

Geohazard Management – An Operator's Perspective

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Geohazard Management vs.

Threat Program Attributes	Traditional Pipeline Threats (Crack/Corrosion/Deformation)	Geohazard Threats
Well Defined Models for increasing threat vs. operating condition?	●	●
Predictable pipeline condition from routine inline inspections?	●	●
Pipeline failure risk can be determined based on pipe material and fabrication attributes.	●	●
Threat management improvements have been developed over 70+ years of operation.	●	●
The load/stress that increases threat risk is under the control of the operator and is decreasing.	●	●
Probability of Detection & Identification of the threat is well defined with the tools available.	●	●

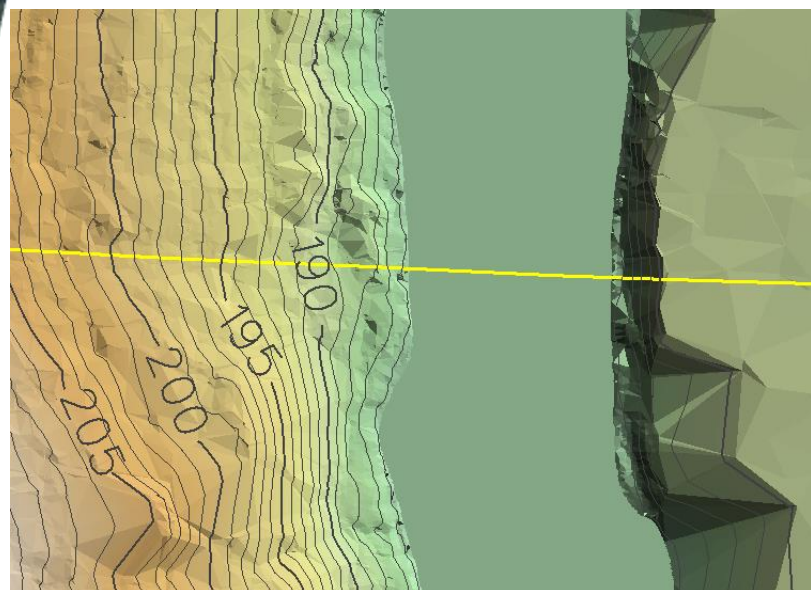
Levels of Monitoring - Geotechnical

100,000+ ft (inSAR)



P.O.D. – Probability of Detection

10,000 ft (LIDAR)



