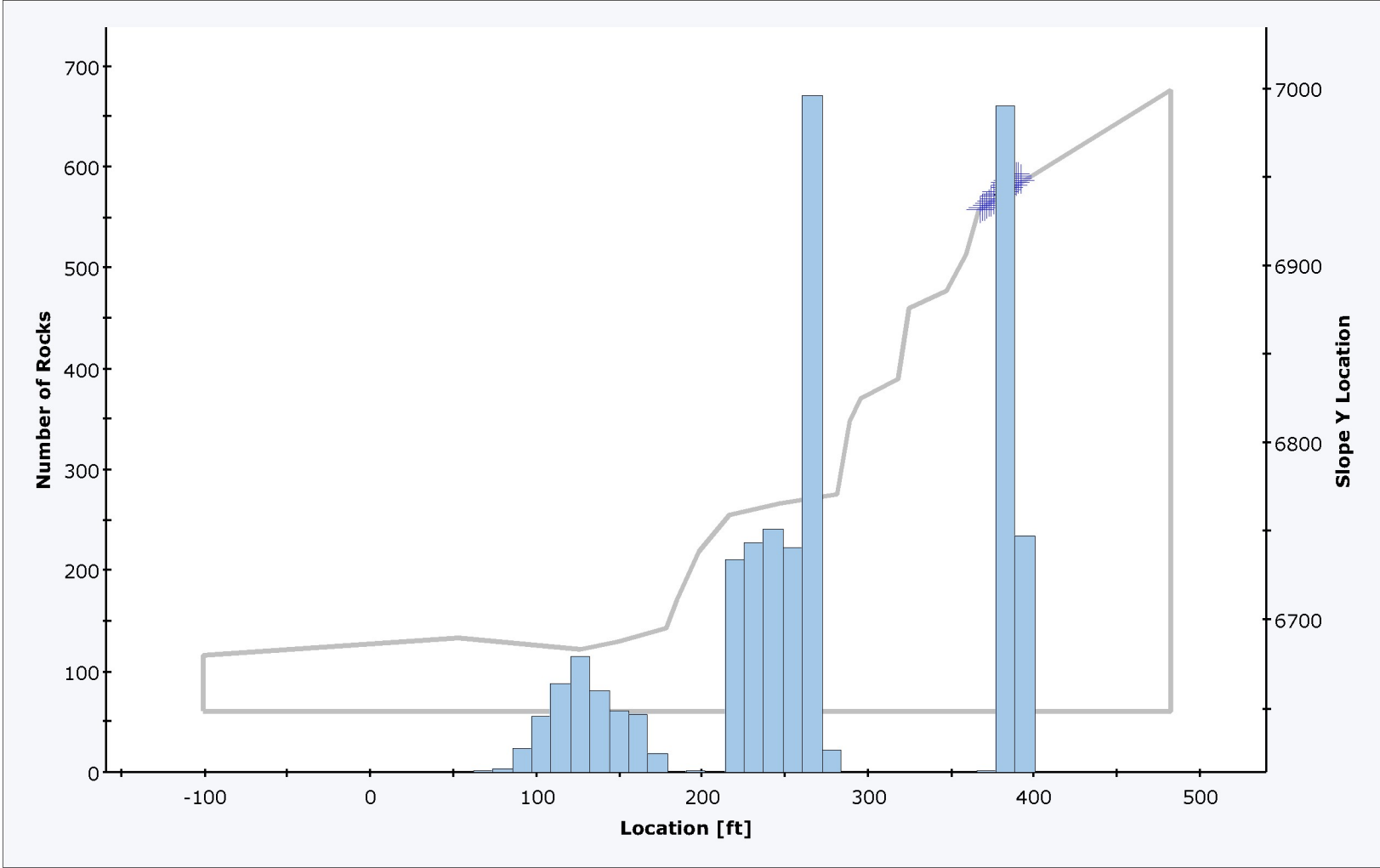
Total number of rock paths: 2993

	<i>Project</i> Mid Continent Mine	
	<i>Analysis Description</i> East Face 2 - Center Trend - Runout	
	<i>Drawn By</i> Sundermann	<i>Company</i> Kilduff Underground Engineering
	<i>Date</i> 5/26/2023, 12:24:29 PM	<i>File Name</i> EastFace2_Center_Runout.fal8




