2023 Fall Conference at Ashore Resort & Beach Club
Ocean City, Maryland

Utilizing Unmanned Aerial Vehicles & Data in Geotechnical Analysis & Construction

Mike Close, P.E. M.S.

September 29, 2023

BIOGRAPHY

- 40 years of engineering experience
- Bachelors & Masters degree in Civil Engineering
- Licensed Unmanned Aerial Vehicle Pilot
- Licensed Professional Engineer in Maryland, Michigan, North Carolina, South Carolina, & Virginia

ABSTRACT

Utilizing Unmanned Aerial Vehicles & Data in Geotechnical Analysis & Construction

Brief overview of presentation

- How can professionals use Unmanned Aerial Vehicles (UAVs) or drones to do more in less time?
- What online data and tools are available to make the most of the data collected using drones (UAVs)?
- 1.0 PDH

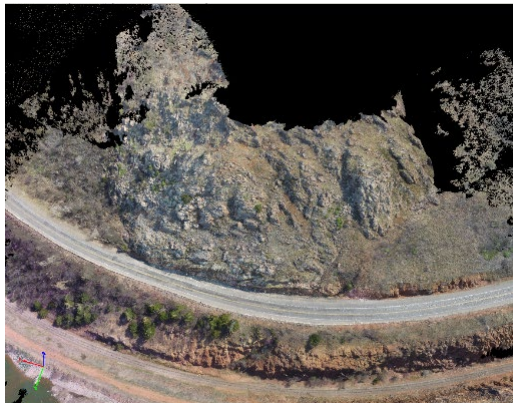
Agenda

Introduction & Definition of Terms

UAV Recon vs. Traditional

Post Processing

Applications



Conclusions

How Many of Your Firms/Agencies utilize UAV Technology

Introduction & Definition of Terms

GeoStabilization International®

Introduction & Definition of Terms

Basic Terminology of Unmanned Aerial Systems (UAS)

Unmanned Aerial System (UAS) consists of:

- **UNMANNED AERIAL VEHICLE (UAV)** commonly referred to as “drones”.
- A **PILOT** the operator responsible for safe operation of the flight
- **SOFTWARE –** a variety of software is available to aid in the pilot in safely operating the drone to obtain data required to complete mission objectives.
- **SENSORS & ACCESSORIES** – Any combination of customizable data collection devices that store data and provide information to the pilot.

Mission Planning and Safety

Regulations for Commercial Flights

- **Part 107**
  - Pass FAA Knowledge Test
  - 16 Years Old
- **Section 333 Exemption**
  - Part 61 Pilot's Licensed & current
  - Requires Visual Observer
  - Airman Medical Certificate

UAV Recon vs. Traditional

GSI
GeoStabilization International®

TRADITIONAL SITE CHARACTERIZATION

- Access limitations
- Time intensive
- Physical demands
- Expensive (to get what we want)
- Subject to human error
- Spatial gaps (hundreds of points)

UAV SITE CHARACTERIZATION

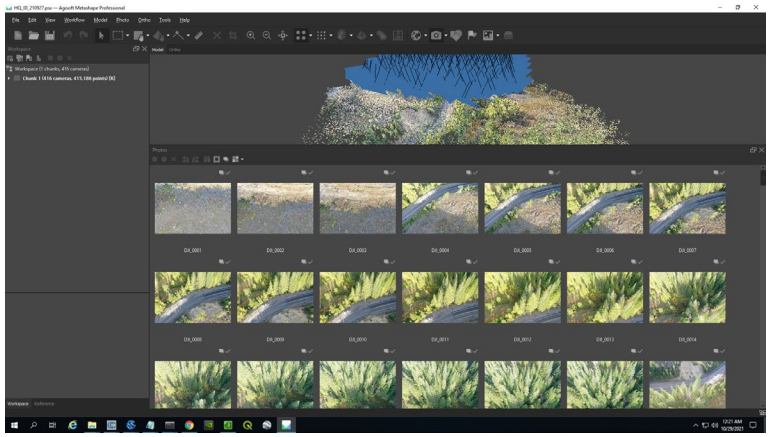
- Safe
- Quick & easy
- Affordable
- Thorough (millions and millions of points)

UAV RECON VS. TRADITIONAL

Post Processing

Processing—Drone Images

Raw images



Photogrammetry (SfM) software

Agisoft Metashape /Pix4D, etc.

Ground control panels

Point Cloud

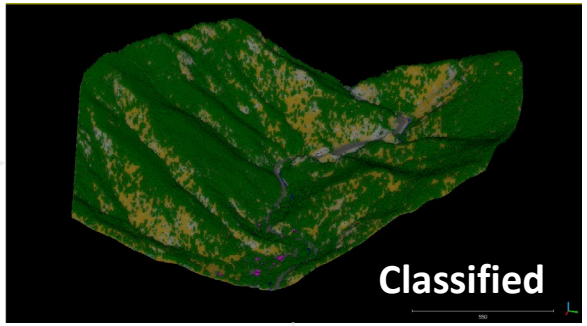
Orthomosaic

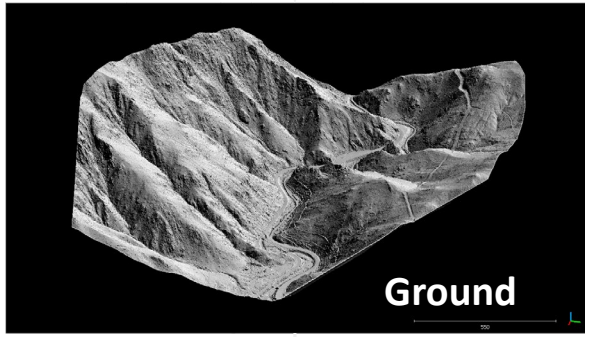
Geohazard Workflow

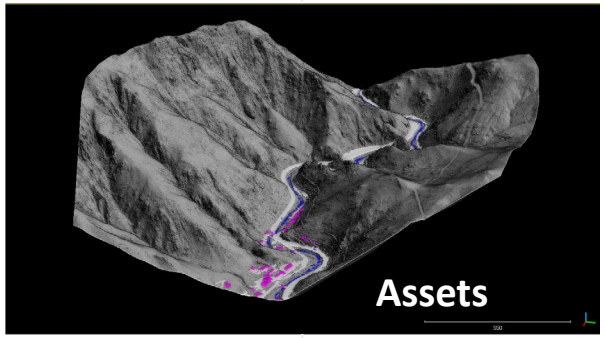
Classification

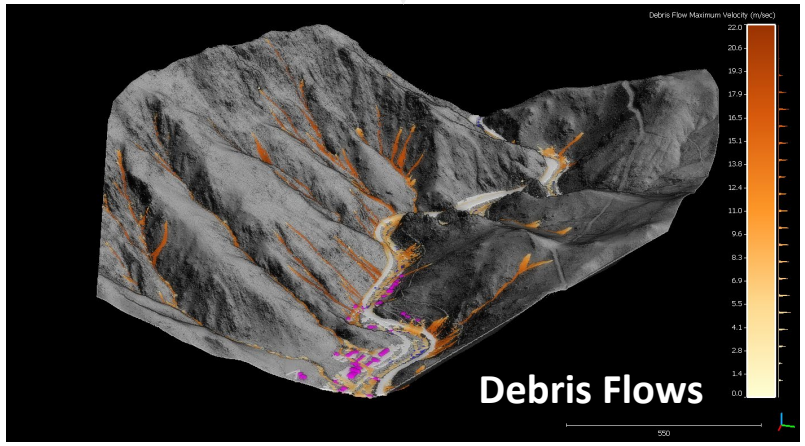
Feature extraction

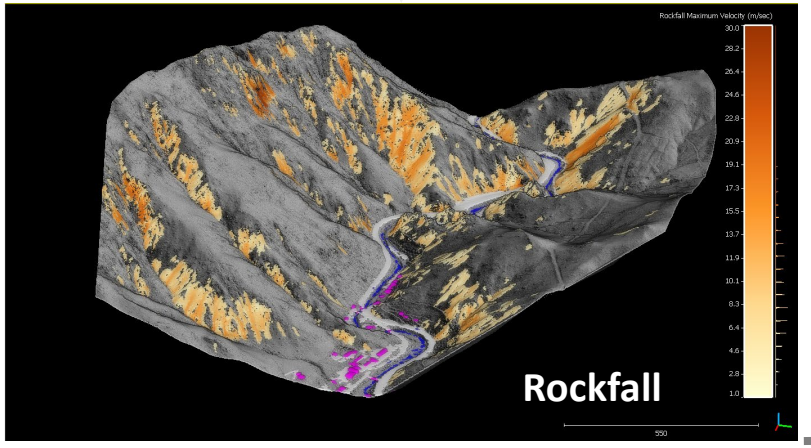
Modeling











ML/AI/Runout models, etc.

Applications

GeoStabilization International®

Applications

What can you do with Point Clouds?

- Engineering & Design
- Planning & Logistics
- Post-construction Monitoring
- Change Detection & Monitoring
- Susceptibility & Risk Modeling
- Asset Management

Applications

What can you do with Point Clouds?

- Engineering & Design
- Planning & Logistics
- Post-construction Monitoring

REACTIVE

- Change Detection & Monitoring
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Applications

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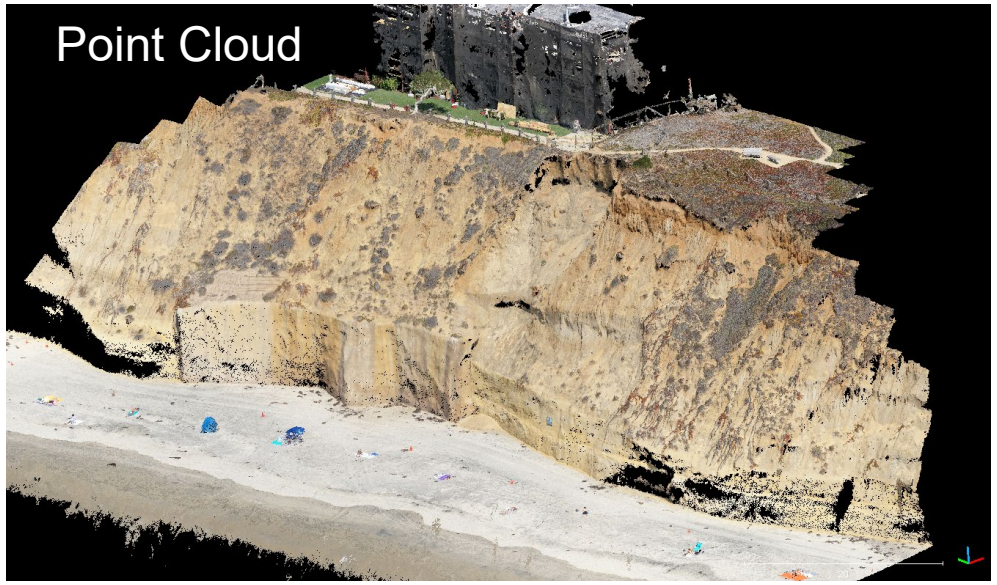
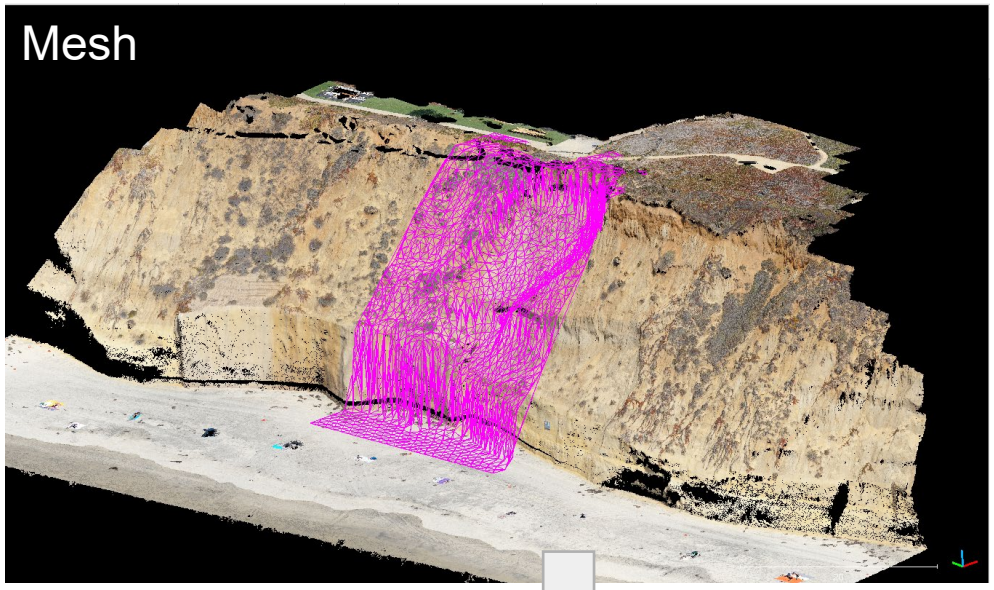
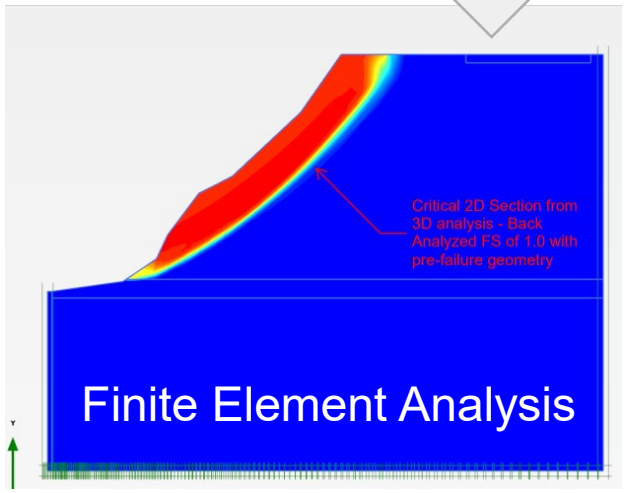
PROACTIVE

