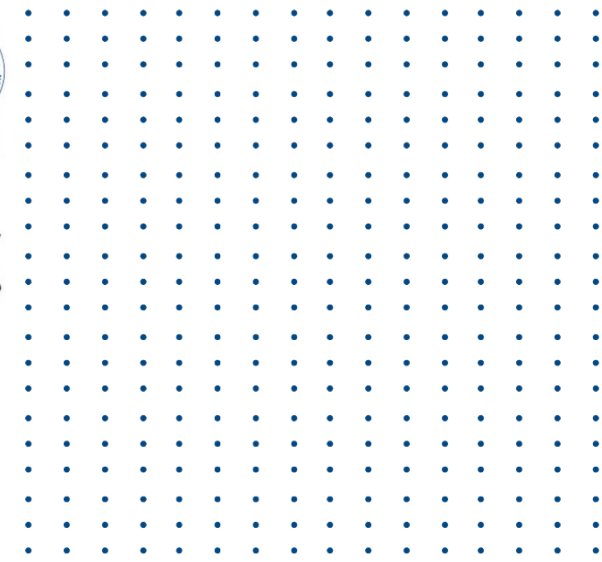


From Reconnaissance to Asset Management: Rethinking Workflow, Project Delivery, and System Performance in the Digital Age



Tech Tools to Improve GAM System Performance

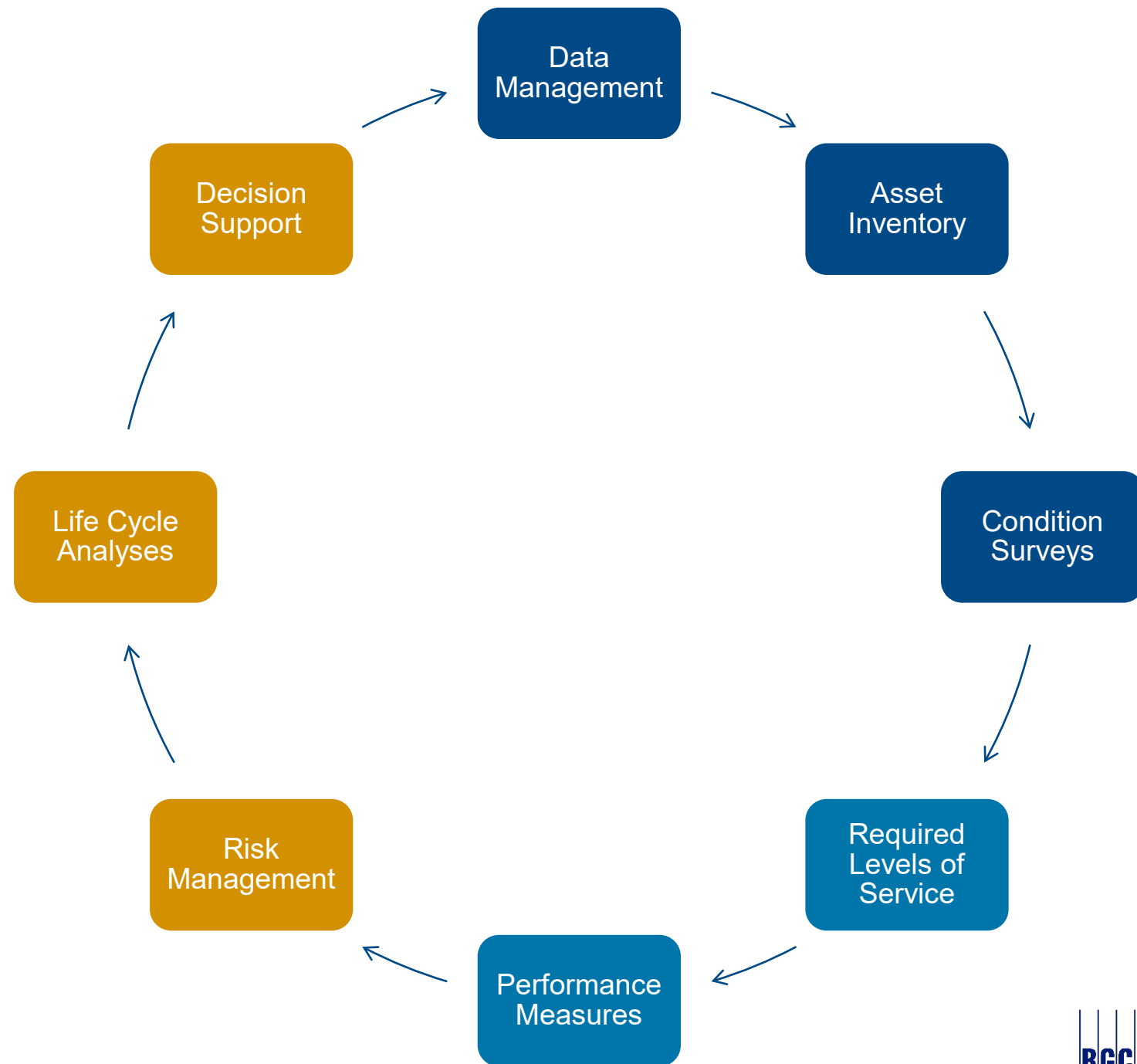
Scott A. Anderson, Ph.D., PE, and Nathan Thompson, PE
BGC Engineering, Inc.
November 2, 2023



GAM Workflows

How tech tools are improving GAM system performance by:

