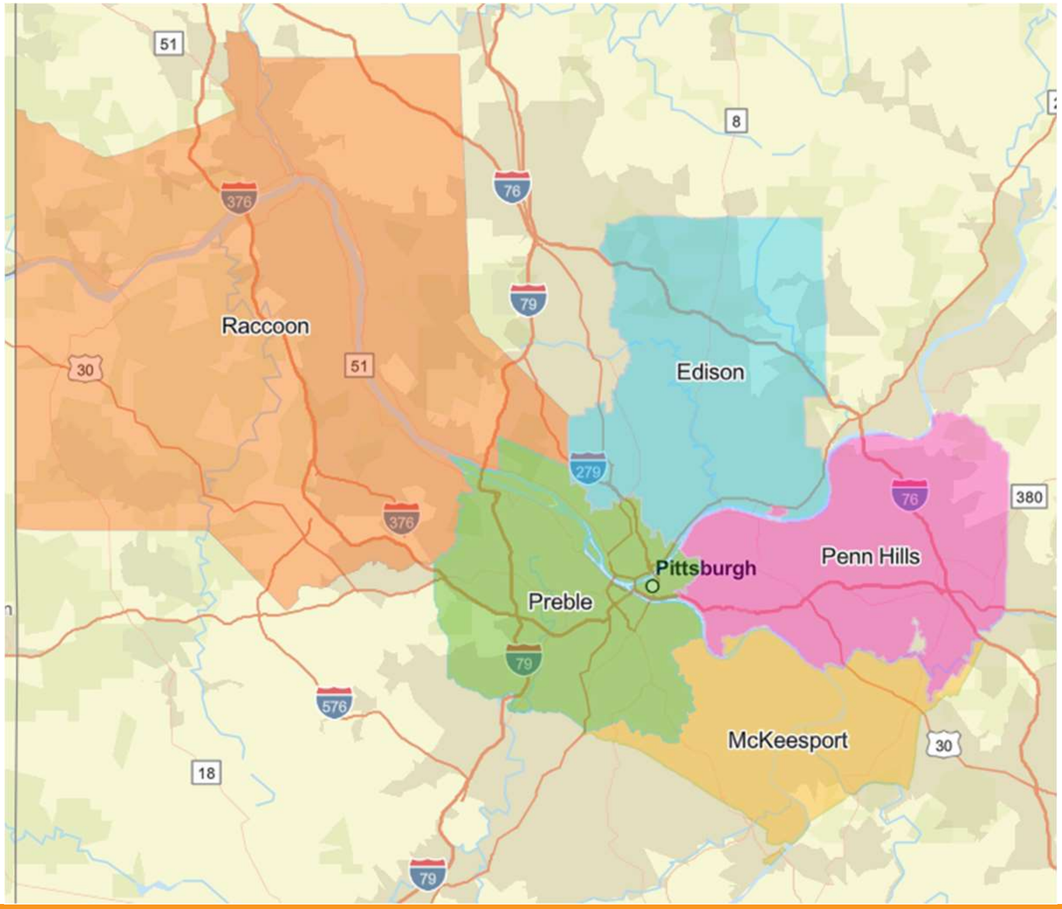
Fall 2024 Energy Association of PA Meeting
Managing Natural Disasters