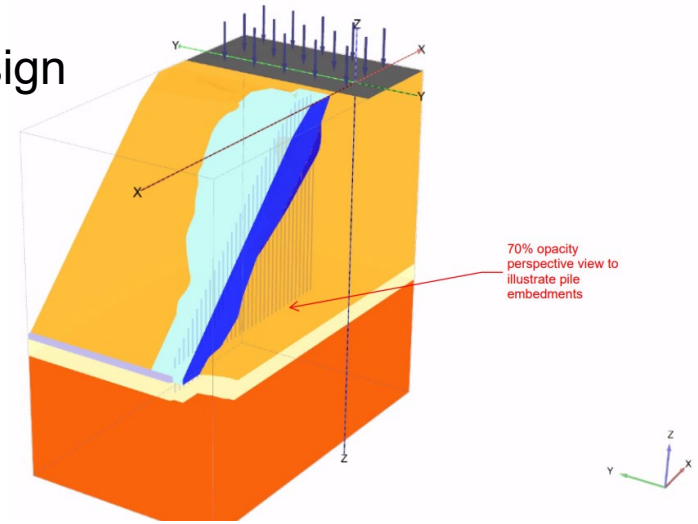
Applications—Design & Engineering



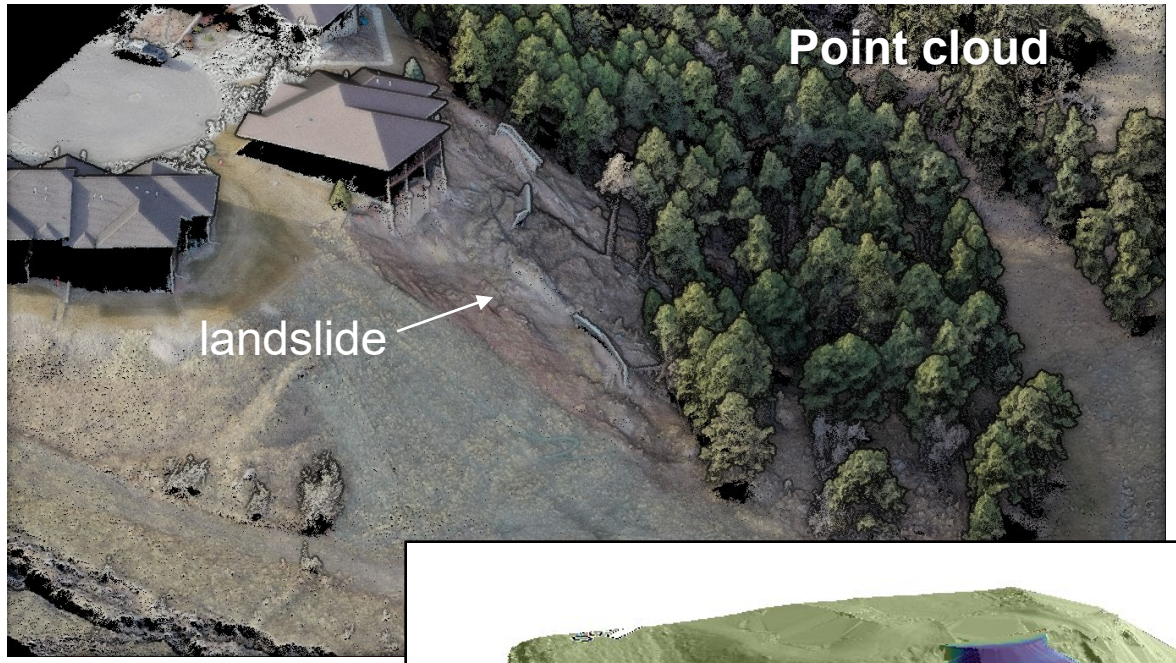


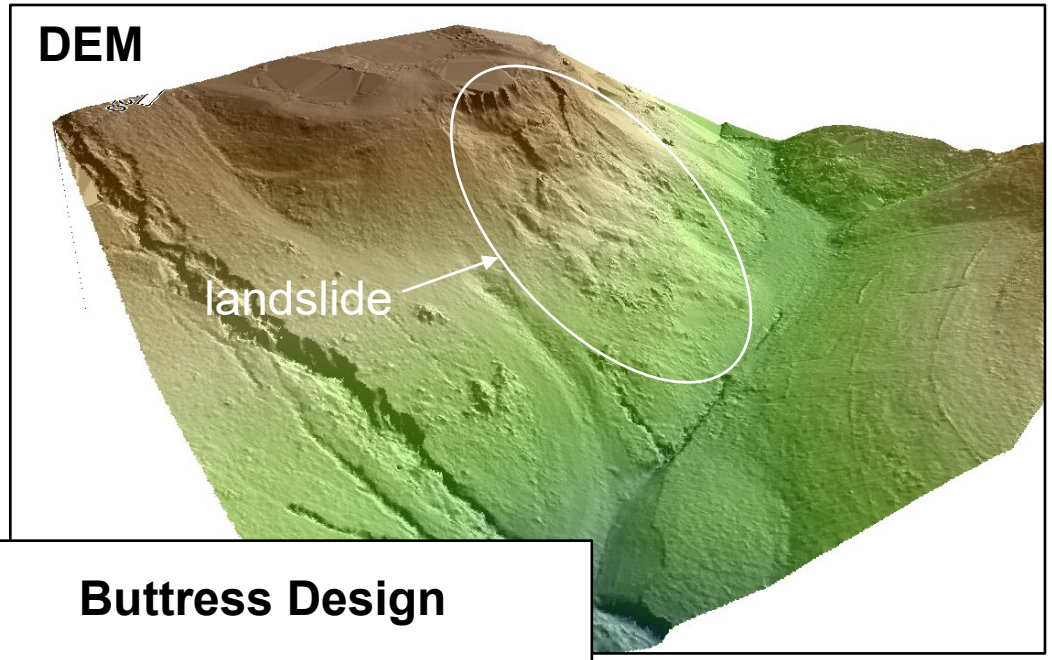


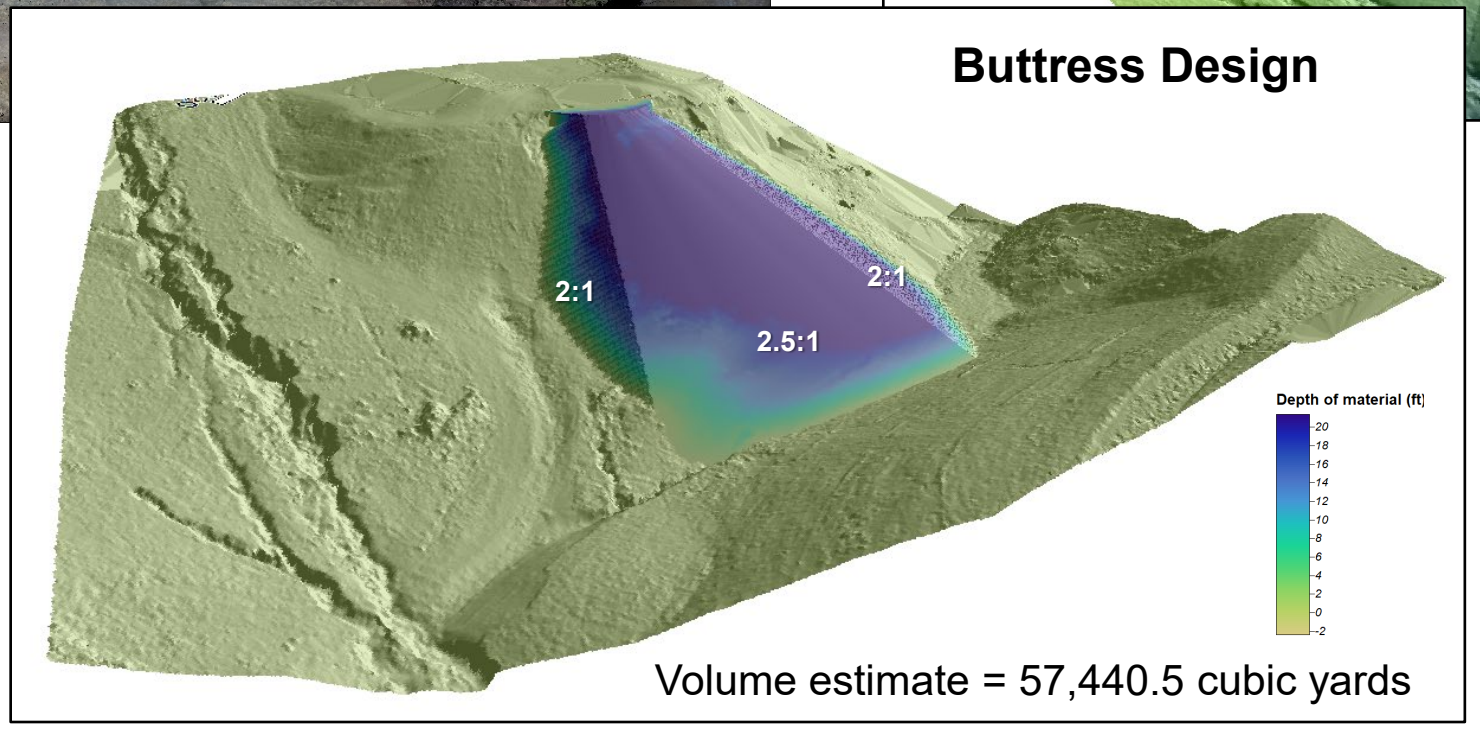
Robust Design



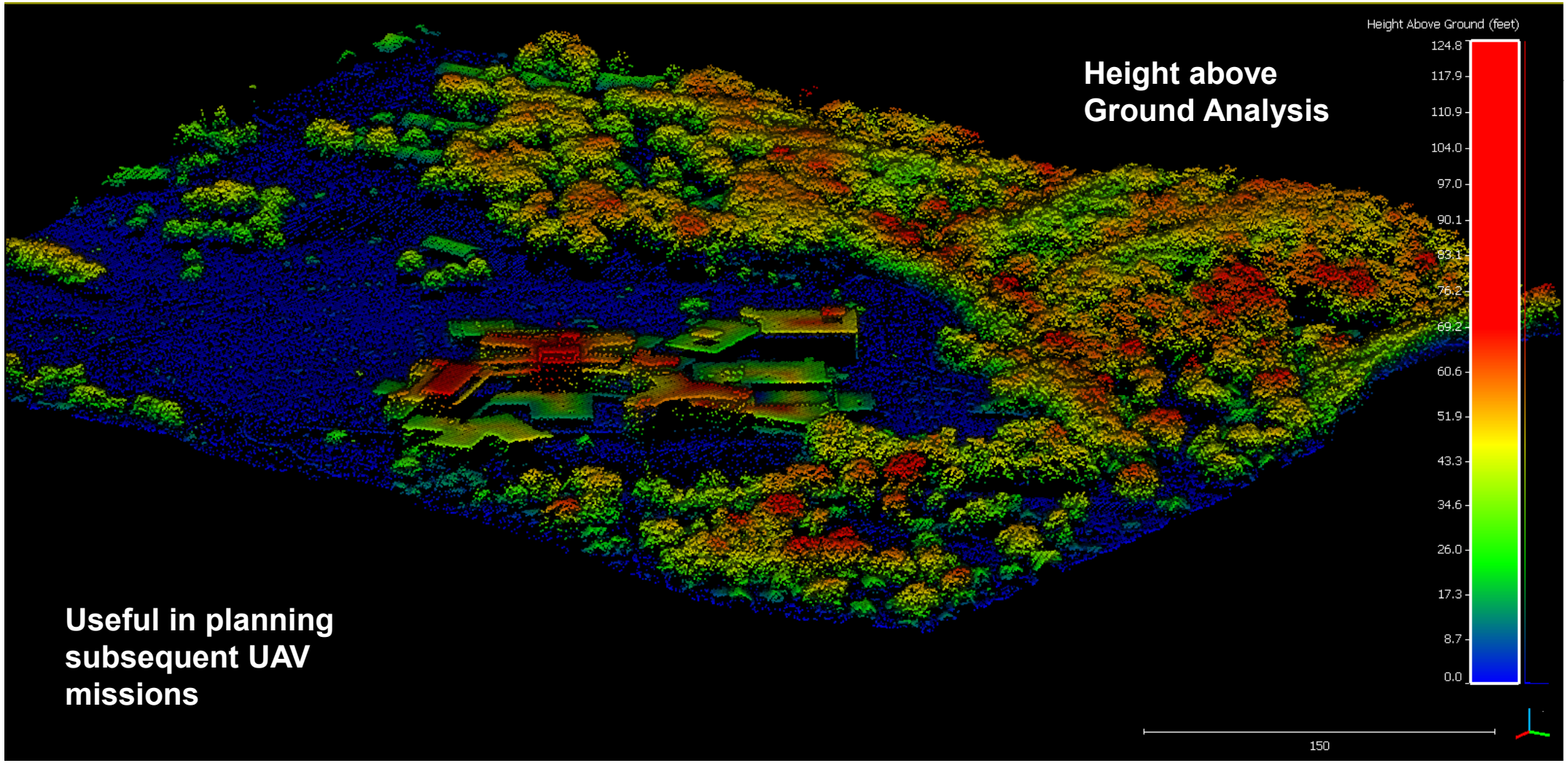
Applications—Design & Engineering







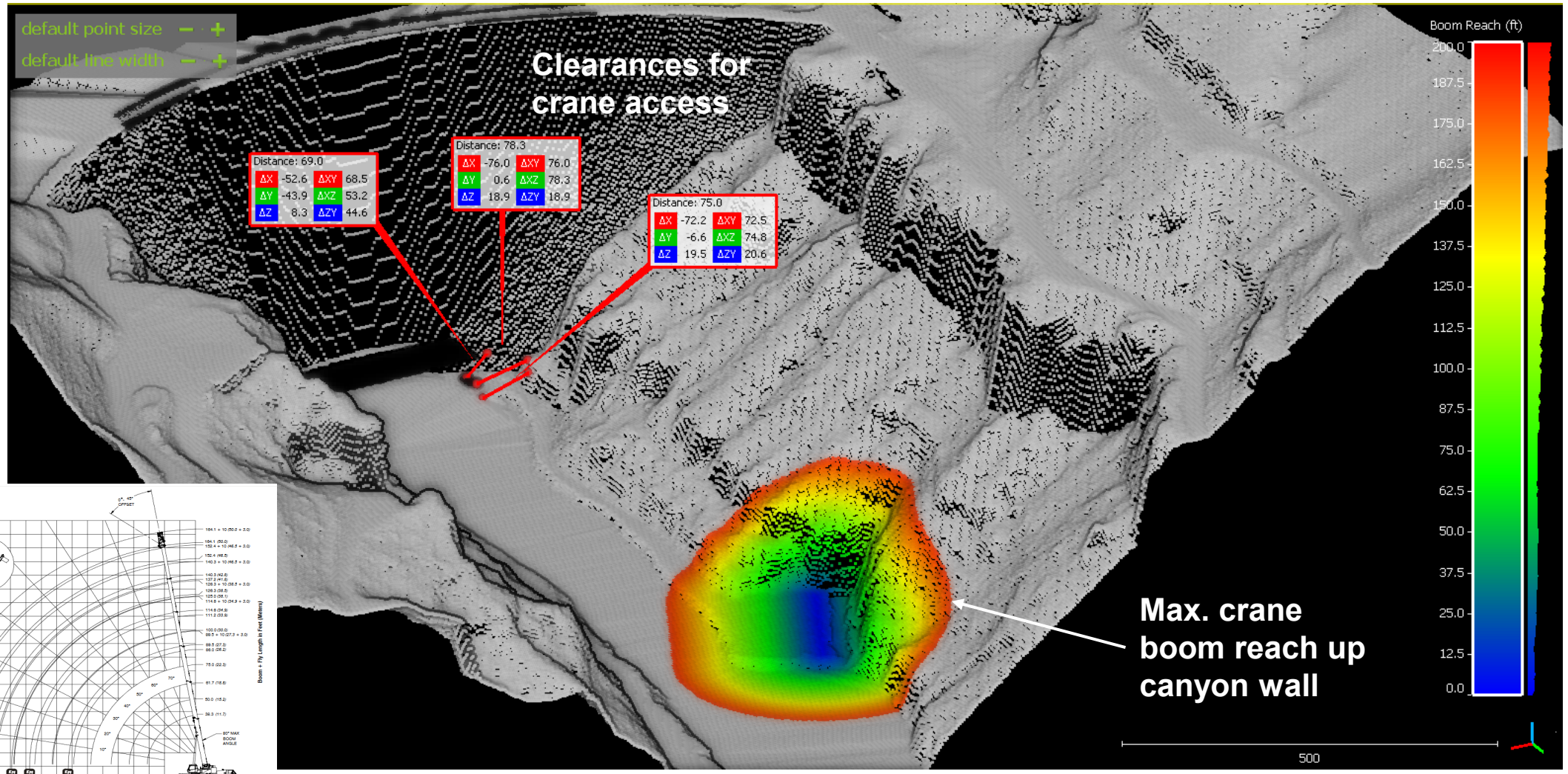
Applications—Planning & Logistics



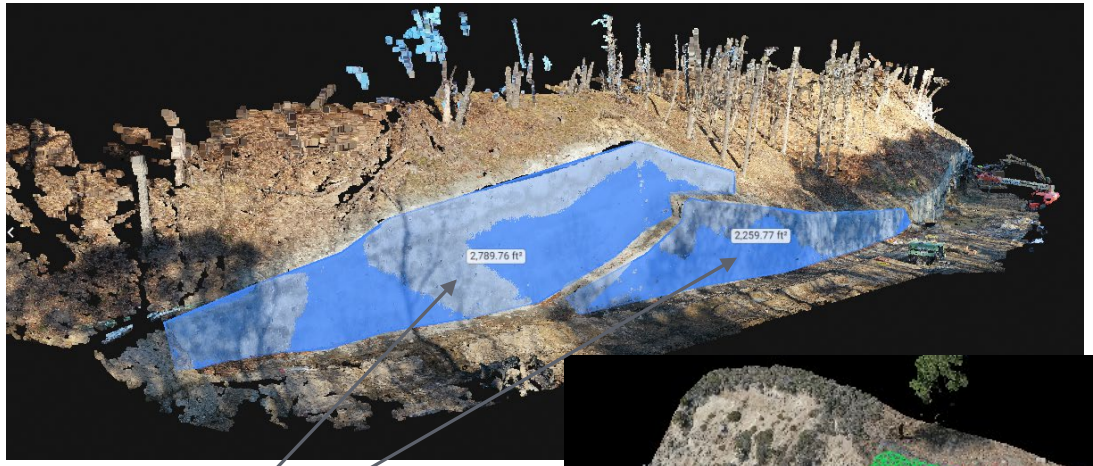
Height above Ground Analysis

Useful in planning subsequent UAV missions

Applications—Planning & Logistics



Applications—Post Construction Monitoring

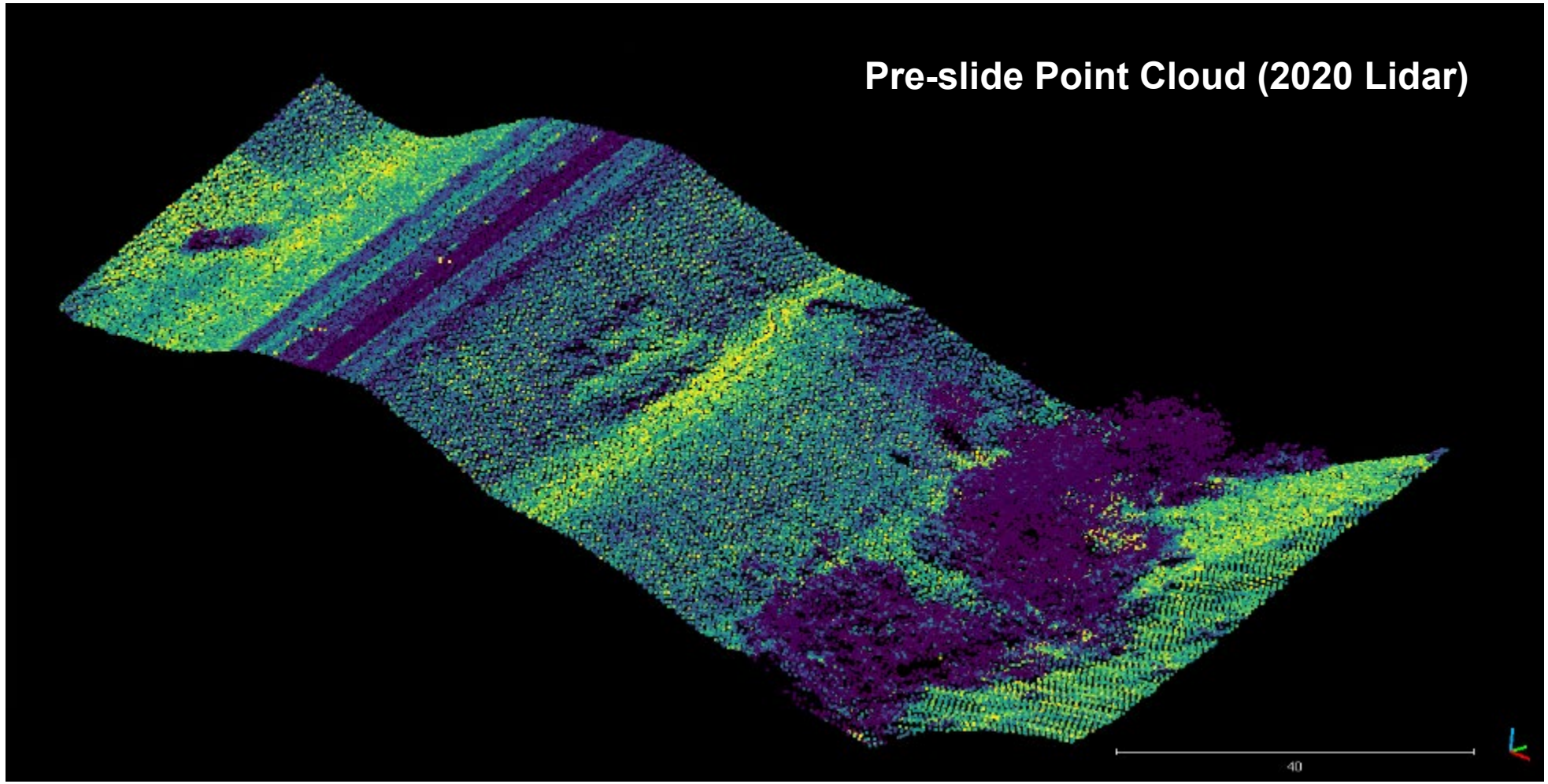


Shotcrete wall area:
5,118 sq. ft.

3D As-Builts

- Quality assurance
- Materials back-checking
- Warranty assurance
- Performance Monitoring

Applications—Change Detection & Monitoring



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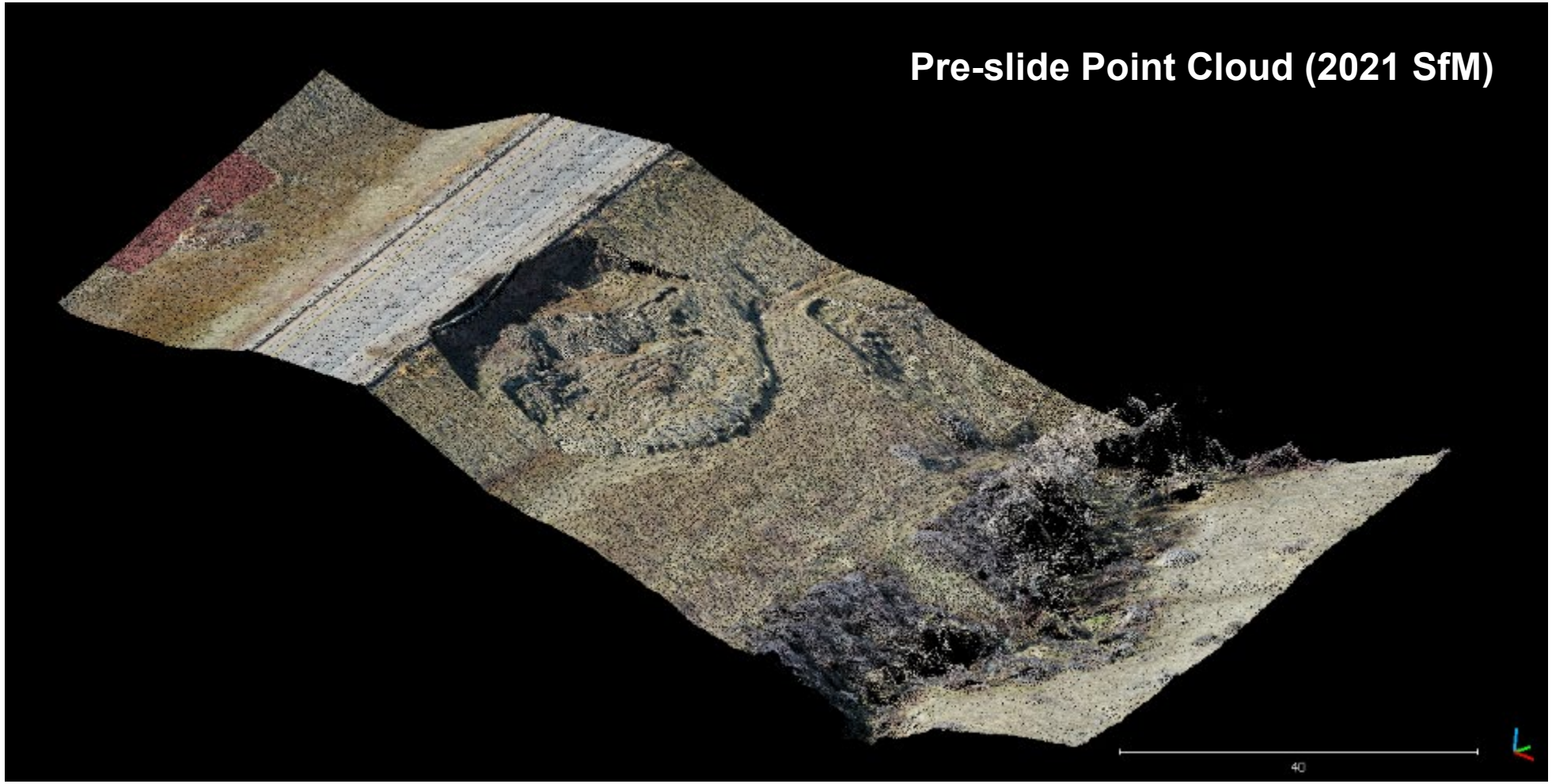

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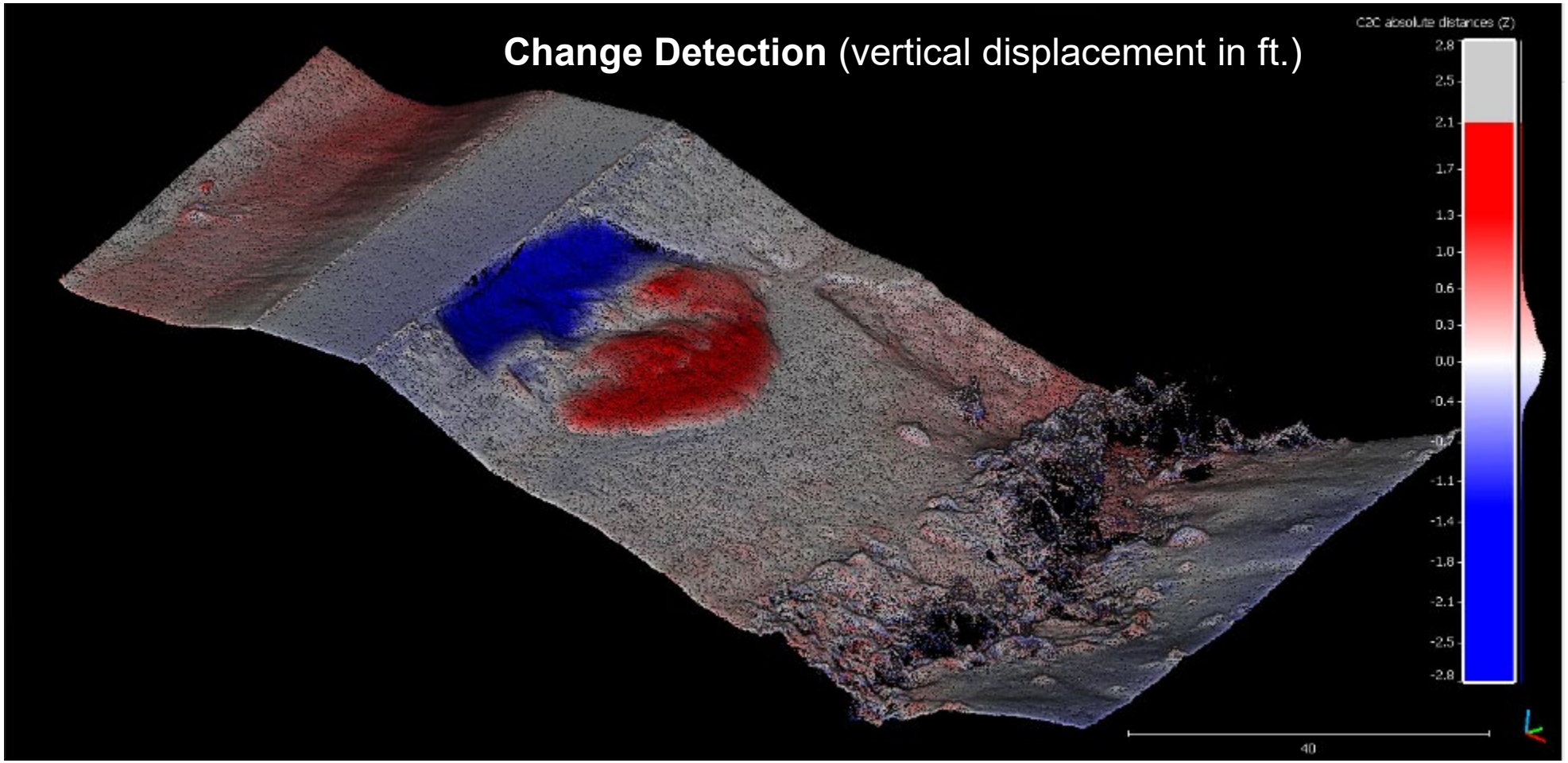