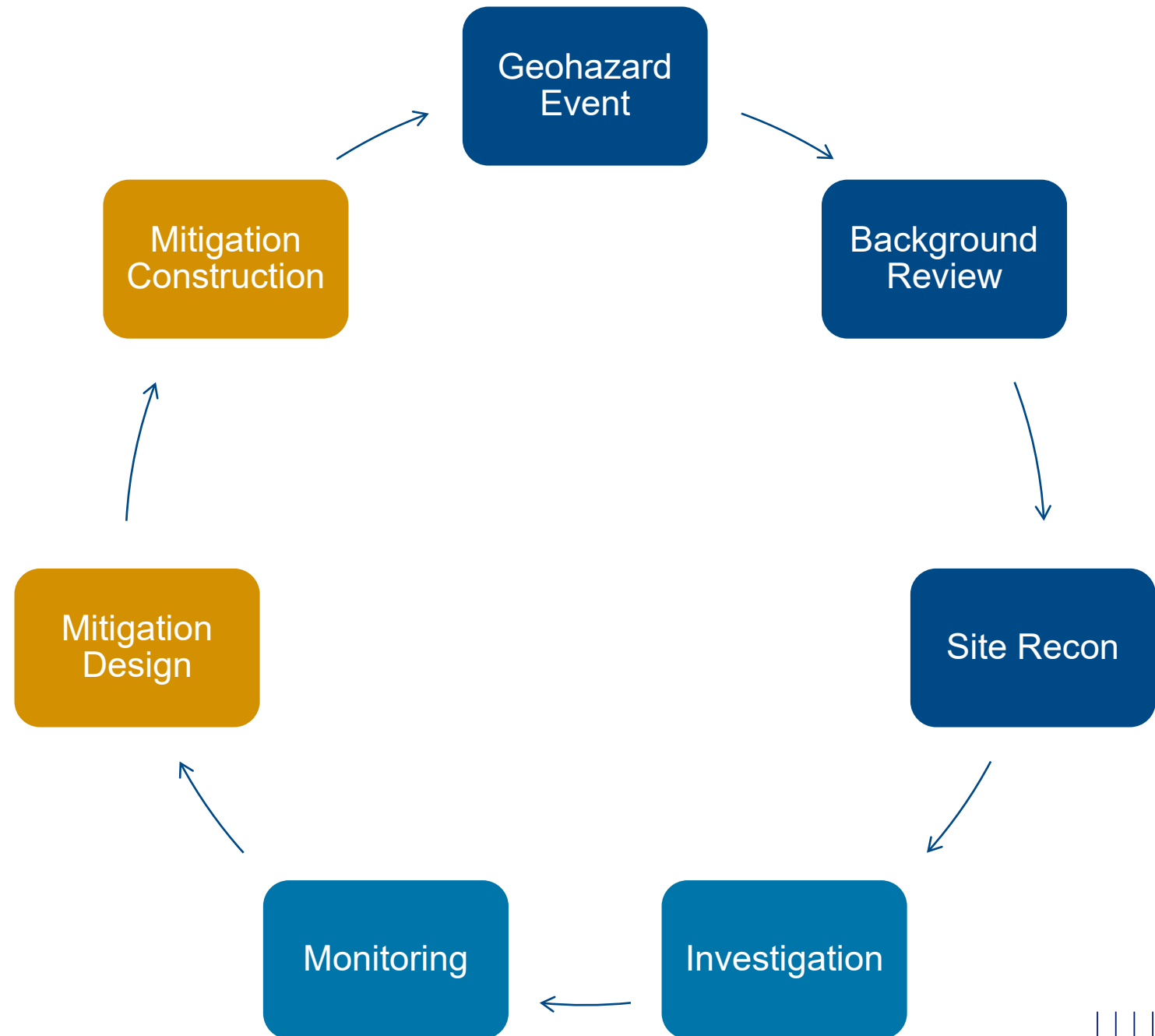
- 1) Accelerating the implementation of Risk-Informed GAM; and
- 2) Improving the efficiency of reactive response to geohazard events.



GAM Workflows

How tech tools are improving GAM system performance by:

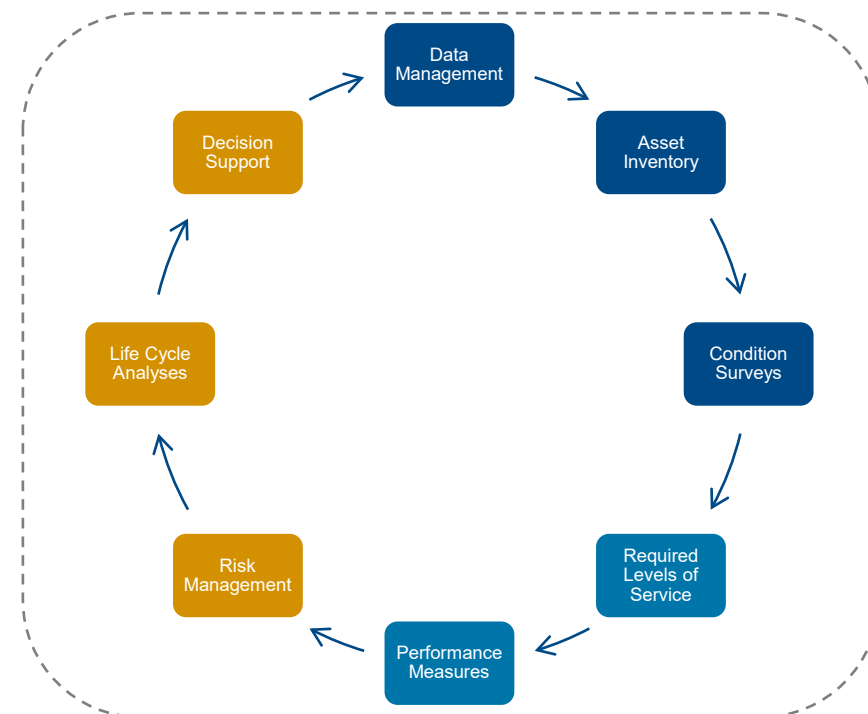
- 1) Accelerating the implementation of Risk-Informed GAM; and
- 2) Improving the efficiency of reactive response to geohazard events.



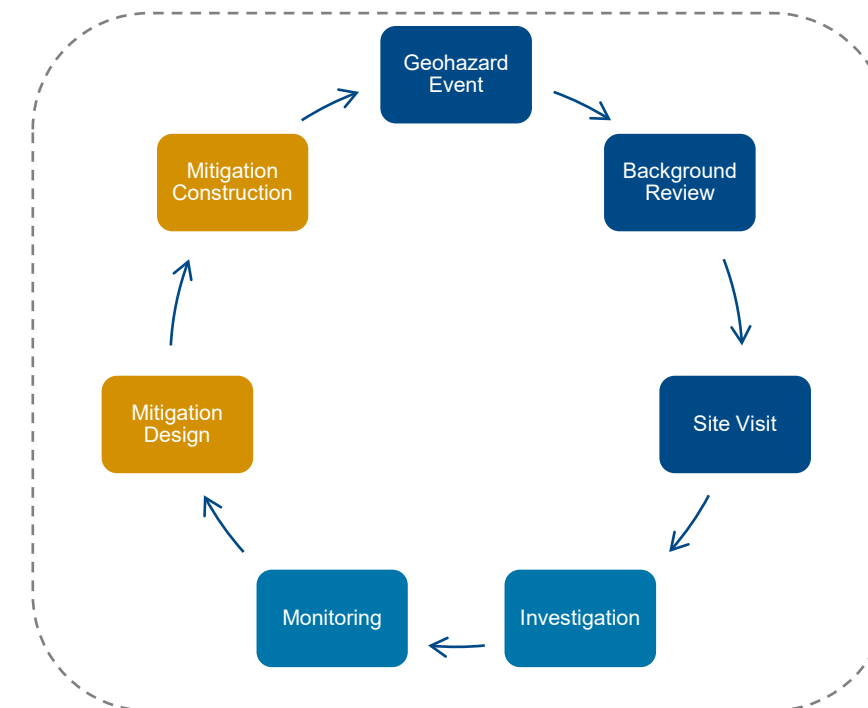
Tech Tools Highlighted

Tools highlighted:

- Change Detection w/ Remote Sensing
- Algorithmic Asset Identification
- Digital Data Management in GAM Platform
- 3D/4D Data Visualization
- Near Real-time Monitoring