Duquesne Light Company - Transmission Tower Landslide Response

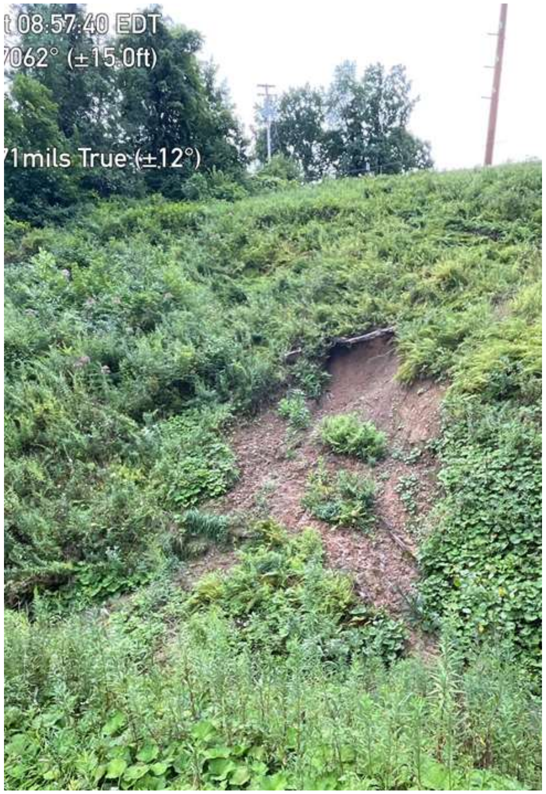
Service Territory

- 600 Miles of OH Transmission Line
- 50 Miles of UG HPFF Pipe Cable
- Primarily 138kV and 345kV voltage levels
- OH Structure Demographics
  - DLC owns and operates approximately 3,200 transmission structures
    - 46% are 138kV lattice towers - avg age of 80 years
    - 29% are 138kV wood poles - avg age of 36 years
    - 19% are 345kV structures - avg age of 45 years
    - 6% are 138kV monopole - avg age of 30 years
- Footprint of disturbance has evolved over 100 years of system construction



Landslide Disaster Response and Risk Assessment at DLC

Landslide Disasters?