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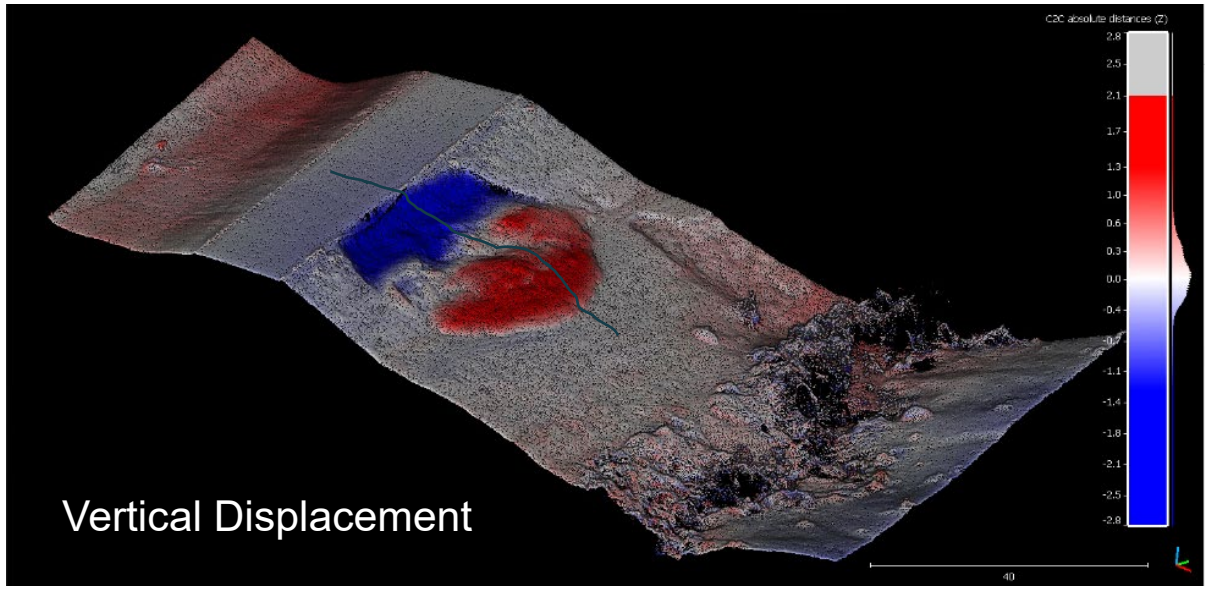
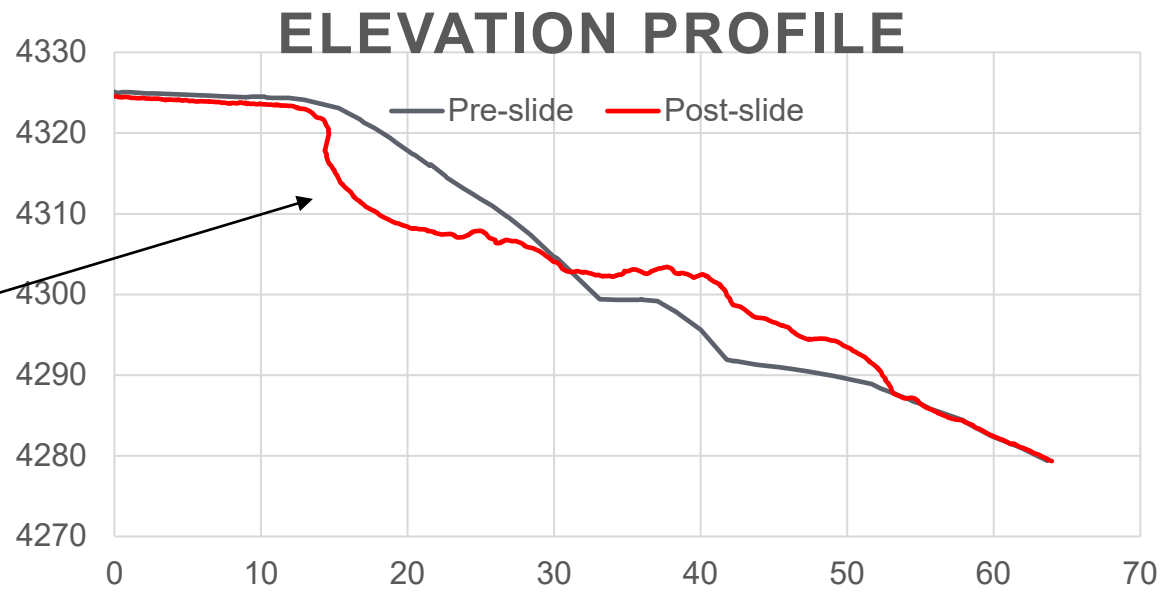
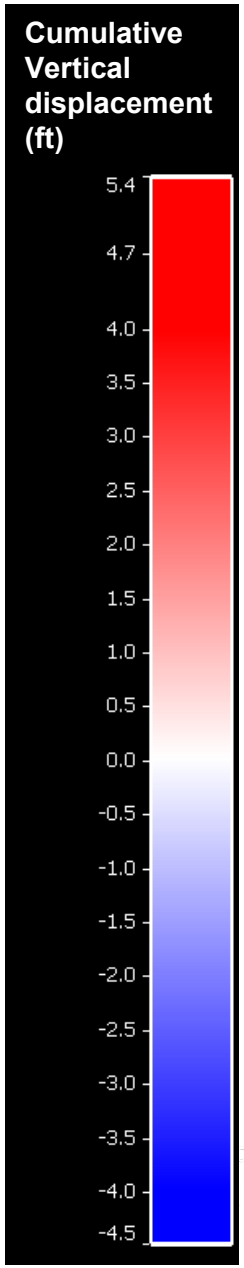
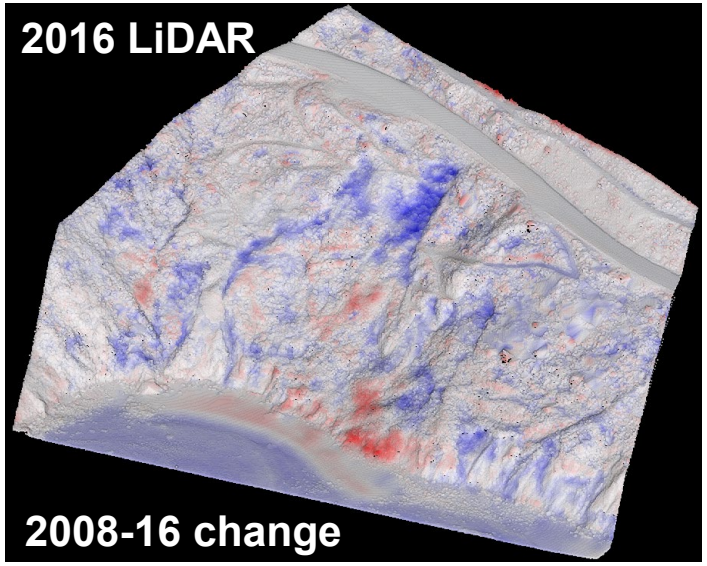


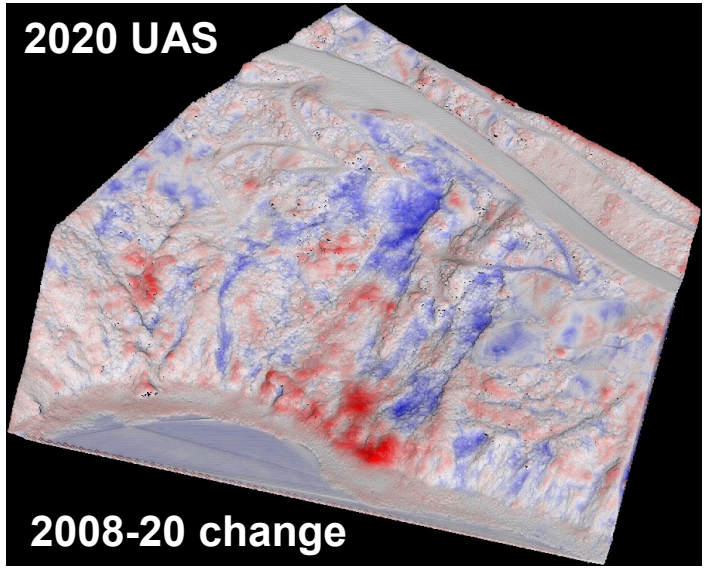
Failure surface

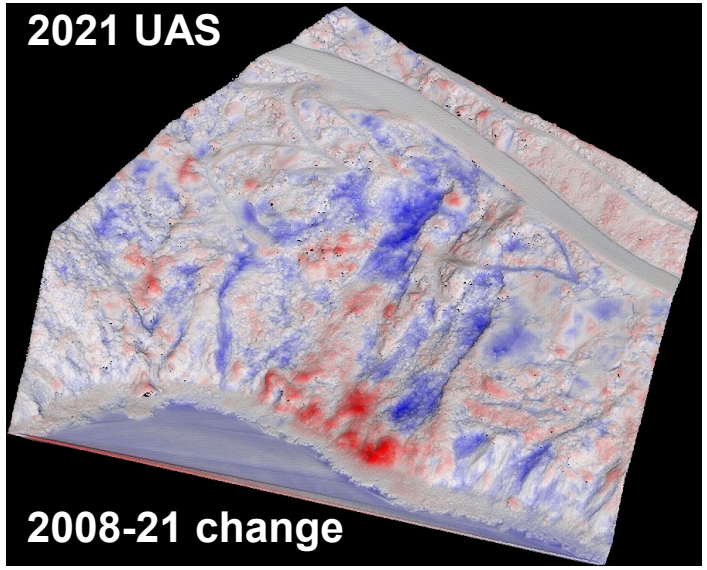


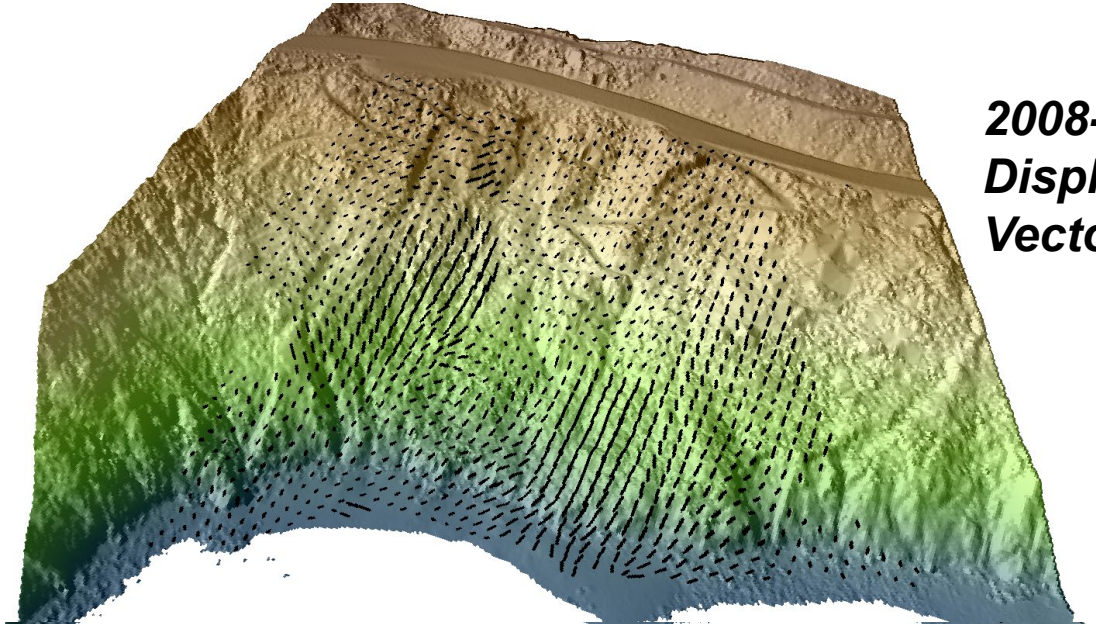
Applications—Change Detection & Monitoring