Risk-Informed GAM

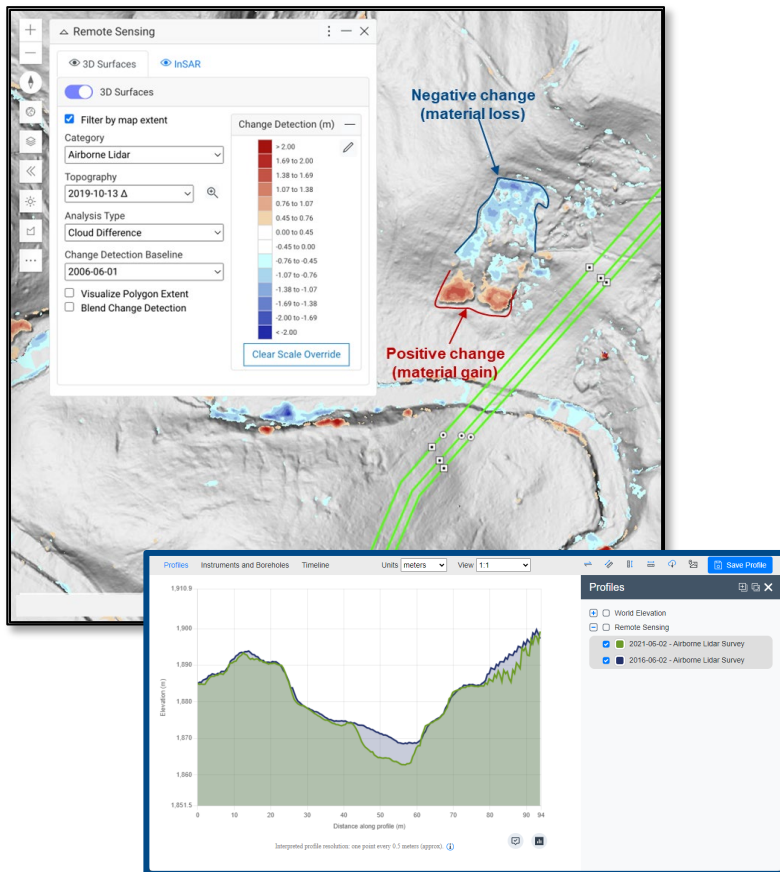


Event Response

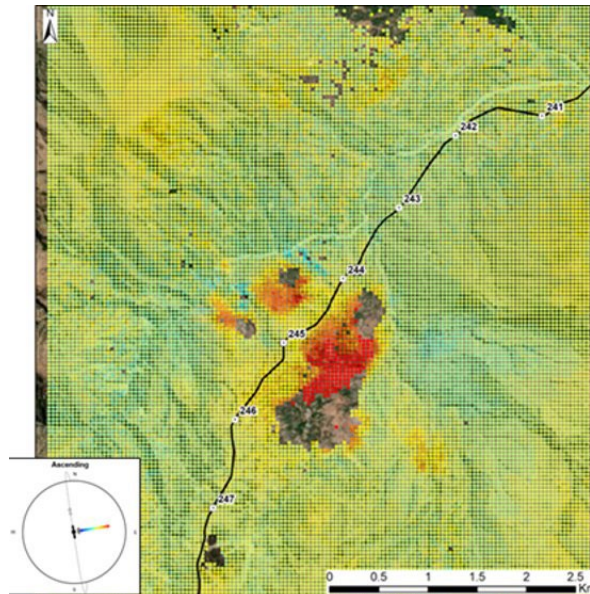
Change Detection

Remote Sensing Techniques

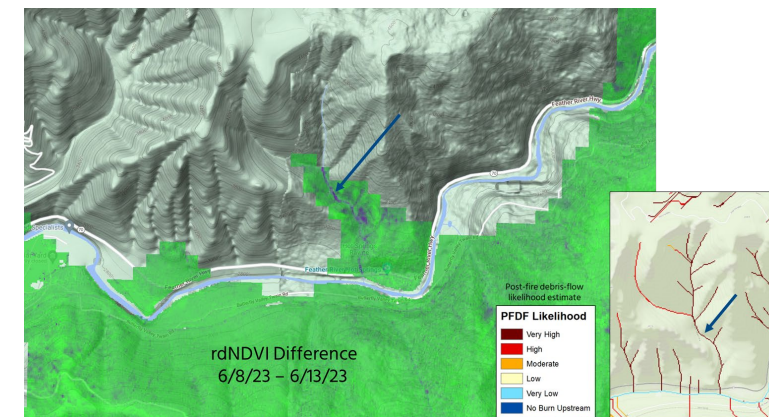
Lidar Change Detection



InSAR-on-Demand

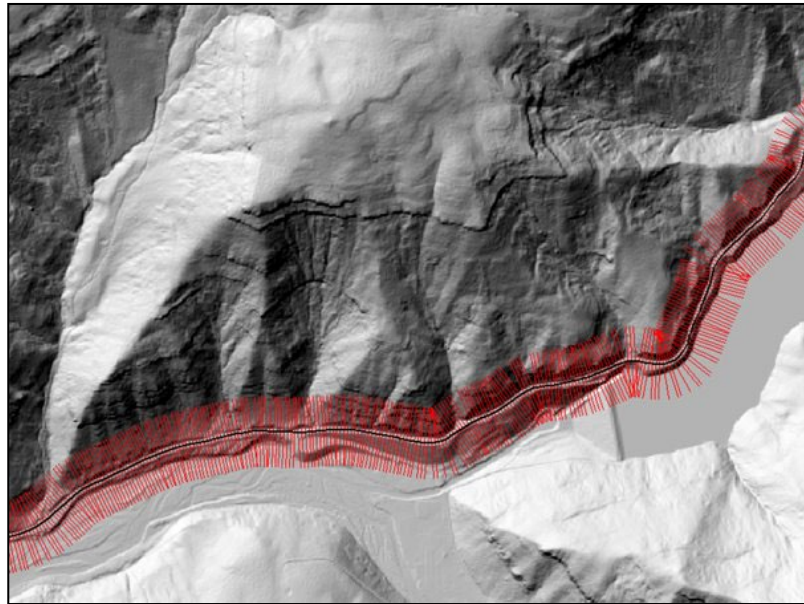


Post-Wildfire Debris Flow

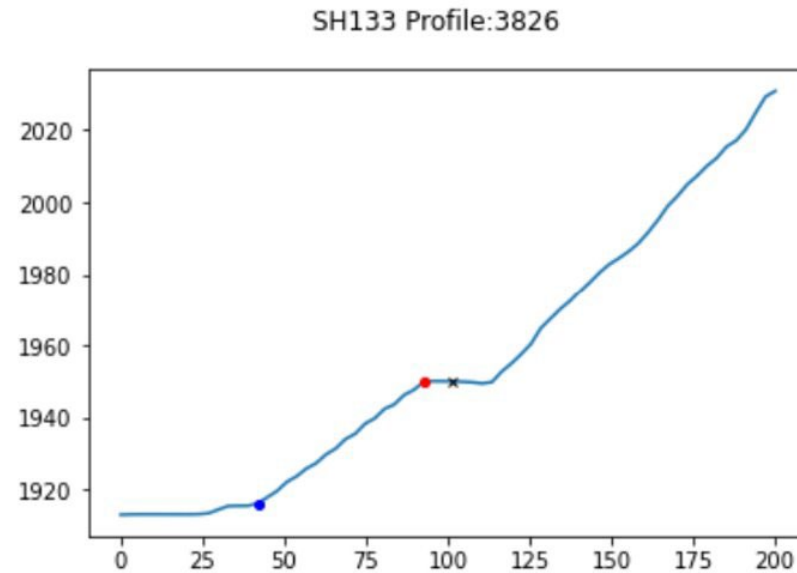


Algorithmic Asset Identification

Embankments, Slopes and Retaining Walls



(1) Draw elevation profiles perpendicular to the roadway



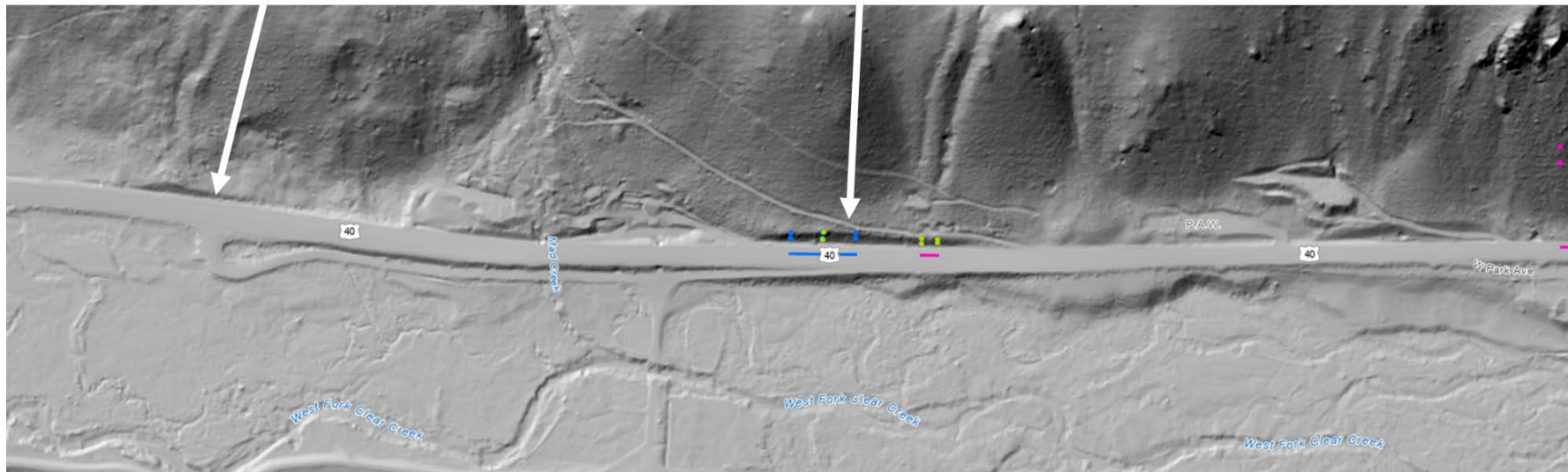
(2) Identify continuous slopes over a specified gradient, height and distance to the roadway