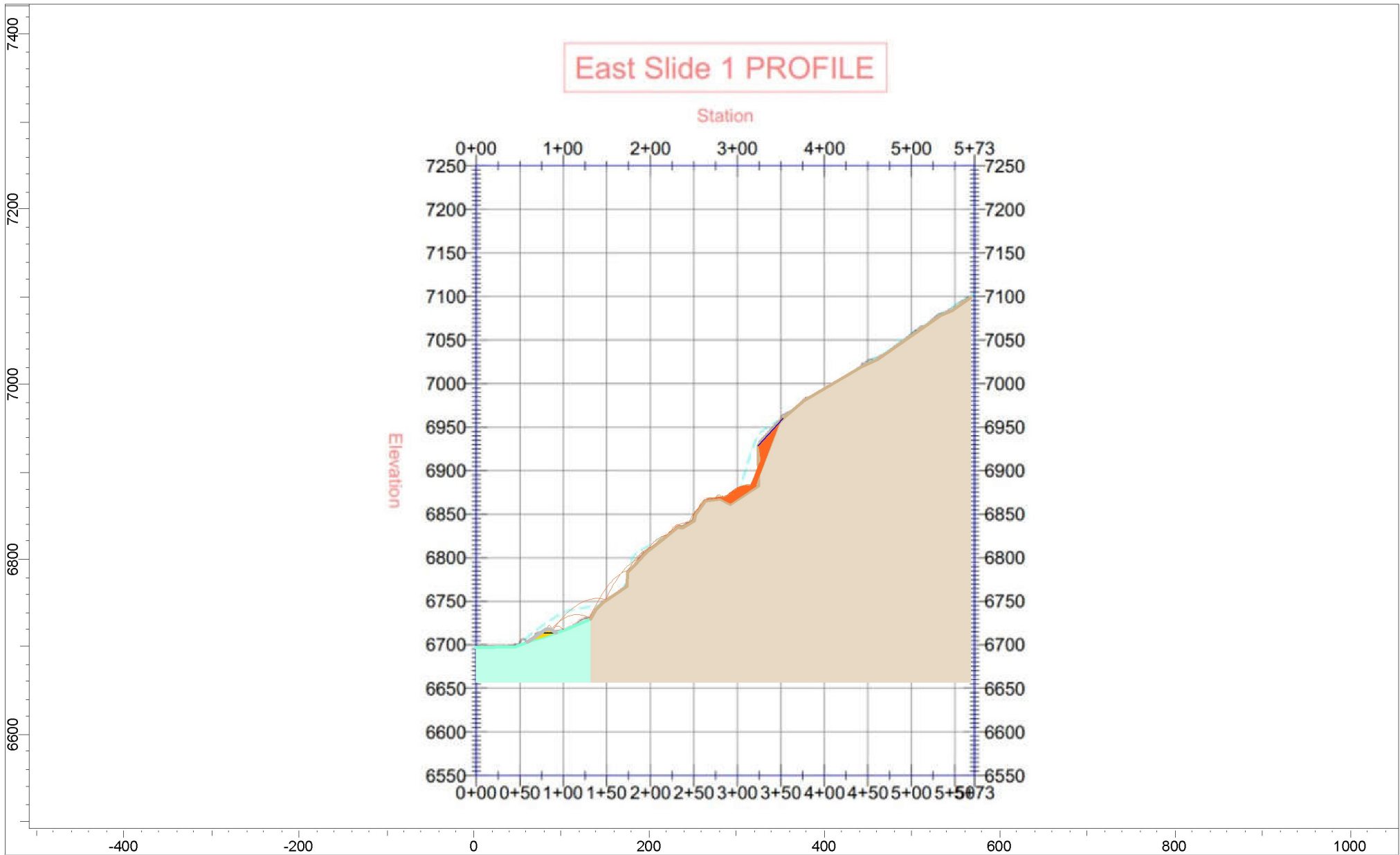
	Project		Mid Continent Mine	
	Analysis Description		East Face 3 - East Trend - Runout	
	Drawn By	Sundermann	Company	Kilduff Underground Engineering
	Date	5/26/2023, 12:24:29 PM	File Name	EastFace3_East_Runout.fal8