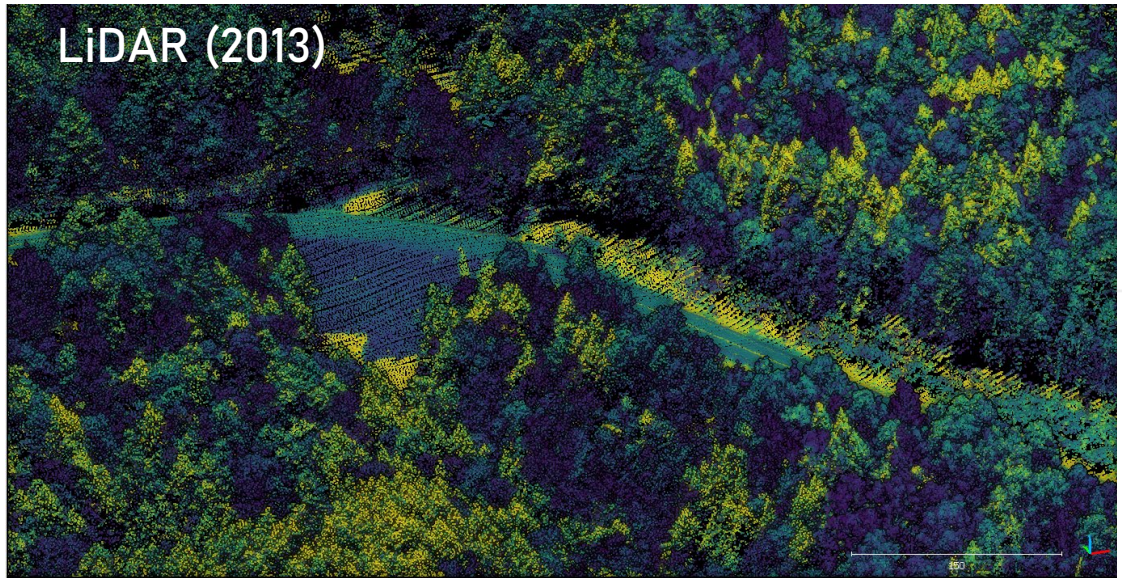


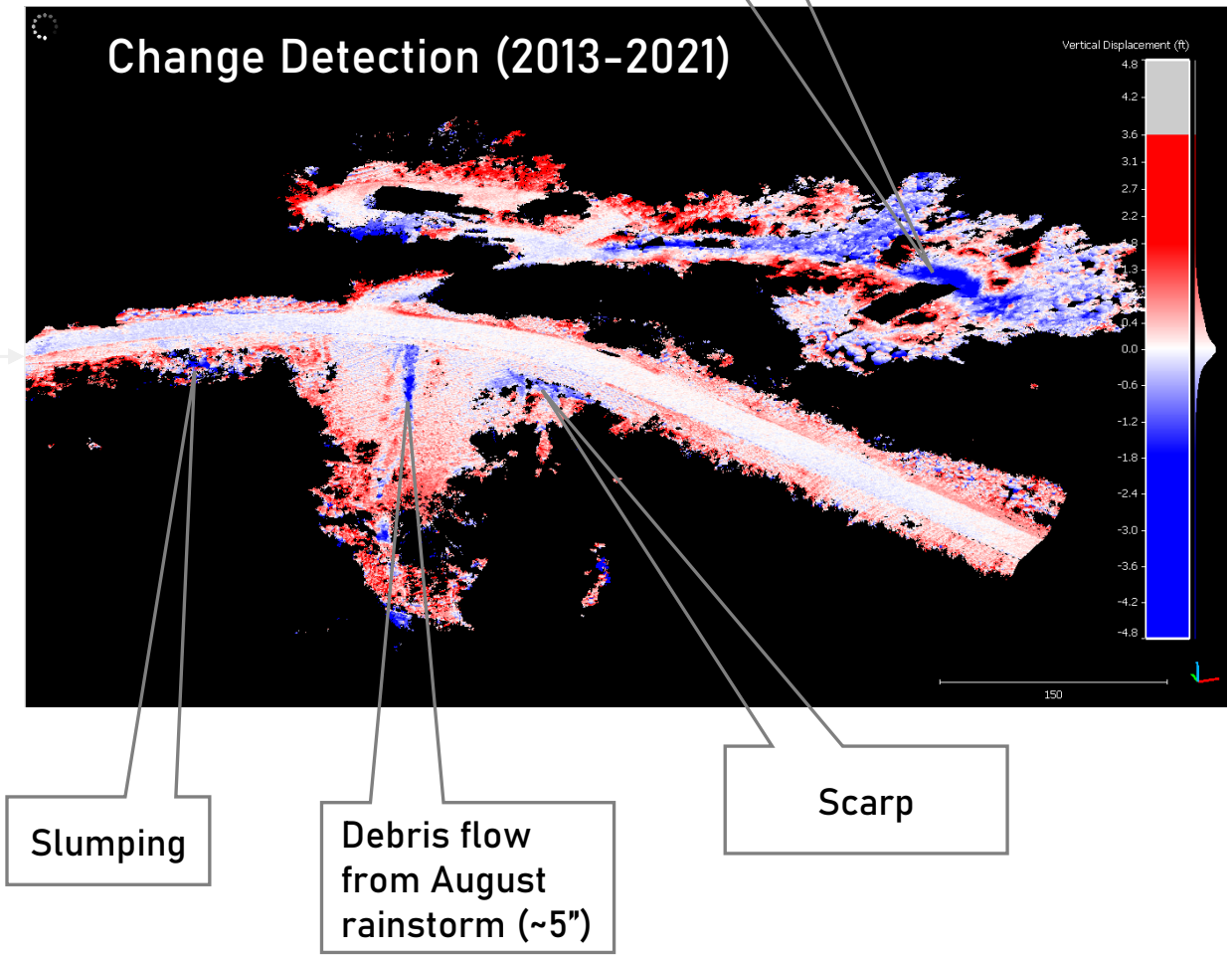




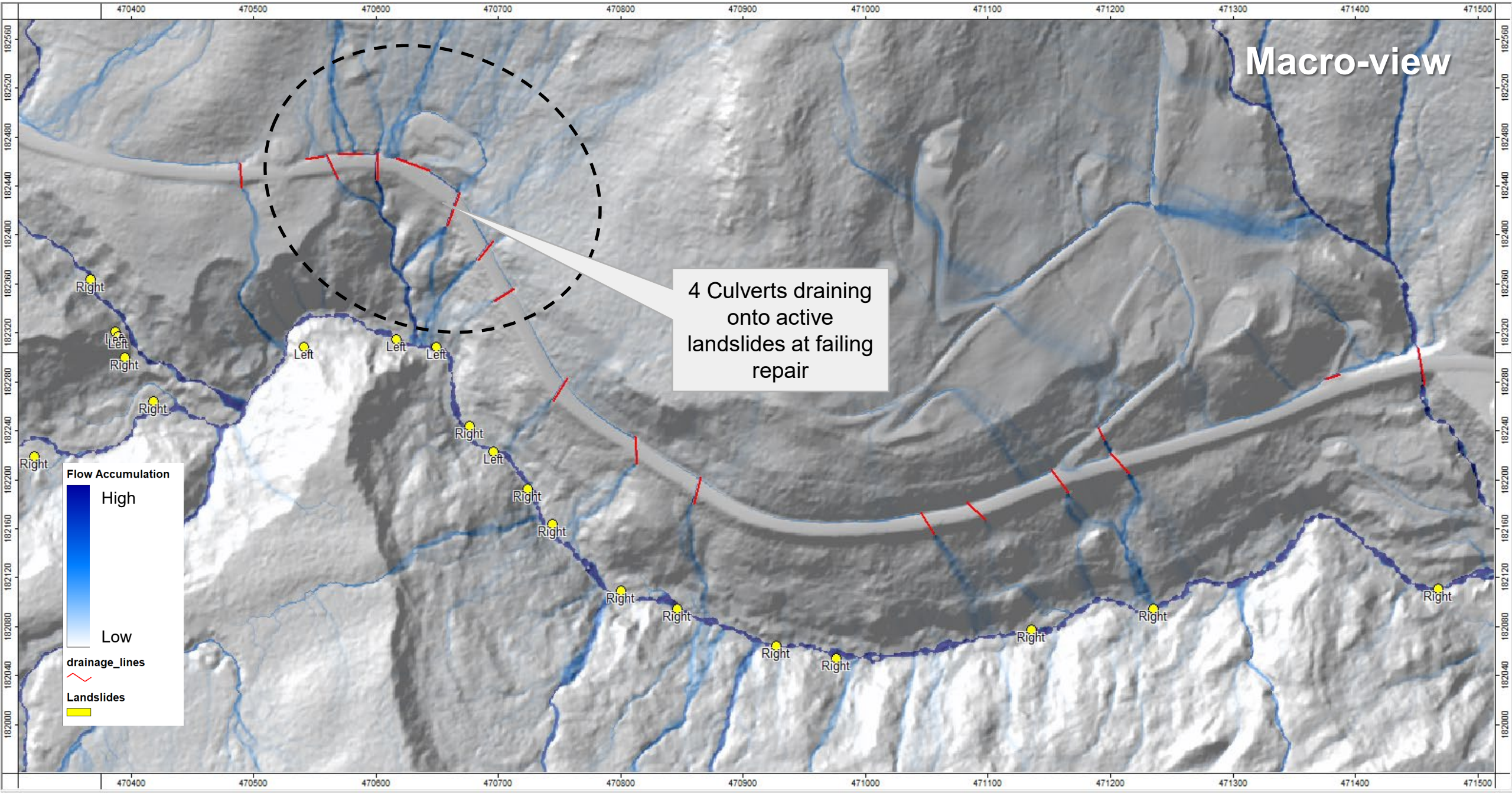
2008-2021 Displacement Vectors

Applications—Change Detection & Monitoring

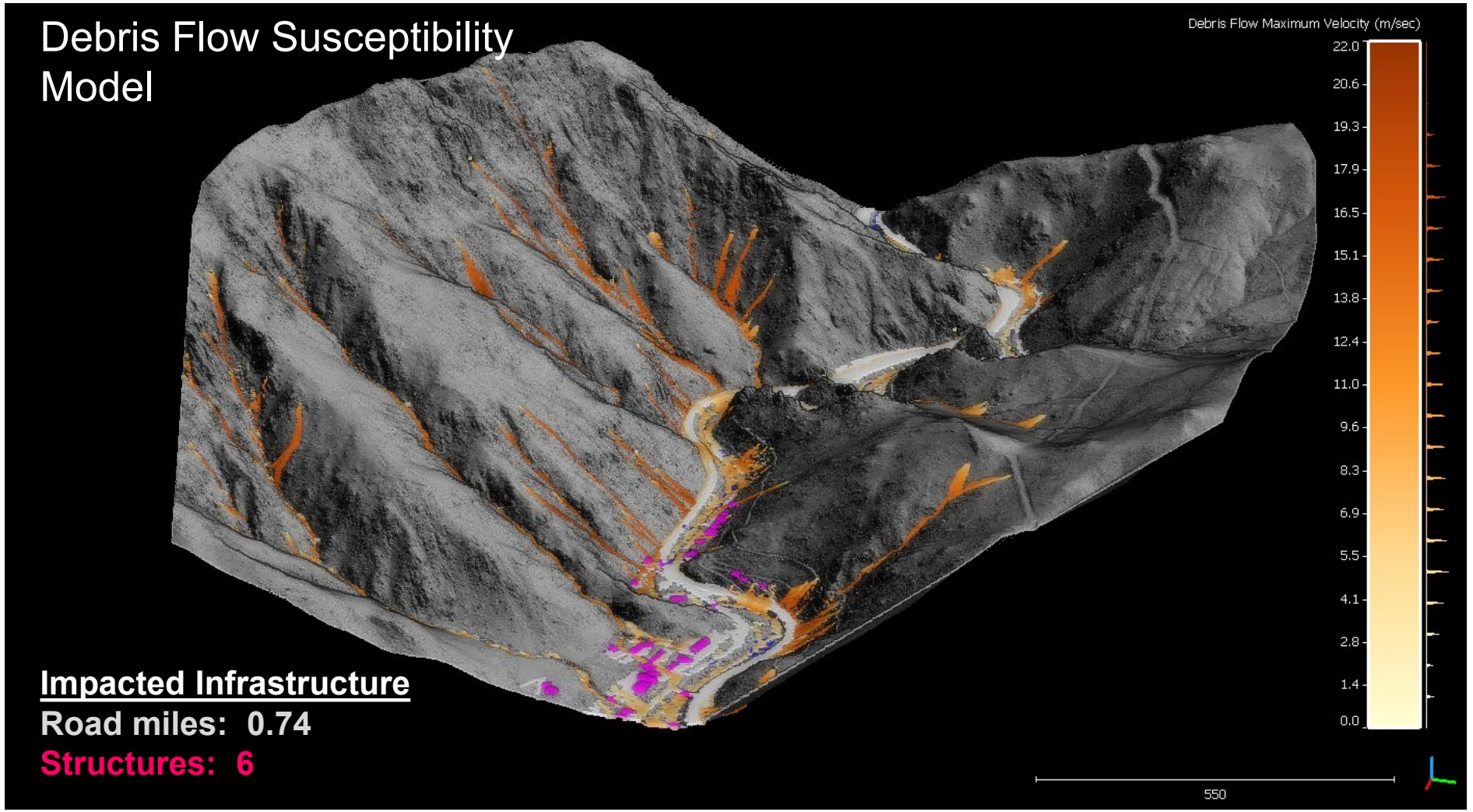




Applications—Change Detection & Monitoring



Applications—Susceptibility & Risk Modeling



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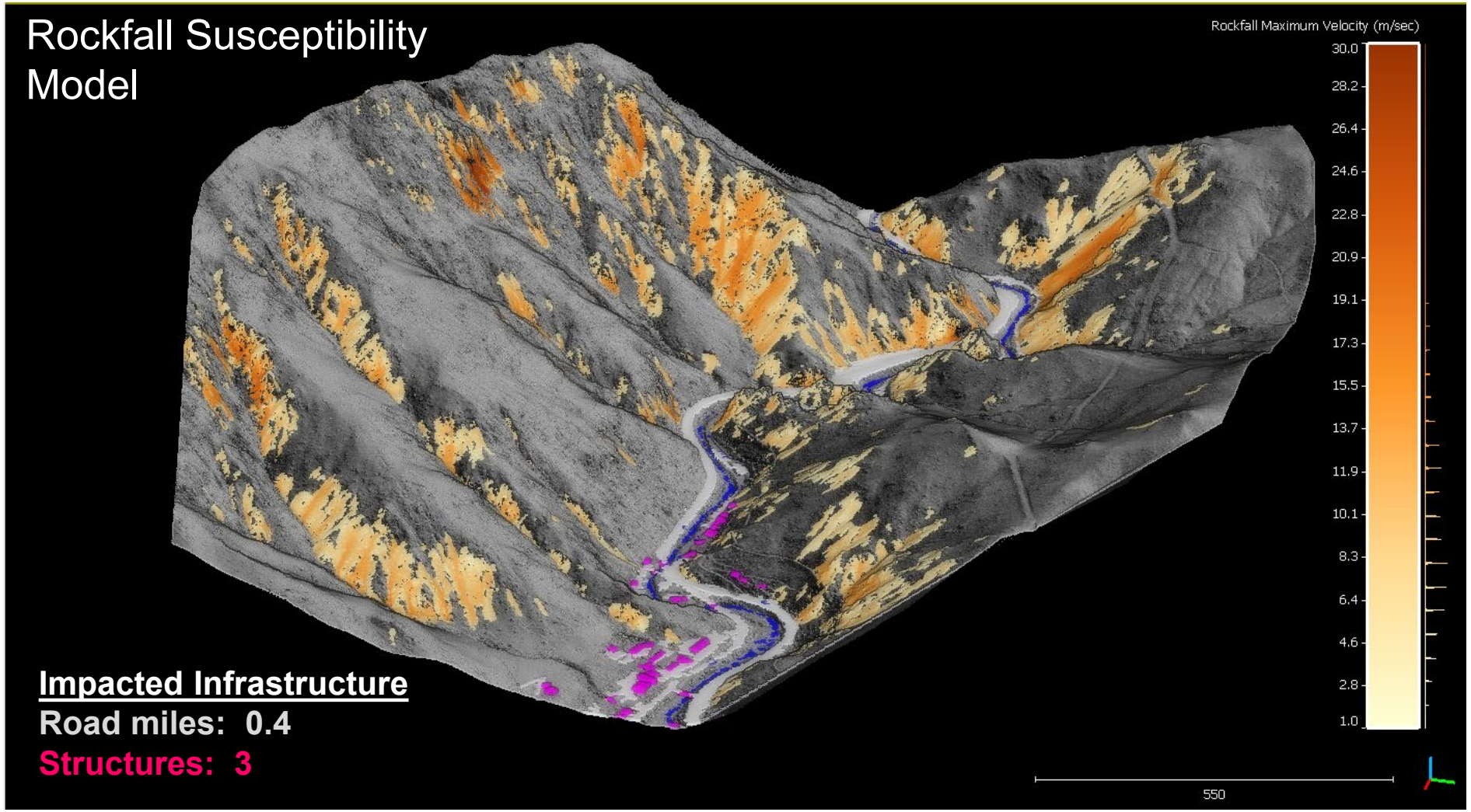

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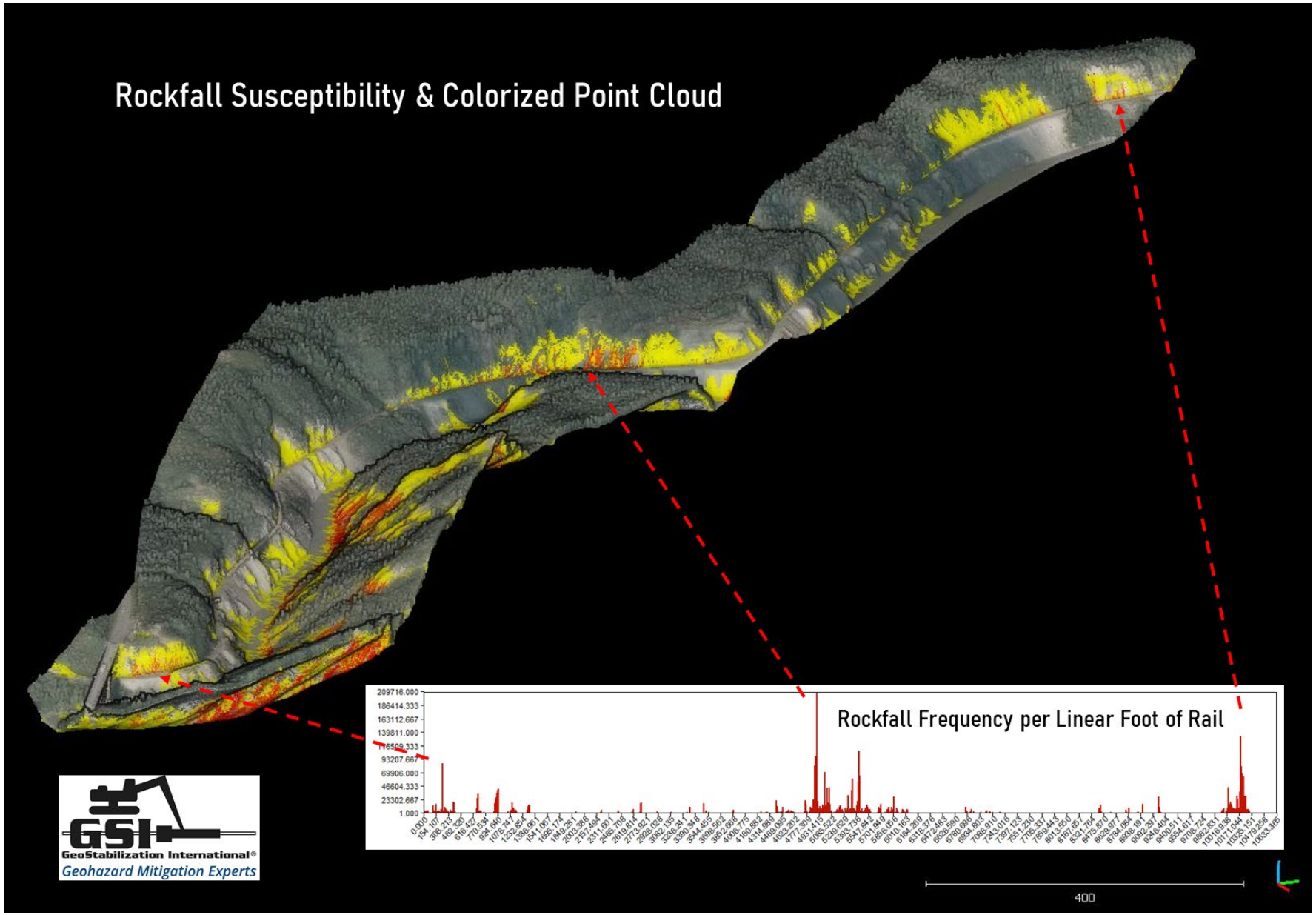

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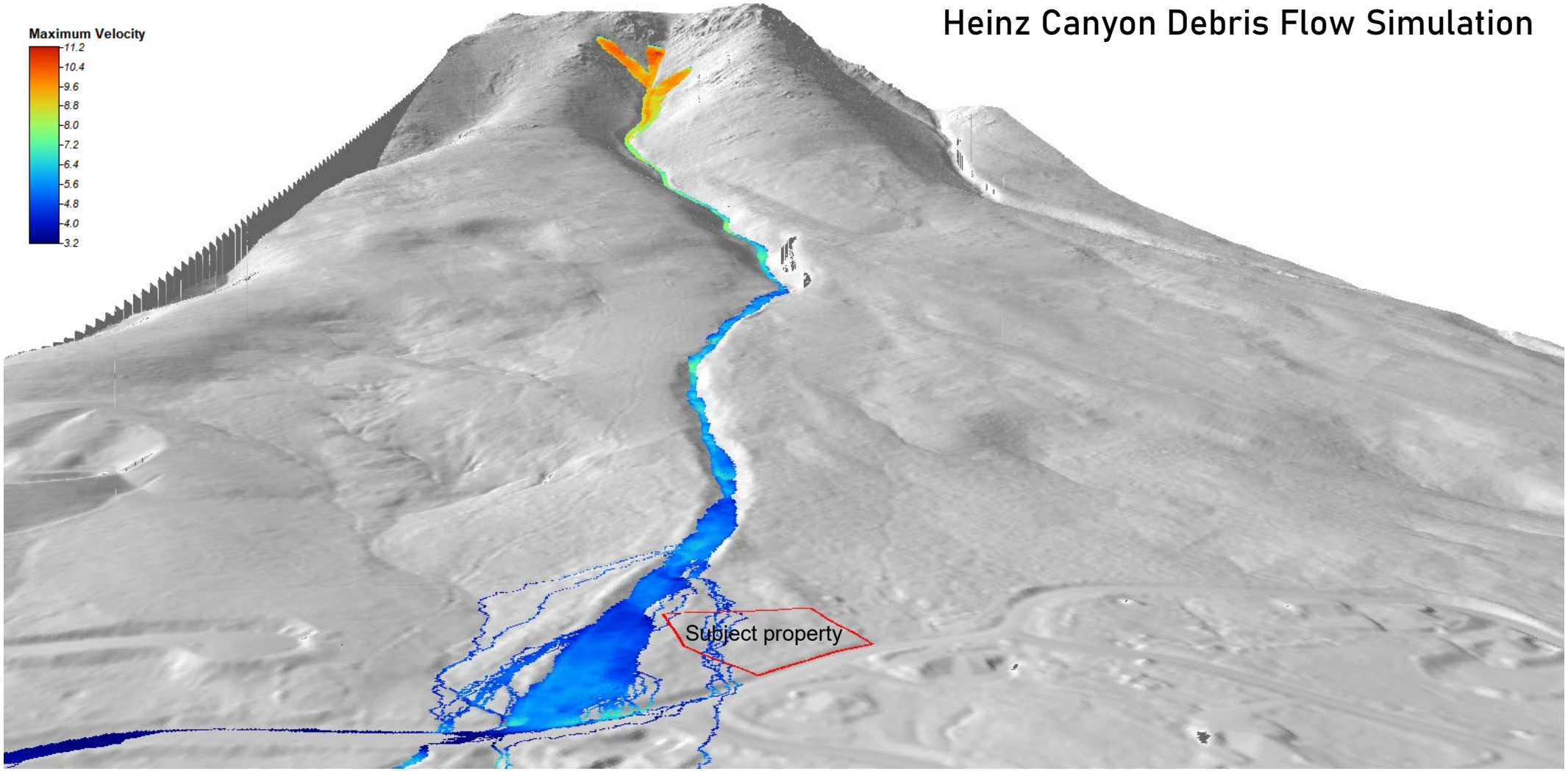


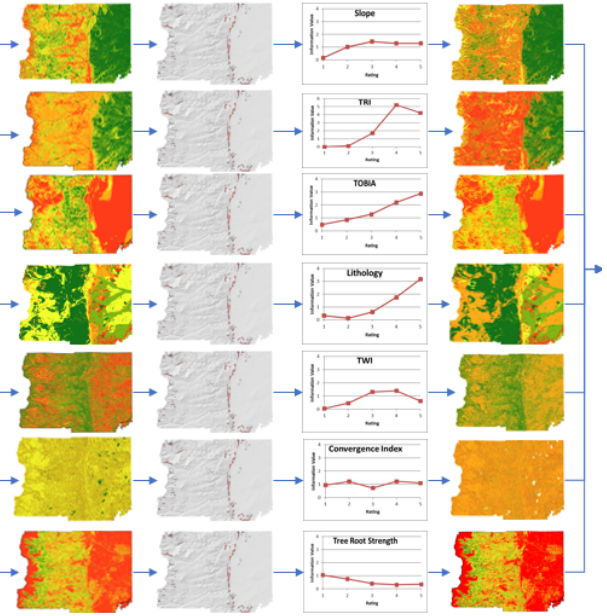
Applications— Susceptibility & Risk Modeling

Modified Information Value Landslide Model

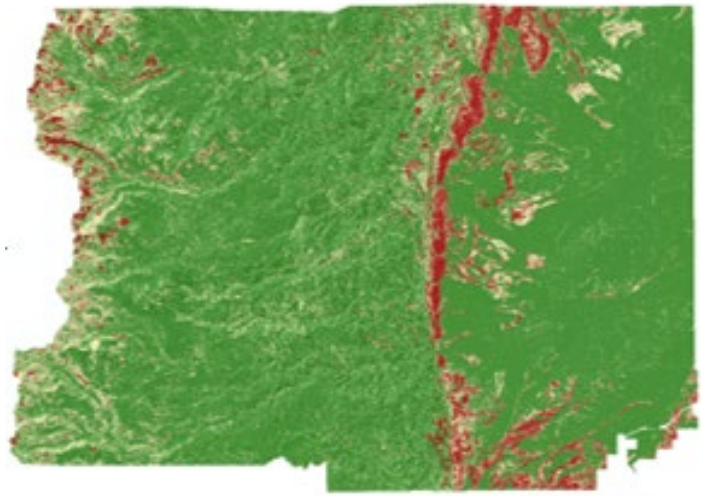
1 = Low
2 = Fair
3 = Moderate
4 = High
5 = Very High

Factor Rating Table → Rated Maps → Landslide Inventory → $I(H, x_i) = log_2\left(\frac{S_i/N_i}{S/N}\right) + 1$

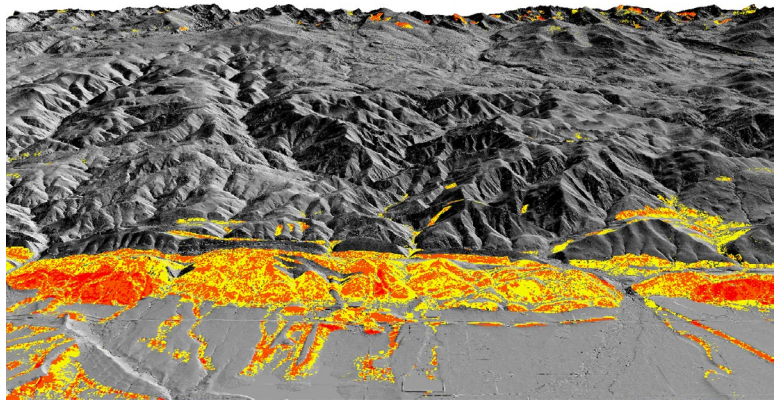
Group	Factor	Subclass	Rating
Topography	Slope	0-5°	1
		5-10°	2
		10-20°	3
		20-30°	4
		>30°	5
	Terrain Ruggedness Index	0-1	1
		1-2	2
		2-4	3
		4-16	4
		>16	5
Geology	Topography Bedding Intersection Angle	Anaclinal	1
		Orthoclinal	2
		Underdip	3
		Dip	4
		Overdip	5
	Lithology Instability	Very Low	1
		Low	2
		Moderate	3
		High	4
		Very High	5
Hydrology	Topographic Wetness Index (surface flow)	0.004-0.176	1
		0.176-0.363	2
		0.363-0.590	3
		0.590-0.851	4
		0.851-1.00	5
	Convergence Index (groundwater flow)	-100 - -25.5	1
		-25.5 - -8.2	2
		-8.2 - 5.1	3
		5.1 - 21.6	4
		21.6 - 100	5
Land Cover	Tree Root Strength Index	0-30	1
		30-194	2
		194-358	3
		358-522	4
		>522	5



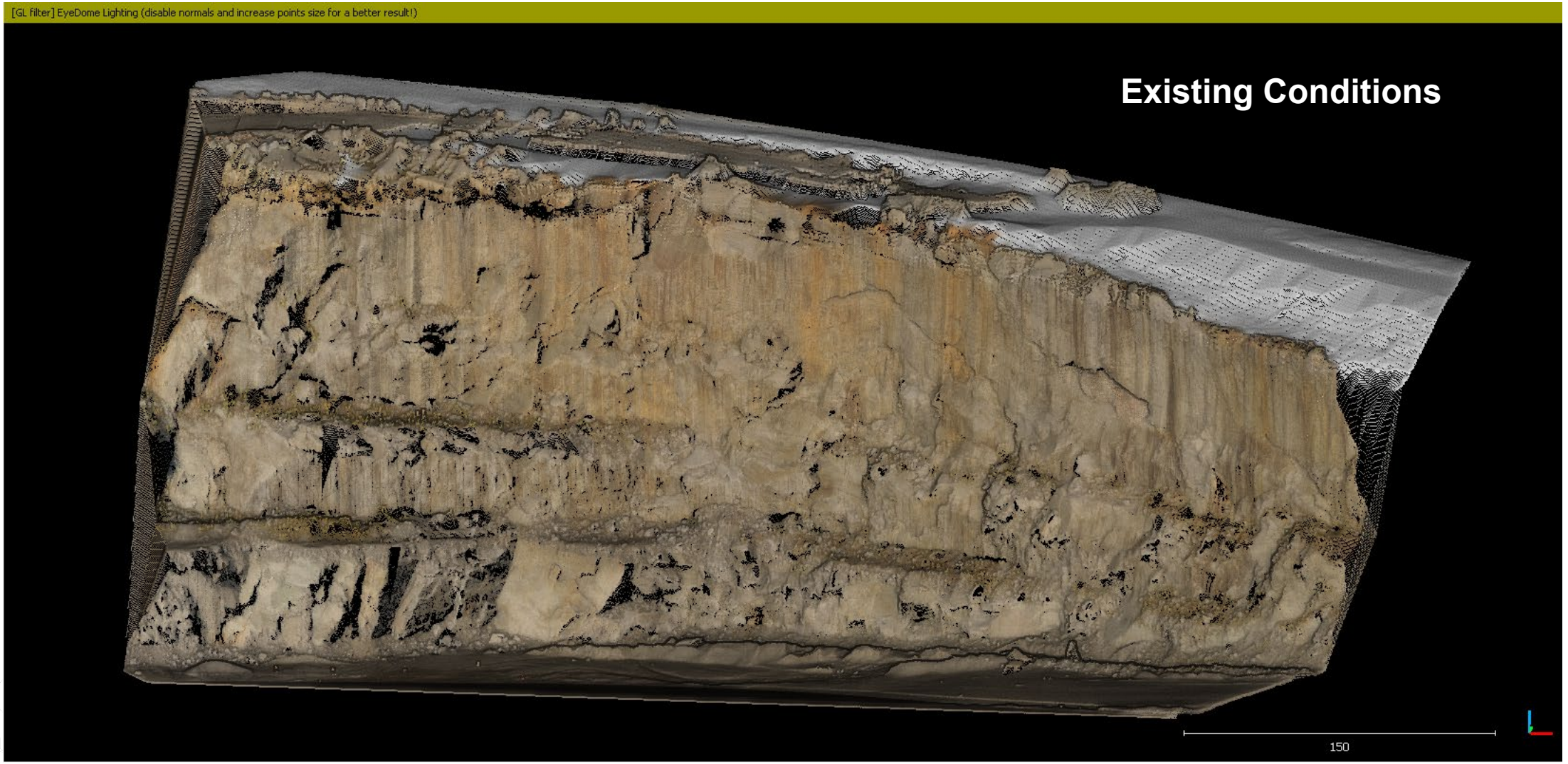
Normalized Landslide Susceptibility Map



Low (0 - 50%)
Moderate (50 - 70%)
High (70 - 100%)