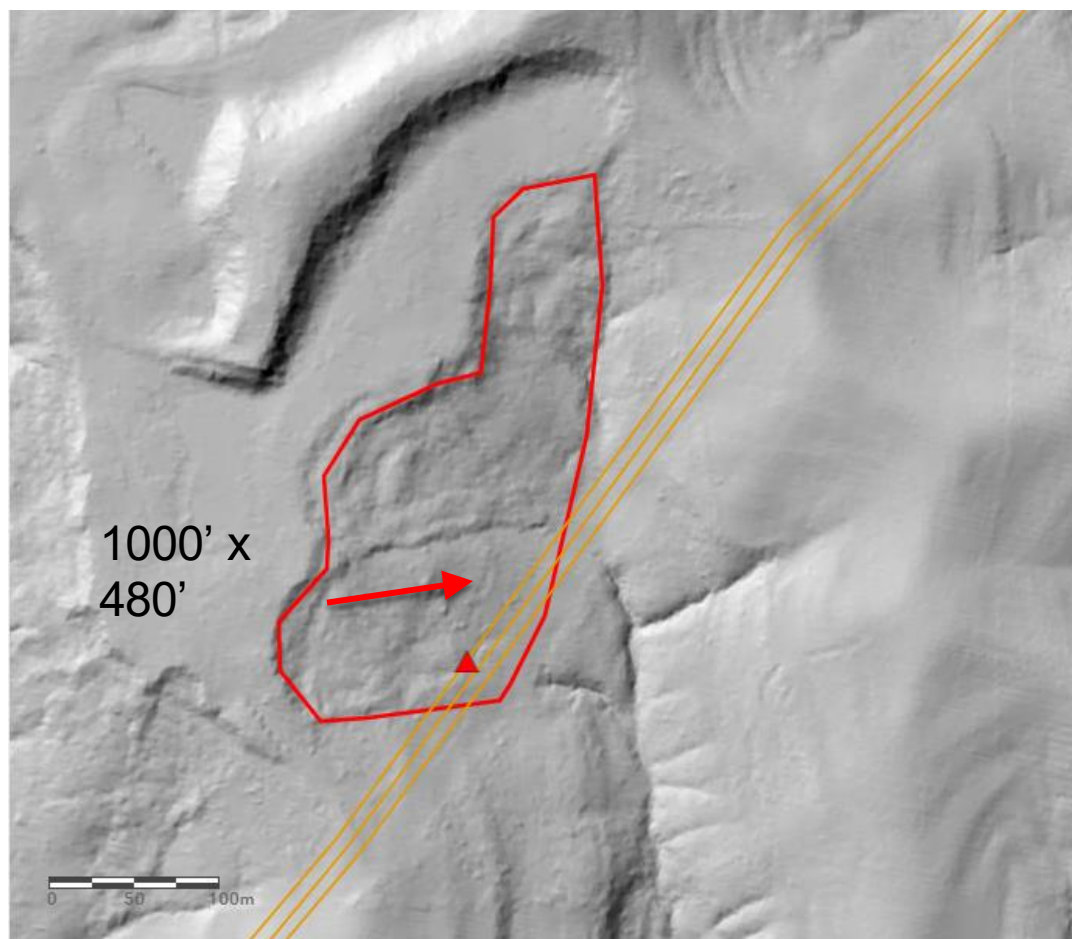
P.O.I. – Probability of Identification

10 ft (Site Survey)

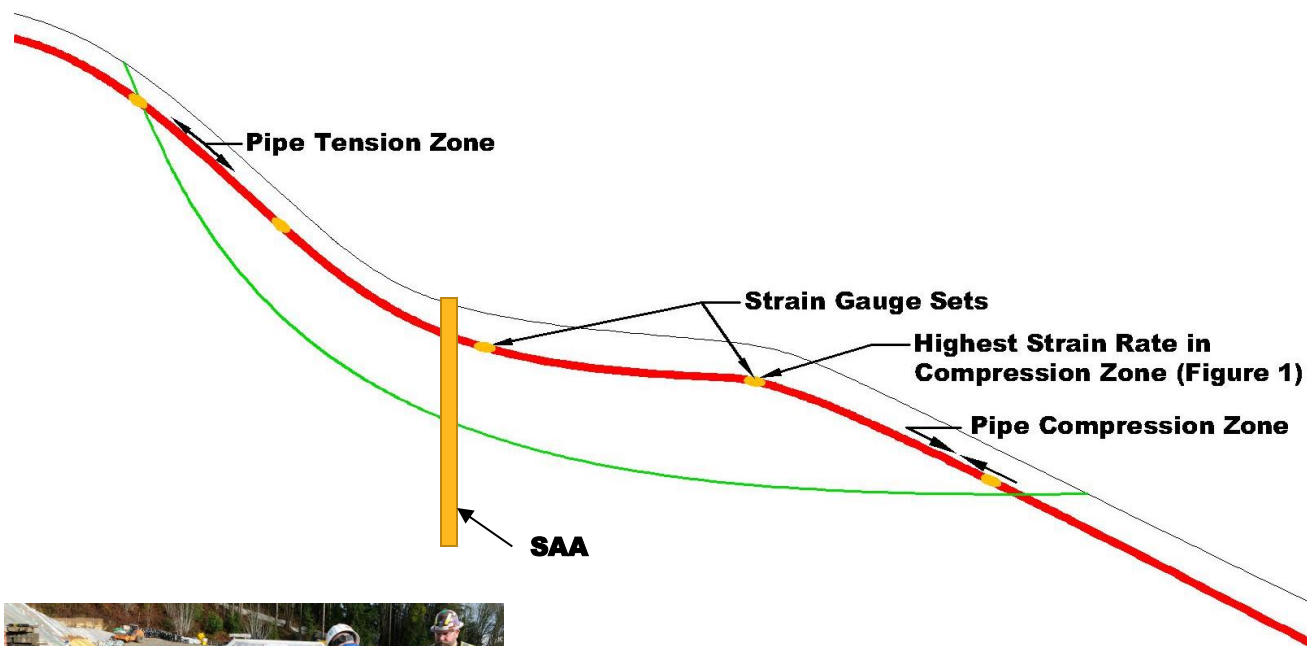


P.O.S. – Probability of Sizing

Geotechnical – Identification of Landslide Terrain



Geotechnical - Is there interaction with the pipeline?



Geotechnical – How do I quantify the strain demand?

