

Alaska's Geotechnical Asset Management Program

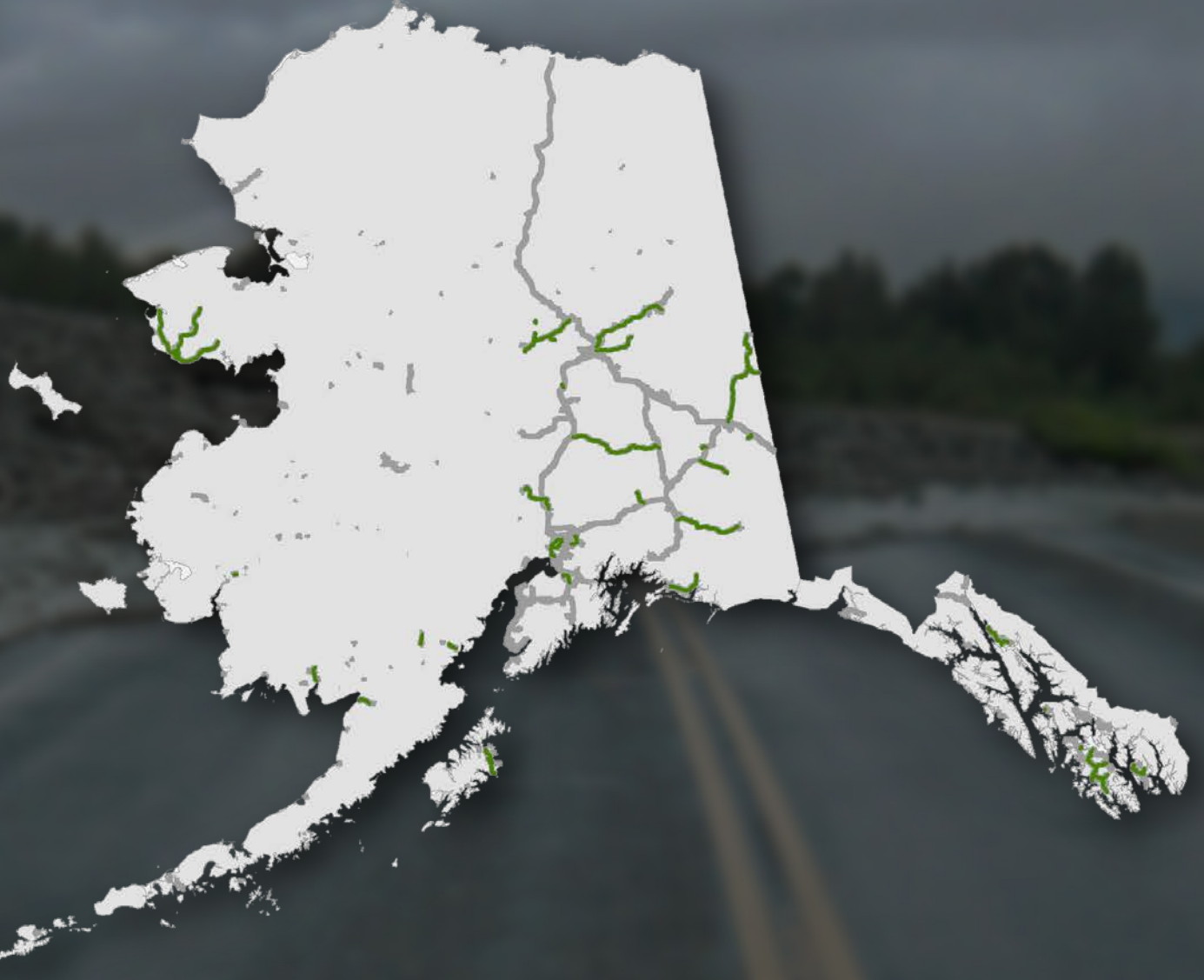
Darren Beckstrand
Aine Mines
Paul D. Thompson



Paul D. Thompson

AKDOT&PF Transportation Network

- Low public road lane mileage (31,618)...
- Low number of bridges (1,196)...
- Vast areas with limited or no connected road system...
- Air travel reliance— 255 airports managed by the agency.
- Extensive marine transportation network: 25 harbors, 33 terminals, 11 ferry vessels



AKDOT&PF GAM PROGRAM

Targeted Asset Classes:

- Rock Slopes
- Unstable Soil Slopes and Embankments
- Earth Retaining Walls
- Material Sites

Use of Online GIS Resources

AKDOT&PF Slope, Wall, & Material Site Management

The Alaska Department of Transportation and Public Facilities (AKDOT&PF) is completing development and implementing a Geotechnical Asset Management (GAM) Program which will help track rock slopes, unstable soil slopes/embankments, retaining walls, and material sites managed by the Department.

This map shows the location of all geotechnical assets in the program database, distinguished by color. The inventory currently contains 1,265 retaining walls, 1,003 rock slopes, 633 unstable soil slopes and embankments, and 2,919 material sites. This extensive inventory will help AKDOT&PF evaluate the overall health of its transportation system, instead of focusing only on under-performing sites.

AKDOT&PF's Rated Assets

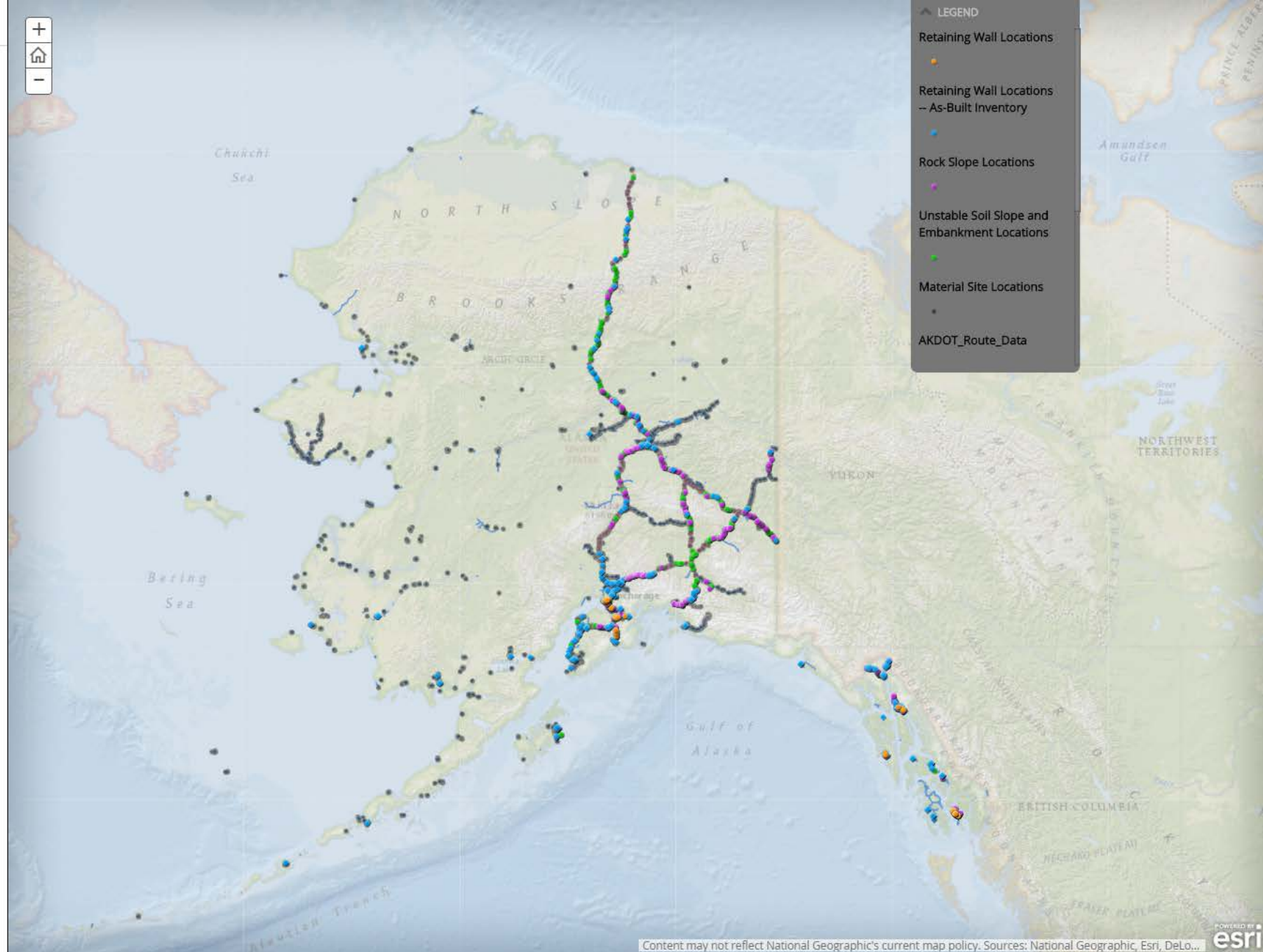
The primary interface for AKDOT&PF's GAM program is shown at right. This online GIS platform was used to compile the individual maps for all 4 geotechnical asset classes evaluated under the Department's current GAM program.

