ls & Advisory Bulletin

Investigator

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cal Advisor

U.S. Department of Transportation
Pipeline and Hazardous Materials Safety Administration

PHMSA: Your Safety is Our Mission

Discussion Topics

- Case Study 1 – Satartia, Mississippi Carbon Dioxide Pipeline Rupture
- Case Study 2 – Hillsboro, Kentucky Natural Gas Pipeline Rupture
- PHMSA Regulatory Oversight Regarding Geohazard Identification and Management
- PHMSA Advisory Bulletin ADB-2022-0063

Case Study 1: Denbury Satartia, Mississippi

Accident Details

- Occurred 1 mile southeast of Satartia, Mississippi
- 200 people were evacuated
- 45 individuals sought medical attention
- Over 30,000-barrels released

OPID 32545 - Denbury Gulf Coast Pipelines, LLC - Satartia, MS. 2/22/2020

Pipeline Details

- 24-inch diameter liquid carbon dioxide (CO_2) pipeline:
  - Constructed in 2009
  - API 5L X80
  - 0.469-inch wall thickness
  - FBE coating
  - E6010 root pass, E9018, then E10045 electrode
- 77 miles (Jackson Dome, Mississippi to Delhi, Louisiana)
- Primary use is for Enhanced Oil Recovery (EOR)