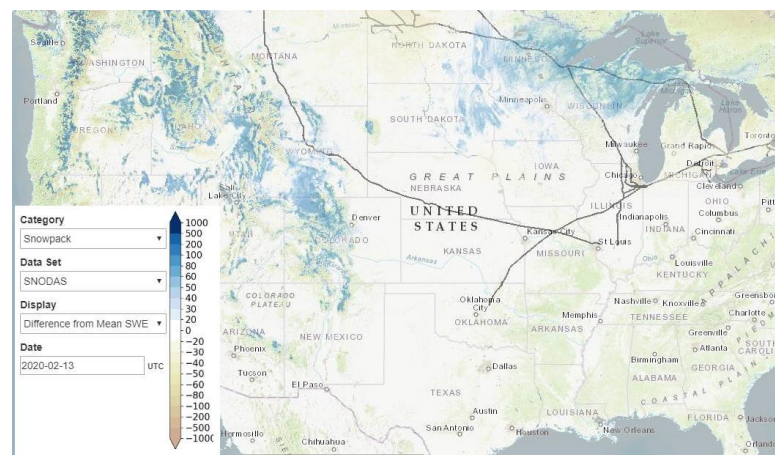
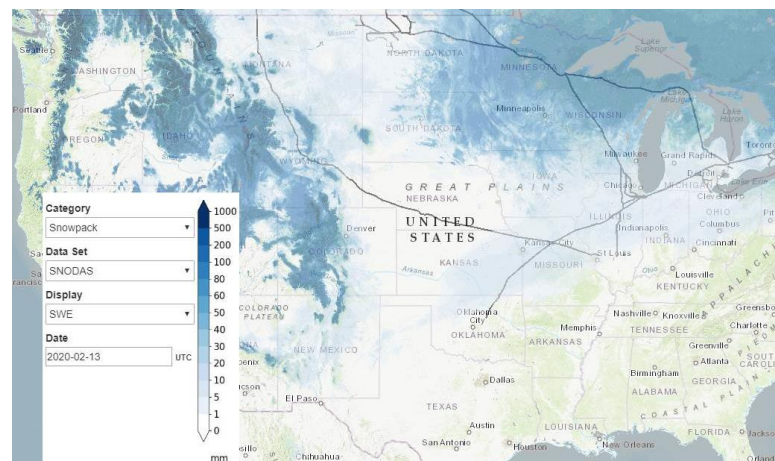
Predictive Techniques	Direct Measurement
Finite Element – Beam/Soil Springs	IMU ILI – Bending Only
Finite Element – Shell/Continuum	Axial Strain ILI – Elastic Range Limit
Parametric Models based on FEA – PHMSA model (lateral to pipe) PRCI model (axial to pipe)	Discrete Strain Gauge
	Fiber Optic Strain
Large Standoff Magnetometry (Qualitative)	

Key Questions:

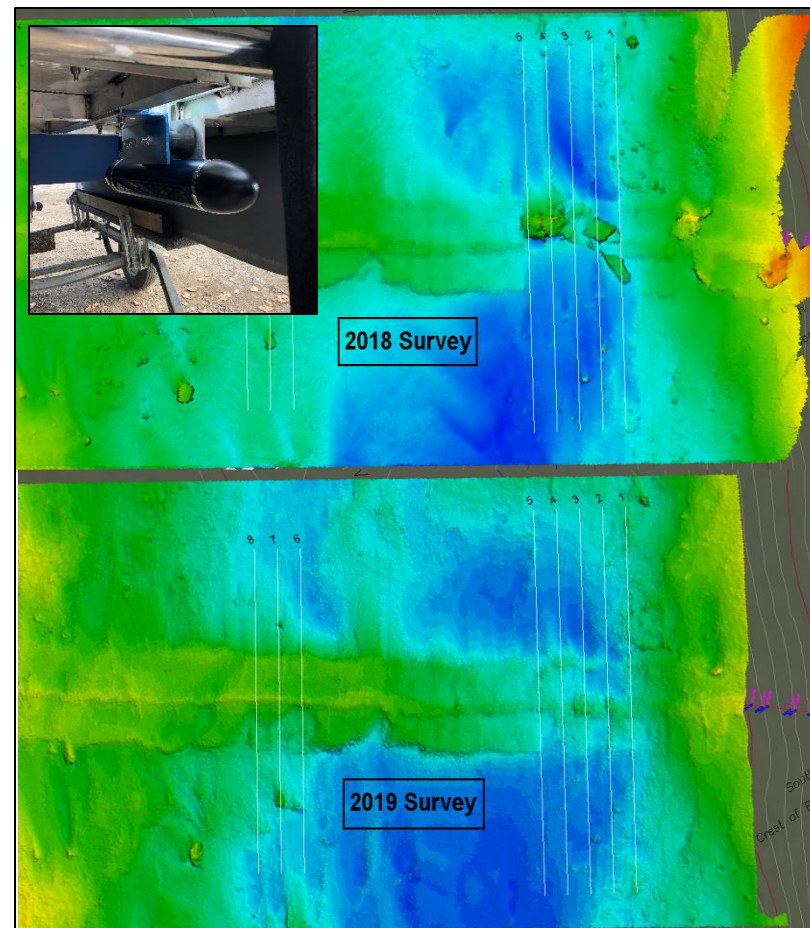
- 1) Is critical loading dominated by compressive strain capacity (buckles), or tensile strain at girth welds?
- 2) Do I know enough about the soil everywhere to utilize a predictive technique?
- 3) How do I ensure my inspection frequency isn't longer than my time for strain demand to reach the limit state? i.e. exceed strain capacity?
- 4) How do I know which model to use for my pipe's tensile strain capacity?