Distribution of Rock Path End Locations



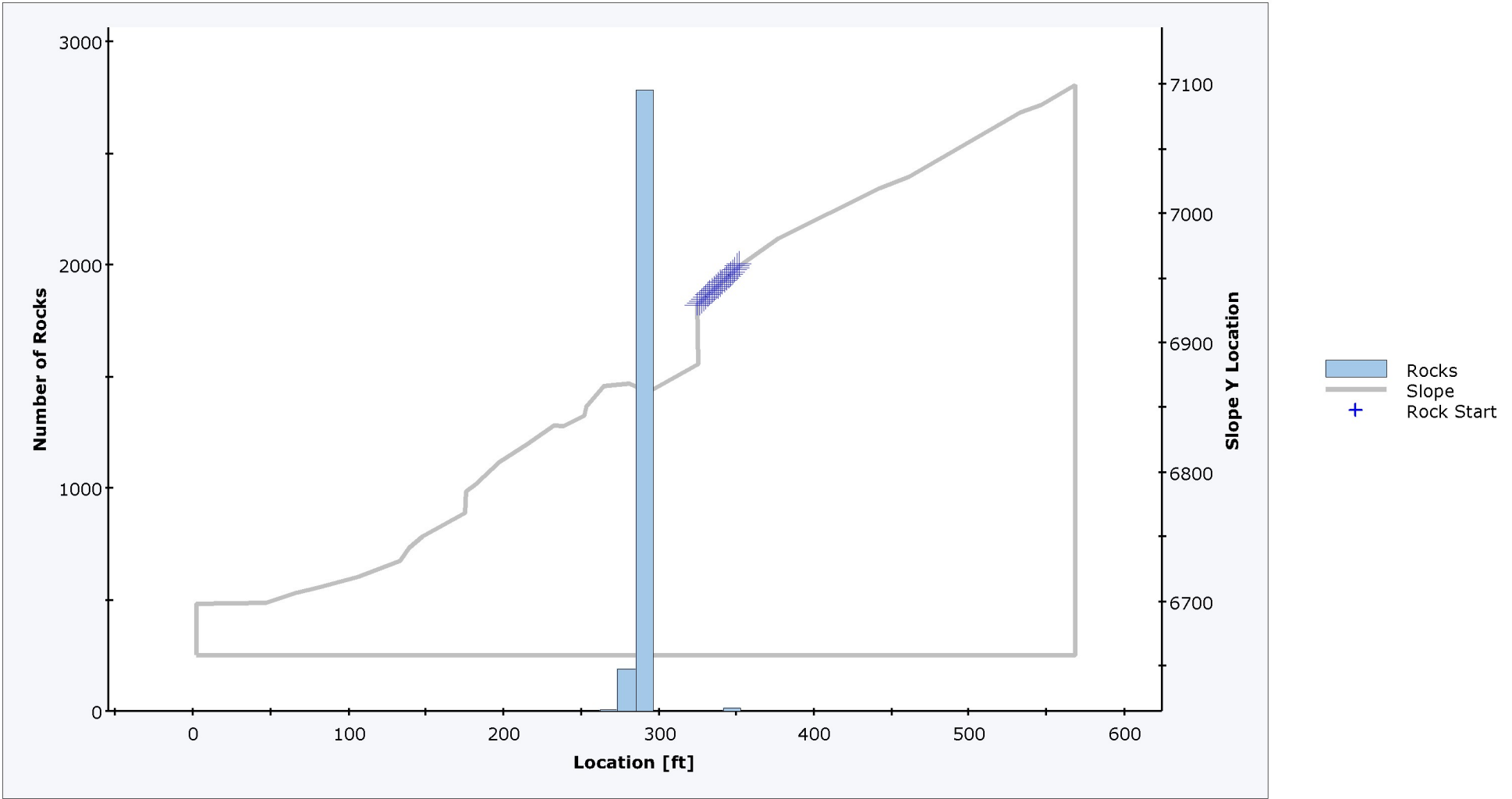
Total number of rock paths: 2996

	<i>Project</i> Mid Continent Mine		
	<i>Analysis Description</i> East Face 3 - East Trend - Runout		
	<i>Drawn By</i> Sundermann		<i>Company</i> Kilduff Underground Engineering
	<i>Date</i> 5/26/2023, 12:24:29 PM		<i>File Name</i> EastFace3_East_Runout.fal8