Non-Hazard

Hazard

Danger, Risk, Impact not Realized

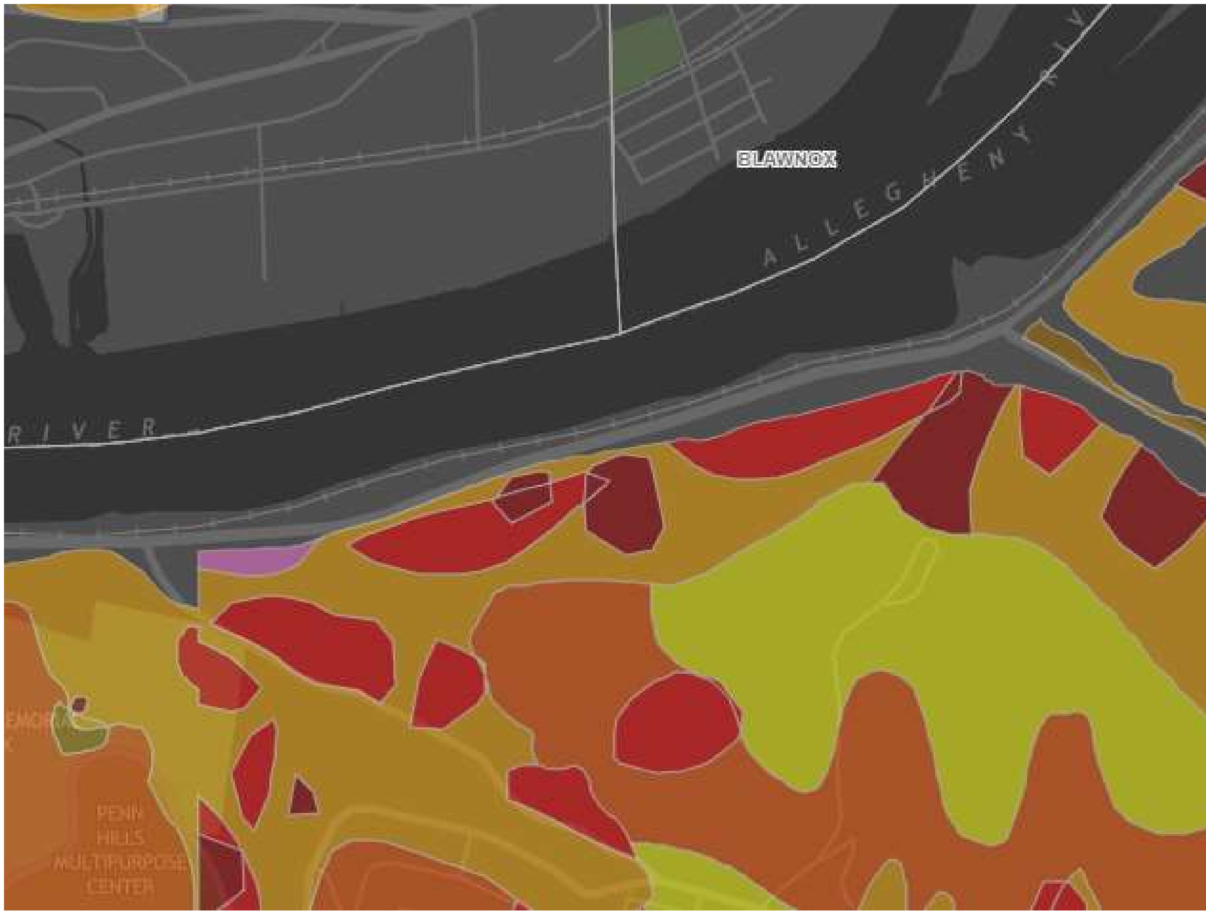
Disaster

Sudden, Calamitous, Impactful

Landslide Disaster Response - Emergency Structures Program & Emergent Service Partnerships

- Overall purpose
  - The availability of emergency transmission structures increases the reliability of the DLC transmission system by providing a contingency replacement plan to minimize outage duration from structural failures, including from landslides.
- Design
  - Direct embed monopoles will be utilized to restore 138kV or 345kV Structures
  - Structure heights range from 80’ -160’ in 10’ increments, providing greater flexibility.
  - Total of 24 structures to replace 12 dual circuit towers
  - Parametric study considering variability in soil conditions and environmental loads across system.
  - Approximately 92% coverage area, (*~2,950 strs)*
- Strategic Emergent Service Partnerships
  - DLC has blanket service contracts for environmental consulting and civil construction to support deployment of emergency structures.
  - Service partners also have access to relationships with specialty design-build geotechnical construction contractors with unique capabilities regarding landslide mitigation design

Preparing for a Landslide Disaster – Landslide Incidence



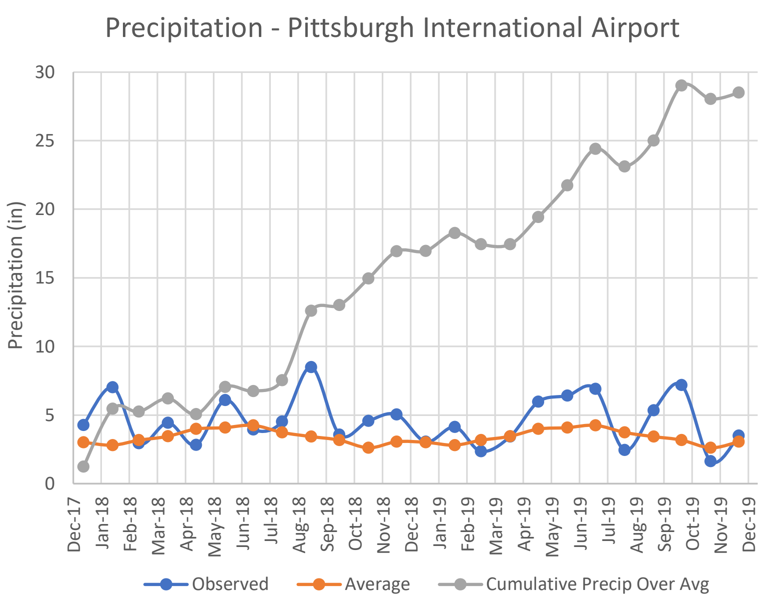
ACTIVE OR RECENTLY ACTIVE LANDSLIDE
Complex landslide composed of earthflow, debris slide, earth and rock slump. Identified from historical records, and from scars, debris and other field evidence. Ground extremely unstable; sliding accelerated by excavation, loading and changes in drainage conditions. May include areas with several active slides too small to be shown separately. Questioned where doubtful.

OLD LANDSLIDE
Area of extensive hummocky ground caused by earthflow and earth and rock slump. Lacks clear evidence of active sliding. Relatively stable in natural, undisturbed state, generally not affected by small structures properly sited in areas away from the edge of the toe; can be reactivated by extensive, rapid excavation, loading, and changes in ground water and surface water conditions. Area of old landslide probably includes recent ones not identified from field evidence or otherwise documented. Upslope boundary of landslide generally defined by modified scarp, but downslope (toe) may be gradational and not well defined. Questioned where doubtful.