Levels of Monitoring - Hydrotechnical

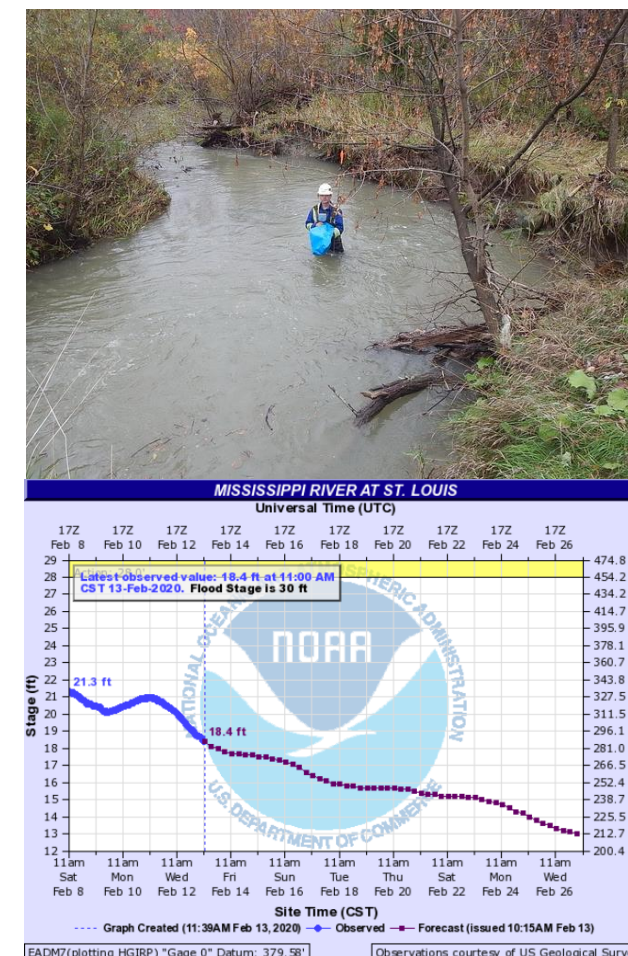
100,000+ ft



100 ft



10 ft



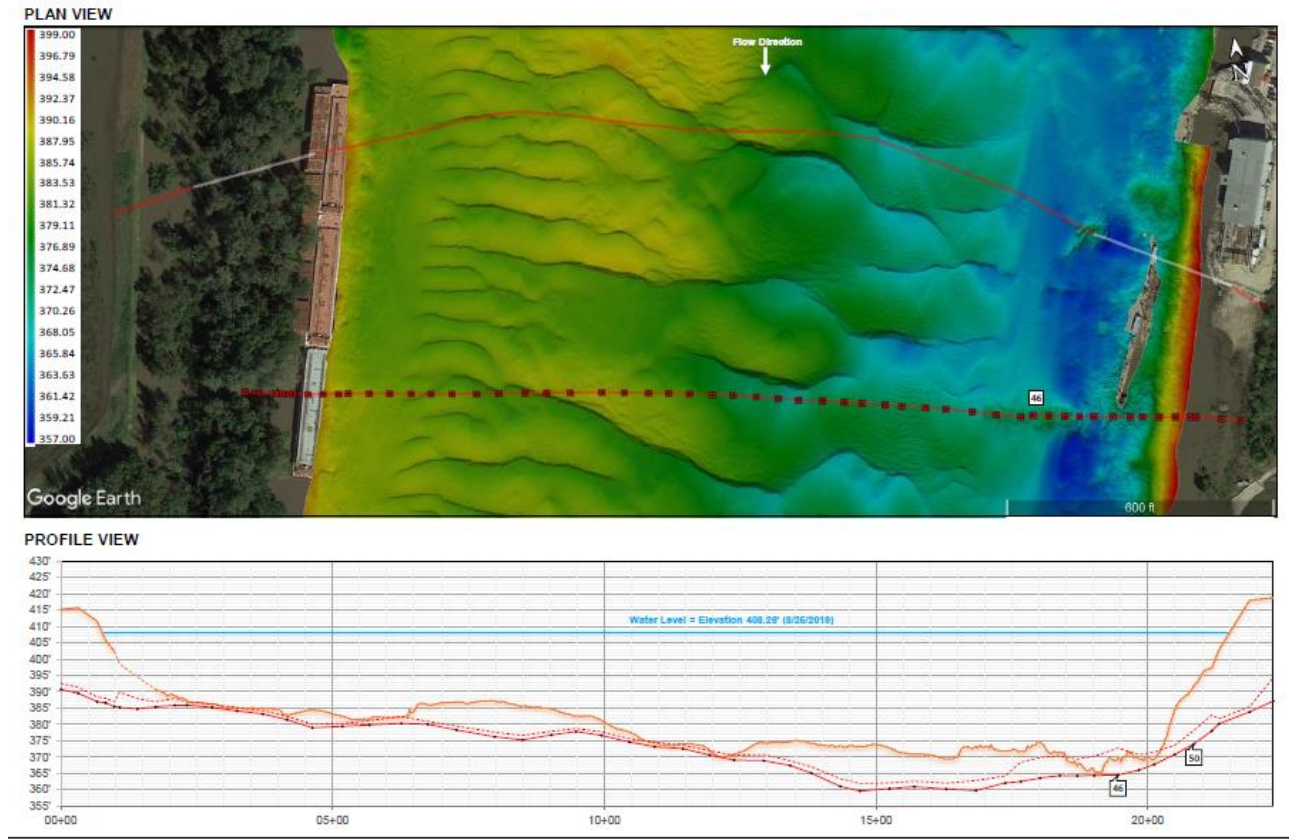
POS/POI – Probability of Sizing / Identification