All evaluation data are available for mapping both with online and desktop GIS software platforms through AKDOT&PF's GIS server. Custom maps using data mined from the rating categories can be formulated and evaluated by geotechnical or planning personnel.

Determining the Condition of GAM Assets

TAM programs require that each asset be assigned a Condition State (Good/Fair/Poor). Inventoried assets receive a TAM-compatible Condition State based on select performance criteria. This Condition State can then be used to assess how well the department is meeting its goals for asset performance on a regional or statewide level. This Geotechnical Asset Management (GAM) program is designed to be TAM compatible. Rock slope sites around Long Lake are shown as Good/Fair/Poor classifications in the map at right.

Tracking Adverse Events



AKDOT&PF's Rated Assets

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Tracking Adverse Events



Rockfall event in Turnagain Arm, Alaska, on October 13, 2015.

In addition to database maintenance, powerful tools were implemented to track individual events. The Geotechnical Event Tracker (GeoForm) is designed to allow AKDOT&PF to easily add events requiring maintenance attention to the map at right. This map currently shows individual location-specific events mined from the MMS program as well as recent unstable slope events.

Better tracking of all geotechnical events will allow maintenance frequency, event size, and other site rating information to be improved. It will also improve assessments of risk and economic costs within the GAM program. Over time, it may also show areas where activity has increased, indicating asset deterioration. As an example, the video below shows rockfall events along the Turnagain Arm from 2009–2015, as obtained from the MMS.

Geotechnical Asset Management Program

Unstable Rock Slopes

Unstable Soil Slopes

Retaining Wall Assets

Material Site Assets

Fair & Poor Rock Slope Size Heat Map

ESAreaN



AKDOT_Route_Data

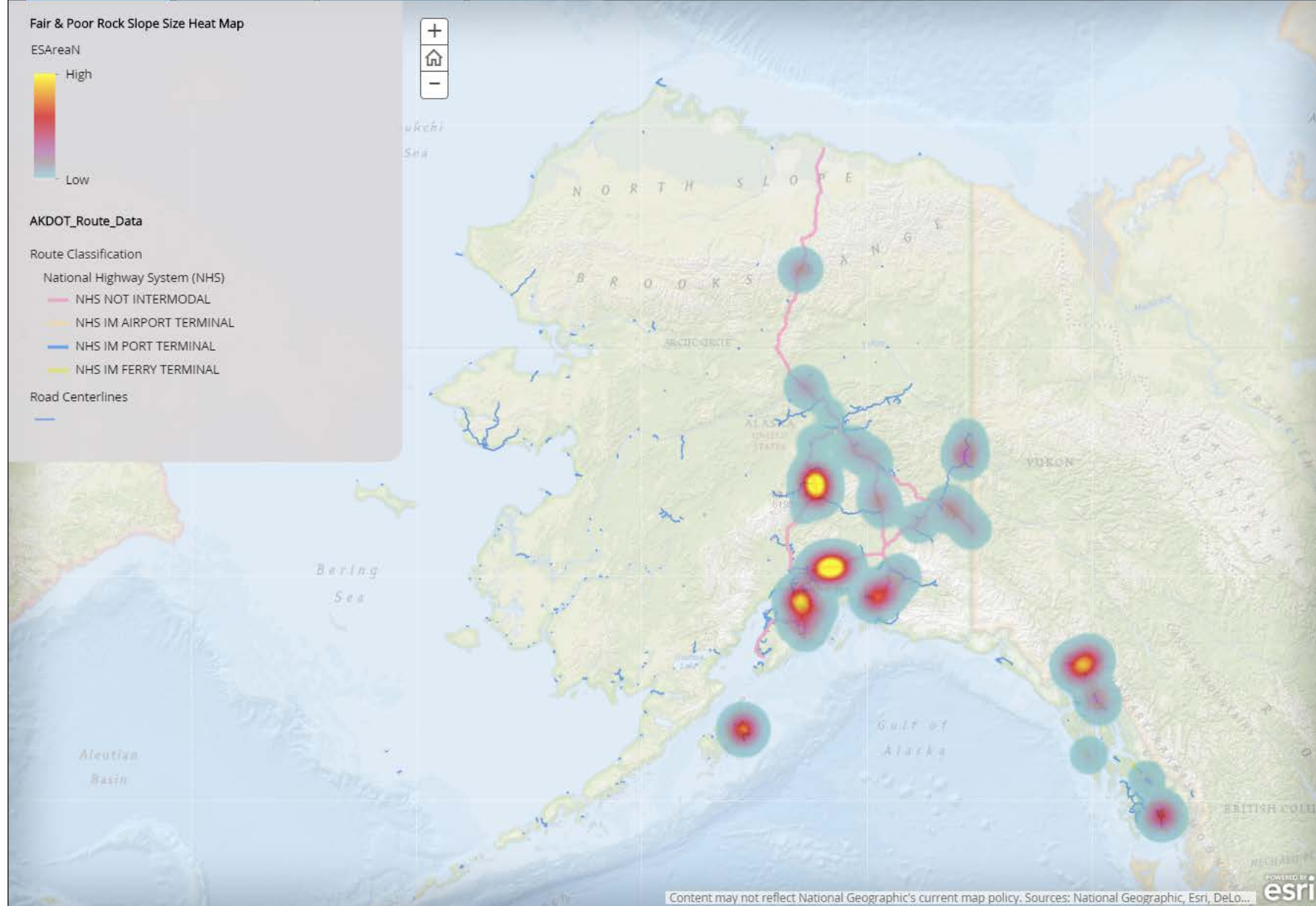
Route Classification

National Highway System (NHS)

- NHS NOT INTERMODAL
- NHS IM AIRPORT TERMINAL
- NHS IM PORT TERMINAL
- NHS IM FERRY TERMINAL

Road Centerlines

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Tracking Adverse Events



Rockfall event in Seward, Alaska on Hwy 97, 1.5 January 2015.