SOIL AND ROCK SUSCEPTIBLE TO LANDSLIDING
Soil and rock similar to that involved in landslides elsewhere in map area; primarily areas underlain by claystone, mudstone and shale associated with other rock types. Rock weathers rapidly on exposure forming clayey soil highly susceptible to sliding. Includes coves (U-shaped, shallow valleys) containing thick layers of clayey soil that are very susceptible to sliding where excavation breaks continuity of slope and where overloaded by artificial fill.

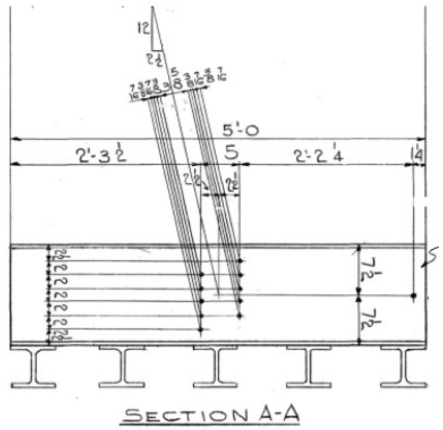
Preparing for a Landslide Disaster – Temporal Changes

Precipitation, Human Activity, Seismicity, Rapid Water Level Change

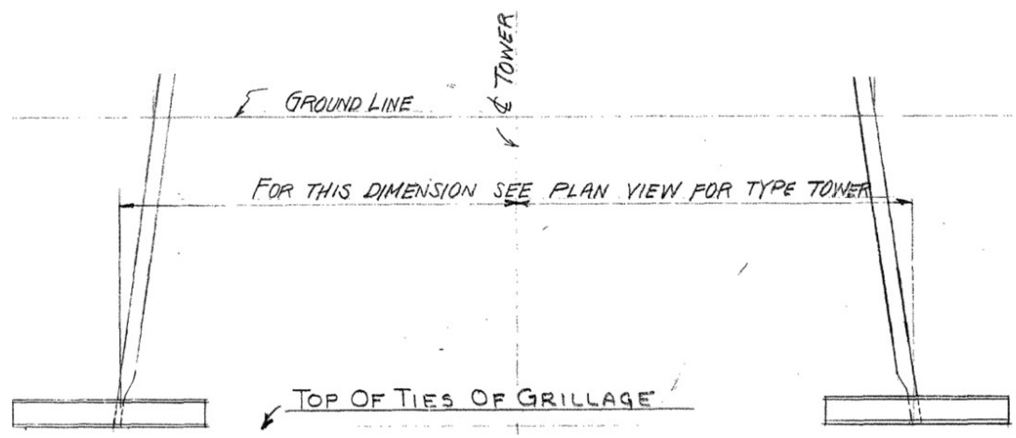