POD– Probability of Detection

Is my pipe spanning?

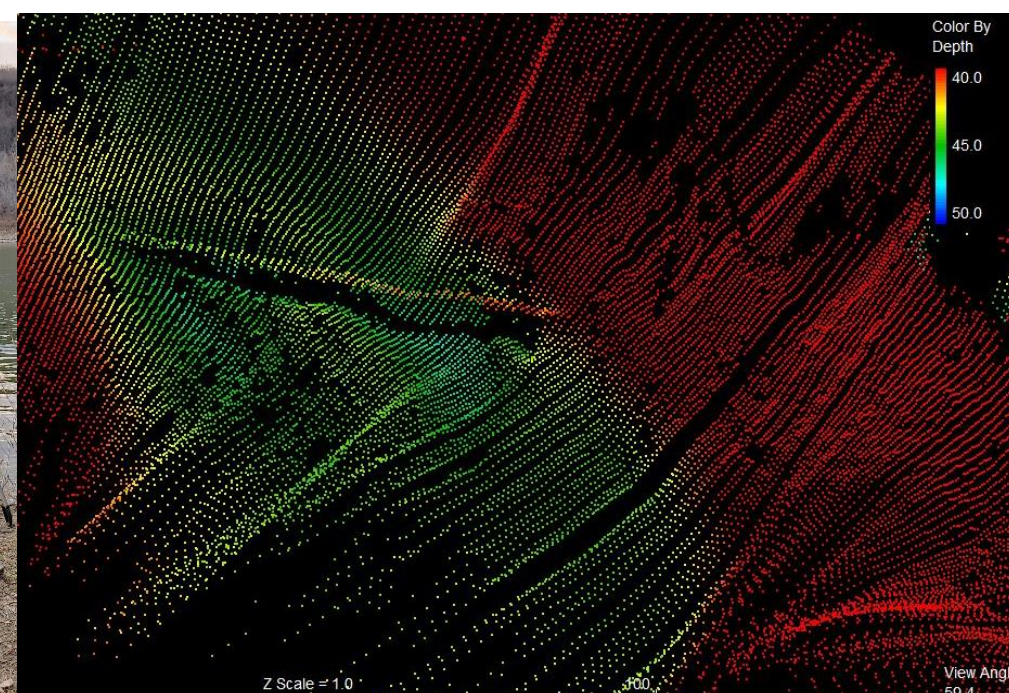
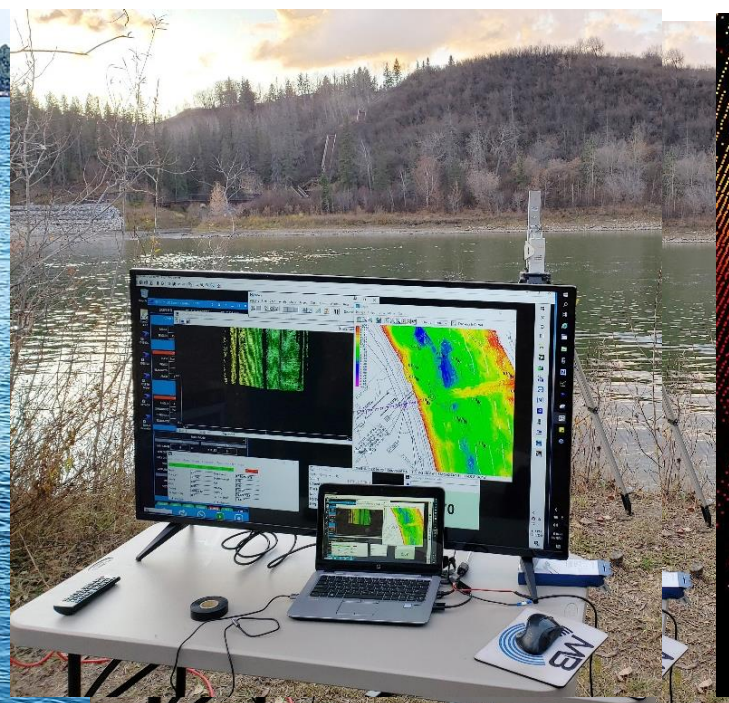
Benefits of routine full bathymetric surveys