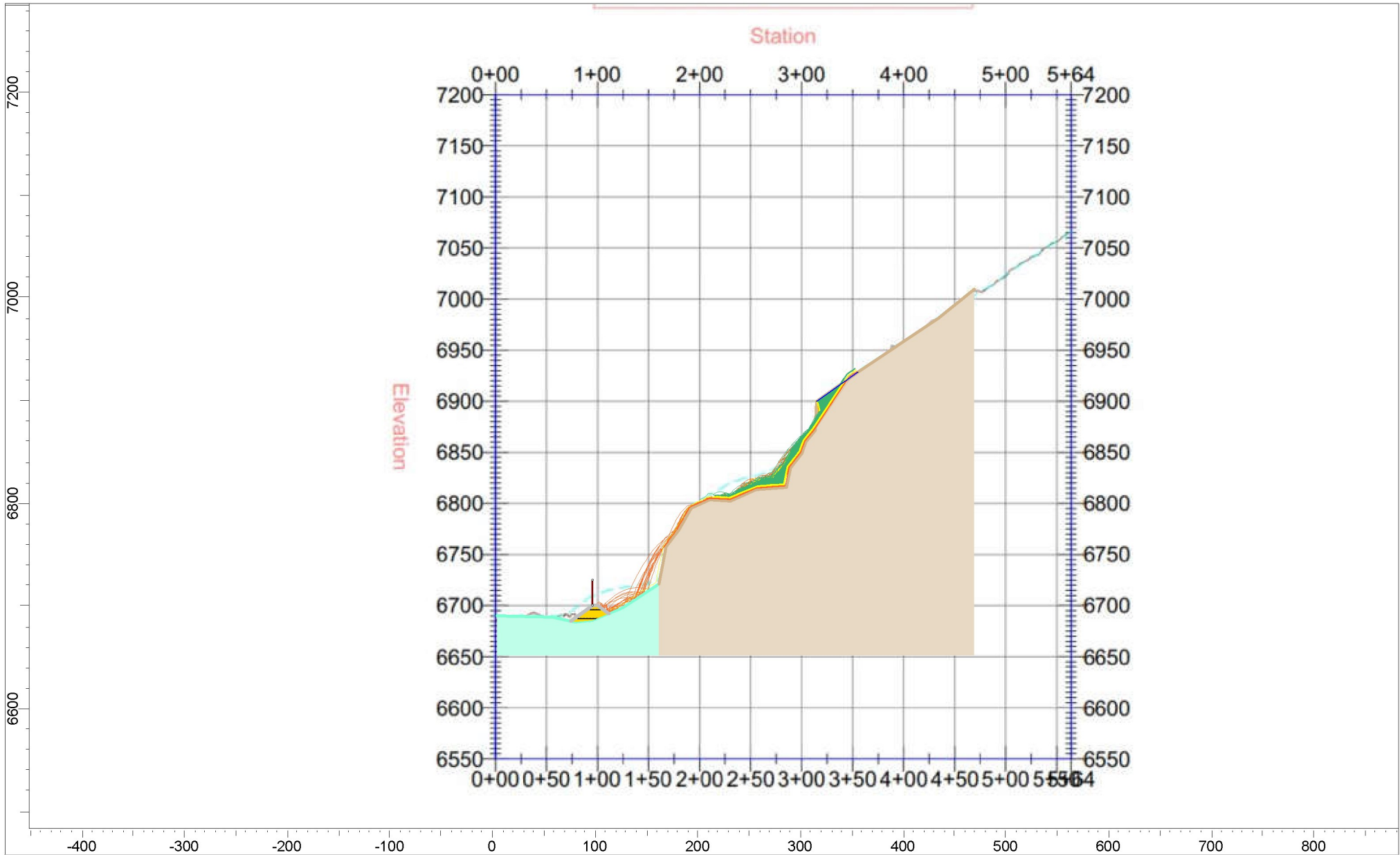
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	Analysis Description		East Face 1 - West Trend - Berm	
	Drawn By	Sundermann	Company	Kilduff Underground Engineering
	Date	5/26/2023, 12:24:29 PM	File Name	EastFace1_West.fal8


