**CAAP Quarterly Report**

**03/31/2025**

*Project Name:* *Easy Deployed Distributed Acoustic Sensing System for Remotely Assessing Potential and Existing Risks to Pipeline Integrity*

*Contract Number:* *693JK3215002CAAP*

*Prime University:* *Colorado School of Mines*

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*Reporting Period:* *[01/01/2025 – 03/31/2025]*

**Project Activities for Reporting Period:**

In the previous reporting period, we completed the installation of the buried pipe at the Edgar Mine. As illustrated in Figure 1, the pipeline was placed within a series of wooden containment boxes, resting on a sand bed and subsequently buried under an additional layer of sand along its entire length.

During this reporting period, we carried out and completed the experiments for Task#3: Detection of Corroded Spots on Pipeline Interior Surface in the buried pipe configuration, as outlined in our proposal. The experiments were conducted on three different test sections, each representing varying degrees of internal corrosion: a pipe with 3 mm wall loss, a pipe with 5 mm wall loss, and a severely corroded pipe exhibiting a minor leak. In addition, we conducted the control experiment using the 1-meter central pipe section without any defects, serving as the baseline for comparison.

***Experimental Challenge***: Replacing the central 1-meter test section in the buried pipe configuration presented significantly greater challenges compared to the supported and unburied setups. The primary difficulty was due to the weight of the overlying sand, which had to be partially removed before accessing the middle section. To facilitate this process, a new piece of equipment—an automatic winch—was acquired and utilized at the Edgar Mine. As shown in Figure 2, the winch was used to lift the two 10-meter pipe sections on either side of the test segment, enabling the removal and replacement of the 1-meter section in the middle. While the winch significantly eased the mechanical handling of the pipe, the buried configuration itself introduced some complications. The confined nature of the sand-filled trench and the pressure from the overlying sand, particularly near the edges of the wooden containment boxes, occasionally led to damage of the external fiber-optic cable. Identifying the exact location of such breakages was particularly difficult due to limited visibility; in several instances, it was necessary to remove sand along the entire length of the pipe to expose the cable and determine the appropriate location for resplicing the external fiber optic cable. These situations required substantial manual effort and extended troubleshooting time.

***Results and Discussion***: As with previous experiments, the test matrix included five standard flow rates ranging from 2 m/s to 18 m/s. For data processing, standard deviation calculations were first performed to assess the quality and consistency of the recorded signals. This was followed by a Fourier transform to extract frequency-domain information along the fiber for each sensing cable. For a detailed overview of the data processing methodology, please refer to prior submitted reports. This consistent approach enabled a direct comparison between the corroded pipeline sections and the control experiment, which used a 1-meter defect-free pipe segment. The experimental results indicate that defects were not quite detectable in the buried pipe configuration compared to unburied or supported ones, likely due to dampened responses caused by the setup.

Moving forward, we will complete the remaining experiments in the buried pipe configuration, focusing on Task #4: Detection of Dent/Deformation.

In addition to the project activities, a manuscript on pipe leakage detection is in progress and nearing completion this quarter. We anticipate submitting it in the next quarter. We also submitted an abstract to ATCE 2025, focusing on the key findings from Tasks#4 and#5.

**Project Financial Activities Incurred during the Reporting Period:**

The following table summarizes the financial activities and the corresponding expenses during the reporting period. Also shown are the updated total budget for the last two quarters in Year 3 and Year 4 (i.e., Q11-Q16), and the total expenses in this reporting period (Q14), as well as in Q11-Q14. Please note that the actual amount for the expenses might be slightly different from the numbers in the final financial report, since some of the expenses occurring in late of the quarter may not be included in the university's financial system that we use for managing the funds and expenses by the time the report is submitted. Normally, it takes several days for an expense to be shown in the system after its occurrence.

| Items\Budget and Expenses | | Total Budget for Q11-Q16 | Total Expenses in Q14 | Total Expenses in Q11-Q14 |
|---|---|---|---|---|
| 1 | Faculty Salaries and Wages including Fringe Benefits | $33,502.00 | $0 | $29,031.37 |
| 2 | Student Salaries | $34,701.00 | $9,003.38 | $28,688.51 |
| 3 | Graduate Student Tuition | $24,564.00 | $7,057.50 | $19,425.00 |
| 4 | Experimental Expenses (experimental work supplies, services, maintenance, cables, etc.) | $15,537.00 | $1,200.06 | $8,043.20 |
| 5 | Travel | $8,000.00 | $0 | $4,081.71 |
| 6 | Indirect Costs (51.5%) | $47,246.80 | $5,254.79 | $35,970.09 |
| **Total** | | **$163,550.80** | **$22,515.73** | **$125,239.88** |

**Project Activities with Cost Share Partners:**

The cost shares are the AY efforts of the PI and co-PIs. Activities are the same as above.