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Geotechnical Asset Management Program

Unstable Rock Slopes

Unstable Soil Slopes

Retaining Wall Assets

Material Site Assets

Fair & Poor Condition Soil Slopes - Heat Map

MSLengthN

High

Low

AKDOT_Route_Data

Mileposts

Mileposts Points < 1:3 mil > 1:1 mil

Route Classification

National Highway System (NHS)

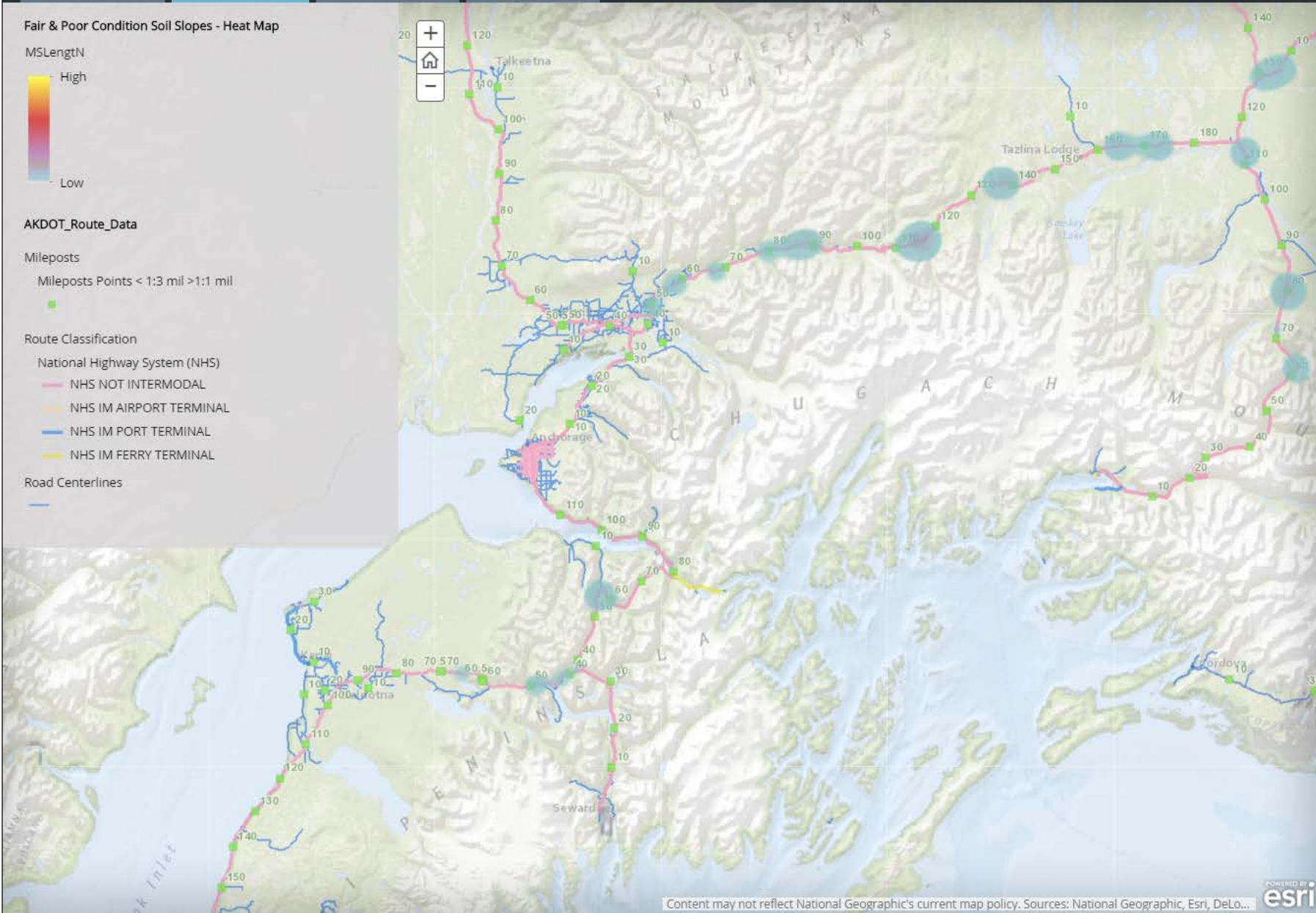
NHS NOT INTERMODAL

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AKDOT&PF Slope, Wall, & Material Site Management

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Tracking Adverse Events



Rockfall event in Longlake region on Hwy 40, 1.5 January 2015

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Geotechnical Asset Management Program

Unstable Rock Slopes

Unstable Soil Slopes

Retaining Wall Assets

Material Site Assets

Retaining Walls

- POOR
- FAIR
- GOOD

Retaining Walls -- As-Built Inventory

●

Fair & Poor Retaining Wall Area Heat Map

EWAreaN



AKDOT_Route_Data

Mileposts

Mileposts Points < 1:3 mil > 1:1 mil

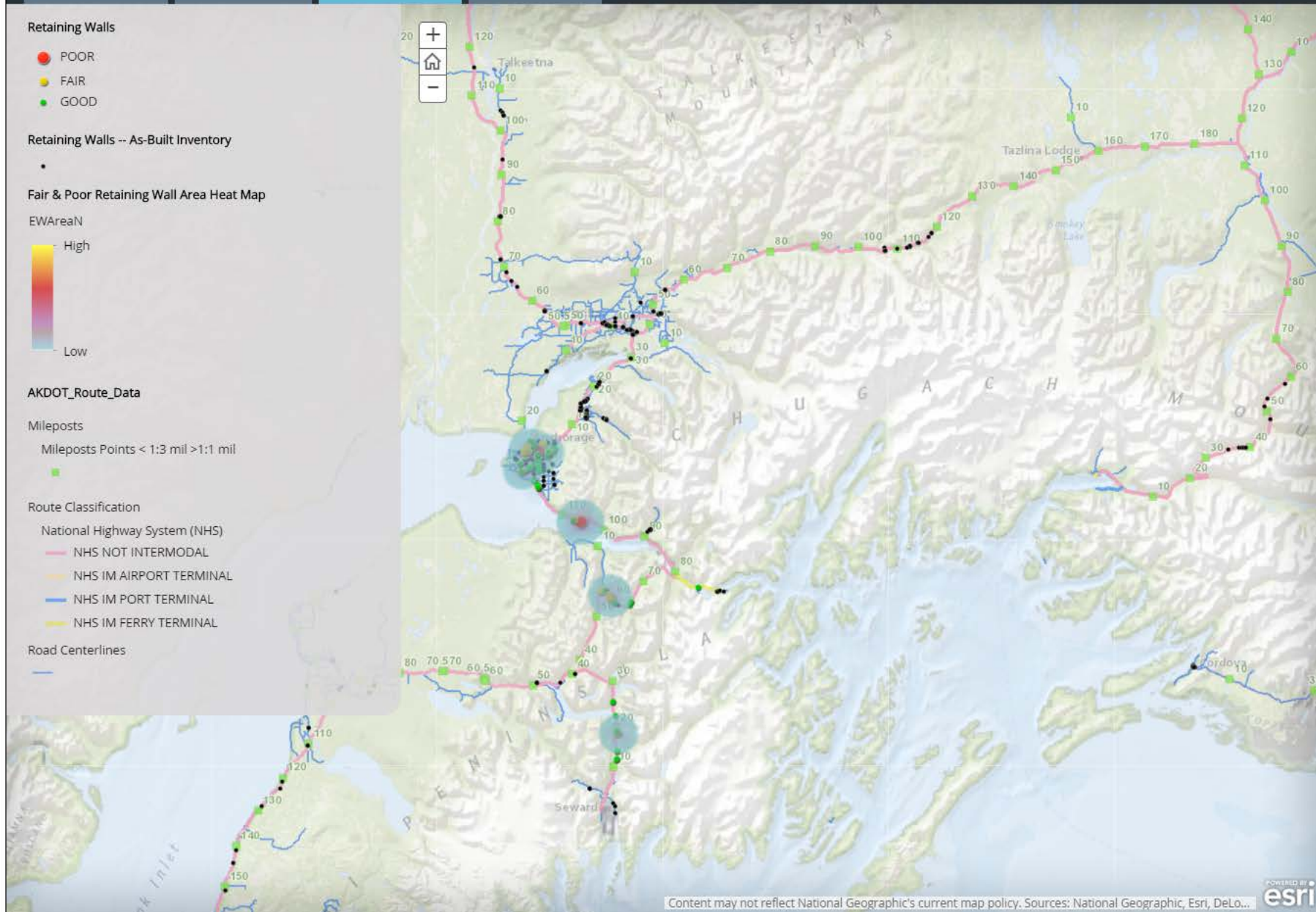
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Rockfall event in Seward Creek region on Seward Rd. 1.5 January 2015.

