Quarterly Report – Public Page

Date of Report: *3rd Quarterly Report – June 30, 2024*

Contract Number: *693JK32310007POTA*

Prepared for: *DOT-PHMSA*

Project Title: *An Integrated Knowledge Graph Model for Geohazard Monitoring Data*

Prepared by: *University of Wyoming*

Contact Information: *Dr. Minou Rabiei, mrabiei@uwyo.edu*

For quarterly period ending: *June 30, 2024*

1: Items Completed During this Quarterly Period:

- Comprehensive literature review on the formation mechanism of various types of geohazards, specifically landslides and earthquakes have been conducted and the most common techniques in monitoring these types of geohazards are identified and studied.
- All publicly available geohazard related data sources and available data types are identified and collected. Figure below summarizes the data sources for each of the target states under study as well as the resources providing national geohazard related data.

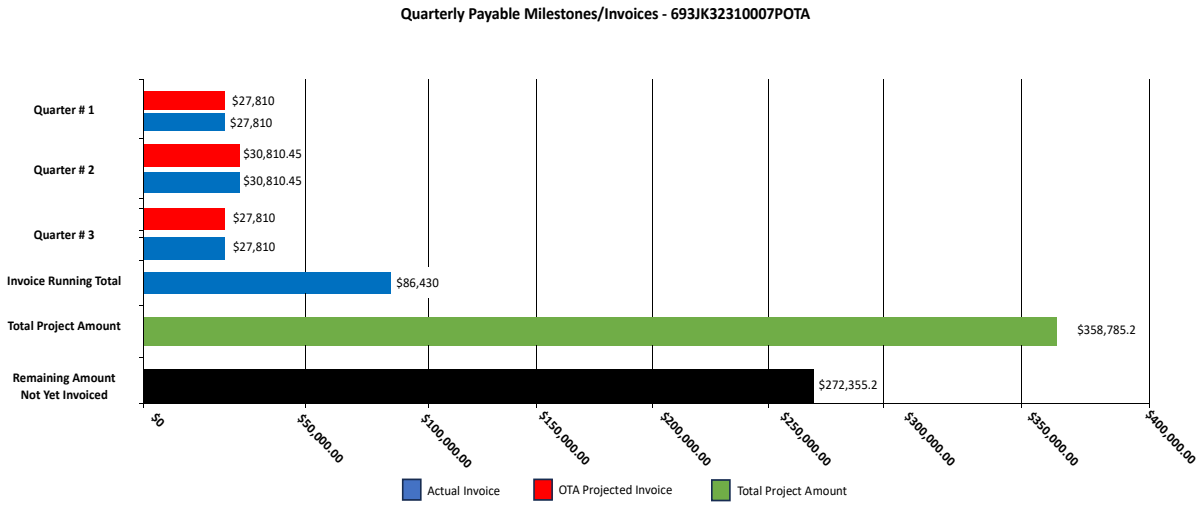
The following activities are ongoing and will be completed during the 4th quarters.

- Prepare questionnaires and setup interviews with stakeholder to gather expert knowledge and feedback.

2: Items Not-Completed During this Quarterly Period:

The project is on time.

3: Project Financial Tracking During this Quarterly Period:



4: Project Technical Status

Item 6, Task 2: Prepare questionnaires and setup interviews with stakeholder to gather expert knowledge and feedback - *Questionnaire and interview questions.*

Narrative: Through discussions and feedback from the industry collaborators and academic TAP members we have prepared the draft of the questionnaire to be sent to industry stakeholders for their feedback on the generation of the geohazard monitoring dataset and development of the KG models.

Other Items, Task 2: Comprehensive literature review on geohazards formation

1. Landslides and Common Techniques in Monitoring them:

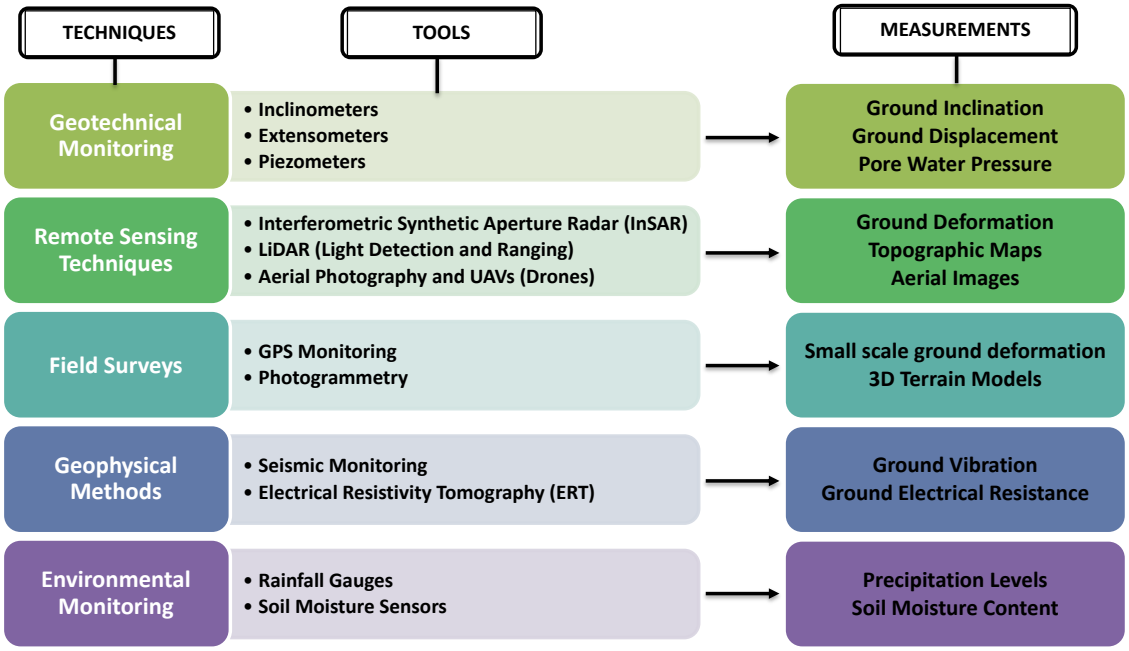
- Landslides are down-slope movements of soil or rock masses, triggered by:
    - Changes in moisture or water table conditions in the ground
    - Changes in slope geometry, such as undercutting of the toe of a slope
    - Inertial forces associated with seismic ground shaking

