# Quarterly Report – Public Page

**Date of Report:** *2nd Quarterly Report – March 31, 2024*

**Contract Number:** *693JK32310007POTA*

**Prepared for:** *DOT-PHMSA*

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

**Prepared by:** *University of Wyoming*

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**For quarterly period ending:** *March 31, 2024*

## 1: Items Completed During this Quarterly Period:

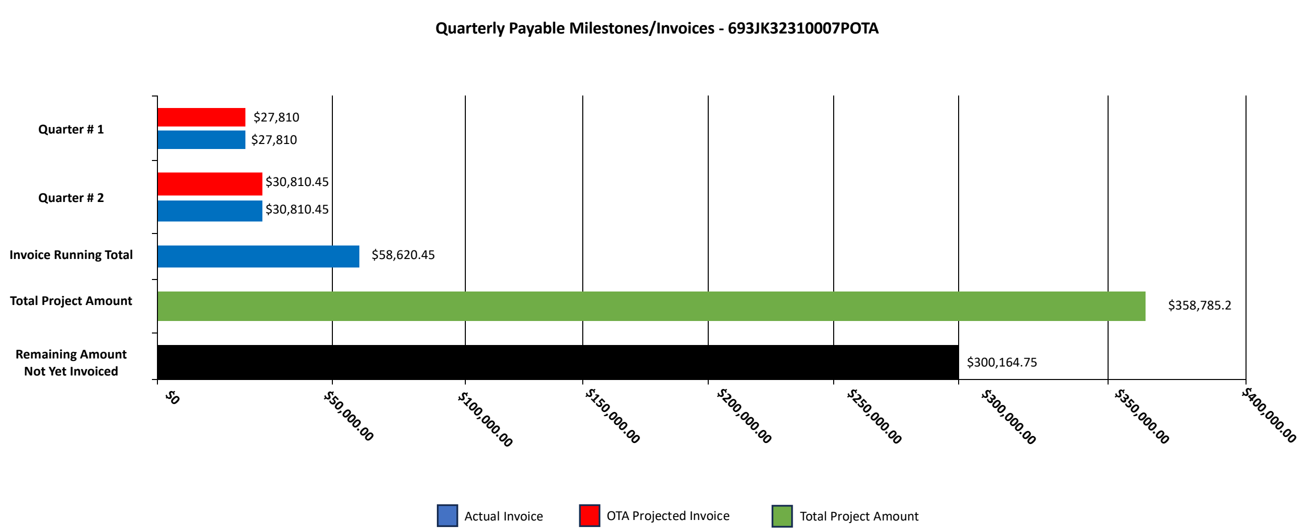
The following activities are ongoing and will be completed during the 3rd and 4th quarters.

- Comprehensive literature review on various types of geohazards, their impacts on pipelines and current monitoring techniques.
- Gathering the relevant geohazard data from various sources.
- Preparing 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 5, Task 2**: Gather the relevant geohazard data from various sources - *List of identified and collected geohazard monitoring data from public sources as well as industry partners.*

**Narrative:** This is an ongoing task, and a continuation of items 1 and 2 from the previous quarter, where we are exploring each of the identified geohazard data resources in details, to identify the types of data available from these sources.

**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 initiated the development of questionnaire and interview questions to engage more stakeholders in the generation of the geohazard monitoring dataset and development of the KG models. Once the available resources and data types are identified, we will have a clearer picture of what to enquire from the relevant stakeholders and how to get them more involved in the process.

**Other Items, Task 2**: Comprehensive literature review on different types of geohazards

**1. Pipelines Geohazards:**

Geohazards are defined as a naturally occurring or human-triggered geologic processes that has caused, or may result in, damage to the operation of a pipeline or associated facility; may impede the operation of a pipeline or associated facility; or may negatively affect the land, structures, and health and safety of landowners and other stakeholders who reside near the pipeline.

In general, assessed geohazards include the following:

- Landslides and rock fall hazards
- Ground subsidence hazards related to karst, underground mining, and fluid withdrawal,
- Seismic hazards related to fault rupture, ground shaking, liquification,
- Growth fault/coastal subsidence hazards,
- Hydrotechnical hazards related to watercourse crossings,
- Meteorological hazards related to hurricanes, tornadoes, lightning, and frost heave,
- Volcanic hazards.
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Managing geohazards throughout the life cycle of a pipeline include 4 phases:

- **Identification:** geohazards are systematically identified along a pipeline or facility.
- **Characterization:** geohazards are evaluated to determine the threat they may pose to the pipeline or facility, and ultimately, which hazards require mitigation or monitoring.
- **Mitigation:** targeted geohazards are mitigated.
- **Monitoring:** different areas are monitored to identify new hazards, evaluate the need for future mitigation at existing geohazards, and investigate the performance of existing mitigation approaches.