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Geotechnical Asset Management Program

Unstable Rock Slopes

Unstable Soil Slopes

Retaining Wall Assets

Material Site Assets

This map contains data from the Material Site Inventory (MSI).

STIP_AGOLv38 - STIP Points

Valuable Material Sites

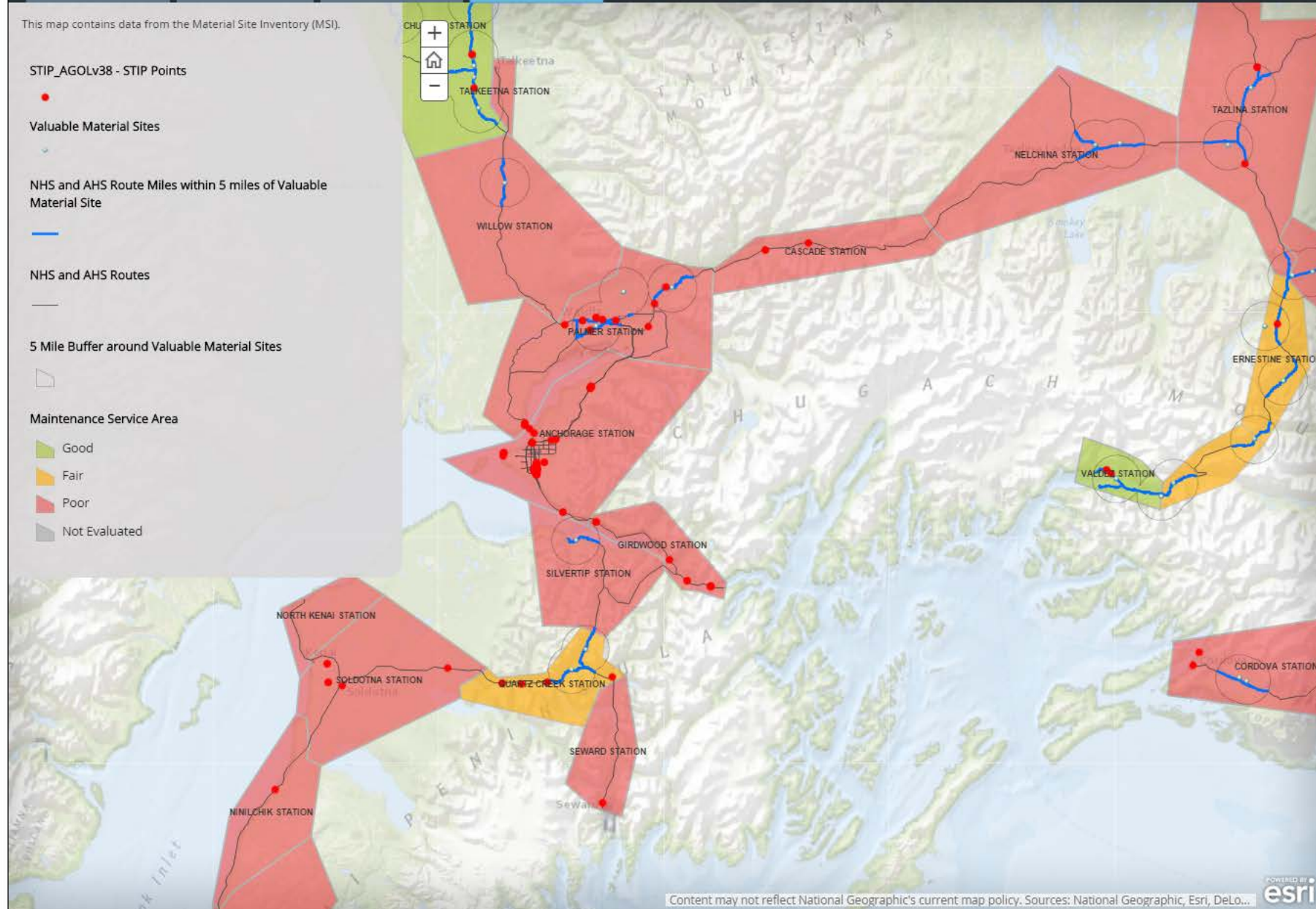
NHS and AHS Route Miles within 5 miles of Valuable Material Site