(3) Outputs include polygons representing the credible geoasset or natural feature

Algorithmic Asset Identification

Embankments, Slopes and Retaining Walls

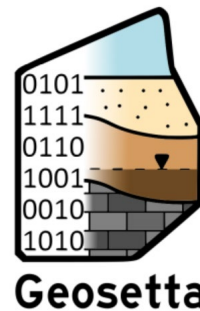
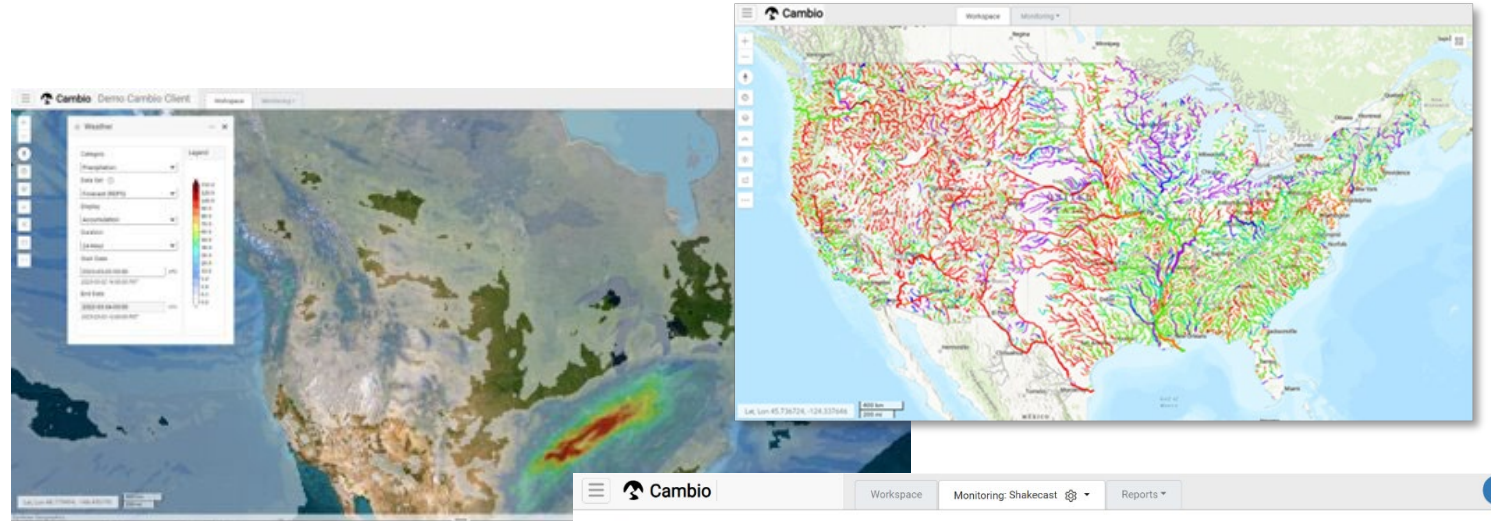


Gaining Insights from GAM Platform

Public Data Integration

Examples:

- Multiple base map & imagery options (including highway network)
- Geologic Maps – USGS
- Precipitation – NOAA
- River Network
- Flood (Streamflow) – USGS, National Water Model
- Seismic – USGS/Shakecast
- Wildfire – USGS
- Snowpack – SNODAS, Copernicus
- Publicly funded geotechnical data – Geosetta