Applications—Mine Highwall



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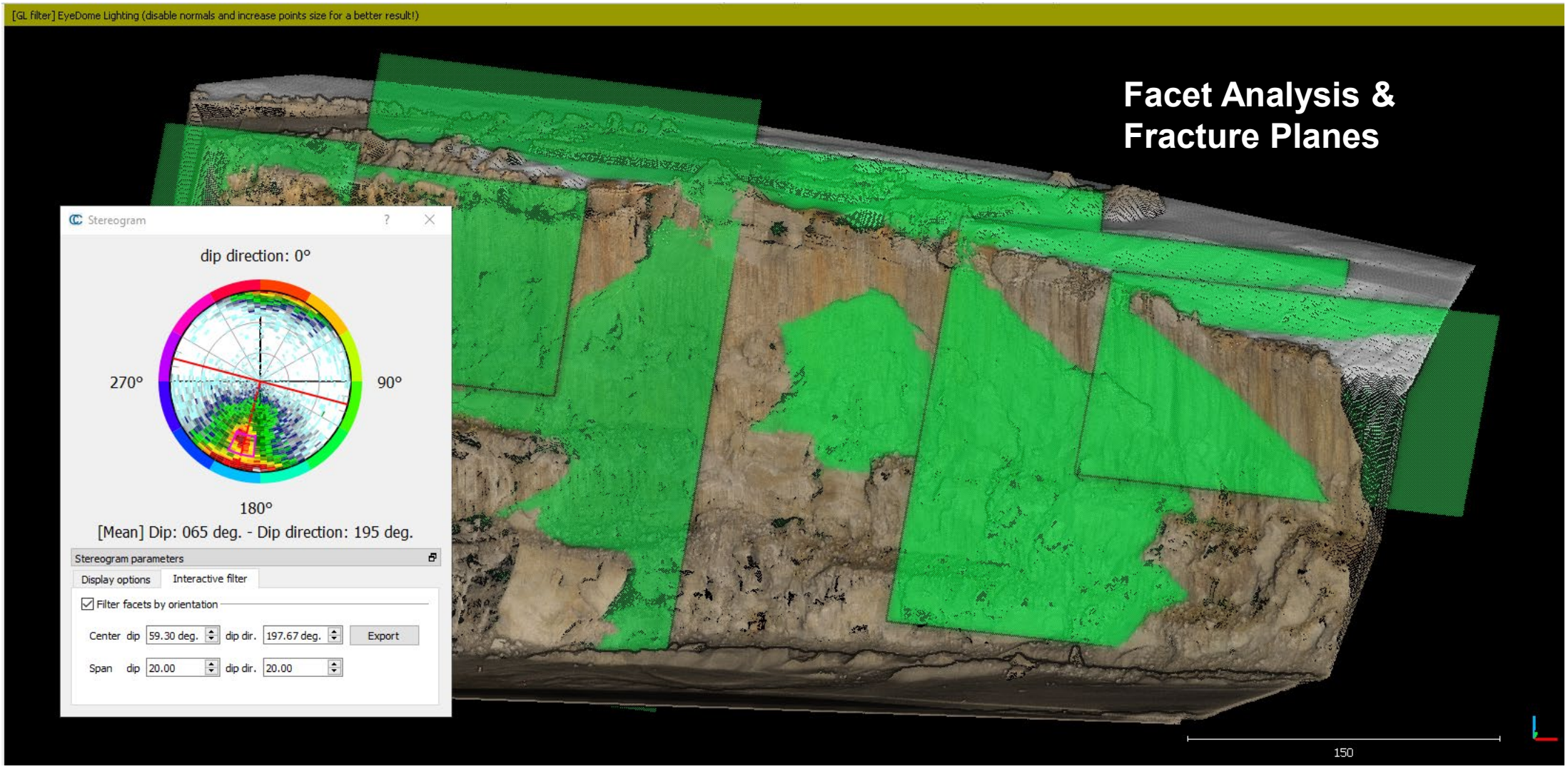

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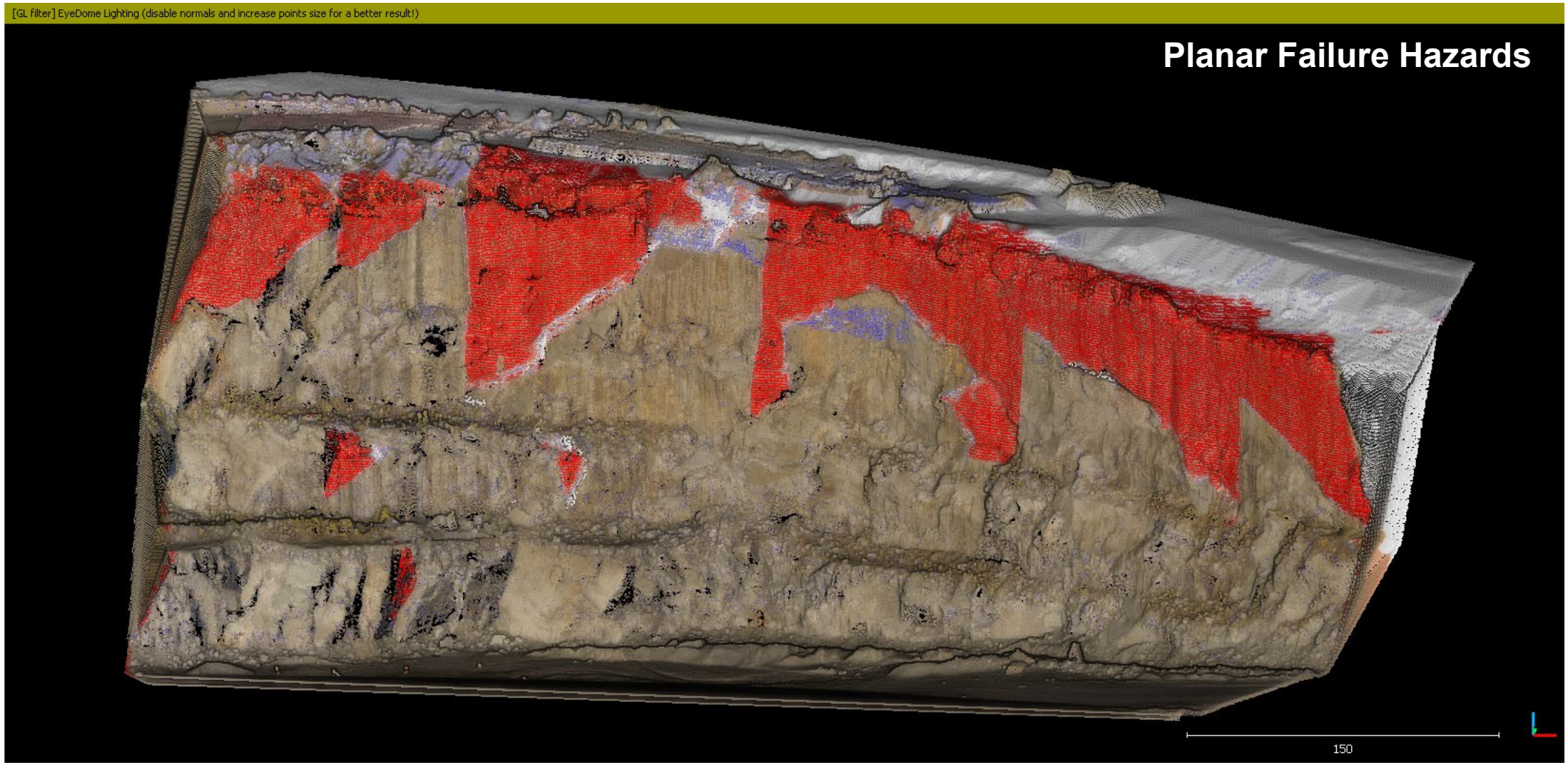

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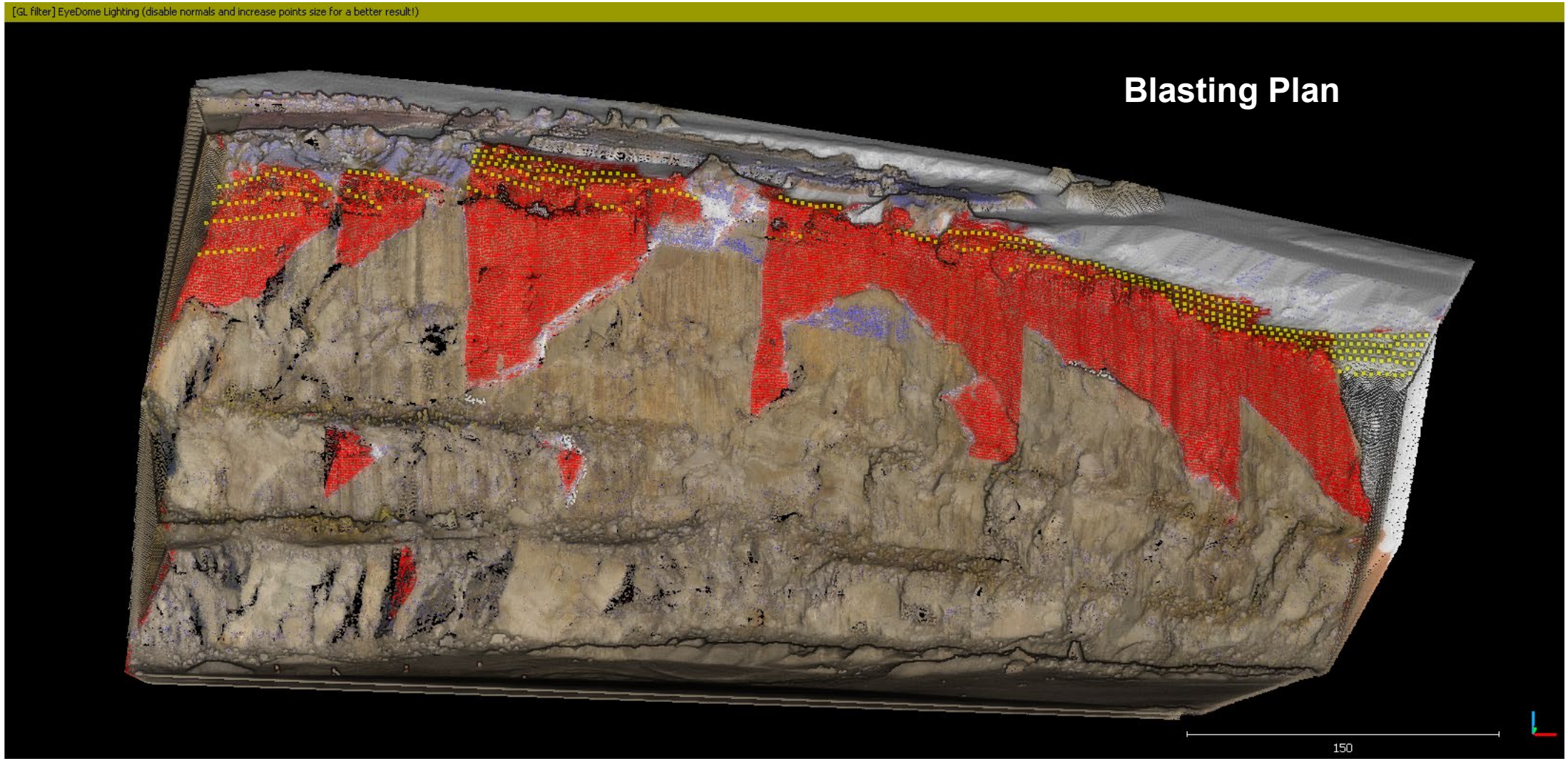

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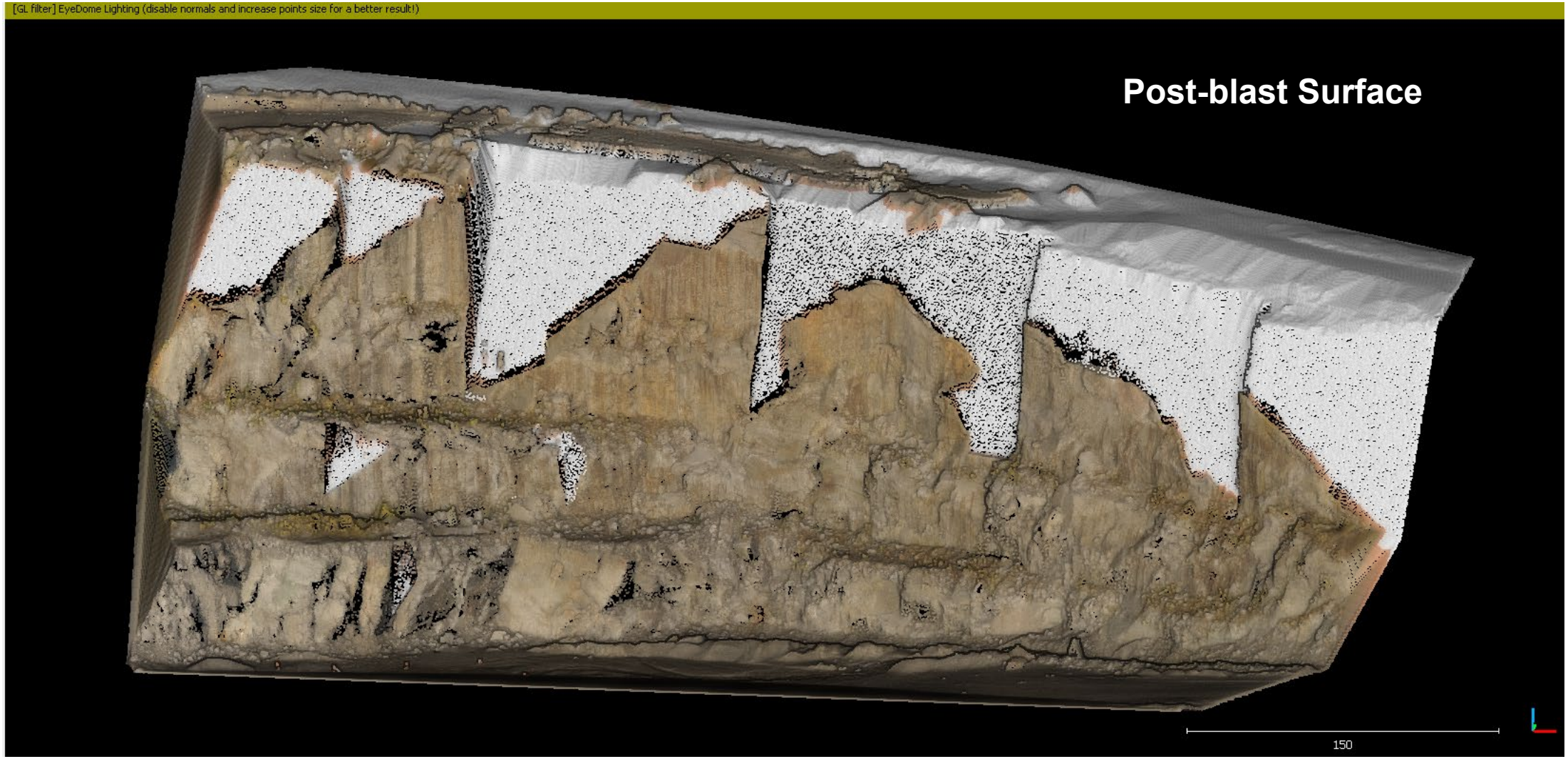
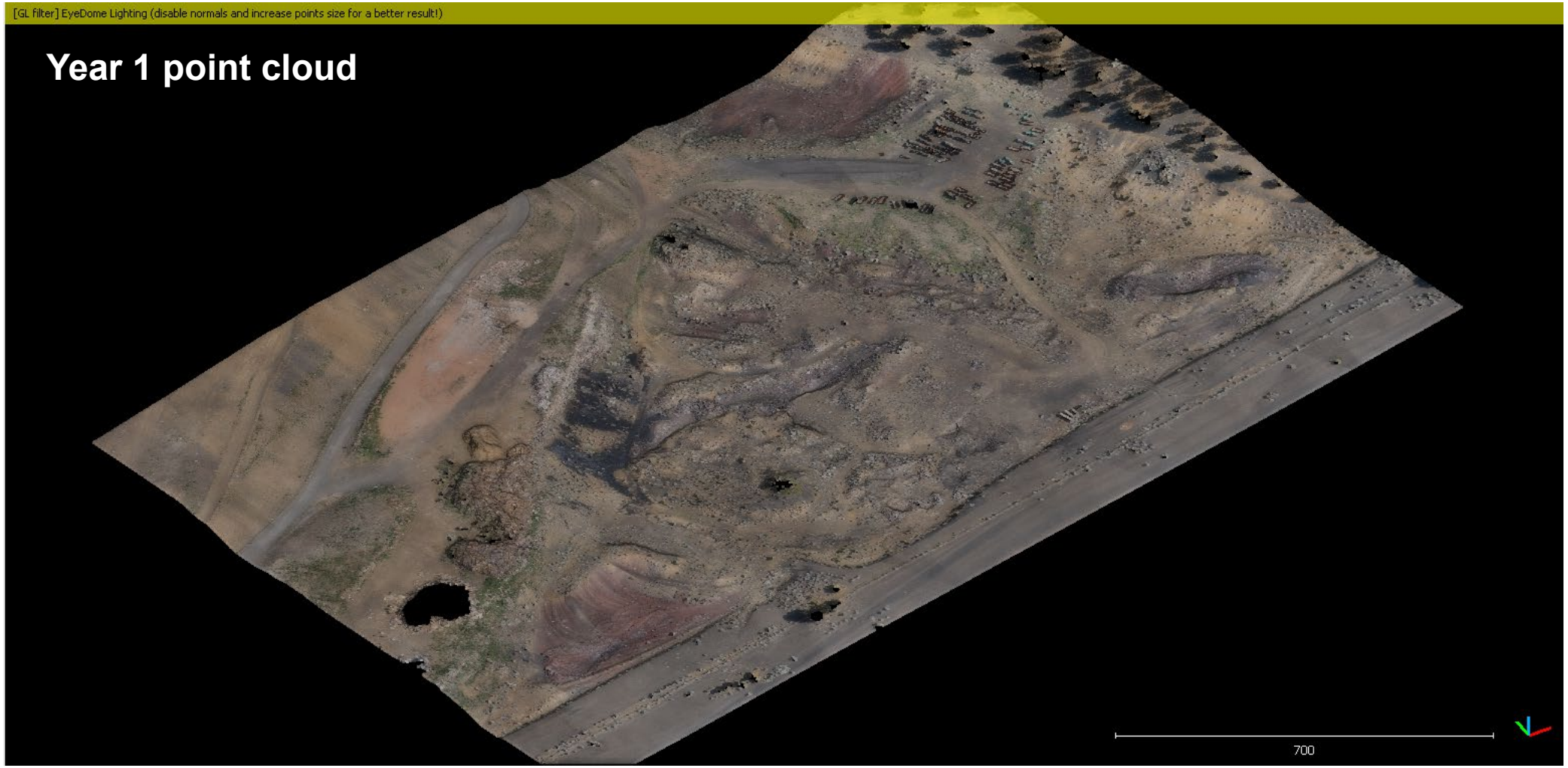
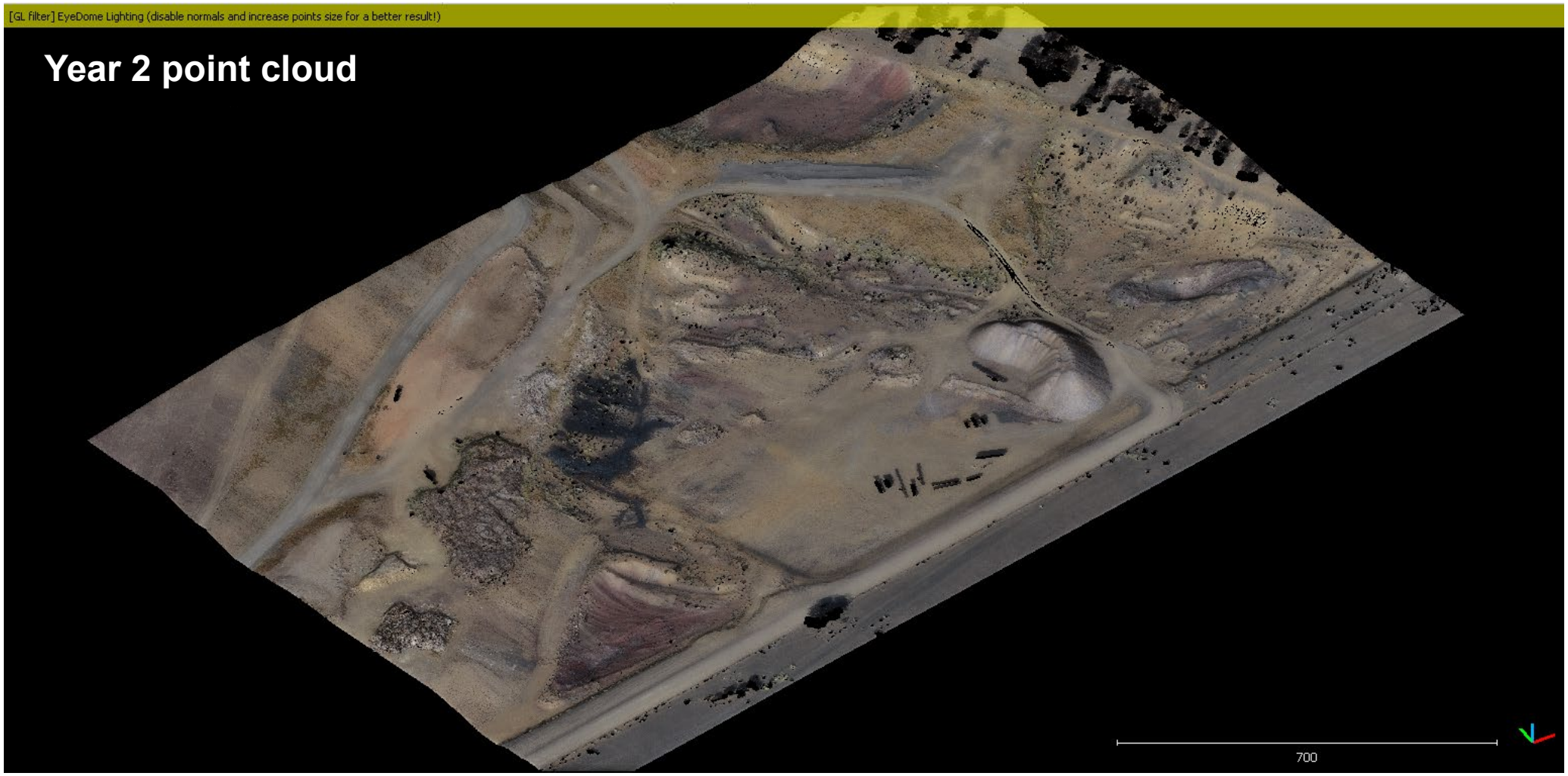