**Project Activities with External Partners:** No external partners.

**Potential Project Risks:** Same as previous reports.

**Future Project Work:**

Over the next 30 days, we will continue the experimental work for Task #4 and process the data accordingly. Additionally, we are drafting a journal paper on leakage, which we anticipate submitting in April.
In the next 60–90 days, we plan to continue the experimental work and conduct data processing and analysis. If the ATCE paper is accepted, we will also work on its manuscript. Besides, we will work on the final project report.

**Potential Impacts to Pipeline Safety:**
Tasks#1 and #2 can potentially help identify and characterize the possible liquid accumulation in a gas gathering or transmission pipeline using DAS, while Tasks#3-6 will potentially help detect the internally corroded surface, deformation, infrastructure damage, and leakage in a gas pipeline.

## Appendix

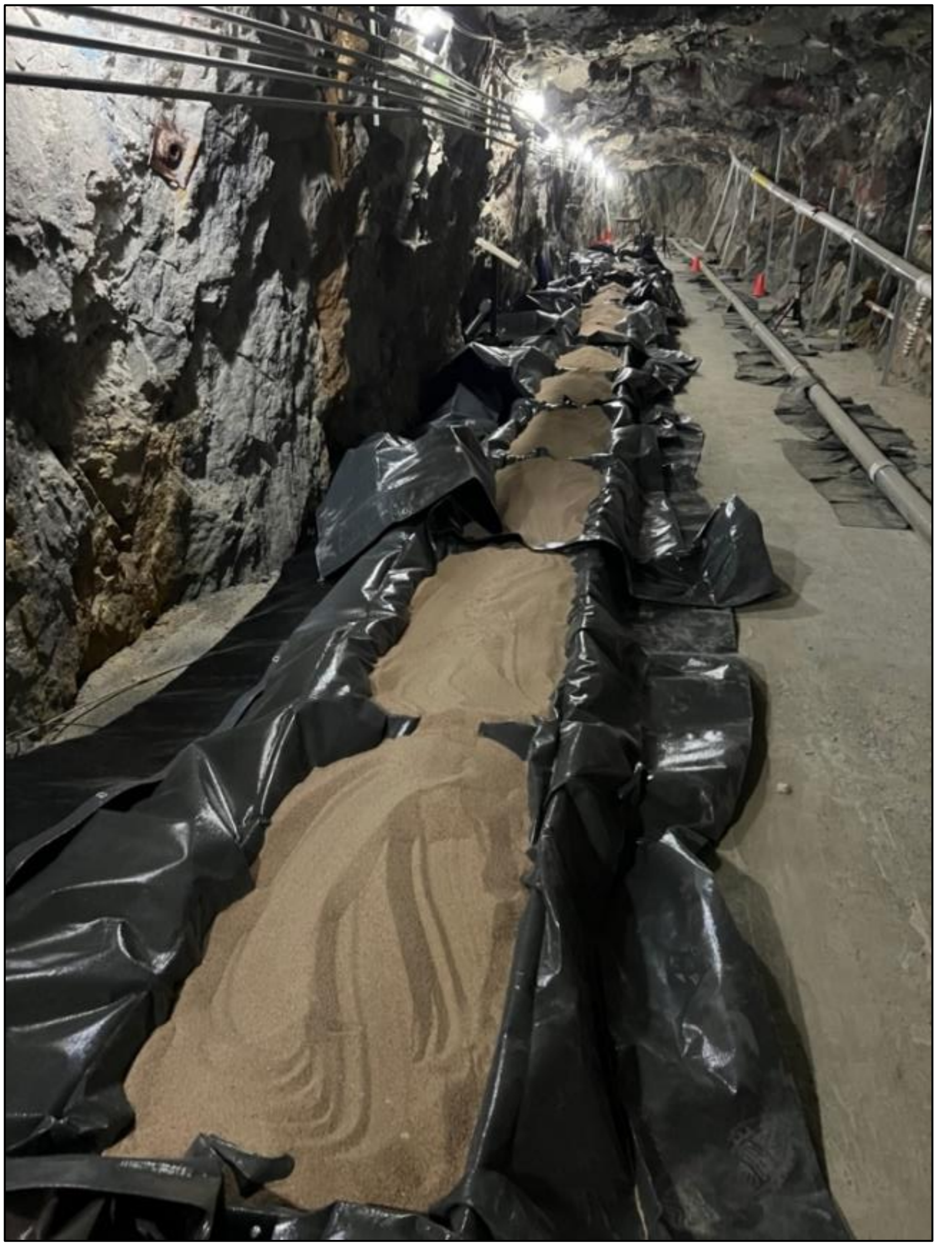

Figure 1. Photograph of the Buried Pipeline

Figure 2. Setup for replacing the 1-meter test section in the buried pipe configuration using the automatic winch