Distribution of Rock Path End Locations



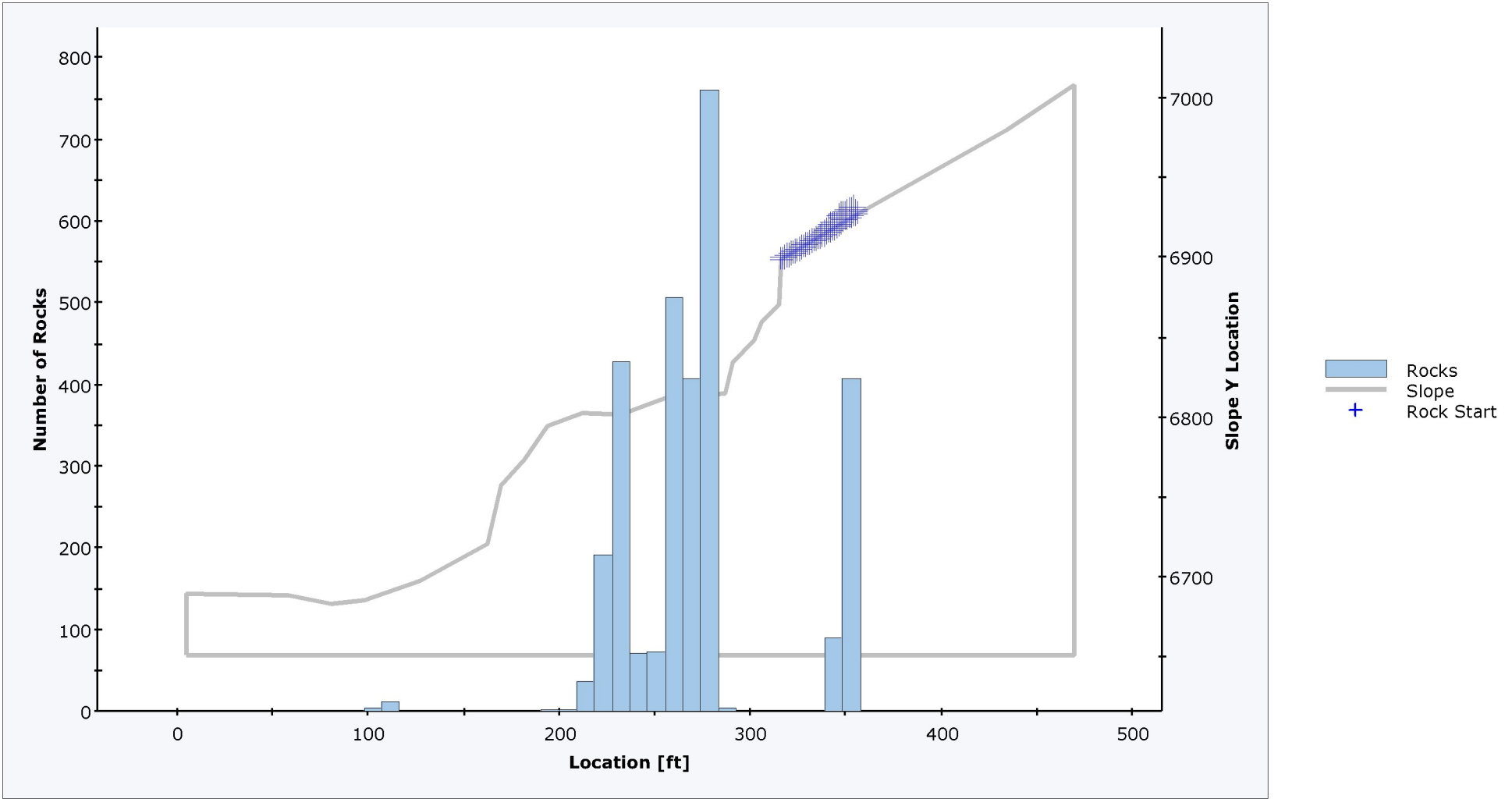
Total number of rock paths: 3000

	Project		Mid Continent Mine	
	Analysis Description		East Face 1 - West Trend - Berm	
	Drawn By	Sundermann	Company	Kilduff Underground Engineering
	Date	5/26/2023, 12:24:29 PM	File Name	EastFace1_West.fal8