Landslide Risk Management Case Study

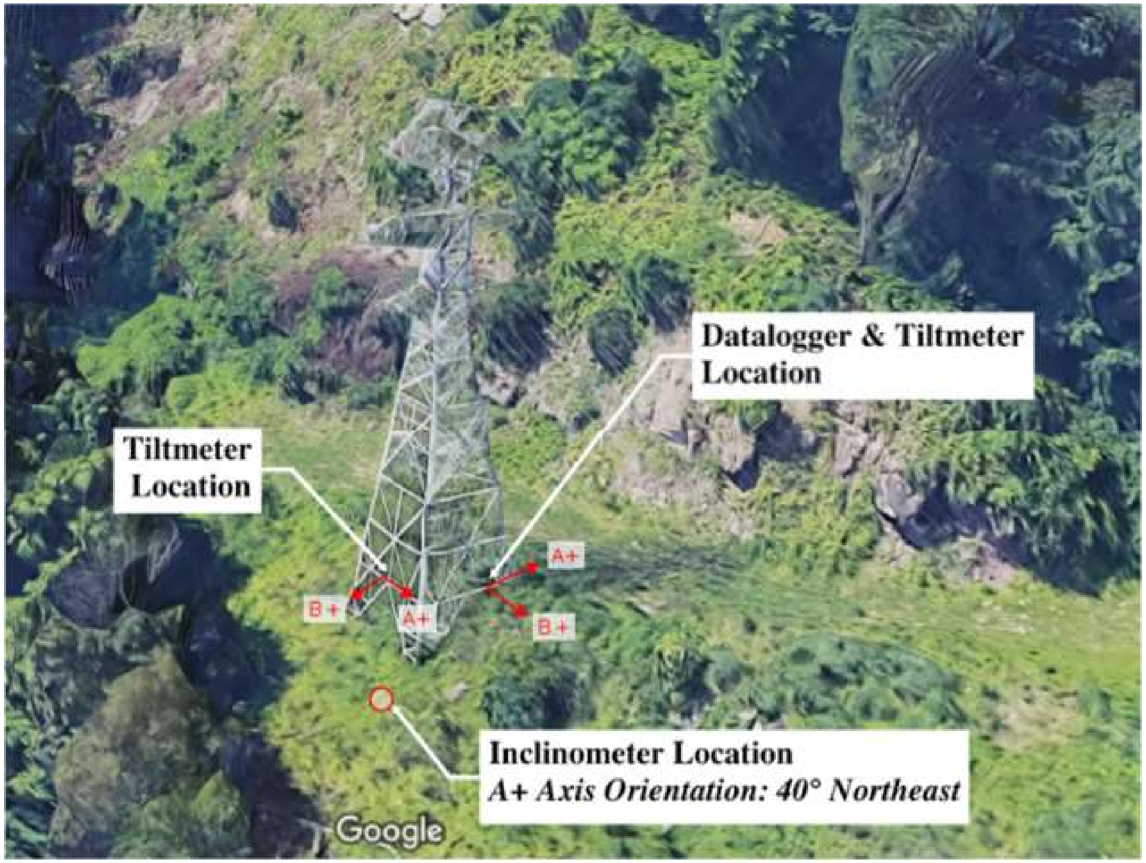
Risk Assessment / Risk Management



- Landslide limits overlap with tower, but is the tower affected?
- The ground has moved, is it still moving or done moving?
- How often are conditions revisited and what sort of assessment is repeated at each visit?



Instrumentation Program



Instrumentation Program

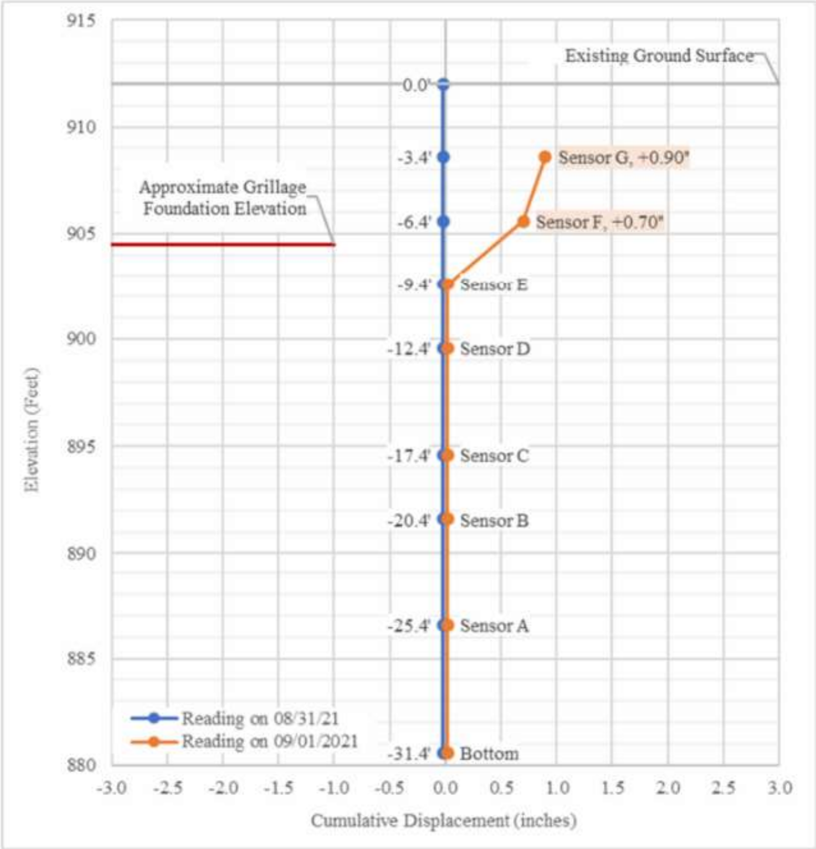
Instrumentation Data

Data Collection and Management

- Sensor data collected hourly, transmitted via cellular modem every twelve hours
- Data hosted and processed/presented on a DLC accessible cloud-based server
- Data server configurable with alarm points to automatically notify users if alarm points are reached