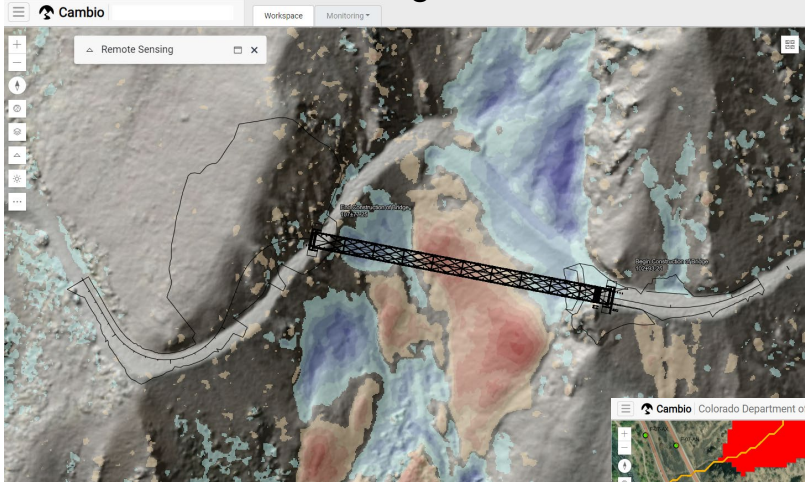


Latitude	Longitude	Depth (km)	Magnitude	Title	Place
46.984000	-66.656000	10.1	5.7	M 5.7 - 86 km E of Hamlin, Maine	86 km E
46.975000	-66.659000	7.0	5.4	M 5.4 - 86 km E of Hamlin, Maine	86 km E
56.080000	-119.810000	10.0	5.3	M 5.3 - 44 km NE of Dawson Creek, C...	44 km E
37.938000	-88.357000	15.7	5.3	M 5.3 - 5 km SSW of Norris City, Illinois	5 km S
38.451500	-87.886200	14.3	5.2	M 5.2 - 7 km NNE of Belmont, Illinois	7 km N
38.710000	-87.950000	4.6	5.2	M 5.2 - 2 km ESE of Claremont, Illinois	2 km E
36.474300	-81.086500	4.1	5.1	M 5.1 - 4 km SE of Sparta, North Caro...	4 km S
48.800000	-123.356000	62.0	5.1	M 5.1 - 10 km ESE of Salt Spring Islan...	10 km E
54.968000	-116.537000	10.0	5.0	M 5.0 - 49 km ESE of Valleyview, Can...	49 km E
56.366000	-120.762000	5.0	5.0	M 5.0 - 14 km NNE of Fort St. John, C...	14 km N
48.845000	-122.160000	11.9	5.0	M 5.0 - 4 km ENE of Deming, Washing...	4 km E
41.650000	-81.162000	10.0	5.0	M 5.0 - 4 km NNW of Chardon, Ohio	4 km N

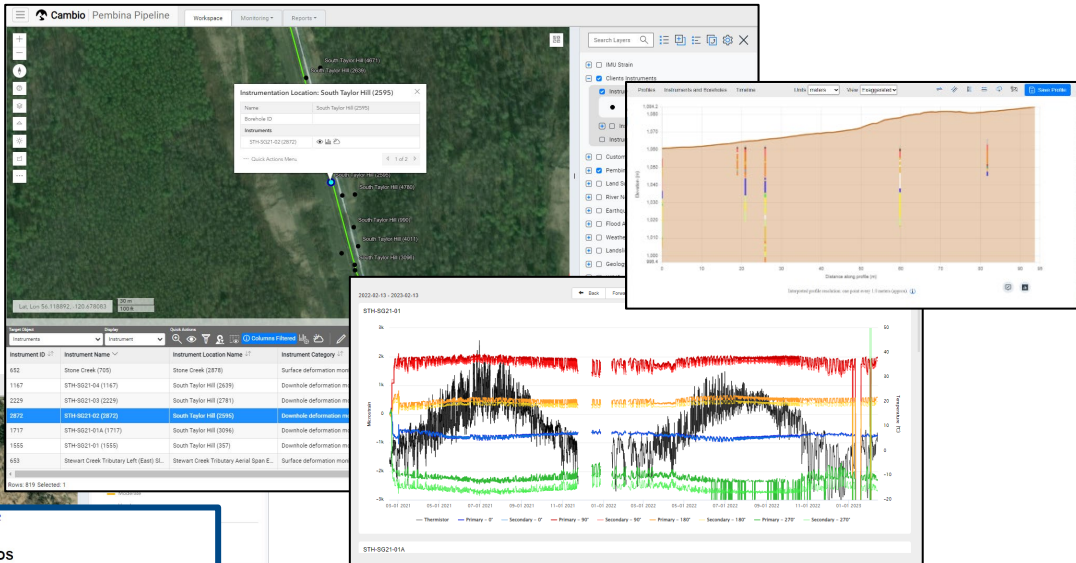
Gaining Insights from GAM Platform

Site Data Integration

Lidar, LCD, design files



Boring logs and instrumentation



Asset inventory, photos, and inspections

Bridge F-07-AP

STWD	F-07-AP
WASH	F-07-AP
ROUTE	270A
Facility Carried	
Feature Requested	
LOCATION	CLAYED-DOWN-W/O OF 08221 ONE
PRECEDENT	24-262947
PRECEDENT	107-261471
S. Zovick	

F-07-AP INVENTORY PHOTOS

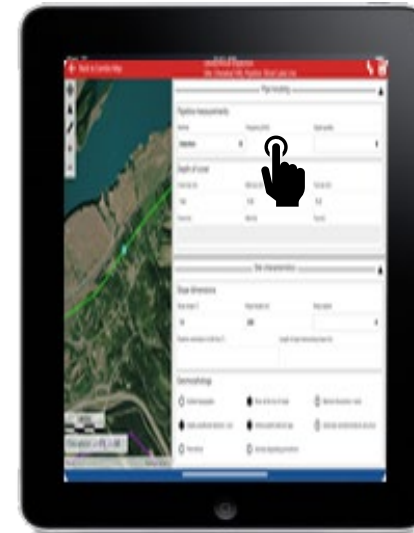
Structure: F-07-AP-B SOUTHEAST 2016 06 20.JPG
 Taken: 6/20/2016 11:10 AM
 Posted: 7/20/2017

Structure: F-07-AP-A EAST 2016 06 20.JPG
 Taken: 6/20/2016 11:08 AM
 Posted: 7/20/2017



Site Recon and Investigation

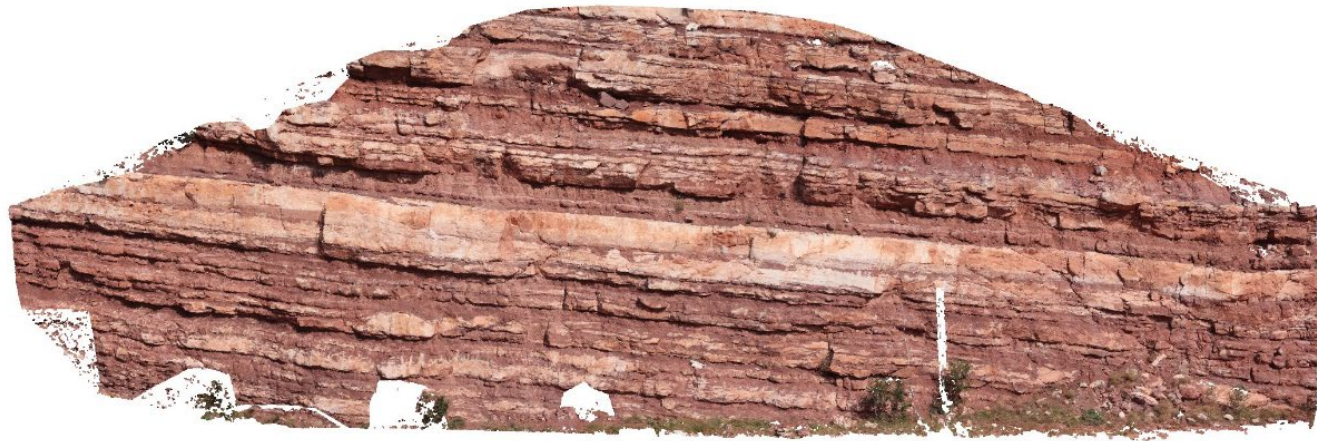
Digital Data Management



Mobile



Web

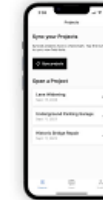


BOREDM Field

Available for iPad and iPhone today
Android devices next week

Modern and adaptable
logging from the field.
Finally.