Applications—Asset Management



Applications—Asset Management



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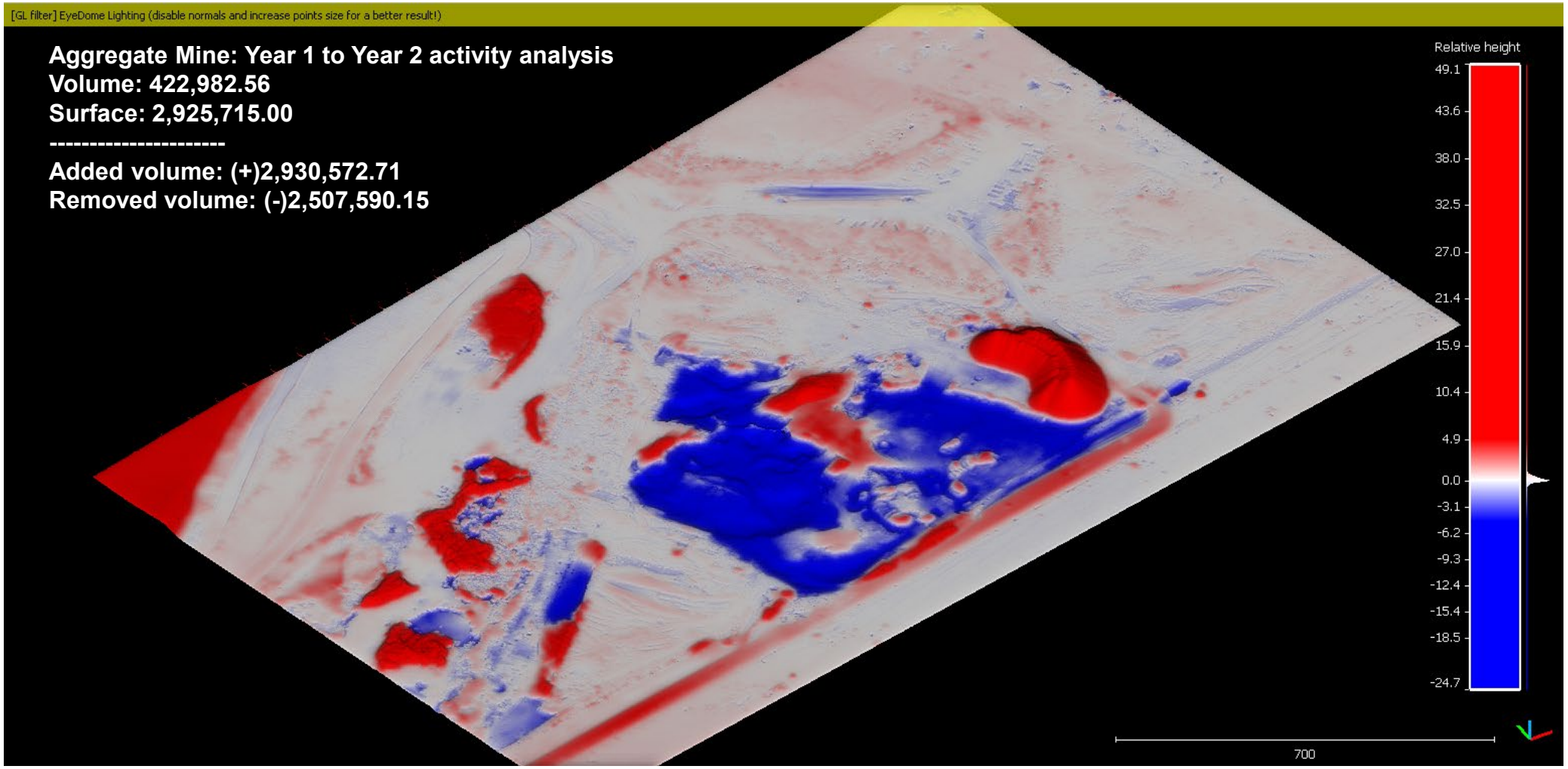
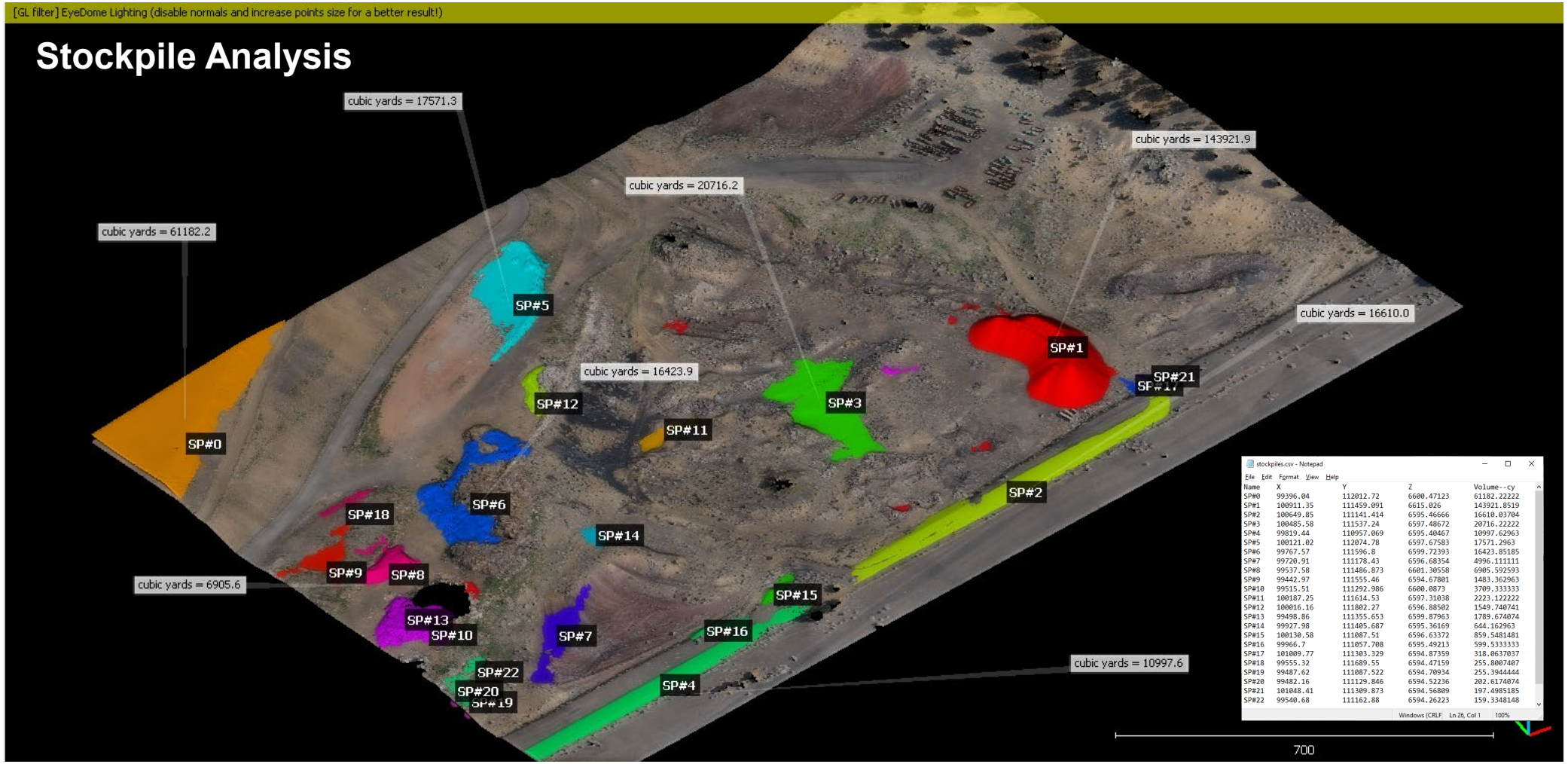
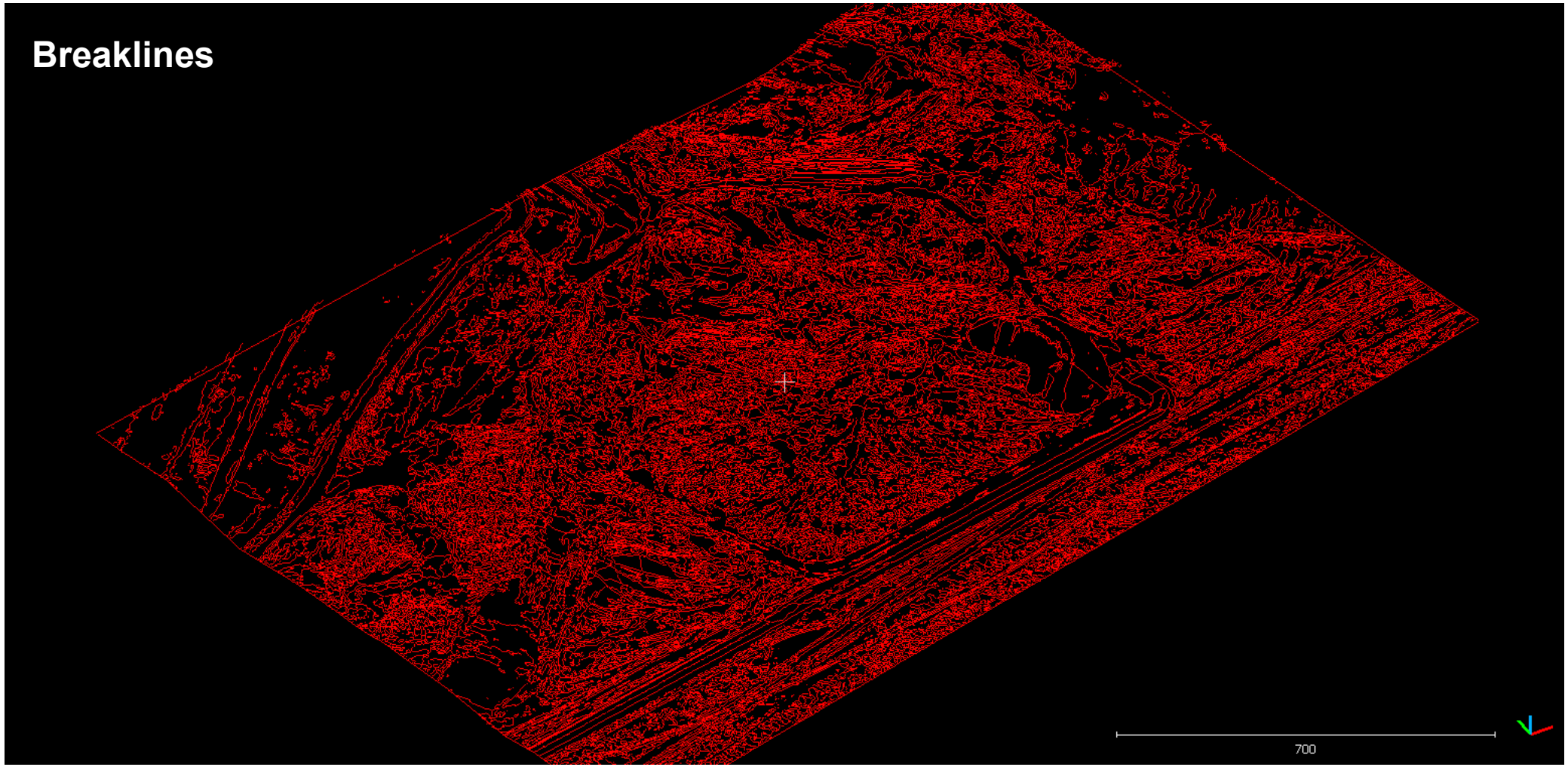