- Landslides are the dominant geohazard in mountainous terrains.
    - Older, traditional pipelines: Rupture rate of 2.8/1000 km per year.
    - Modern, geo-engineered pipelines: Rupture rate of 0.33/1000 km per year.

1.1. Landslides Failure Modes:

- **Lateral Displacement:** Resulting from differential ground movements, either horizontal or vertical, causing failure either at the margins (bending) or within the body of the slide (tension).
    - **Crossing landslide:** Lateral forces cause longitudinal strain and failure under tension.
    - **Running parallel to landslide:** Axial friction causes compression buckling.
    - **Risk factors:** landslide depth, material behavior (plastic or block deformation), movement rate, and cumulative displacement over time.
    - **Minimum failure criteria:** Larger than one meter of ground displacement for a landslide > 30 m wide.
- **Spanning:** Ruptures occur due to the removal of support along a significant pipeline length, either from a landslide or from erosion of a gully removing material beneath the pipeline.
    - Failure prevention design criteria: The minimum unsupported span the pipeline must safely withstand without causing serious distress or leaks.
- **Loading:** Occurs when an imposed load, such as burial by landslide debris or impact from falling rocks, exceeds the pipeline's capacity (Uncommon for buried pipelines).
    - Depends on the depth of landslide debris or the size and height of falling material

1.2. Common Techniques in Monitoring Landslides:



2. Earthquakes and Common Techniques in Monitoring them:

2.1. Earthquakes Failure Modes:

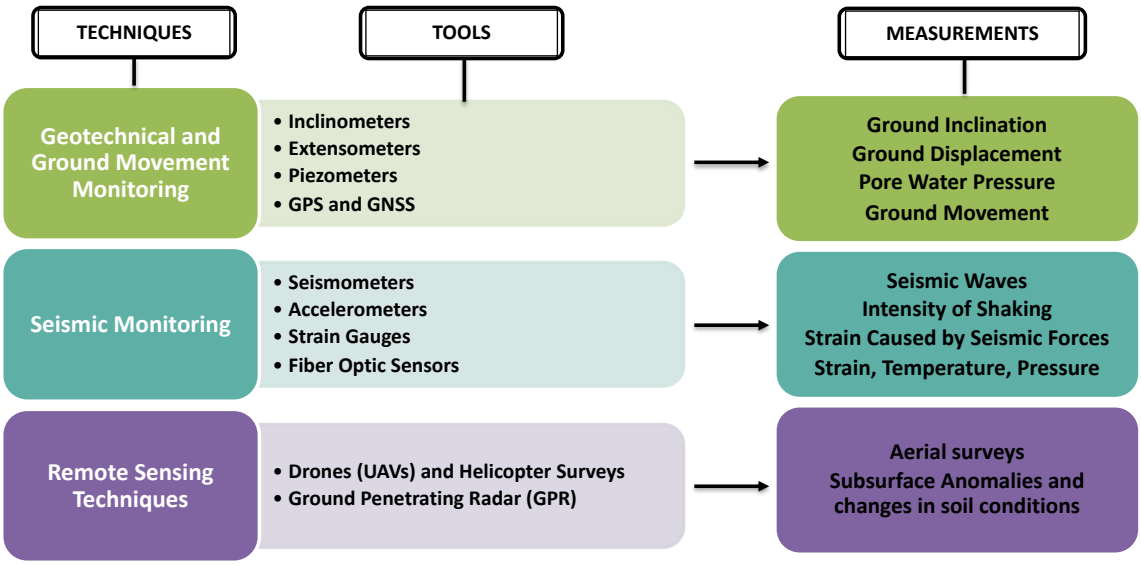
Fault Crossings

- Faults are classified based on their direction of movement or slip with respect to the ground surface.
    - Pipelines crossing fault zones deform longitudinally and in flexure to accommodate ground surface offsets.
    - Strike-slip fault displacement: Loads induced, imparts tensile strains and curvature to the pipeline on both sides of the fault. Pipeline displaces laterally.
    - Vertical fault movement: For a shallow buried pipeline, the uplift resistance of the soil is typically lower than the downward bearing resistance. Pipeline may be able to lift upward with relative freedom to accommodate the vertical fault movement.

Liquefication

- The transformation of a granular soil from a solid state to a liquefied state due to increased pore water pressure and reduced effective stress.
- Damaging if liquefaction leads to flow failure, lateral spread, ground oscillation, buoyant rise (of buried pipelines), or ground settlement.
- The type and extent of ground failure depends on site geometry and the depth, thickness, and extent of the liquefied layer.

2.2. Common Techniques in Monitoring Landslides:



5: Project Schedule

The project is on time.