iOS + Android | Work offline, sync later
Free with a BoreDM subscription



Site Investigation

4D Data Visualization

Hwy 101 – Last Chance Grade

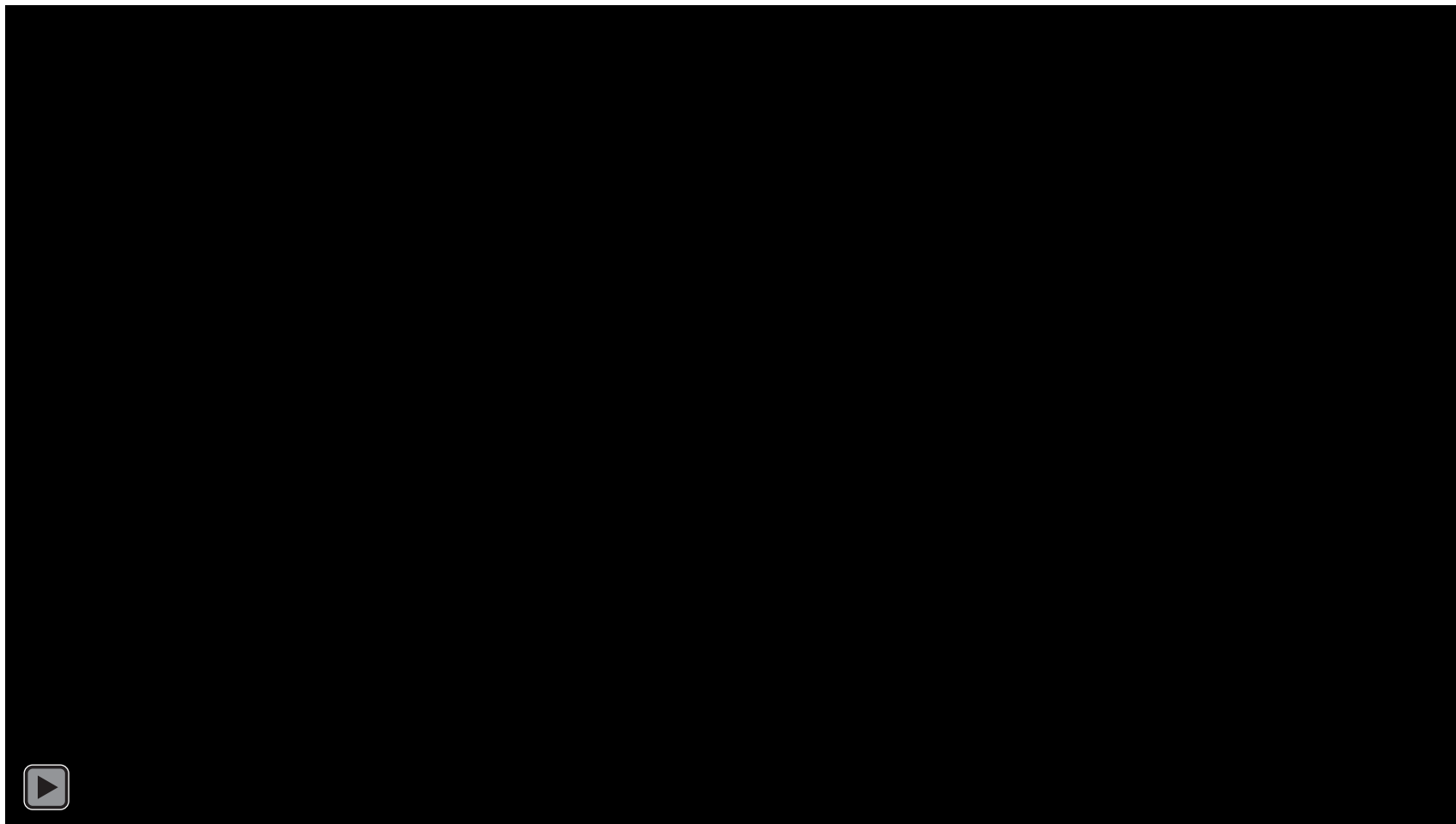
A Leapfrog™ model

- Hwy 101 – critical corridor
- ~3mi landslide complex
- Alternative alignments
- ID critical sections
- Support stability analysis

● InSAR reflectors

▶ Inflections from inclinometer plot

Blue / red color overlays: lidar change detection



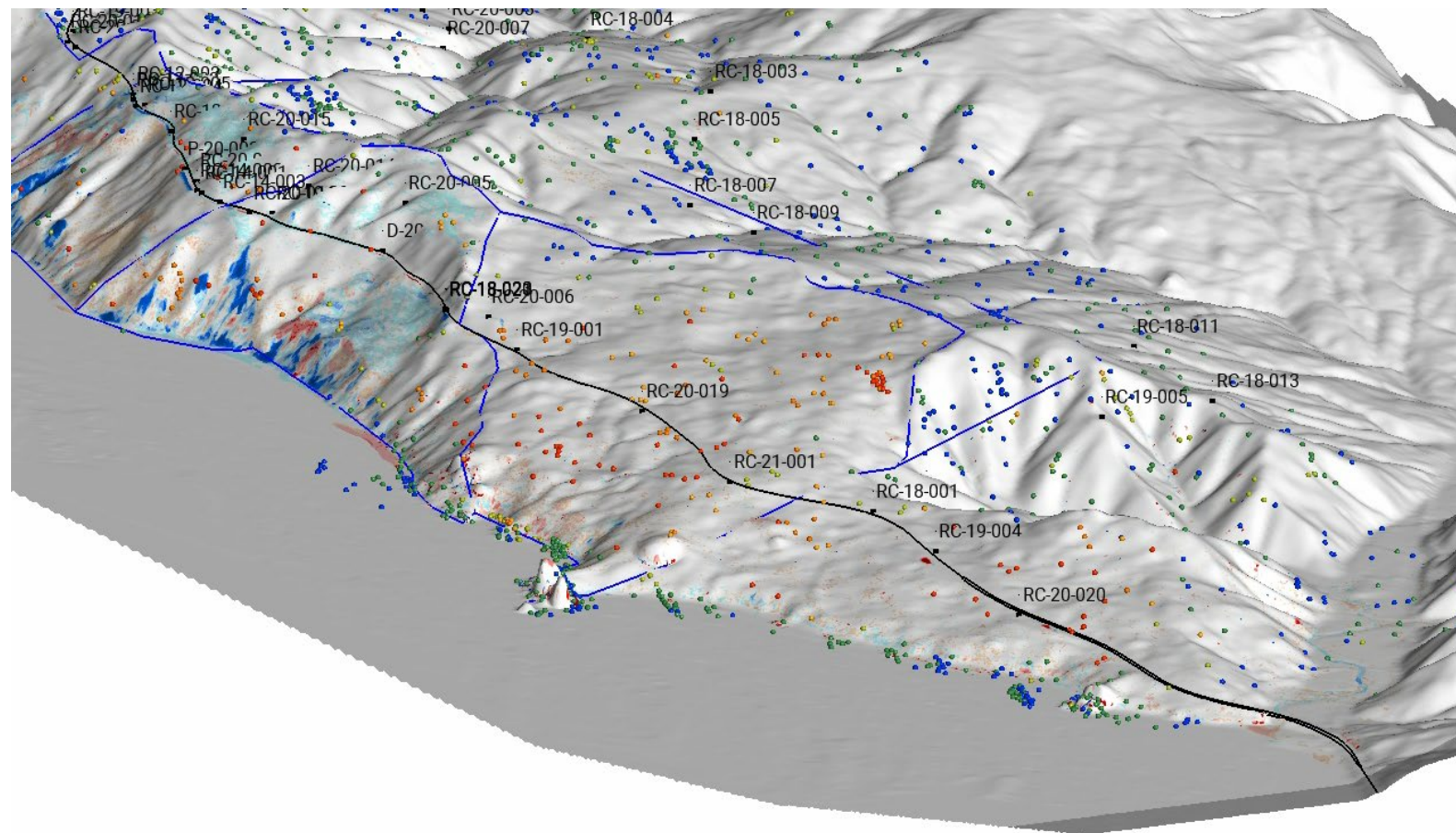
Site Investigation

4D Data Visualization

Hwy 101 – Last Chance Grade

A Leapfrog™ model

- Static model, but
- Time dimension preserved
- Select design section(s)