NHS and AHS Routes

5 Mile Buffer around Valuable Material Sites

Maintenance Service Area

- Good
- Fair
- Poor
- Not Evaluated



GAM Program Overview

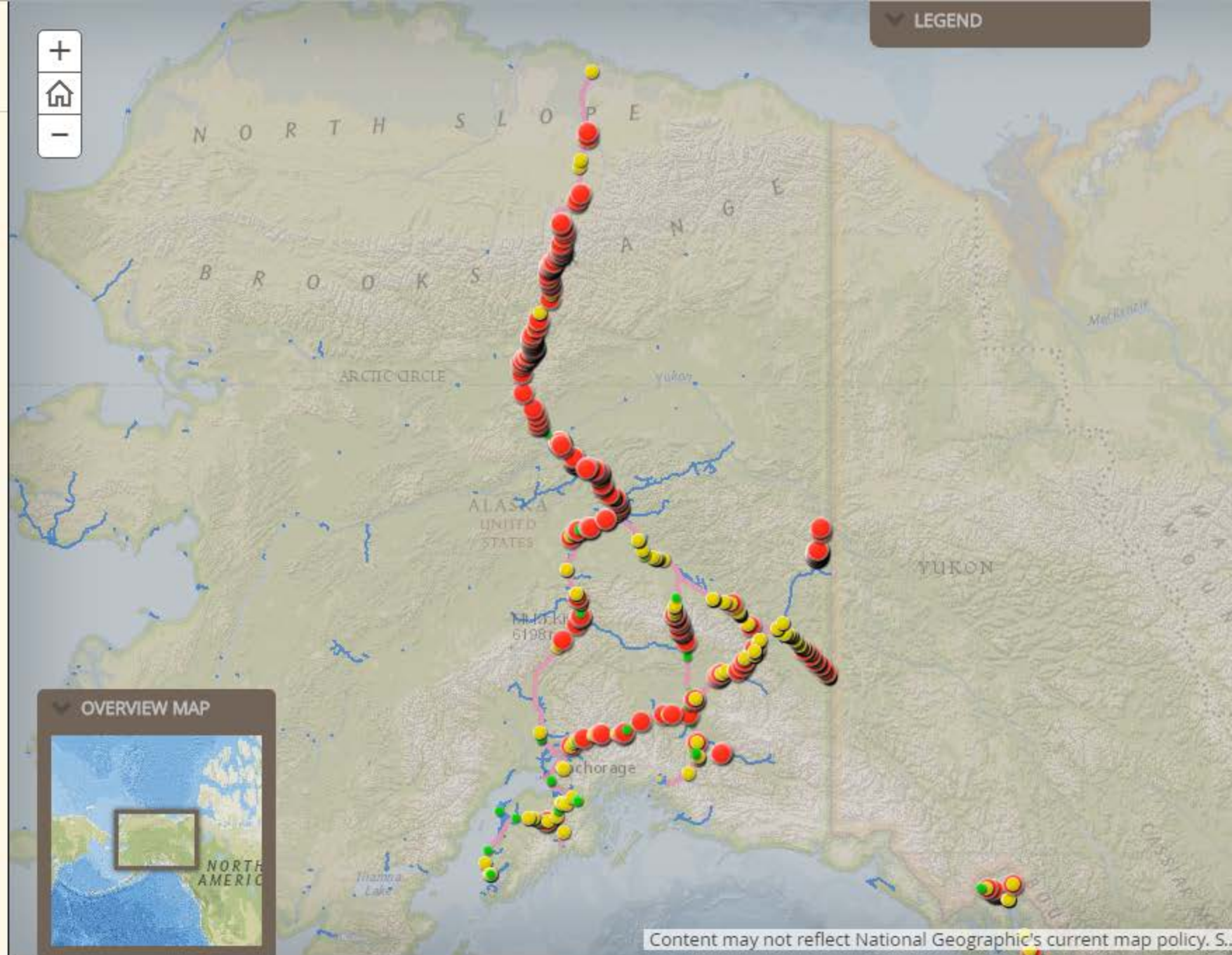
Integrating USMP Unstable Soil Slope and Embankment Assets into GAM



Repeated patching required to address frost heave on the Elliott Highway, MP 48.3. This embankment is in a Poor Condition State due to permafrost-related instability.

The Condition State map of unstable soil slopes and embankments shown at right helped highlight that most of AKDOT&PF's poorly performing soil slopes/embankments are located in the Northern Region, where permafrost impacts are a dominant concern.

The developed Condition States can be directly mapped to TAM's Good/Fair/Poor criteria. The



Applying GAM - Incorporating Thawing Permafrost Risks



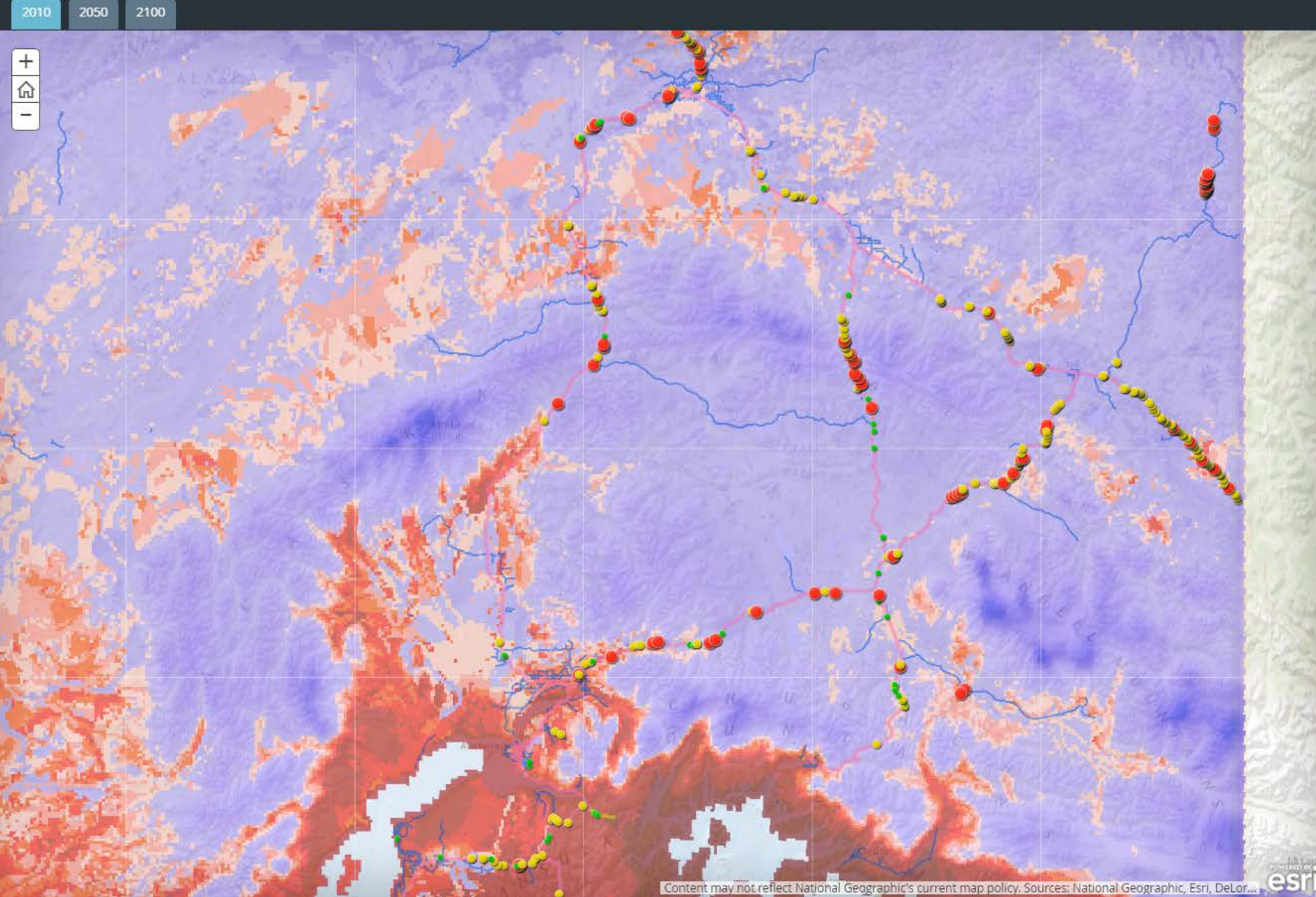
Thawing permafrost causing embankment damage. Tok Highway, MP 42.

Throughout Alaska, mean average ground temperatures are projected to increase throughout the next century. Work conducted under Dr. Marchenko at the University of Alaska at Fairbanks modeled projected warming of Alaskan soils, and created the Alaska Permafrost Risk Application. When coupled with AKDOT's existing unstable soil slope inventory, this model can help the department predict areas where thawing permafrost will result in increased maintenance requirements and prepare long-term budgets accordingly.

Applying GAM - Combining Activity and Asset Improvement Costs



Alaska Permafrost Risk Model



Applying GAM - Incorporating Thawing Permafrost Risks



Thawing permafrost causing embankment damage. Tok Highway, MP 42.