## 2. Pipeline Geohazard Assessment Approaches:

The approaches for identifying and assessing the potential likelihood and severity of geohazards exhibit significant variability. They range from expert judgment-based methods, heavily reliant on visual geomorphological observations, to more analytically intensive approaches incorporating phenomenological and/or mechanistic models. These models take into account route, pipeline properties, and operational monitoring data where applicable. Each of these methods can be employed to evaluate hazard and risk associated with specific geohazards, using qualitative, semi-quantitative, or quantitative approaches, as long as the underlying assumptions are clearly understood. Some methods are better suited for providing a continuous, contiguous geohazard risk assessment for a pipeline system, while others excel in localized, site-specific risk assessments.

- **Qualitative Methods:**

A qualitative approach involves expressing geohazard frequency and consequences using descriptive terms to establish a qualitative representation of relative risk, such as categorizing it as high, medium, or low.

- **Semi Quantitative Methods:**

A semi-quantitative approach entails using qualitative categorization or index-based ranking to articulate the geohazard frequency, coupled with a quantitative estimation of consequences. This combined information is then utilized to determine the relative risk.
Semi-quantitative risk assessment approaches aim to pinpoint areas susceptible to specific hazards, including geohazards, and rank the associated risks in a relative manner. Typically, these approaches involve categorizing parameter values or site conditions into discrete ranges, generating combined index values related to both likelihood and consequences. Subsequently, these index values are utilized to rank the relative risk associated with each identified threat. This approach is particularly well-suited for the design stage and initial operational assessments of geohazards in pipelines, where the available data for a robust quantitative risk assessment may be insufficient. The general application of the semi-quantitative geohazard assessment approach involves evaluating various semi-quantitative indices for each geohazard on a case-by-case basis along the pipeline route. Initial calculations assume an unmitigated pipeline design to identify areas requiring mitigation and the type of mitigation needed. The potential impact of mitigation measures is then considered to determine a post-mitigation index value.

According to the literature, the susceptibility of the pipeline to various geohazards is assessed using four distinct indices:

- **Initiation Index:** This index characterizes the potential for the geohazard to initiate at a specific location along the route.
- **Frequency Index:** This index characterizes the potential number of occurrences of a specific geohazard at a particular location relative to the life of the project.
- **Rate Index:** This index characterizes the rate at which a specific geohazard and its associated effects may occur. It differentiates between rapid and gradual events or processes that could impact the pipe, ditch, and/or right-of-way.
- **Vulnerability Index:** This index characterizes the potential effects of a specific geohazard on the three primary pipeline elements—pipe, ditch, and right-of-way. It distinguishes between geohazards that may potentially impact pipe integrity and those that may necessitate routine or non-routine intervention. The vulnerability criteria take

into consideration the design strain capacity and durability of the pipe, thus varying for different pipeline designs.

- **Quantitative Methods:**

A quantitative approach is characterized by estimating an annual probability of failure for each geohazard and integrating this result with a quantitative estimate of consequences. This combination is utilized to estimate risk in terms of annual cost, encompassing factors such as loss of life, financial loss, or damage to property and the environment. Quantitative and probabilistic risk assessment approaches, when effectively applied, offer several potential advantages compared to other assessment methods. These advantages include consistency, achieved through a rational and systematic approach, and compatibility, enabling the comparison of risks between different pipeline integrity hazards, such as geohazards and metal loss processes. However, the deployment of probabilistic geohazard assessment approaches may demand a substantial amount of site-specific and general route data. These approaches are generally more suitable for operational stages post-construction, once there is an as-built characterization and a sufficient base of operational data available. Practical limitations exist regarding the level of information required to generate defensible estimates of failure probability. Consequently, attempting to implement a probabilistic risk assessment of geohazards with insufficient data as input should be avoided. In cases where quantitative risk estimates are derived from relatively limited data and expert judgment, it is crucial to explicitly identify the uncertainty in the estimated risk and the underlying assumptions (e.g., order of magnitude accuracy).

## 5: Project Schedule

The project is on time.