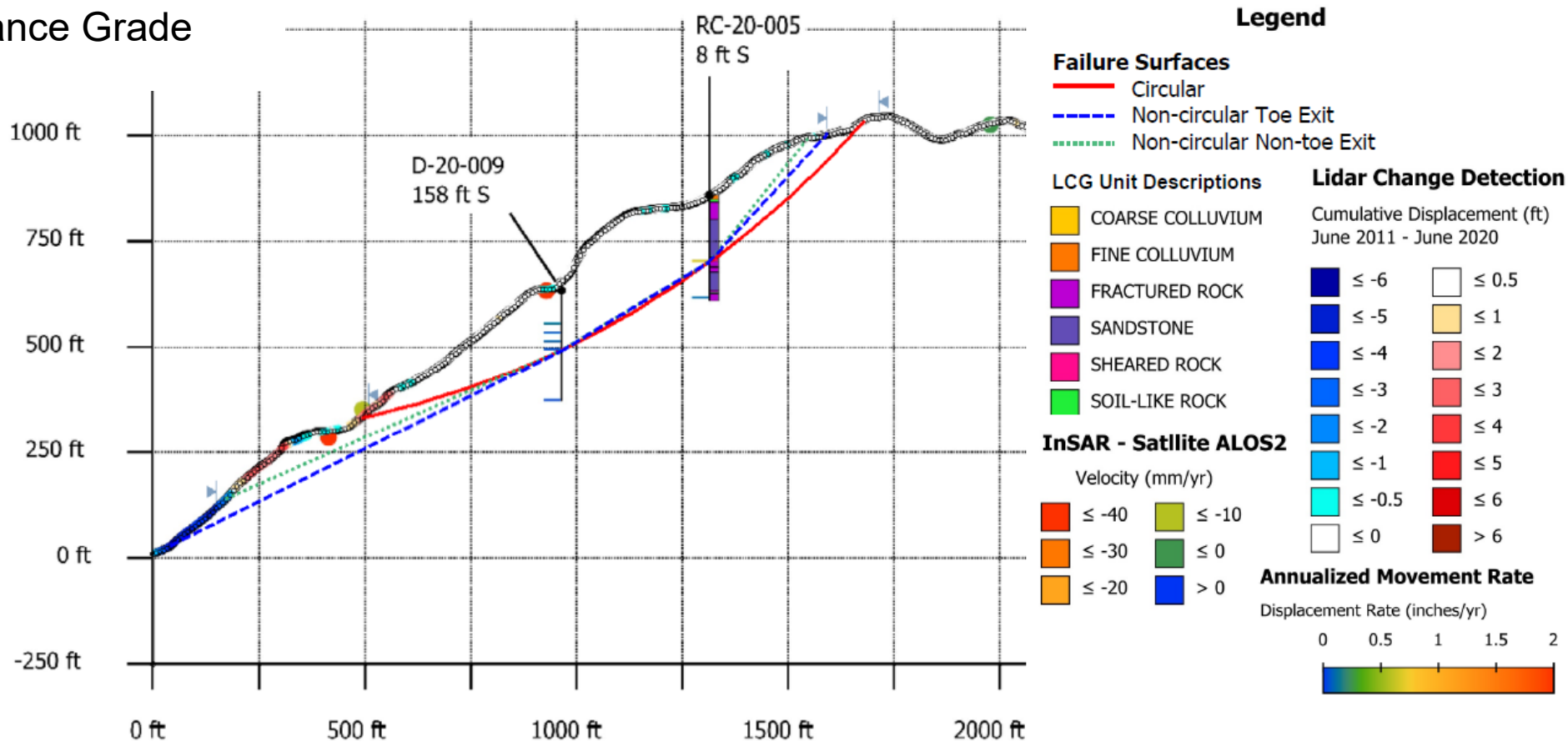


Site Investigation

4D Data Visualization

Hwy 101 – Last Chance Grade

A Leapfrog™ model



Site Investigation

3D Data Visualization

Pretty Rocks Landslide, Denali NP

A Leapfrog™ model

- ~Middle of park access road
- Slide active since <'60s
- <2014: inches/year
- 2017: inches/month
- 2018: inches/week
- 2019: inches/day
- 2021: inches/hour



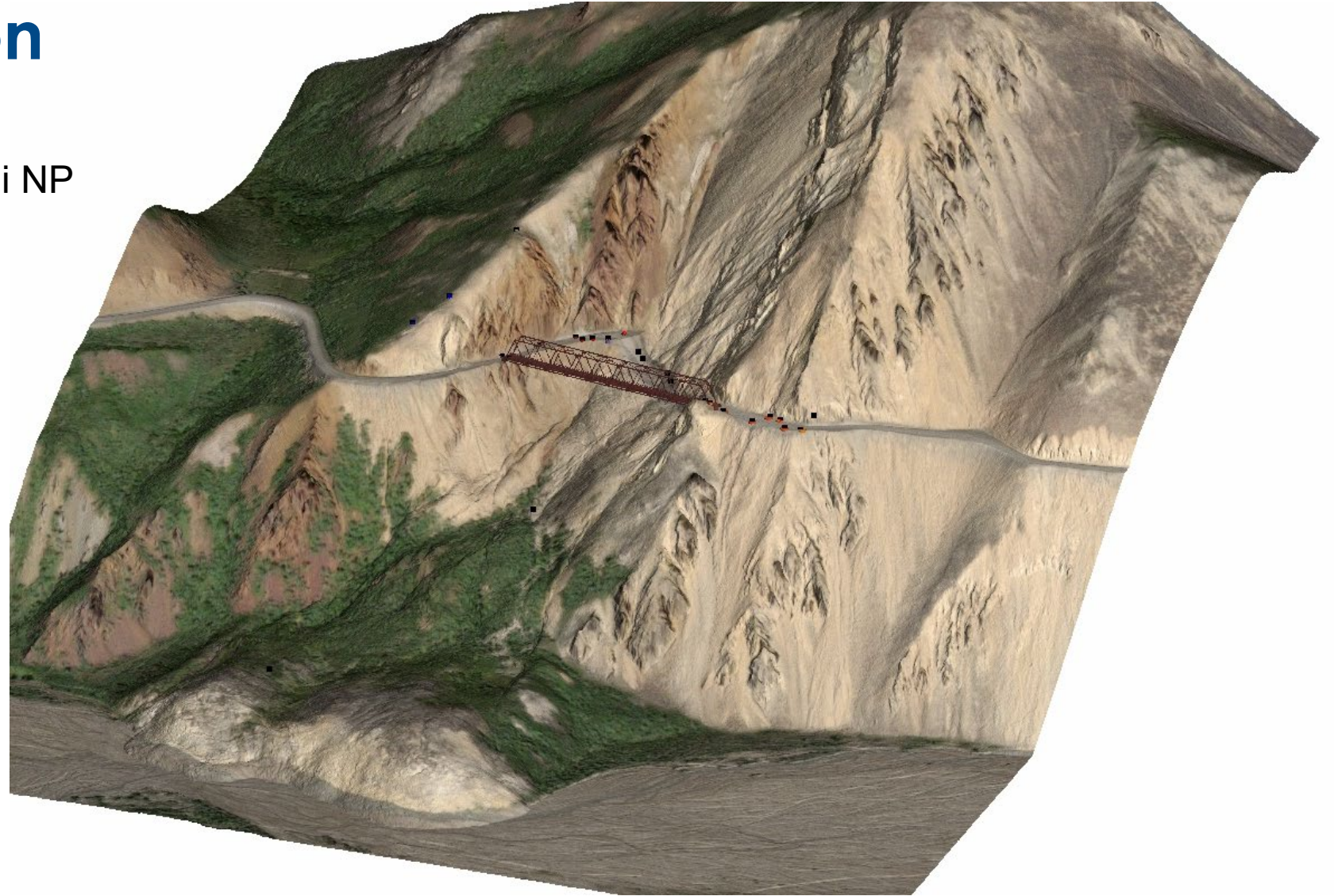
(NPS Photo)