- Identification of upstream obstructions that can cause additional scour
- Assists hydrotechnical consultant in understanding most applicable scour model to use



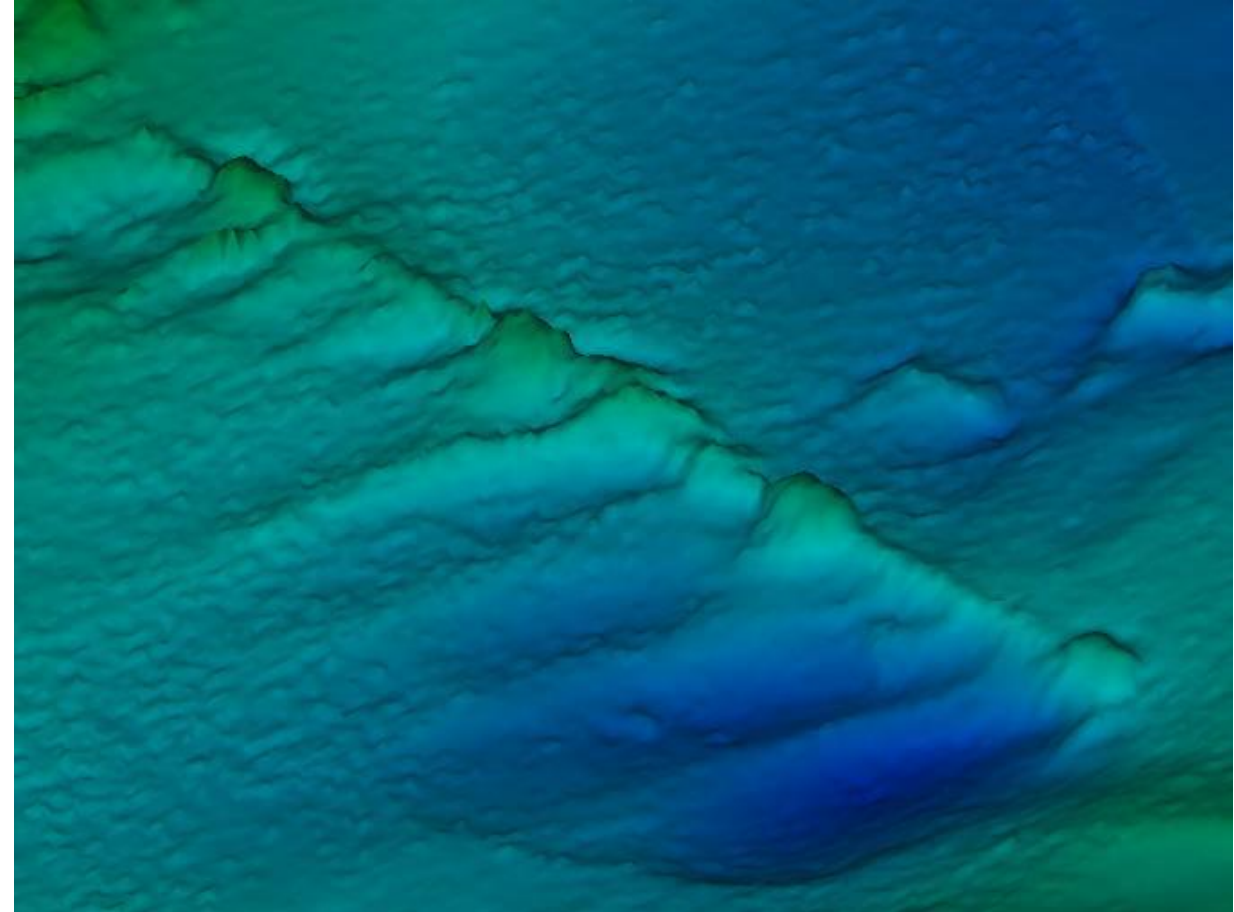
Is my pipe spanning when it's flooding?

- Realtime bathymetric surveys allow for a direct assessment of threat to the pipeline during peak flooding