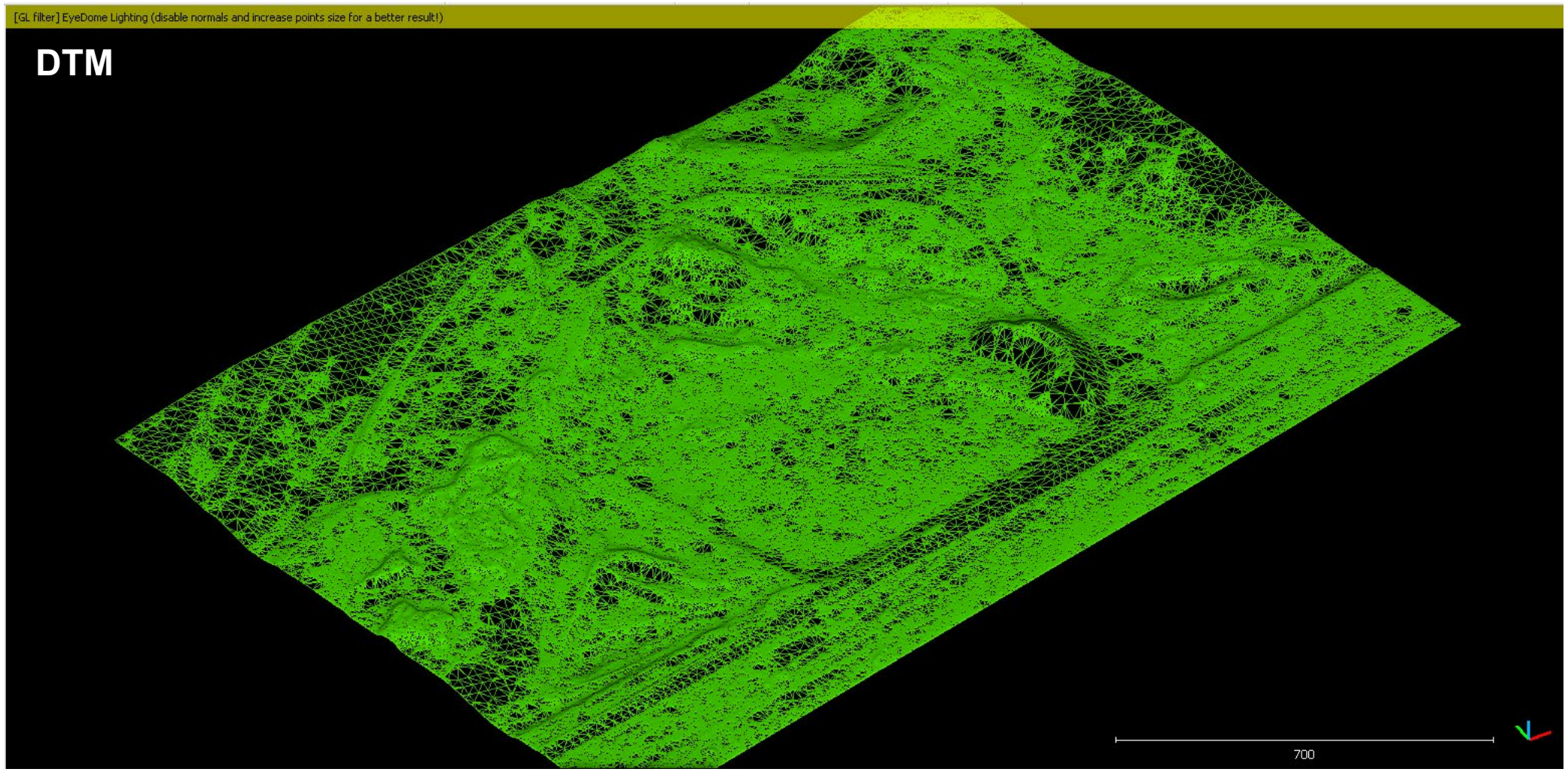
Applications—Asset Management



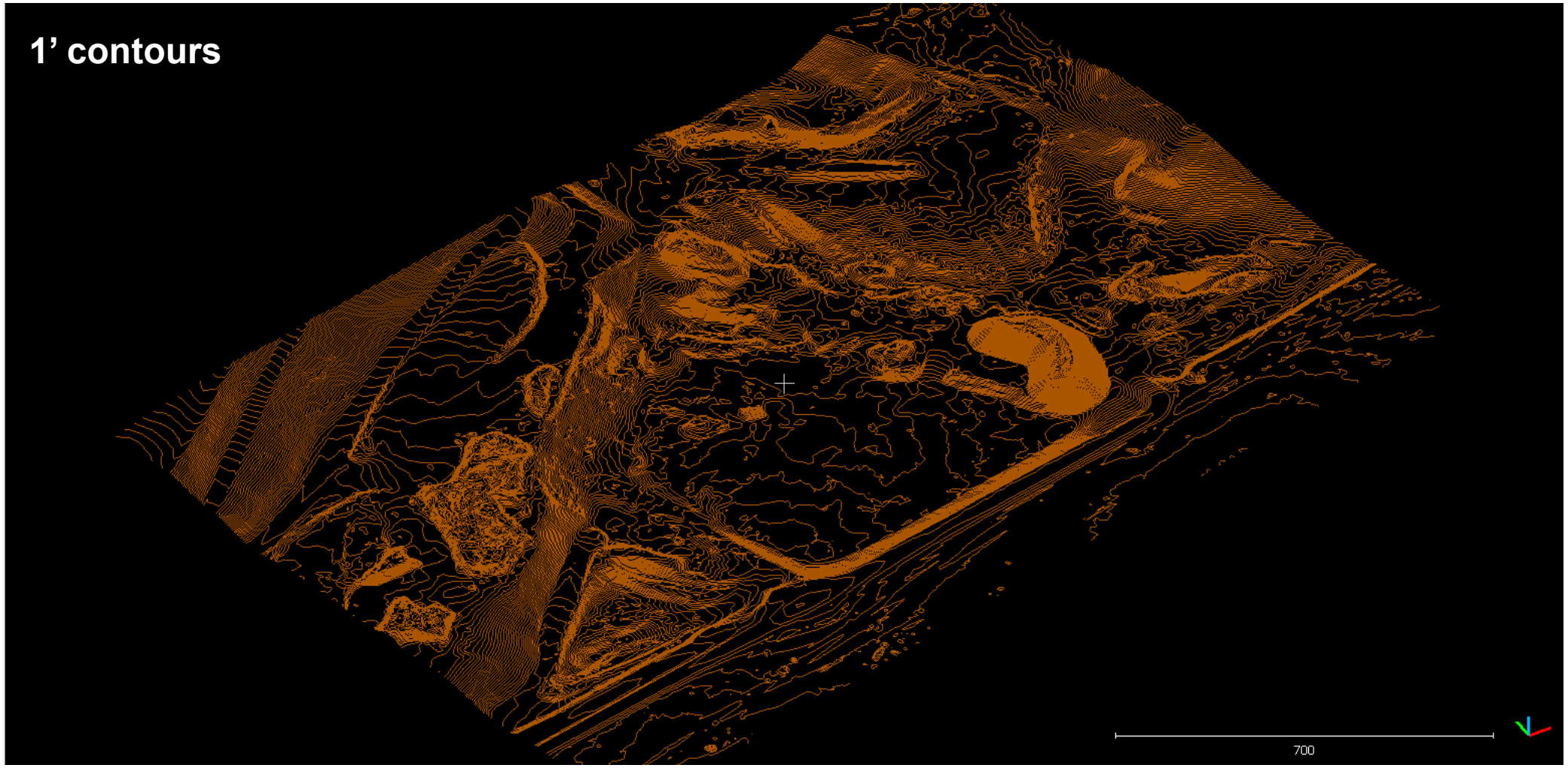
Applications—Asset Management



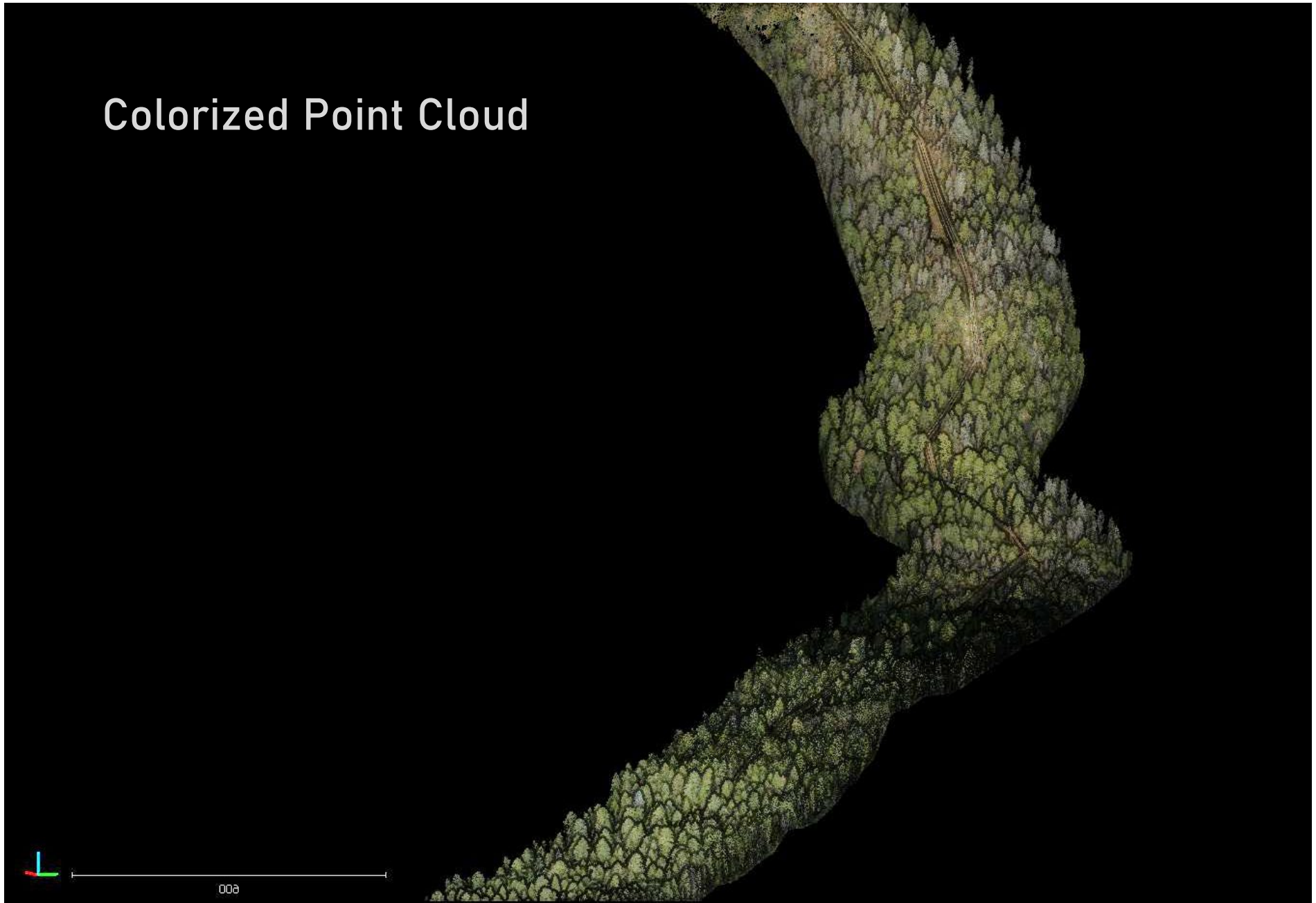
Applications—Asset Management



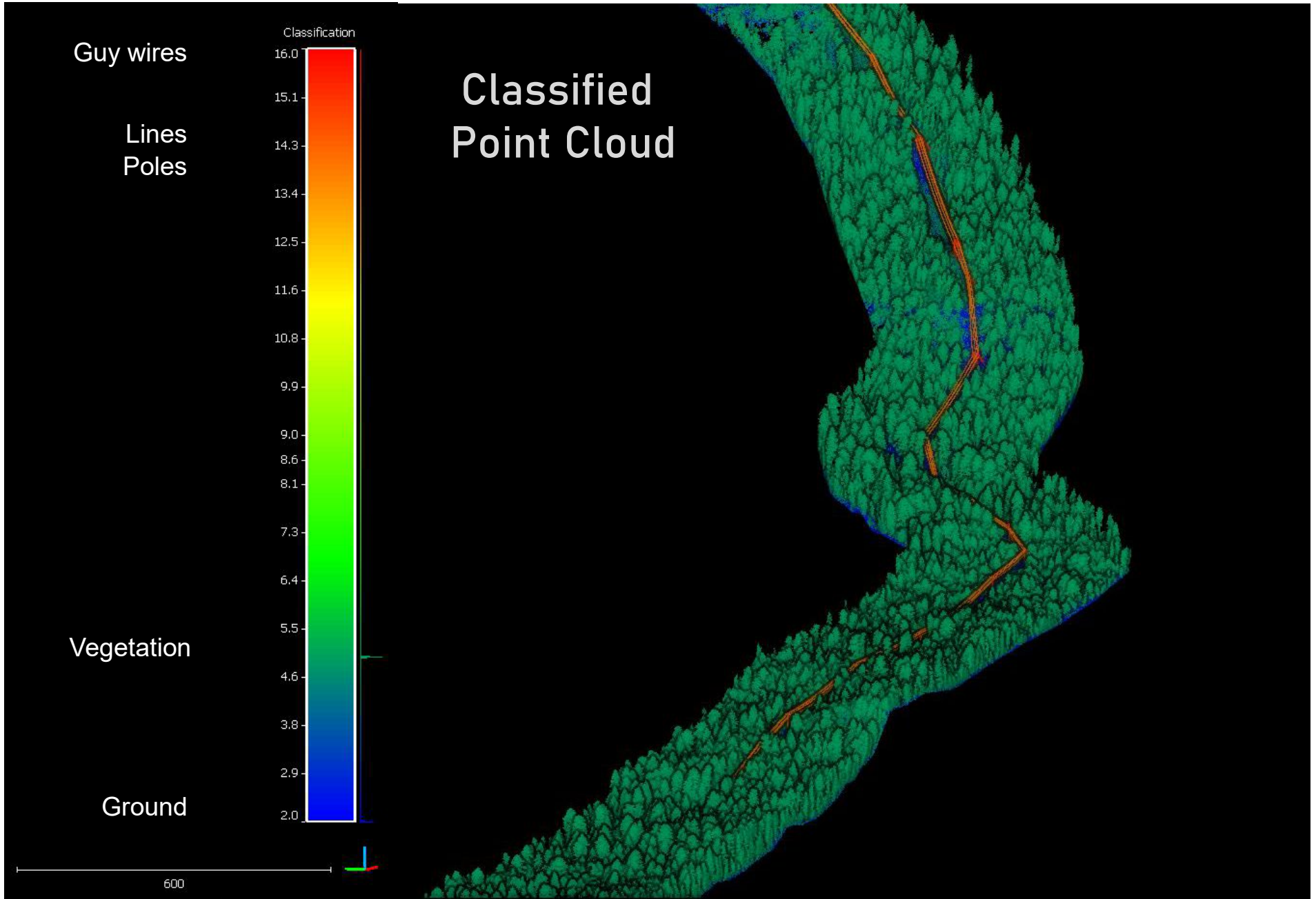
Applications—Asset Management



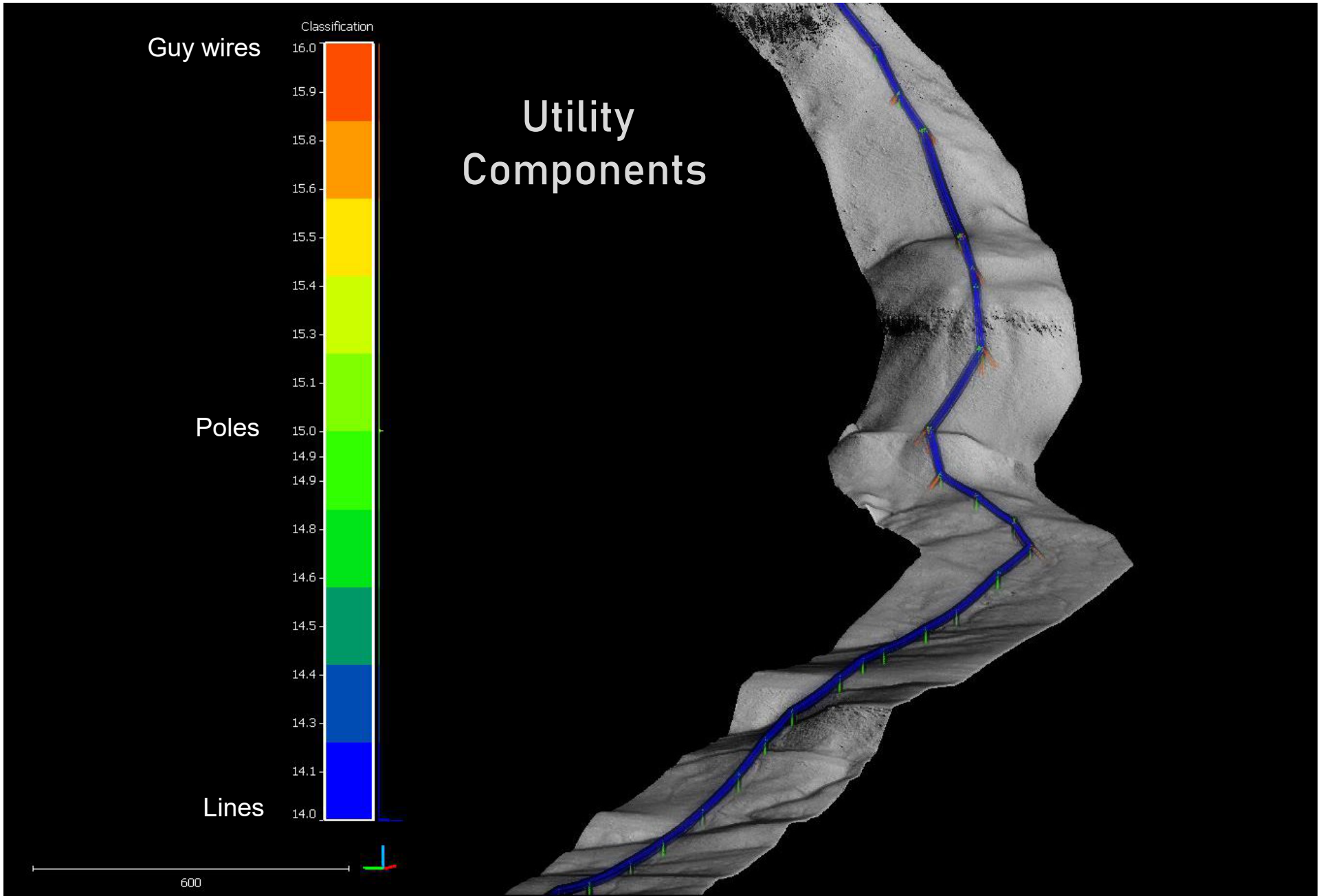
Applications—Asset Management



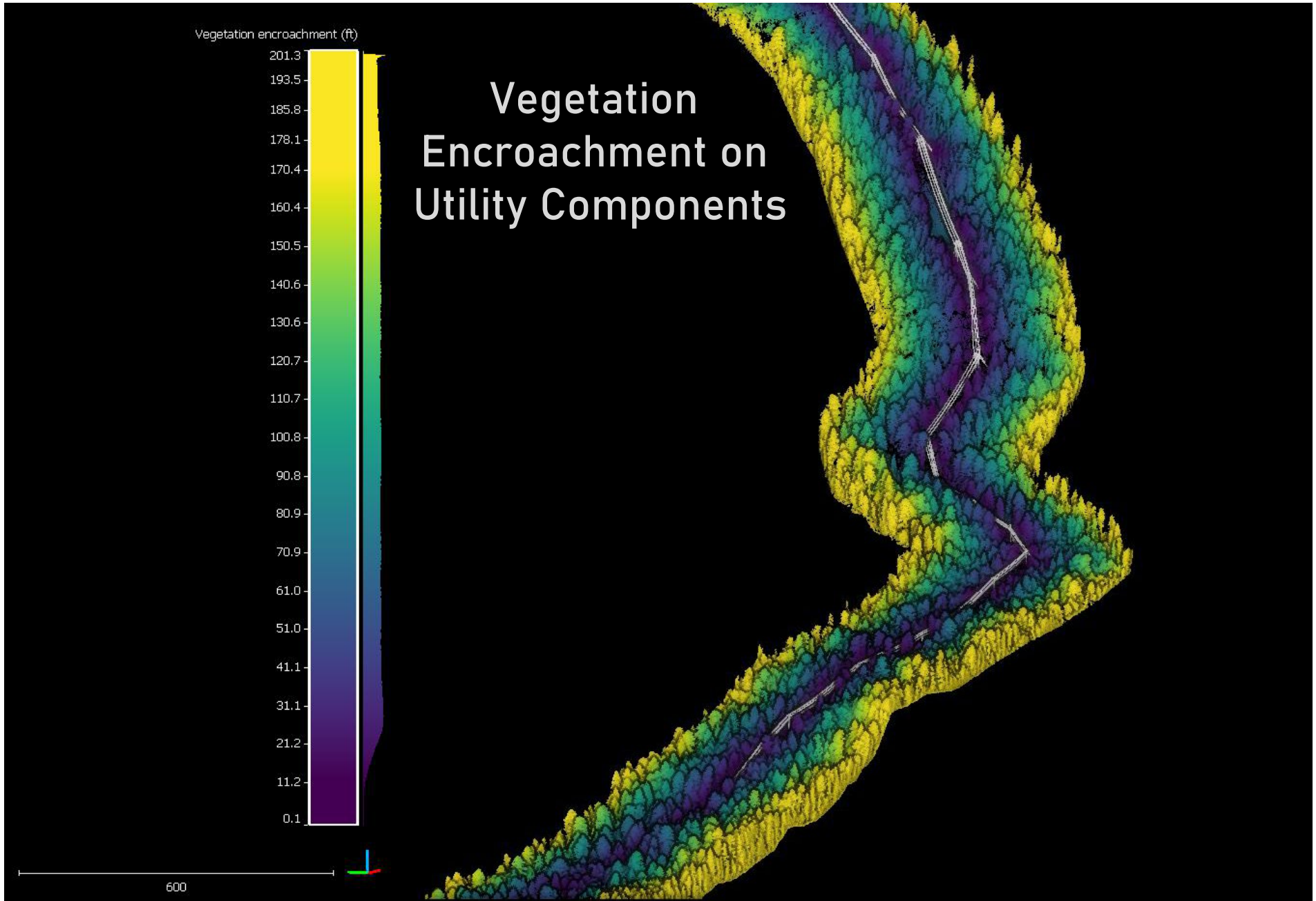
Applications—Asset Management



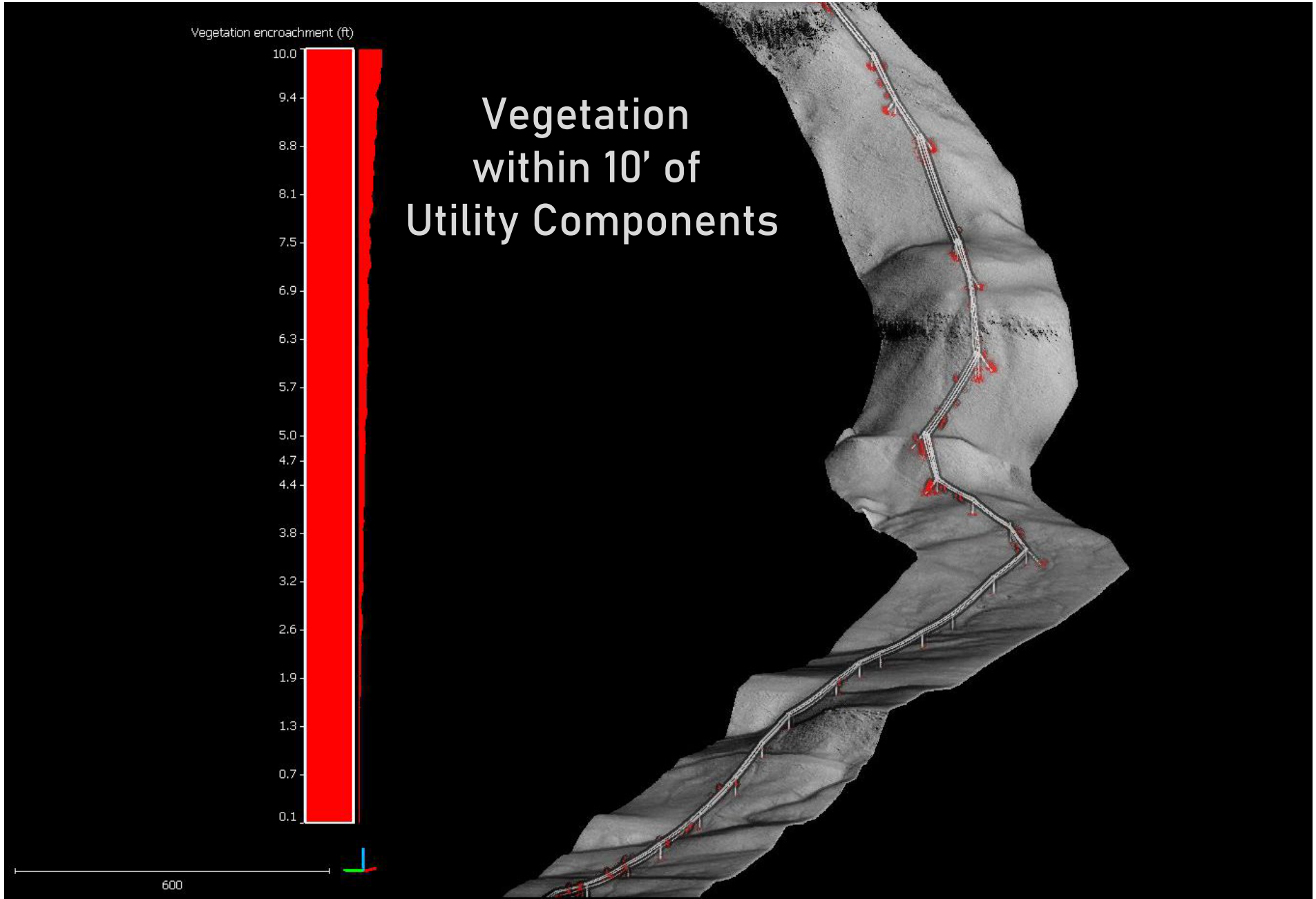
Applications—Asset Management

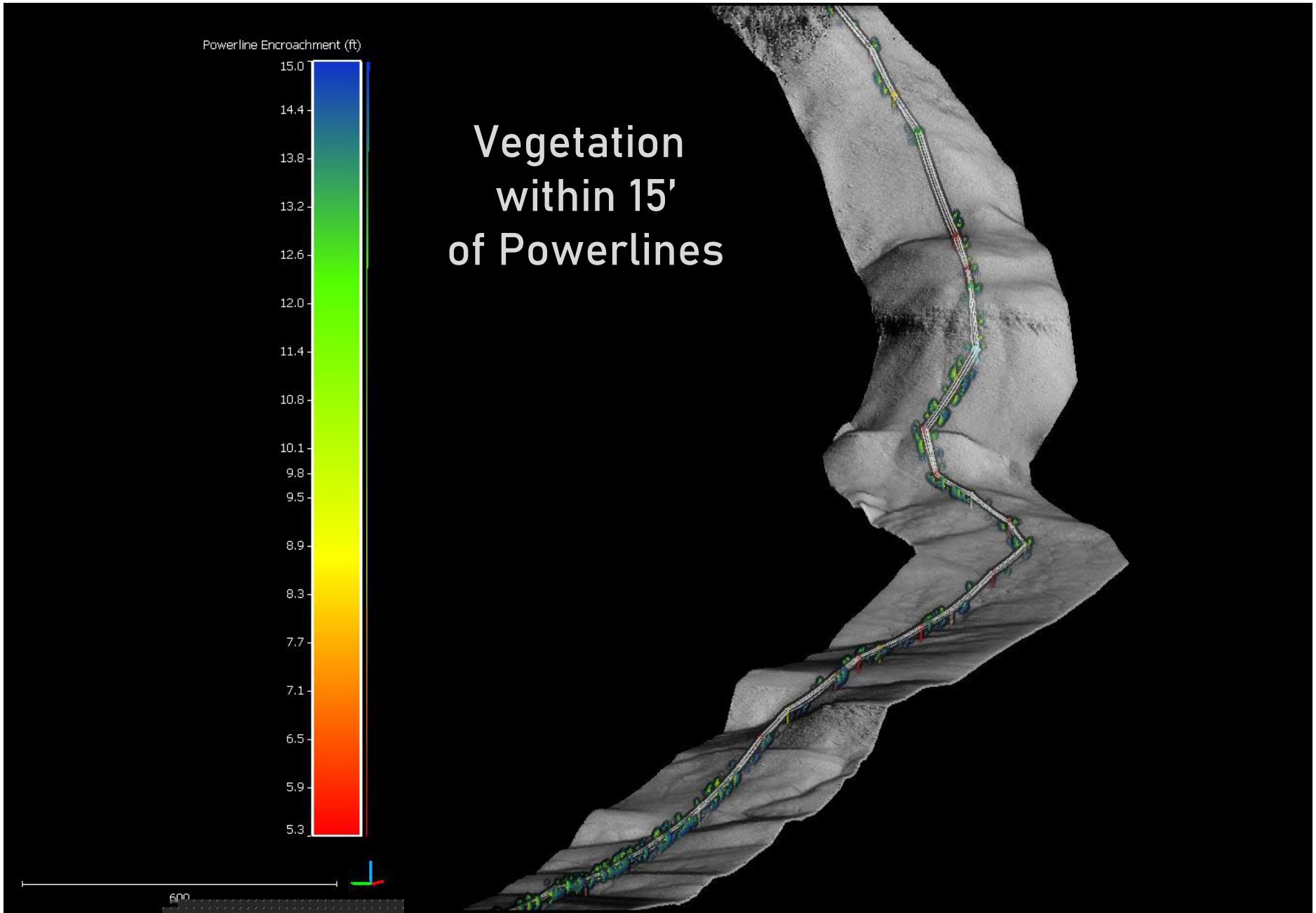


Applications—Asset Management

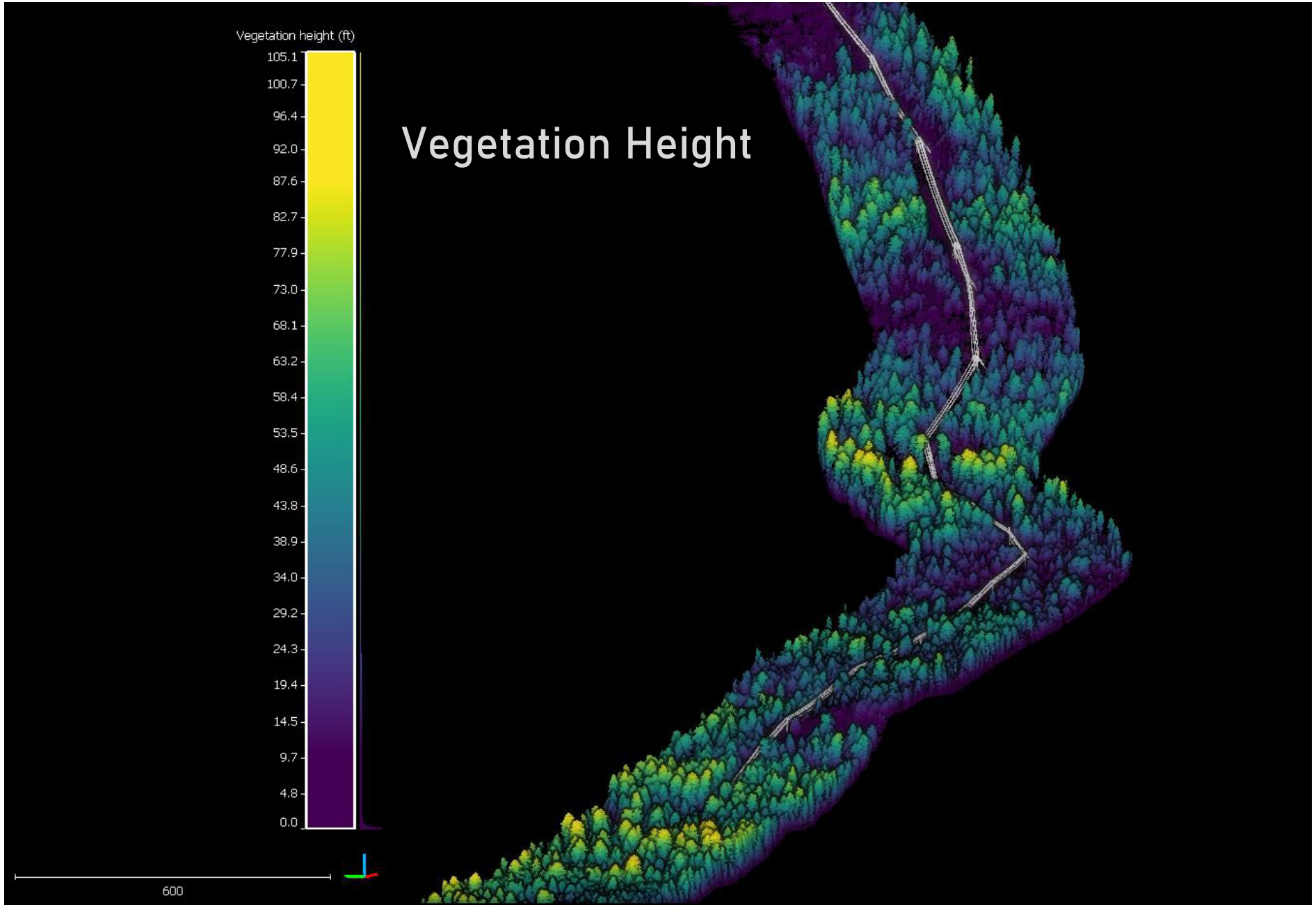


Applications—Asset Management

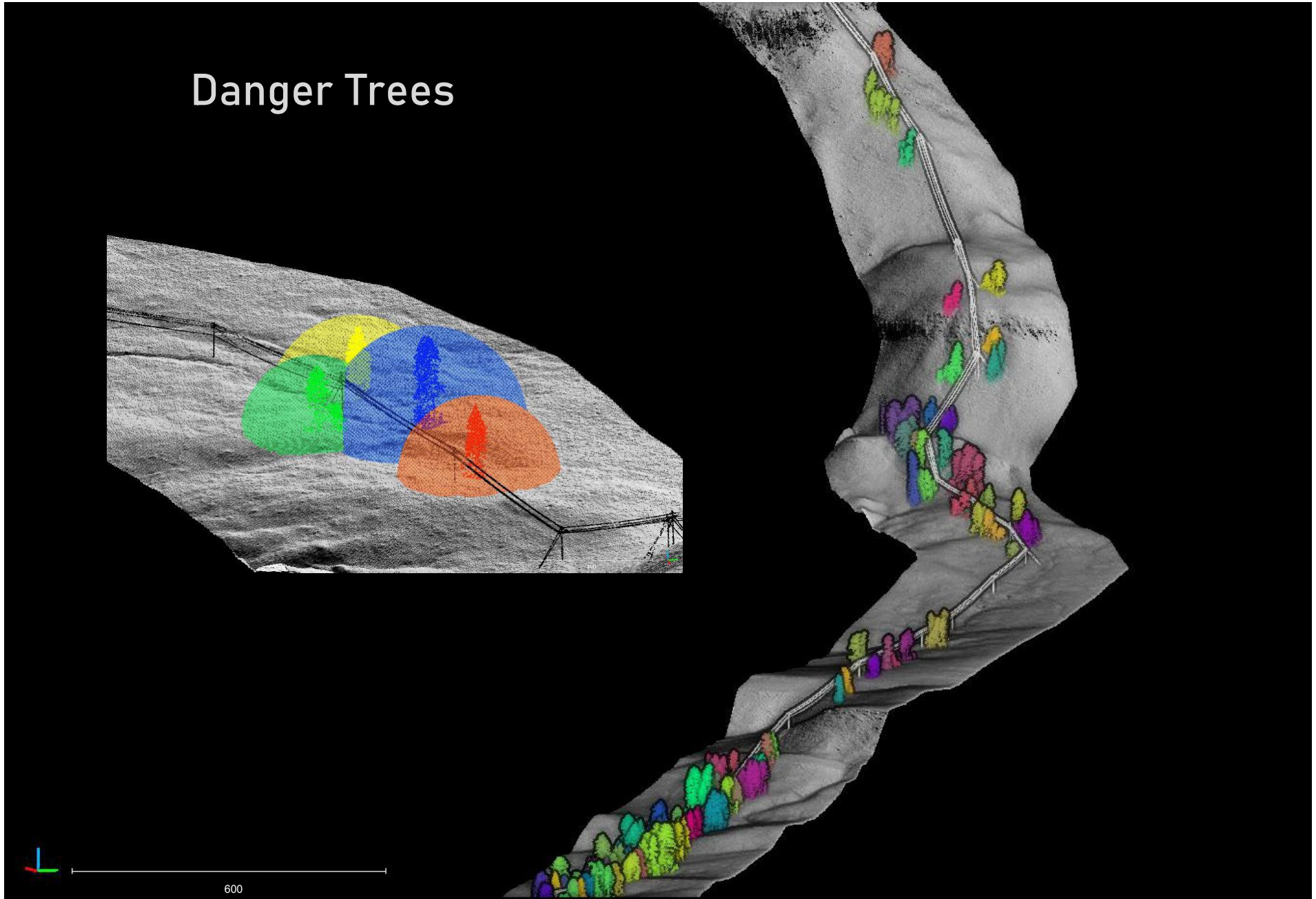



Powerline Encroachment (ft)
15.0
14.4
13.8
13.2
12.6
12.0
11.4
10.8
10.1
9.8
9.5
8.9
8.3
7.7
7.1
6.5
5.9
5.3
600
Vegetation
within 15’