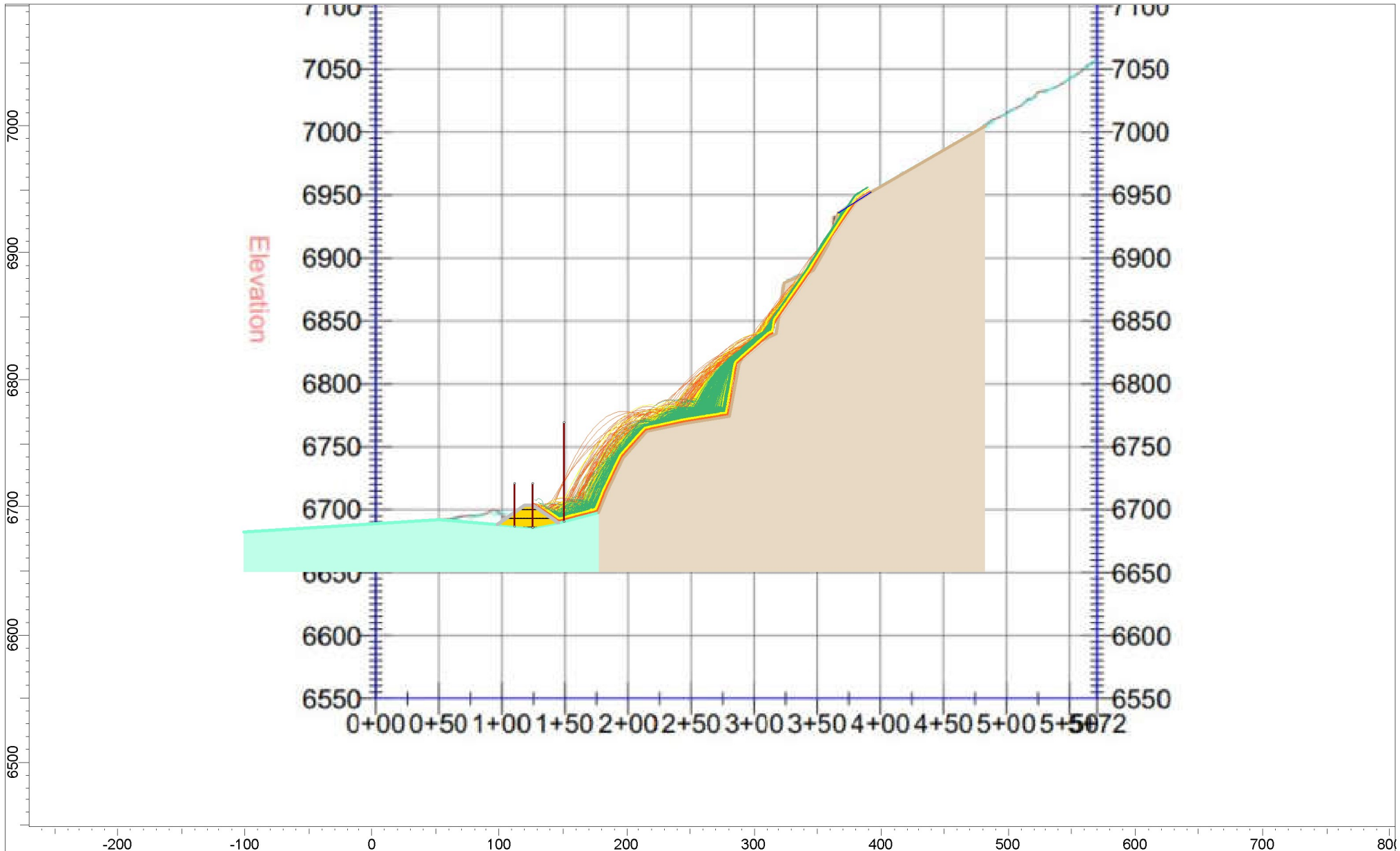
	Project		Mid Continent Mine	
	Analysis Description		East Face 2 - Center Trend - Berm	
	Drawn By	Sundermann	Company	Kilduff Underground Engineering
	Date	5/26/2023, 12:24:29 PM	File Name	EastFace2_Center_Berm.fal8