Inclinometer Data

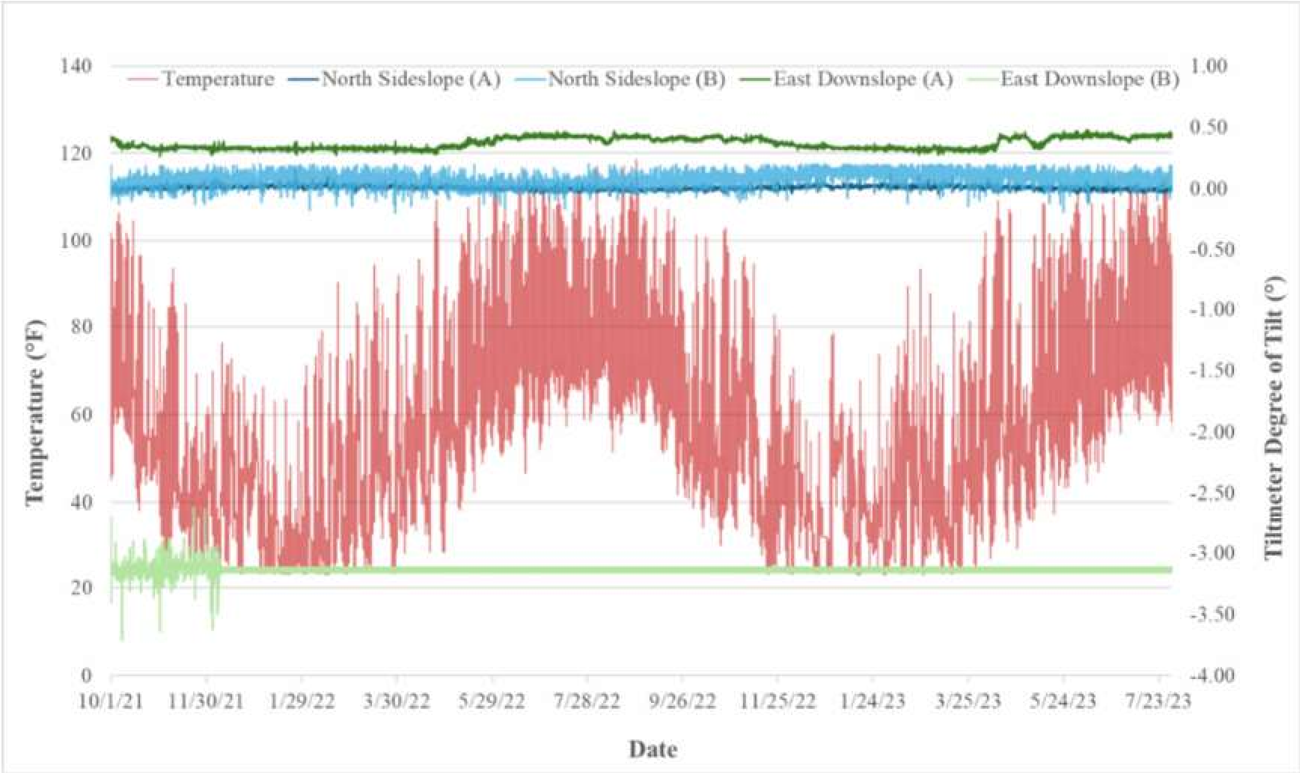
- The monitoring system was completed in August 2021. On September 1, 2021 the remnants of Hurricane Ida moved through the region dumping 2.31 inches of rain (the largest single day rainfall in 2021).
- Online dashboard was viewed to trigger ground inspection
- Movement was observed in the ground between 6.4’ and 9.4’ below the ground surface which was below the depth of the grillage foundation.
- Tiltmeter data was steady and a subsequent visual inspection indicated no impact to the tower



Instrumentation Data

Tiltmeter

- Thresholds set at ± 0.75 deg tilt (~3" differential settlement)
- Wild fluctuations of around 1 deg early on in one tiltmeter, AC interference.
- Supplemental grounding effort in Nov 2021 resolved
- Lesson learned to utilize non-metallic mounting plates and metal conduits for sensor wires



QUESTIONS?