of Powerlines

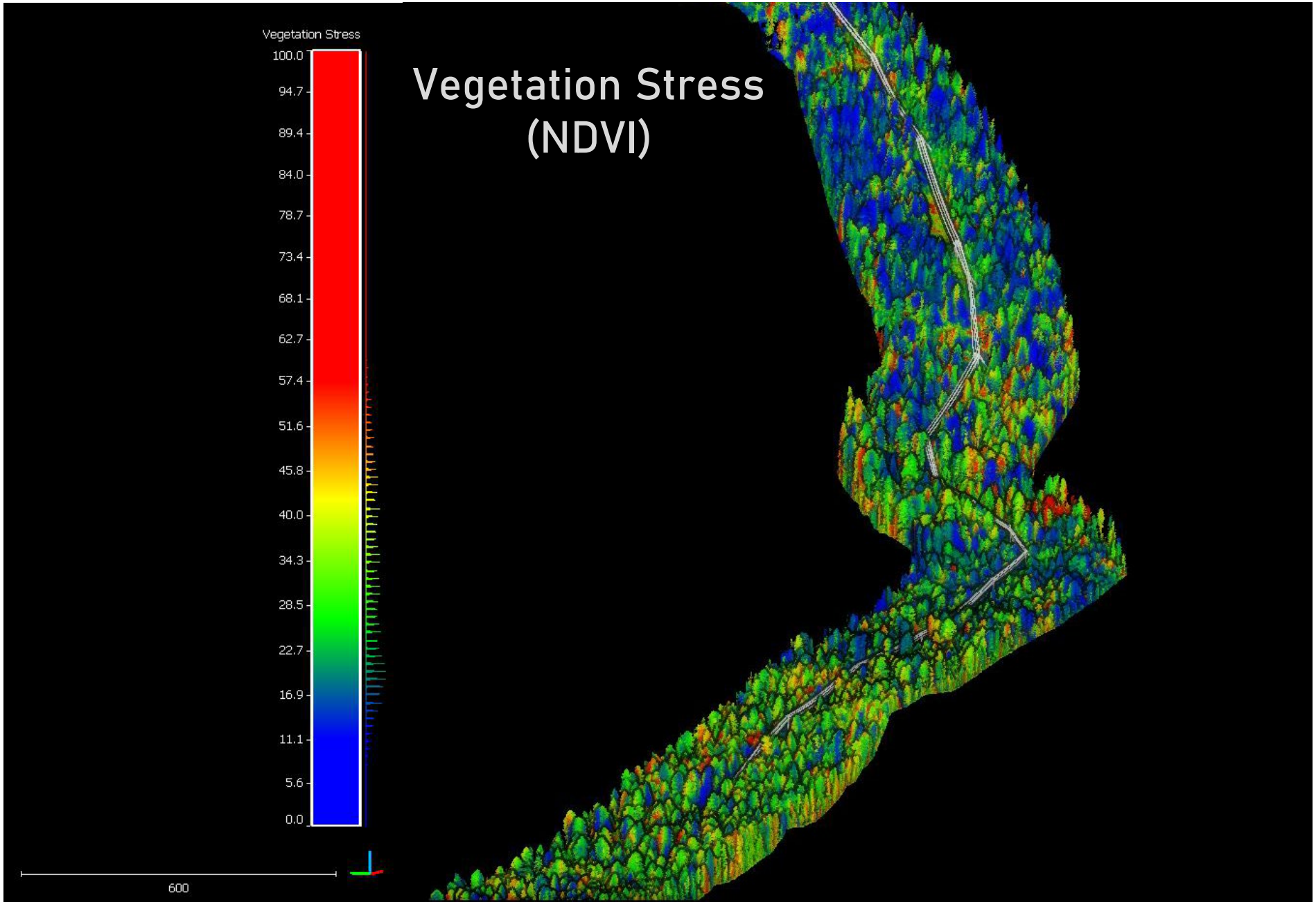
Applications—Asset Management



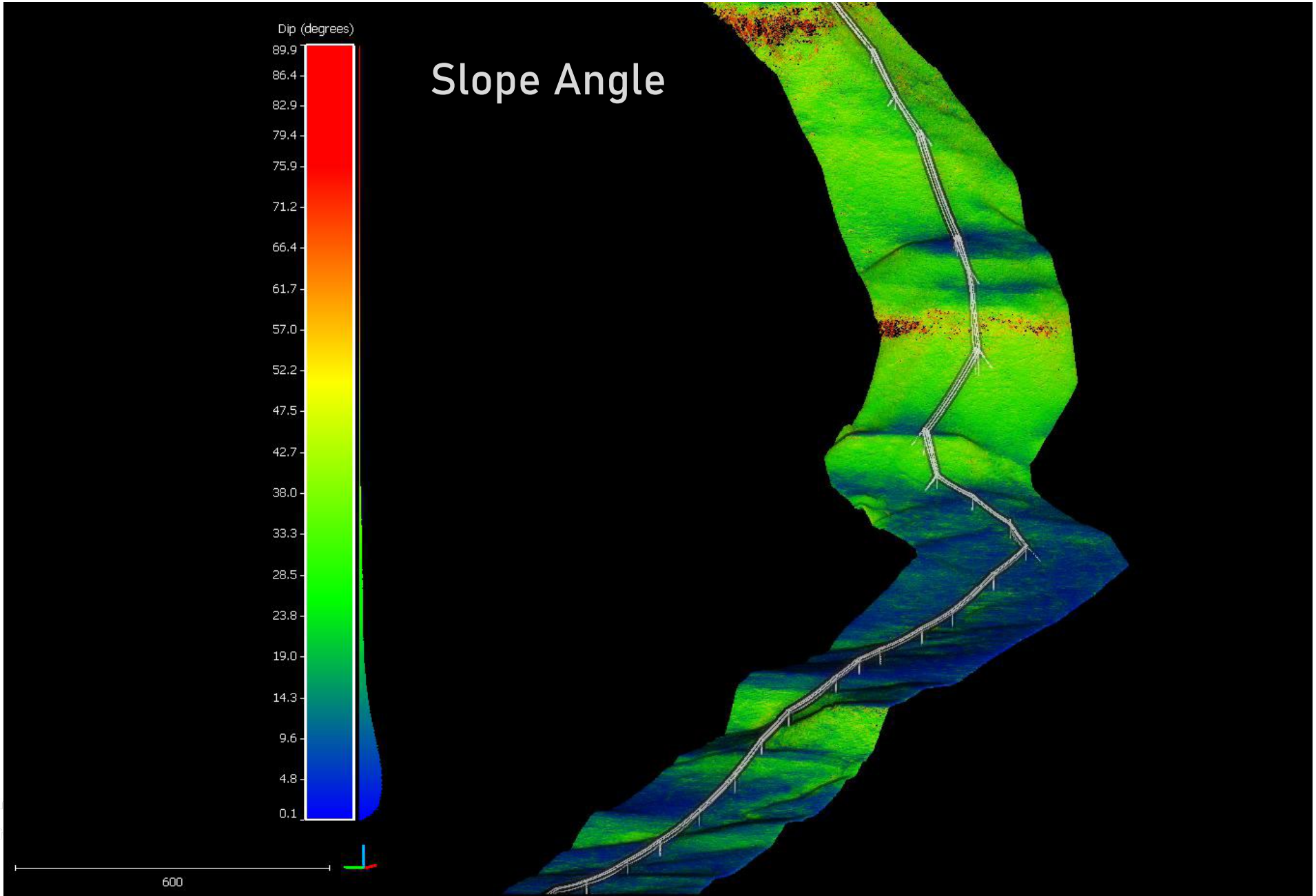
Applications—Asset Management



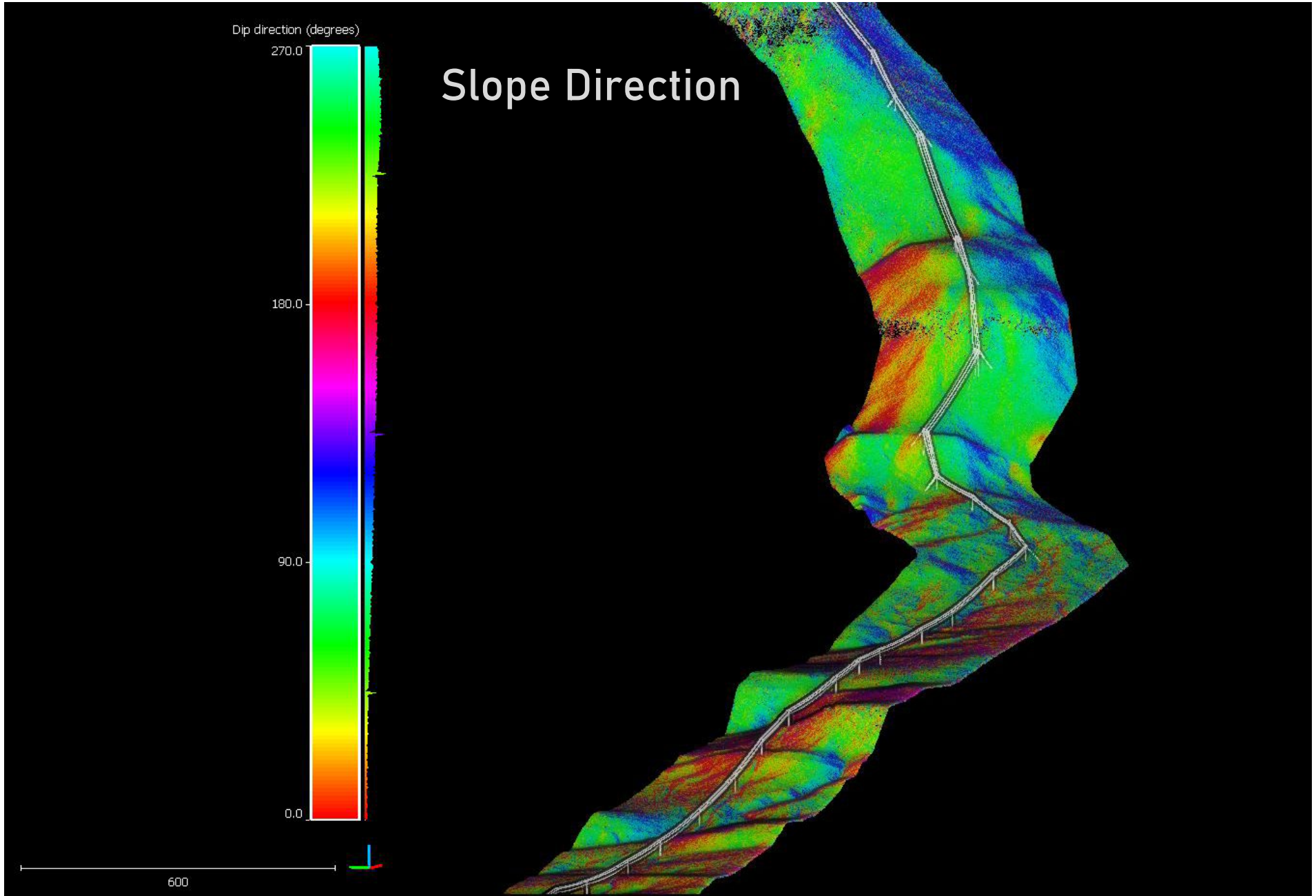
Applications—Asset Management



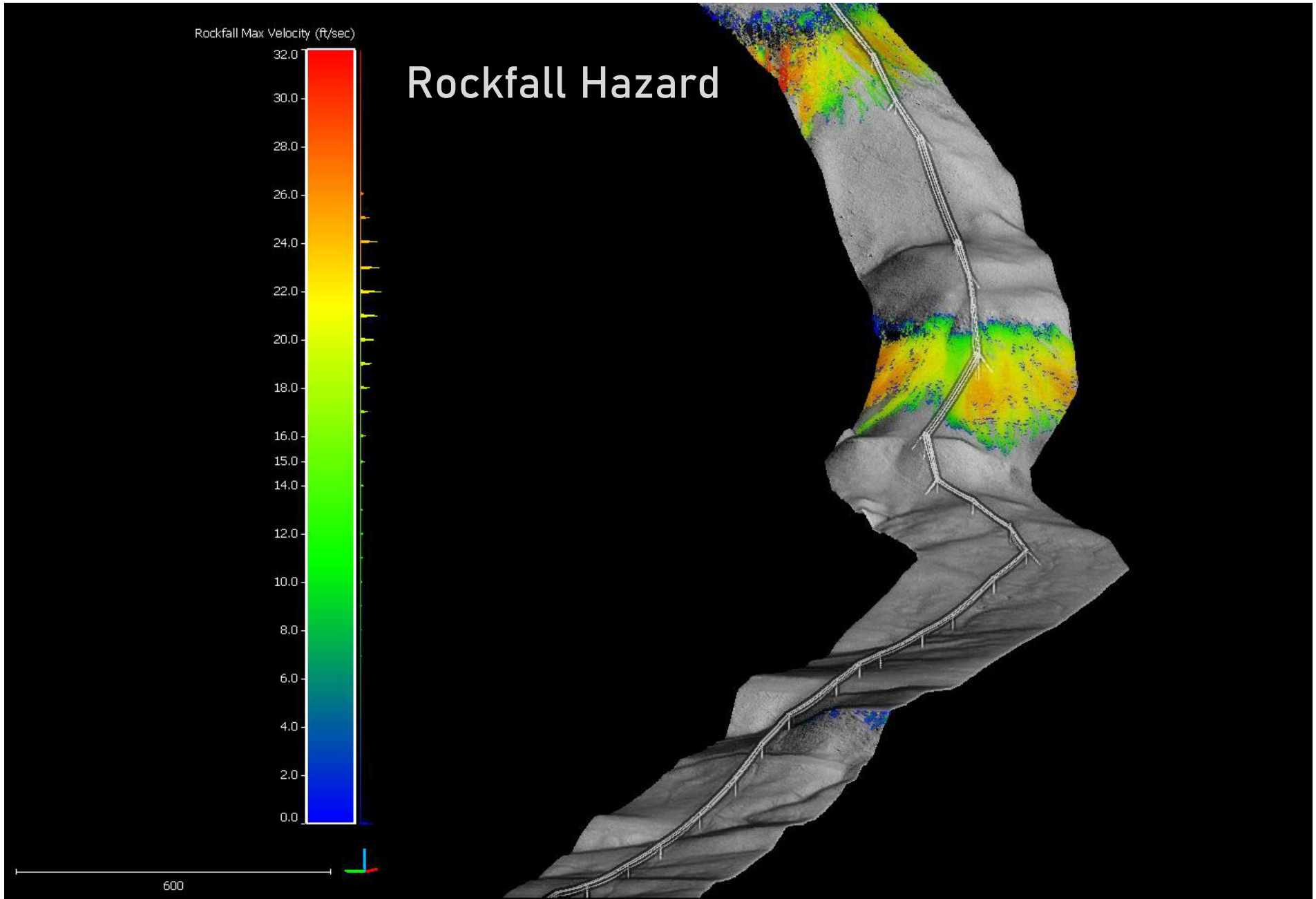
Applications—Asset Management



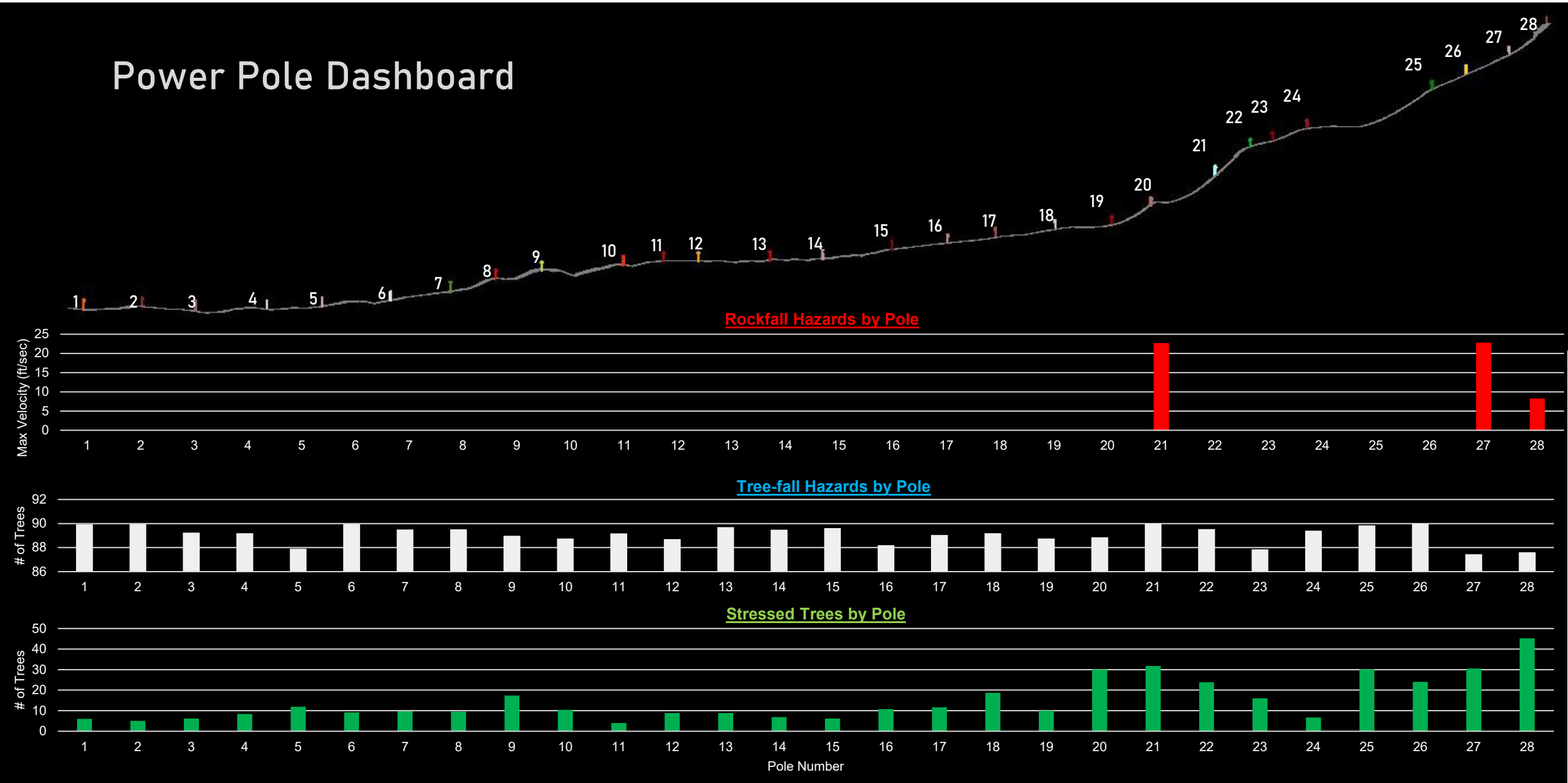
Applications—Asset Management



Applications—Asset Management



Applications—Asset Management



Conclusions

Conclusions

XXX

TEAM

- Useful throughout the entire process from investigation to post-construction
- Useful at multiple scales: regional to site-level support
- Safe
- Accurate (survey/design grade with ground control)
- Quick turn-around time from capture to results
- Easy export to CAD and other formats

QUESTIONS?

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