Site Investigation

3D Data Visualization

Pretty Rocks Landslide, Denali NP

A Leapfrog™ model



Site Investigation

3D Data Visualization



Site Monitoring

Near Real-Time



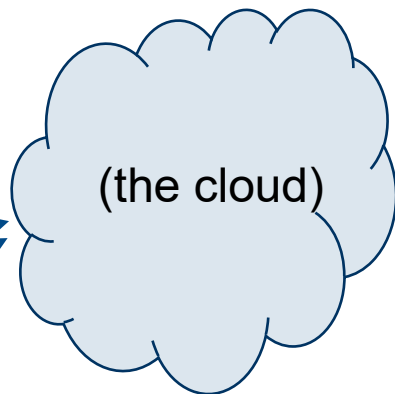
Site Monitoring

Near Real-Time

ALDOT US 231 Slide

Daily, automated groundwater + slope movement readings into digital twin

US 231 Landslide



Automated groundwater readings

Underground slope inclinometers

US 231 Landslide Digital Twin



Site Monitoring

Near Real-Time

ALDOT US 231 Slide
(Green and skinny = good)

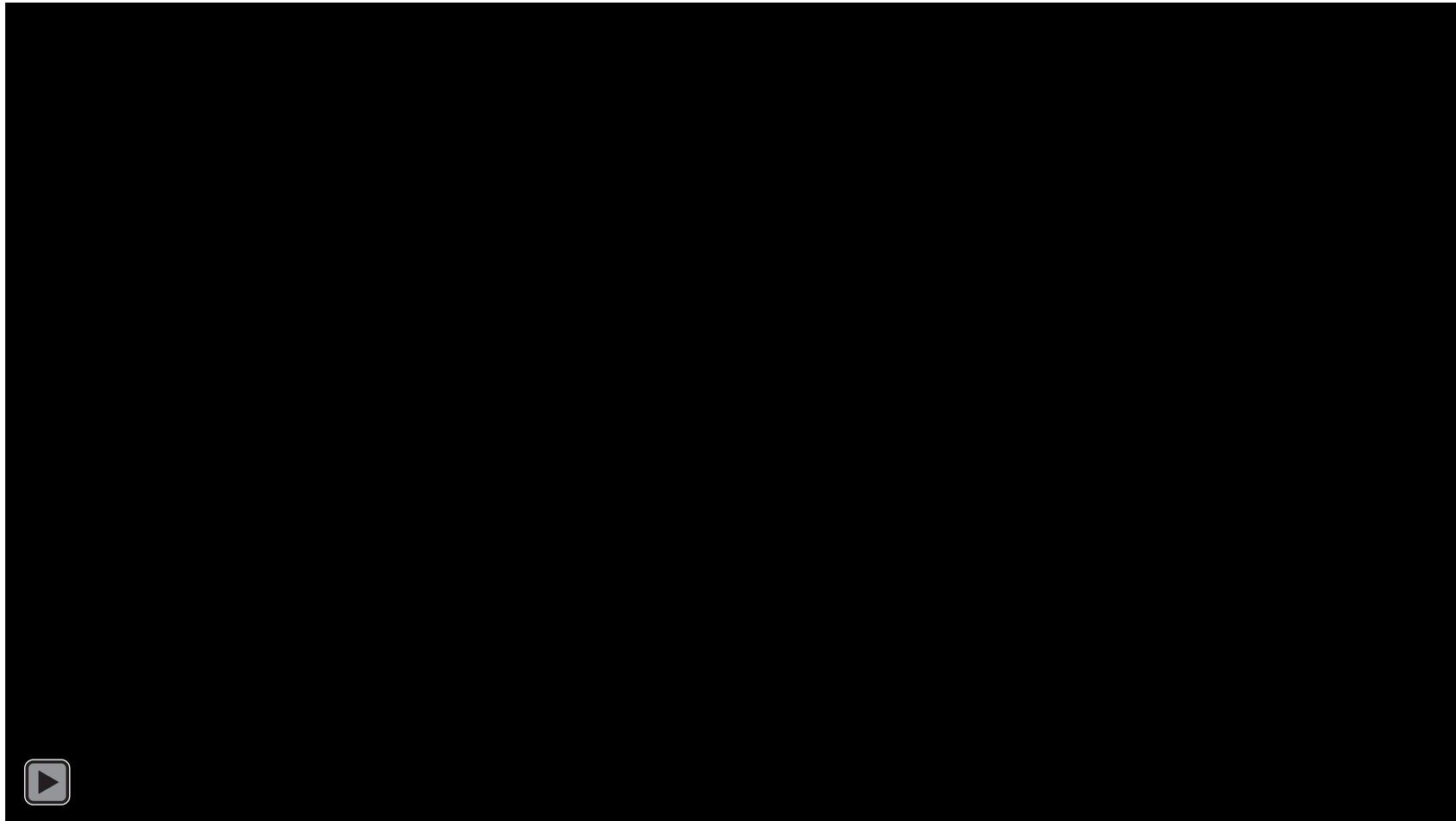


Mitigation Plans

3D Data Visualization – Communicating Design Elements in Augmented Reality

Pretty Rocks Landslide, Denali NP

A Leapfrog™ model



Contact us

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BGC Locations

CANADA

VICTORIA CALGARY KINGSTON
VANCOUVER EDMONTON OTTAWA
KELOWNA TORONTO HALIFAX
KAMLOOPS SUDBURY FREDERICTON

USA

GOLDEN
NASHVILLE

CHILE

SANTIAGO

DOMINICAN REPUBLIC

SANTO DOMINGO

AUSTRALIA

BRISBANE