Distribution of Rock Path End Locations



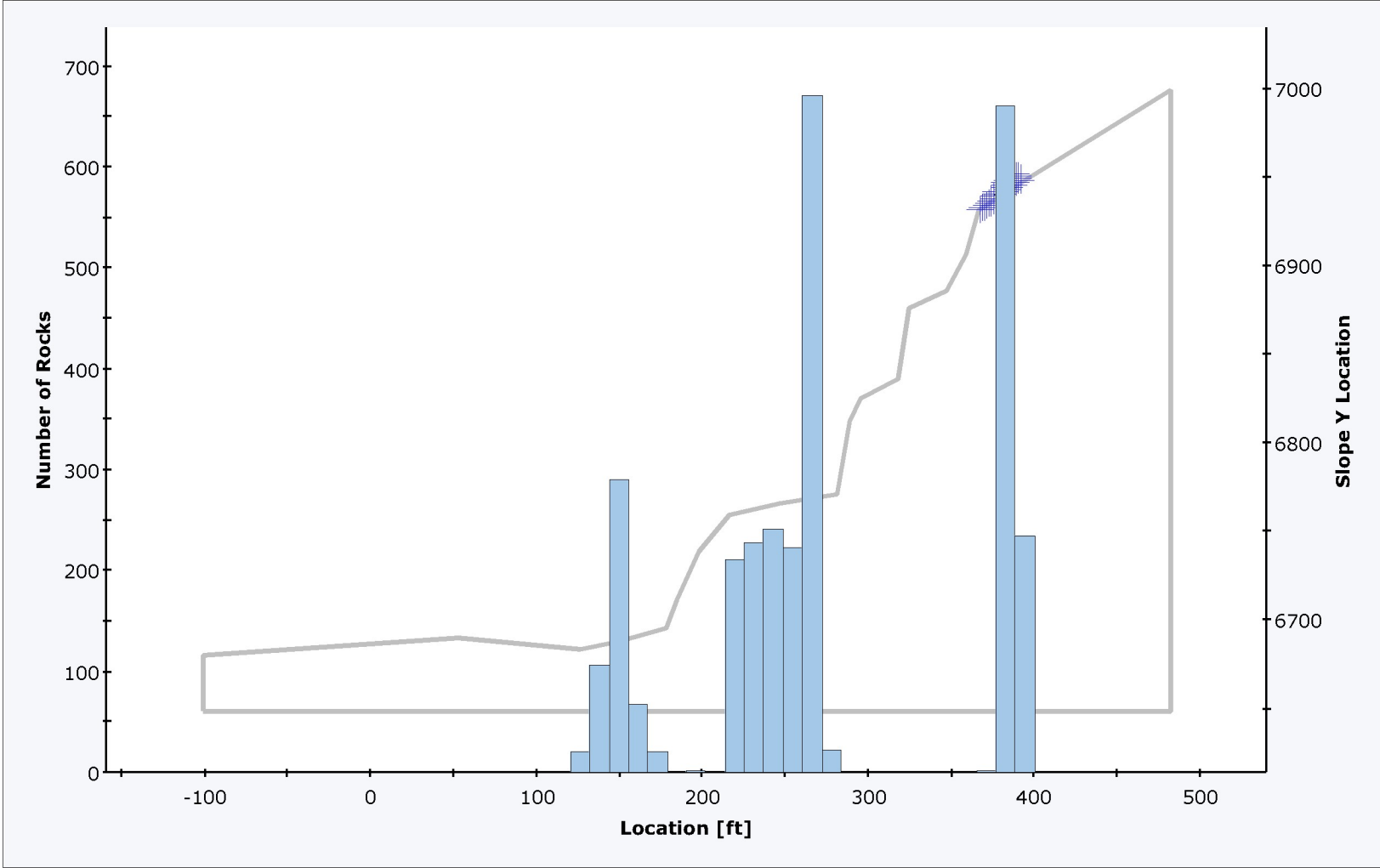
Total number of rock paths: 2993

	Project		Mid Continent Mine	
	Analysis Description		East Face 2 -Center Trend - Berm	
	Drawn By	Sundermann	Company	Kilduff Underground Engineering
	Date	5/26/2023, 12:24:29 PM	File Name	EastFace2_Center_Berm.fal8




	<i>Project</i> Mid Continent Mine	
	<i>Analysis Description</i> East Face 3 - East Trend - 15ft Berm	
	<i>Drawn By</i> Sundermann	<i>Company</i> Kilduff Underground Engineering
	<i>Date</i> 5/26/2023, 12:24:29 PM	<i>File Name</i> EastFace3_East_Berm3000.fal8

Distribution of Rock Path End Locations



Total number of rock paths: 2996

	<i>Project</i> Mid Continent Mine		
	<i>Analysis Description</i> East Face 3 - East Trend - 15ft Berm		
	<i>Drawn By</i> Sundermann		<i>Company</i> Kilduff Underground Engineering
	<i>Date</i> 5/26/2023, 12:24:29 PM		<i>File Name</i> EastFace3_East_Berm3000.fal8



East Face_Berm3000
Mid Continent Mine
Kilduff Underground Engineering
Date Created: 5/26/2023, 12:24:29 PM
Software Version: 8.022

East Face_Berm3000

Mid Continent Mine

Project Summary

File Name	East Face_Berm3000.fal8
File Version	8.022
Project Title	Mid Continent Mine
Analysis	East Face - 15ft Berm
Author	Sundermann
Company	Kilduff Underground Engineering
Date Created	5/26/2023, 12:24:29 PM

Project Settings

General Settings

Engine	Rigid Body
Units	Imperial Foot-Pounds (ft, lbm, ft-lbf)
Rock throw mode	Number of rocks controlled by seeder
Use tangential CRSP damping	Yes