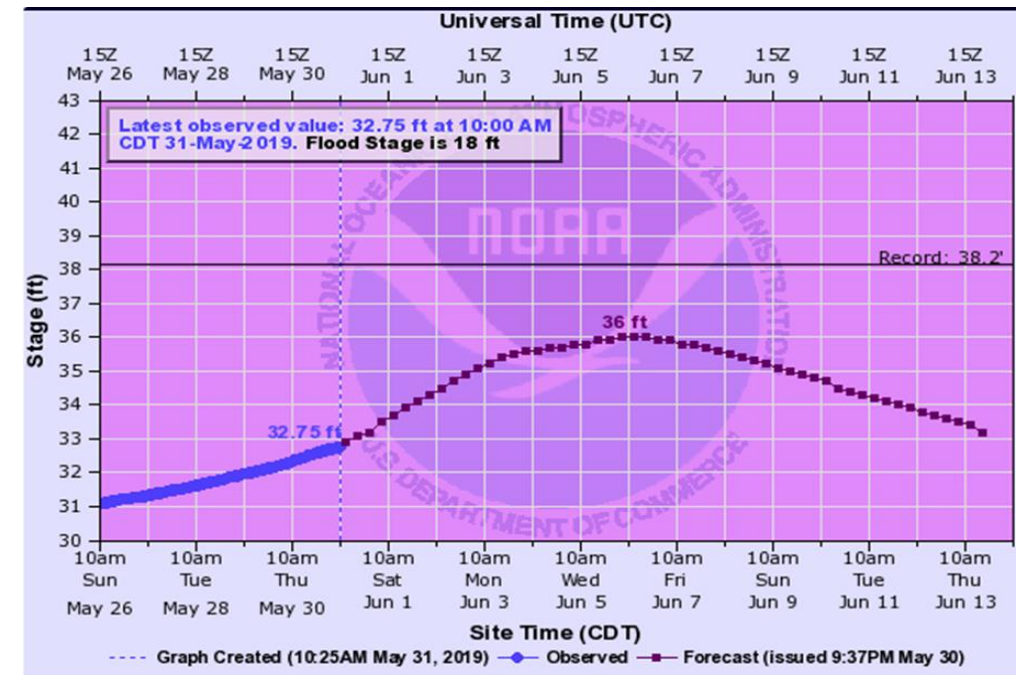
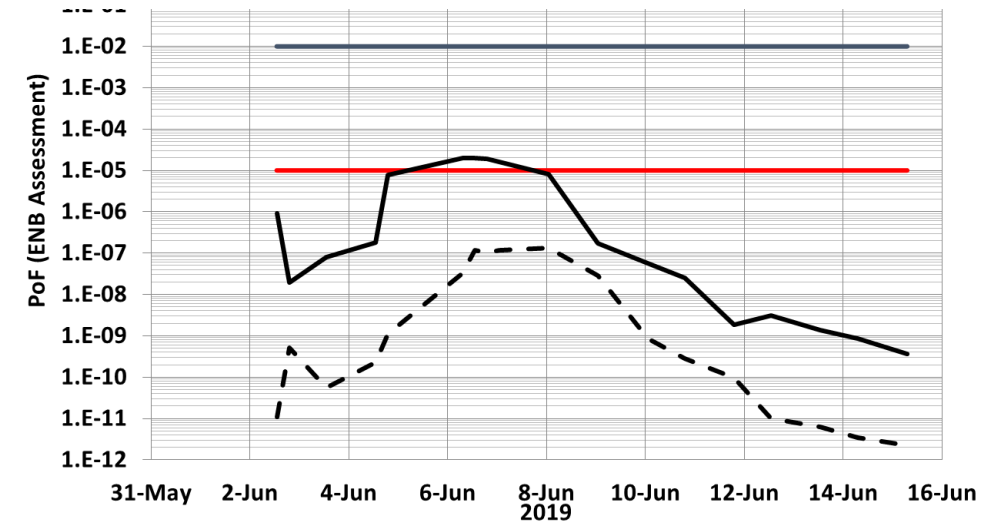
How much can the pipe take?

- DNVGL-RP-F105
- RiverX – PRCI
- VIV failure vs. bending stress
- What are the effects of appurtenances? River Weights? Coatings?
- Is debris loading a concern?