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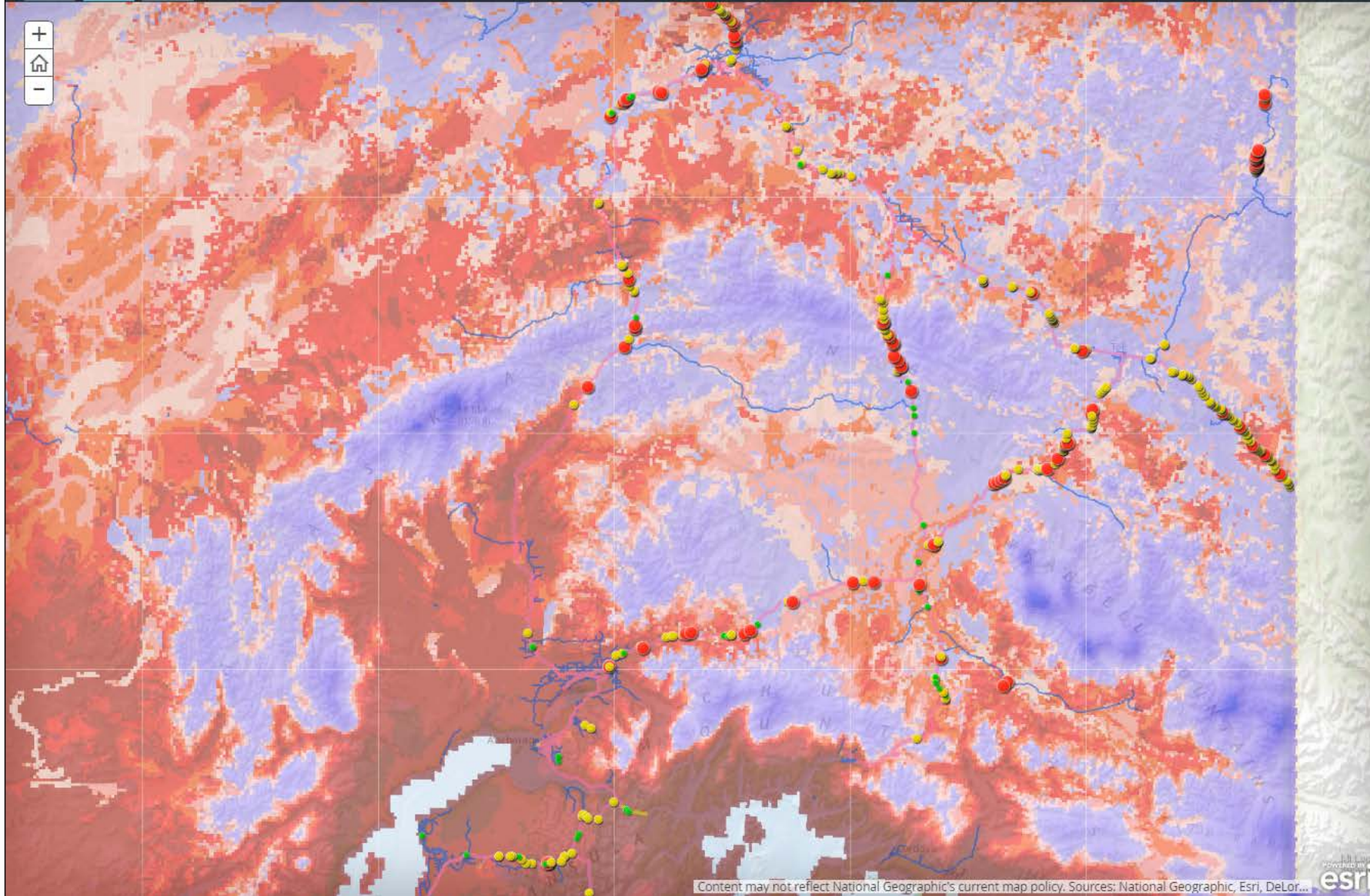



Alaska Permafrost Risk Model

2010

2050

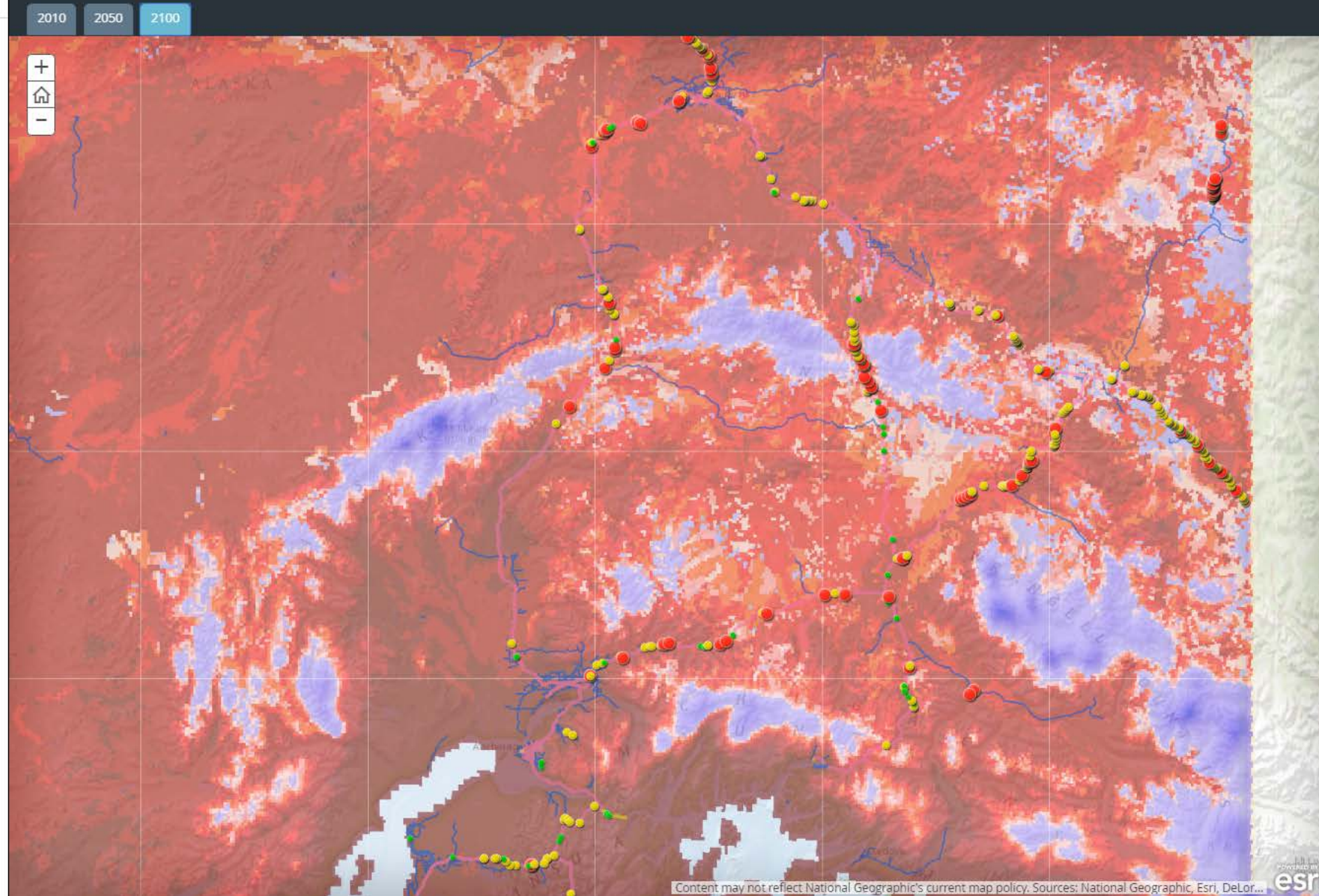
2100



Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLor... 