Engine Conditions

Maximum steps per rock	40000
Normal velocity cutoff (ft/s)	0.33
Stopped velocity cutoff (ft/s)	0.33
Maximum timestep (s)	0.01
Switch velocity (ft/s)	-3.3e-09

Random Number Generation

Sampling method	Latin-Hypercube
Material Properties Sampling	Per simulation
Random seed	Pseudo-random seed: 12345234


Crest Loss

Vertex	Mean	Distribution	Std.Dev	Rel. Min	Rel. Max	Mean	Distribution	Std.Dev	Rel. Min	Rel. Max
11	20	None	.			20	None			
13	30	None	.			30	None			
16	30	None	.			20	None			

Material Properties

Limestone Headwall

"Limestone Headwall" Properties


Color					
	Mean	Distribution	Std.Dev.	Rel. Min	Rel. Max
Normal Restitution	0.32	Normal	0.04	0.12	0.12
Tangential Restitution	0.71	Normal	0.04	0.12	0.12
Dynamic Friction	0.55	Normal	0.04	0.12	0.12
Rolling Friction	0.15	Normal	0.02	0.06	0.06

"Limestone Headwall" Advanced Properties

Forest and Vegetation Damping	Disabled
Scarring	Disabled
Viscoplastic Damping	Disabled

Limestone Scree / Blast Pile

"Limestone Scree / Blast Pile" Properties

Color					
	Mean	Distribution	Std.Dev.	Rel. Min	Rel. Max
Normal Restitution	0.32	Normal	0.04	0.12	0.12
Tangential Restitution	0.71	Normal	0.04	0.12	0.12
Dynamic Friction	0.55	Normal	0.04	0.12	0.12
Rolling Friction	0.3	Normal	0.04	0.12	0.12

"Limestone Scree / Blast Pile" Advanced Properties

Forest and Vegetation Damping	Disabled
Scarring	Disabled
Viscoplastic Damping	Disabled

Berm Properties

Berm

"Berm" Properties

Berm Property	Mean	Distribution	Calculate Impact		
			Std.Dev.	Rel. Min	Rel. Max
Normal Restitution	0.31	Normal	0.04	0.12	0.12
Tangential Restitution	0.82	Normal	0.04	0.12	0.12
Dynamic Friction	0.55	Normal	0.04	0.12	0.12
Rolling Friction	0.6	Normal	0.01	0.03	0.03

Seeders

Seeder 1

Seeder Properties

Name Seeder 1
 Location (366.167, 6931.79),
 (392.116, 6948.01)

Rocks to Throw


Number of Rocks 3000 Overall
 Rock Types Small Blocks, Medium Blocks, Large Blocks

Initial Conditions


	Mean	Distribution	Std.Dev.	Rel. Min	Rel. Max
Horizontal Velocity (ft/s)	6	Normal	2	6	6
Vertical Velocity (ft/s)	0	None			
Rotational Velocity (deg/s)	0	None			
Initial Rotation (deg/s)	0	Uniform		0	360

Rock Types


Small Blocks

Properties					
Name	Small Blocks				
Color					
Smooth Shapes	Square,	Pentagon,	Rhombus		
Polygons	None				
	Mean	Distribution	Std.Dev.	Rel. Min	Rel. Max
Mass (lbm)	2022.2	Normal	2	6	6
Density (lbm/ft3)	150	Normal	3	9	9

Medium Blocks

Properties					
Name	Medium Blocks				
Color					
Smooth Shapes	Square,	Pentagon,	Rhombus		
Polygons	None				
	Mean	Distribution	Std.Dev.	Rel. Min	Rel. Max
Mass (lbm)	20227.2	Normal	2	6	6
Density (lbm/ft3)	150	Normal	3	9	9

Large Blocks

Properties					
Name	Large Blocks				
Color					
Smooth Shapes	Square,	Pentagon,	Rhombus		
Polygons	None				
	Mean	Distribution	Std.Dev.	Rel. Min	Rel. Max
Mass (lbm)	93642	Normal	2	6	6
Density (lbm/ft3)	156.07	None			

Collectors

Record paths' first impacts only? No

Collector 1

Name Collector 1
Location (111.848, 6685.46) to (112.031,
6718.94)

Collector 2

Name Collector 2
Location (150.83, 6689.04) to (150.86,
6766.9)

Collector 3

Name Collector 3
Location (126.142, 6684.2) to (126.306,
6718.94)