2014 Google Earth image

Earth Movement: Two Key Factors

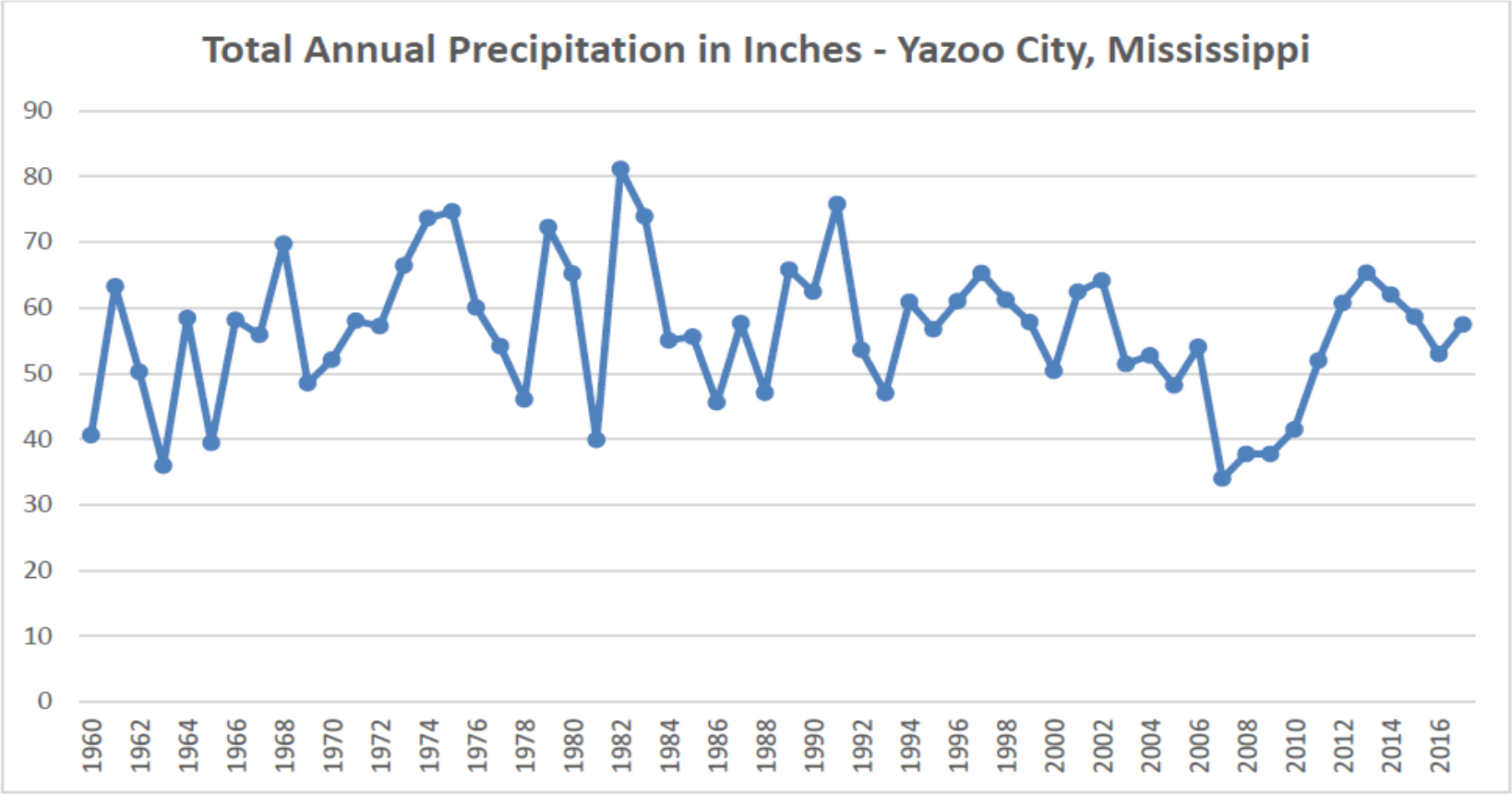
- Loess Soil
- Precipitation

Loess Soil

Photo courtesy of the US National Parks Service

- Sandy and silty, <20% clay – accumulation of wind-blown dust
- Highly porous with vertical capillaries
- Erodes readily

Rainfall History



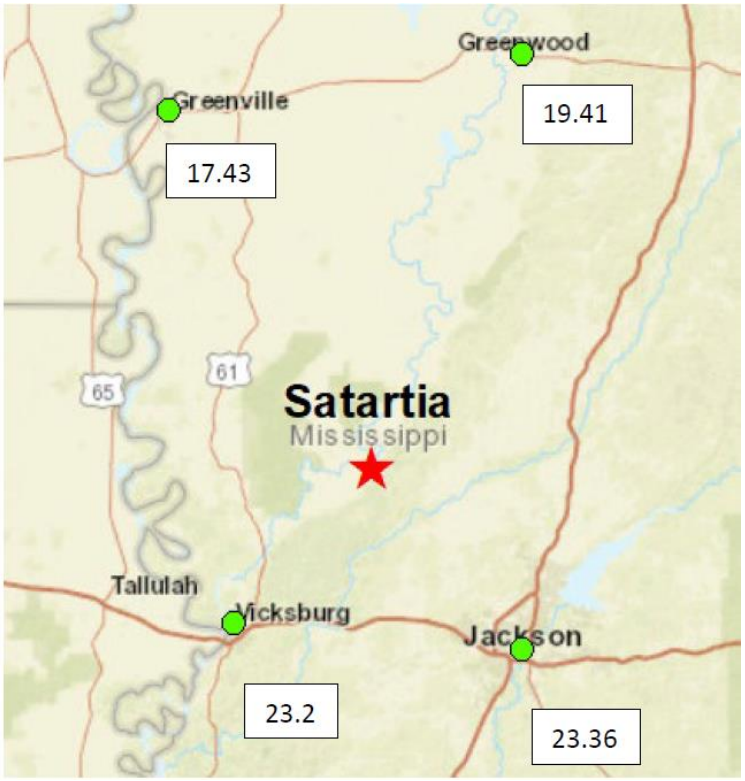
Graph of Annual Rainfall in Yazoo City from 1960 to 2017 – Data averaged for years 1996, 2004, 2008 and 2009

Rainfall History

The cities of Greenville, Greenwood, Vicksburg, and Jackson, Mississippi form a relative square around Satartia and Yazoo County.

According to the National Weather Service (NWS), accumulated rainfall for each of these cities between January 1, 2020, through February 29, 2020 (60 days) was 17.43 inches, 19.41 inches, 23.2 inches, and 23.36 inches of rain, respectively.

The amount of rain recorded in these four cities was **between 7.44 and 13.63 inches above the annual historical average** for the same 60-day timespan.



Findings and Contributing Factors

The failure of the Delhi Pipeline was a result of **soil movement**, which caused excessive axial loading leading to failure at the girth weld.

Area topography, soil type and large amounts of rain over the preceding months saturated and vertically eroded the loess soil on the side of the hill above the pipeline.