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Applying GAM - Combining Activity and Asset Improvement Costs



Resilience in geotechnical asset management

Material condition

Raveling of rock or wall face
Disintegration of rock face or wall
Differential erosion
Debris accumulation
Deformation of wall or soil slope
Water infiltration and accumulation
Loss of vegetation
Permafrost degradation

Contributing properties

Ice and freeze/thaw
Design criteria
Geological character
Climate
Drainage and hydrology
Presence of mitigation features
Geometry and size of slope face or wall
Permafrost quality
Wall foundation

Established practice in half the US states, e.g. Rockfall Hazard Rating Systems

Timely mitigation highly cost-effective



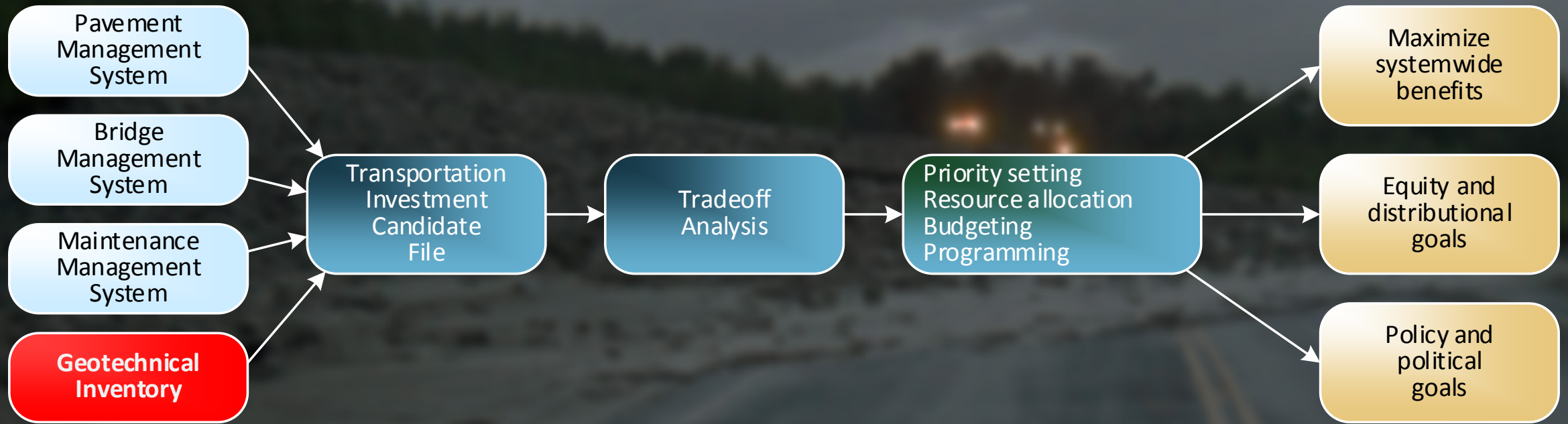
- Finding the best opportunities requires quality asset inventory and condition data
- \$1 spent improving slope and wall conditions not only pays for itself ...
... It returns an additional \$1.06 to the Department and road users!

A massive problem

Rock slopes \$ 3.9 billion	Soil slopes \$ 14.4 billion	Retaining walls \$ 0.7 billion
Good 27%	Good 22%	Good 73%
Fair 65%	Fair 47%	
Poor 8%	Poor 31%	
		Fair 23%
		Poor 4%

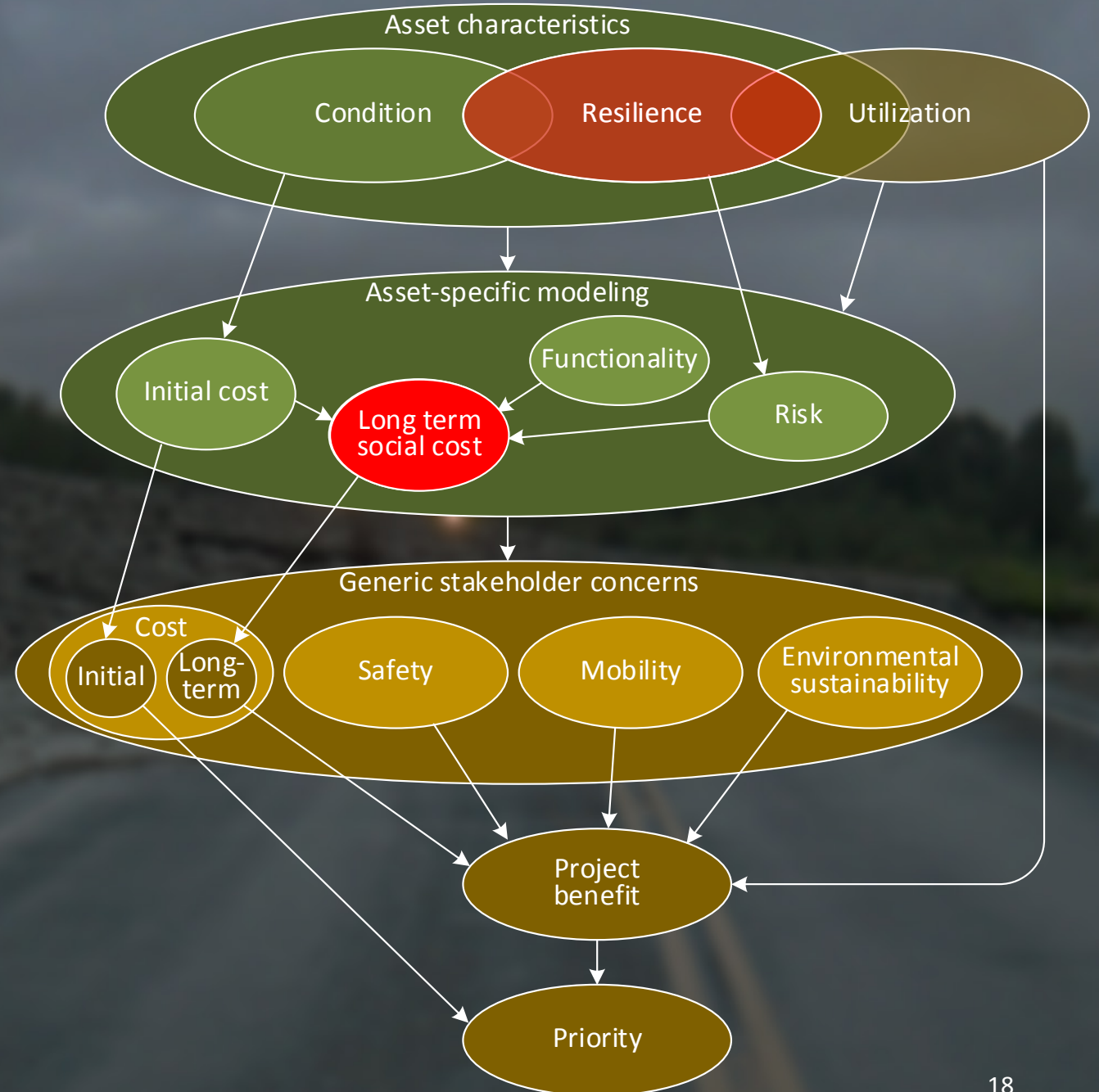
- \$19 billion in geotechnical assets – 3 times the value of the bridge inventory