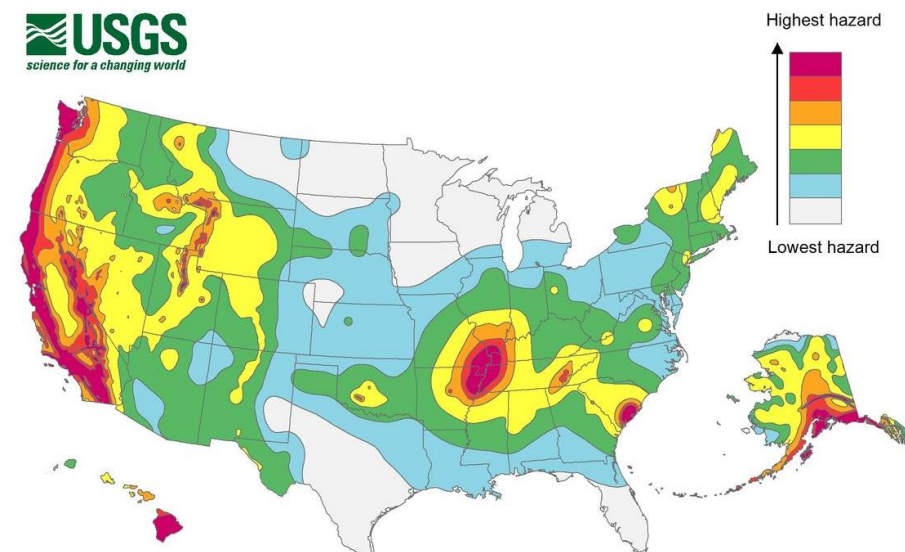
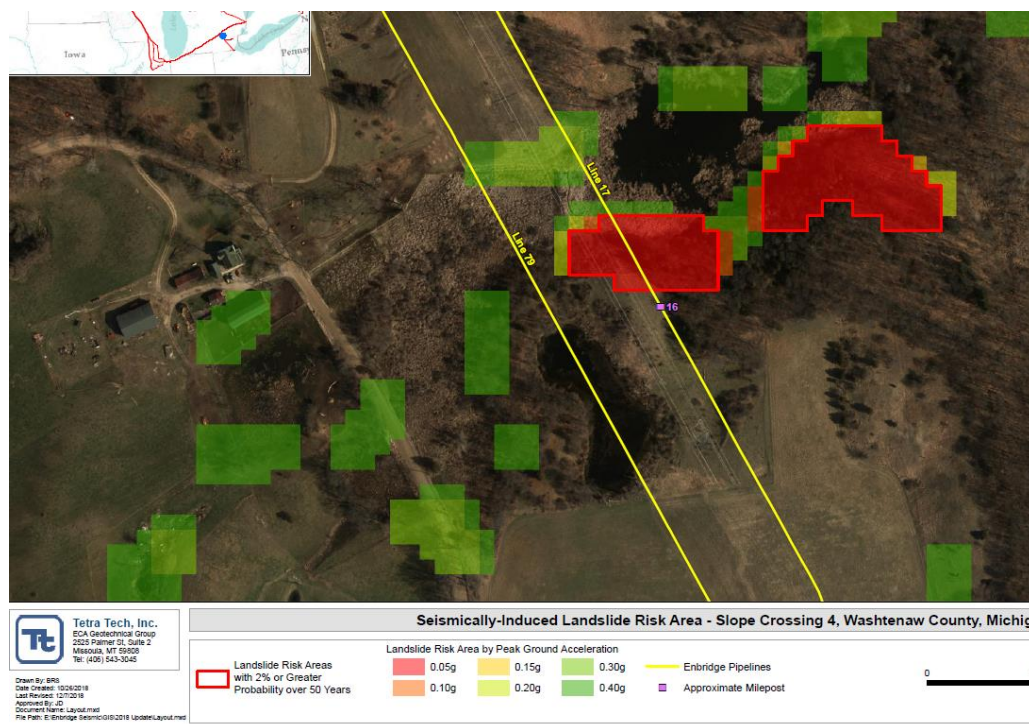
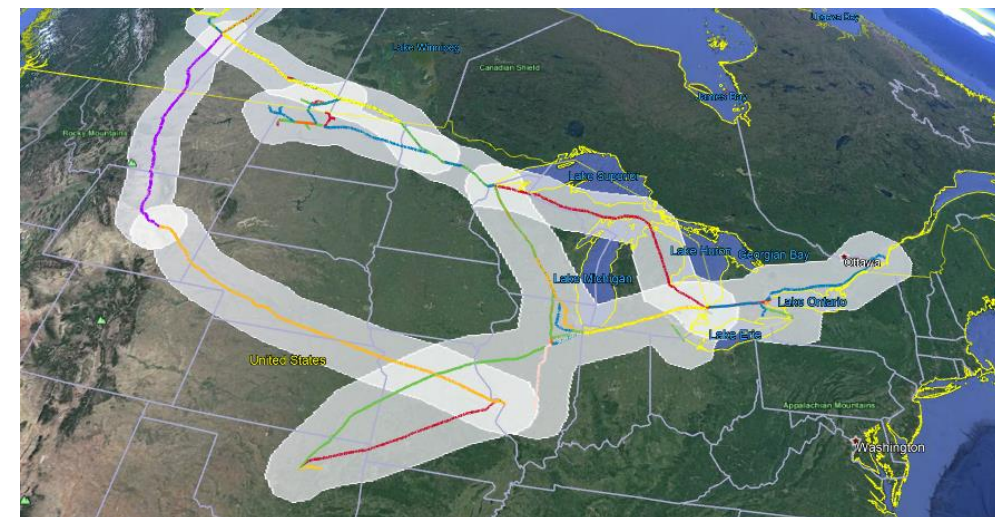
Response & Mitigation Actions

- Shutdown vs. Purge
- Liquid vs. Gas Response
- Armoring vs. HDD approval timing
- Design limits 1:100, 1:200, 1:500 unprecedented?



Other Geohazard Threats

- Subsidence Threats (Karst & Mining)
- Seismic – Susceptibility, Monitoring & Post event actions



Questions and Discussion