Case Study 2 – Hillsboro, Kentucky

Enbridge / Texas Eastern
Hillsboro, Kentucky

National Transportation Safety Board Investigation Report Number PIR-22-01

Accident Details

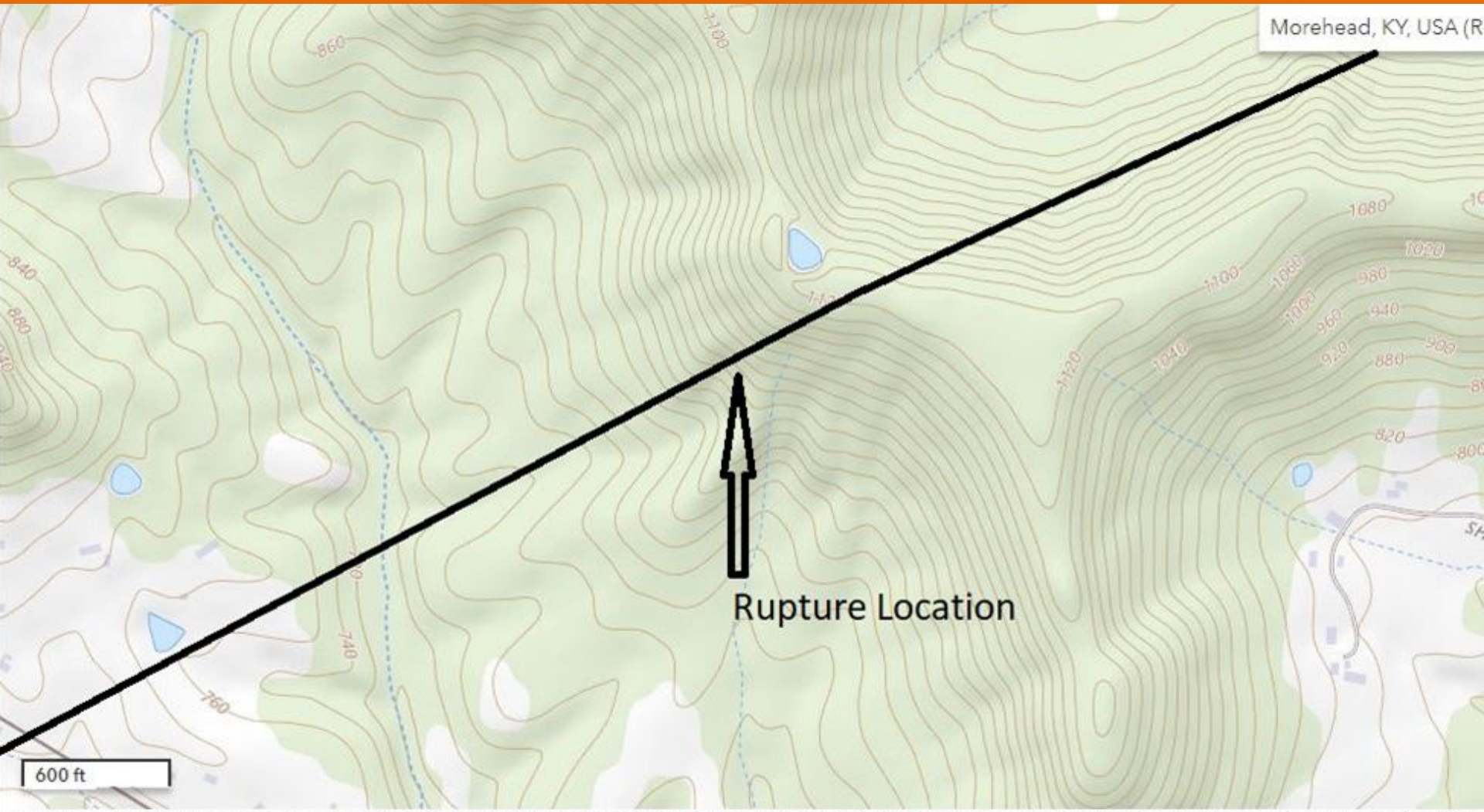
- May 4th, 2020, rupture and fire
- 1952 vintage Line 10
- 30-inch diameter 0.375 wall thickness
- Known geohazard site
- Operator made site visits prior to the rupture
- Multiple IMU data sets available
- Site was on a list to remediate