Fitting GAM into TAM

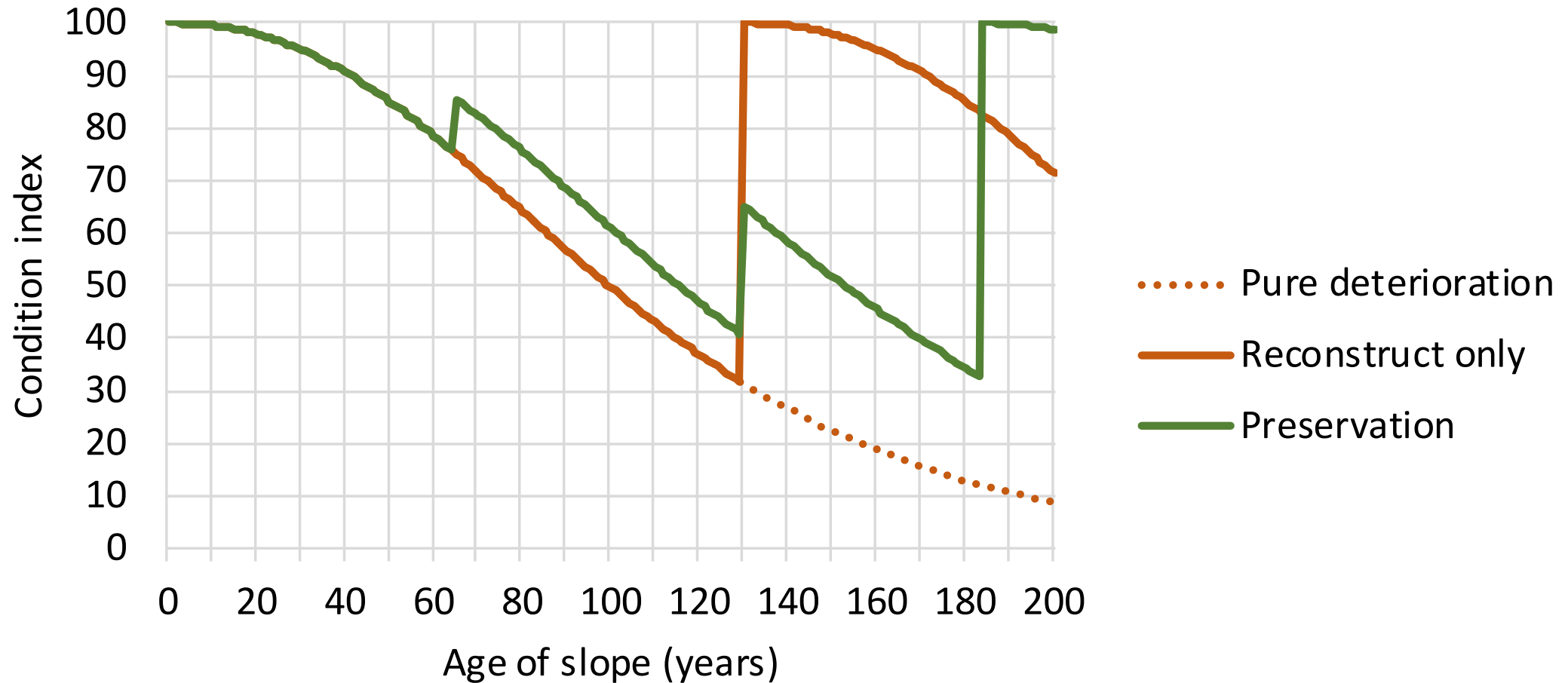


Resilience

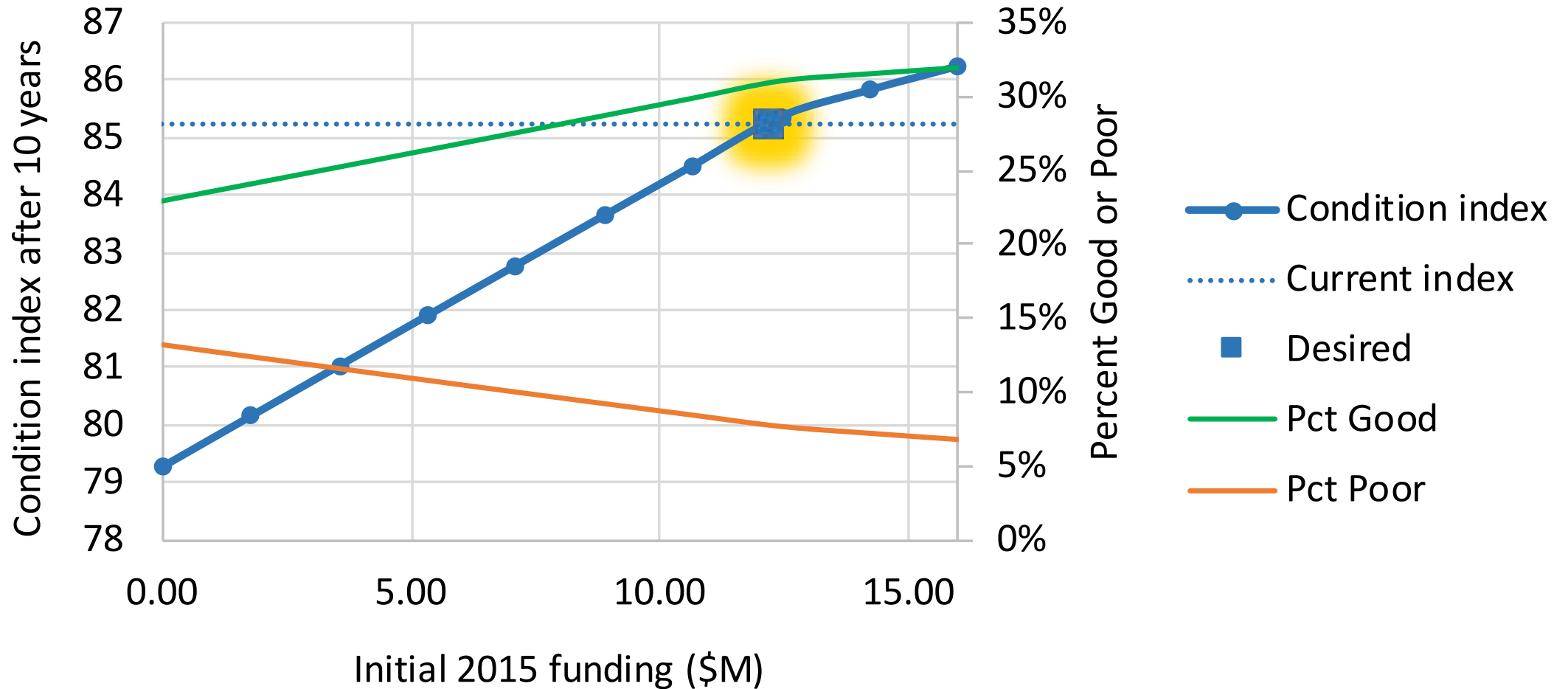
- In the same way condition affects long-term cost, **resilience** affects safety, mobility, and sustainability
- Long-term social cost integrates these concerns
- *Cross-asset*
- *Multi-objective*



Life cycle activity profile: rock slopes



Funding vs. condition tradeoff



Conclusions

- Nation's first comprehensive GAM system
- NHS & AHS assessments underway



Thank you!



Paul D. Thompson