Ruptured Girth Weld

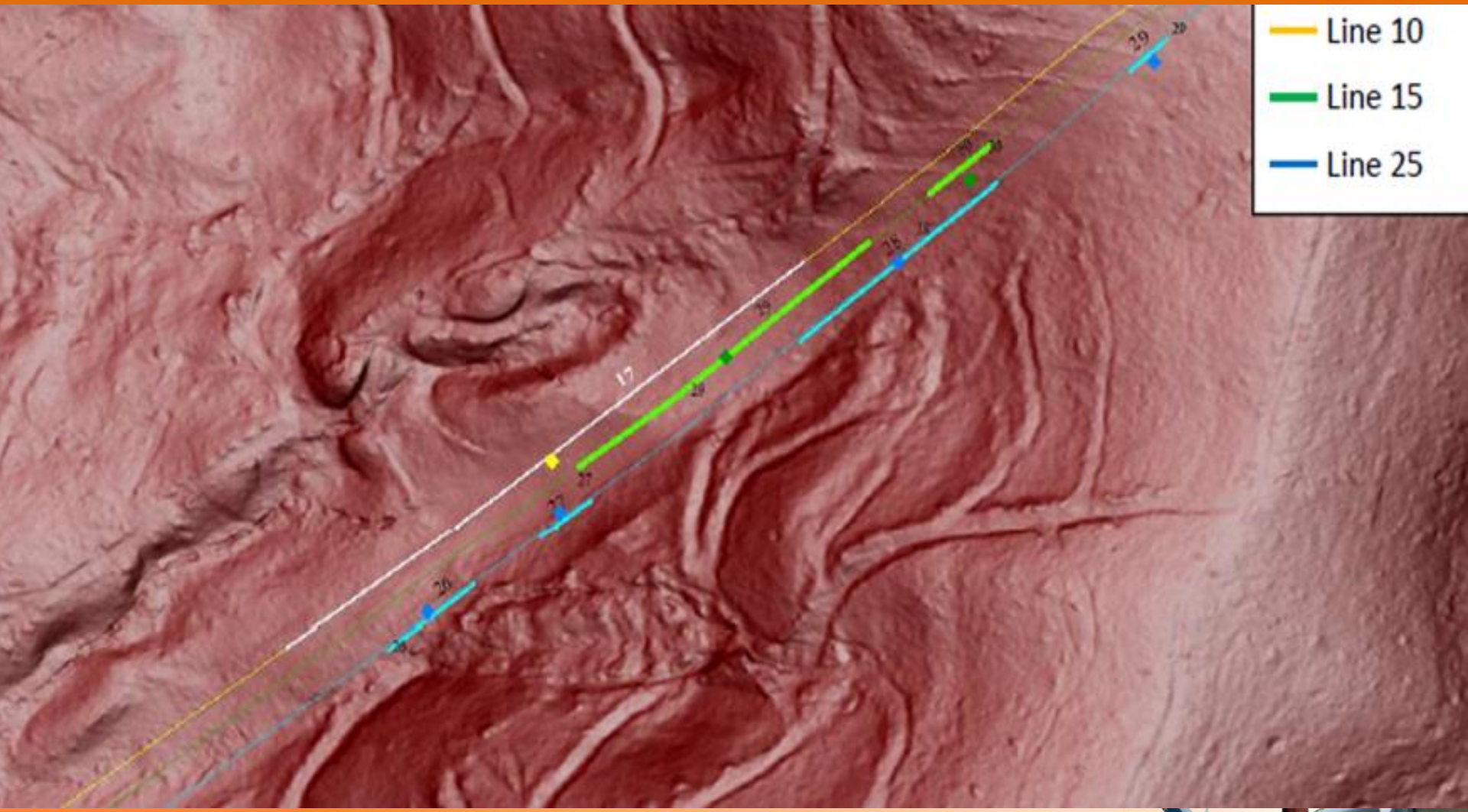
Investigation Details

Investigation Details

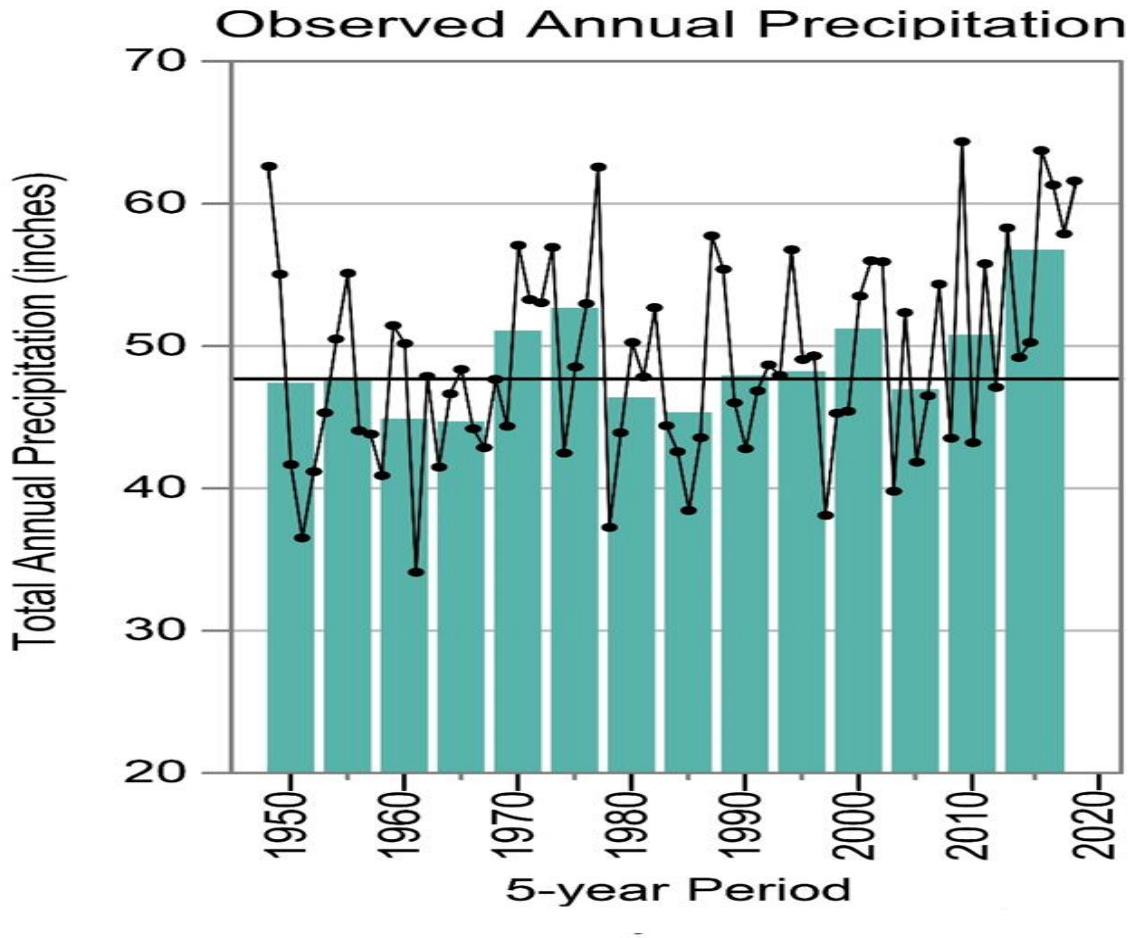
USGS Quadrangle Map



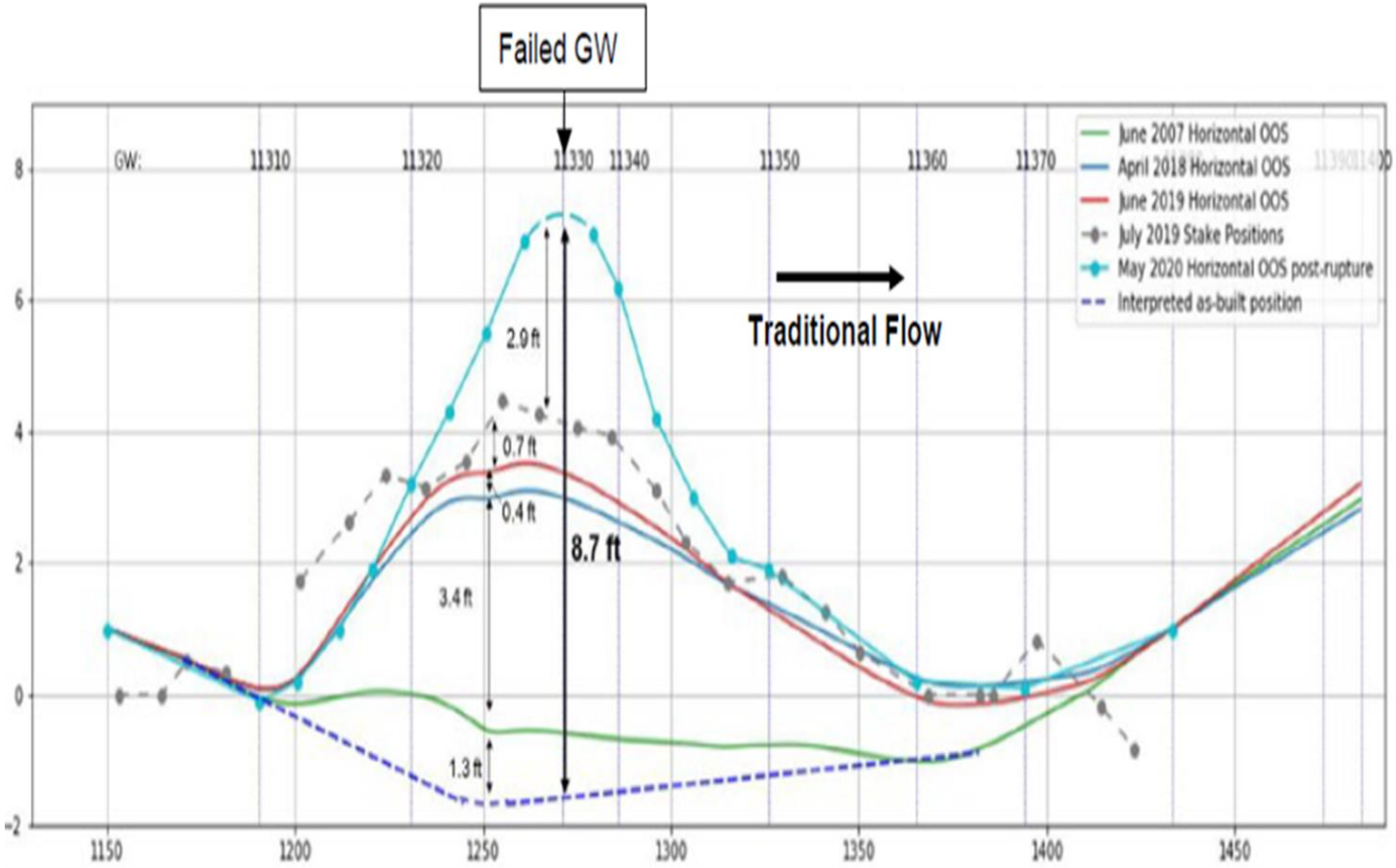
LiDAR



Rainfall History



Pipeline Movement



History of pipeline movement. Vertical axis is “Horizontal out of straight” measured in feet. The horizontal axis is the location on the right-of-way. Note the location of the girth weld.

PHMSA Findings

The pipeline failure was a result of **soil movement**, which caused excessive loading leading to the rupture of a girth weld.

The operator's procedures were inadequate, and the operator’s analysis of the active landslide did not fully address uncertainties associated with the strain-carrying capacity of girth welds, the pipeline loading due to land movement, and the pipeline response.

Regulatory Oversight
Natural Gas
Hazardous Liquids

192 Applicable Code Sections

- Subpart G – General Construction
  - § 192.317 Protection from hazards
- Subpart L – Operations
  - § 192.613 Continuing Surveillance
- Subpart M – Maintenance
  - § 192.705 Transmission lines: Patrolling
- Subpart O – Integrity Management
  - 192.917(a)(3)

§192.317 Protection from hazards

- **Construction Requirement**
- Take steps to protect pipelines from:
  - Washouts;
  - Floods;
  - Unstable soil;
  - Landslides;
  - Or other hazards that may cause the pipeline to move or sustain abnormal loads.

§192.613 Continuing Surveillance

- **Operations Requirement**
- Establish a procedure for continuing surveillance to determine and take appropriate action for changes such as:
  - Class location;
  - Failures;
  - Leakage history;
  - Corrosion;
  - Substantial changes in cathodic protection requirements; and
  - Other unusual operating and maintenance conditions
- Once an unsatisfactory condition is identified, initiate the program to:
  - Recondition or phase out the identified segments; or
  - Reduce the MAOP to reduce the risk.

§ 192.705 Transmission lines: Patrolling

- **Maintenance Requirement**
- Program to observe surface conditions on and adjacent to the ROW to identify:
  - Indications of leakage;
  - Construction activity; and
  - Other factors affecting safety and operation
- Frequency dependent upon:
  - Diameter;
  - Operating pressure;
  - Class locations;
  - Terrain;
  - Seasonal weather conditions; and
  - Other relevant factors.

§ 192.917 Integrity Management

- **Integrity Requirement – Threat Identification**
- Identify and evaluate all potential time-dependent threats to the pipeline system:
- Third-party damage;
- Mechanical damage;
- Incorrect operational procedures; and
- Weather-related and outside force damage:
- Seismicity;
- Geology; and
- Soil stability.

Hazardous Liquids

195 Applicable Code Sections

- Subpart L – Operations & Maintenance
  - § 195.401 General Requirements
  - § 195.412 Inspection of rights-of-way and crossings under navigable waters
  - § 195.452 Pipeline Integrity Management in HCAs

§195.401 General Requirements

- **Operation and Maintenance Requirements**
- No pipeline can operate at a level of safety lower than that required by Part 195 and in accordance with operator procedures.
- If an adverse condition is identified:
  - Non-immediate hazard:
    - must be corrected within a reasonable time.
  - Immediate hazard:
    - operator may NOT operate the segment(s) until the condition has been corrected.

§195.412 Inspection of rights-of-way and crossings under navigable waters

- **Operation and Maintenance Requirement**
- Inspect the surface conditions on or adjacent to each pipeline right-of-way.

§195.452 Pipeline Integrity Management

- **Operation and Maintenance Requirements**
- Integrity Management repairs
  - Prompt action to address anomalous conditions;
  - Remediate integrity threat areas
  - Safe and timely manner
    - Temporary pressure reduction;
    - Long-term pressure reduction
- Risk factors and threat identification (e)(1)(vii and viii)
  - Local environmental factors that could affect the pipeline (e.g., seismicity, corrosivity of soil, subsidence, climatic;
  - Geo-technical hazards.

Advisory Bulletin

ADB-2022-0063, June 2, 2022

Updated ADB-2019-02

"All owners and operators of gas and hazardous liquid pipelines, including supercritical carbon dioxide pipelines, are reminded that earth movement, particularly in variable, steep, and rugged terrain and terrain with varied or changing subsurface geological conditions, can pose a threat to the integrity of a pipeline if those threats are not identified and mitigated. Additionally, changing weather patterns due to climate change may result in heavier than normal rainfall and higher temperatures, resulting in soil saturation and flooding or soil erosion, each of which may adversely impact soil stability surrounding or supporting nearby pipeline facilities."

Advisory Bulletin

- Earth movement can pose a threat to the integrity of a pipeline if those threats are not identified and mitigated;
- Pipelines traverse variable, steep, and rugged terrain with changing subsurface conditions;
- Changing weather patterns due to climate change resulting in heavier than normal rainfall;
- Soil stability at risk.

Advisory Bulletin

- Become more familiar with the areas surrounding pipelines to better assess risks;
- Include geotechnical considerations in design and construction planning;
- Develop monitoring plans;
- Conduct site-specific visits to enhance visibility to potential geohazards;
- Installation of equipment to monitor land movement and potential strain on the pipeline;
- Monitor weather conditions and changing weather patterns; and
- Develop and adjust mitigative measures to prevent threats associated with geohazards.

Additional Materials

- Link to Advisory Bulletin: https://www.phmsa.dot.gov/regulations/federal-register-documents/2022-11791
- Advisory Bulletin Questions? contact: Mary McDaniel at 202–366–4595 or Mary.McDaniel@dot.gov.
- Link to FIRs: https://www.phmsa.dot.gov/safety-reports/pipeline-failure-investigation-reports

Questions

Thank you