Public Quarterly Report

Date of Report: 4th Quarterly Report-September 29, 2020

Contract Number: 693JK31910002POTA
Prepared for: DOT PHMSA
Project Title: Data Collection, Normalization and Integration Methods to Enhance Risk Assessment Tools for Decision-Making
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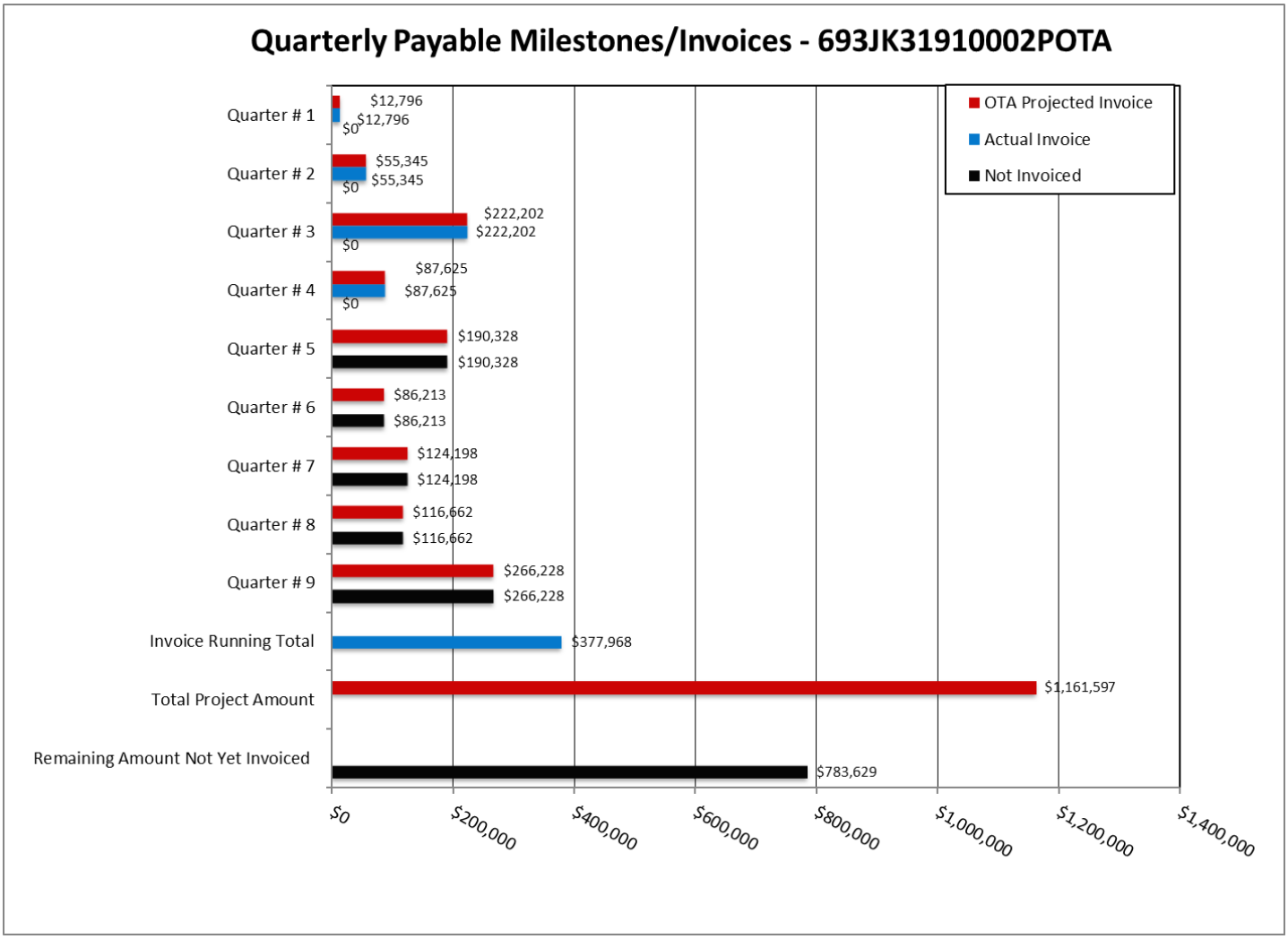
For quarterly period ending: September 29th, 2020

1: Items Completed During this Quarterly Period:

Item #	***Task #***	***Activity/Deliverable***	***Title***	***Federal Cost***	***Cost Share***
15	4.2.3	Data Integration, Normalization and Uncertainty Tools	Data Driven Insights: Machine Learning Data Discovery – identify appropriate techniques and demonstrate usage	11,287.00	21,746.00
16	4.3.1	Data Integration, Normalization and Uncertainty Tools	Causal Modeling and Situational Awareness: Causal modeling framework	19,960.00	0.00
17	4.3.2	Data Integration, Normalization and Uncertainty Tools	Causal Modeling and Situational Awareness: Situational awareness framework Progress report 2	43,580.00	0.00
18	5.4	Project Management	Fourth Quarterly Report	12,798.00	0.00

A contract modification to correct task numbering and reporting schedule to match the extended timeline was submitted and executed.

3: Project Financial Tracking During this Quarterly Period:



4: Project Technical Status –

The technical work for this quarter progressed as planned and all deliverables have been completed. Detailed documentation for each deliverable is provided in attachments. A short description of project activity is provided in the following numbered points:

1. Task 4.2.3
    a. In the first three months, we held extensive discussions with PG&E and other stakeholders to identify key datasets and important general areas of focus that these data sets would allow us to address. In the following three months, we received and began to analyze many of the most important data sets, made progress toward acquiring supplementary data sets, and solidified well-scoped, decision-relevant research questions that we can pursue in coming quarters. We have now performed preliminary analyses to identify appropriate techniques to answer the questions at hand and evaluate the utility of some of these techniques through application.

b. Our preliminary results suggest that ground movement from land subsidence is not particularly correlated with an increase in leak incidence, at least over timescales of 1-5 years. This does not necessarily mean that such ground movement does not pose an integrity risk to distribution system assets on these timescales, but the fact that engineers are able to foresee and plan for such issues reduces our ability to determine such a relationship using observational statistical methods.
c. As a result, we are shifting our analysis of the relationship between ground movement and leak incidence to focus on predicting longer-term trends using a combination of statistical and physical models. Our proposed statistical bounding analysis will provide insight into the extent to which there is significant time variation in leak incidence rates over multi-year-to-decade timescales. An understanding of this variation will help us understand the potential benefits to integrity management planners of improved predictions of such variation through causal physical models.
d. We will integrate the results of these predictive and causal analyses into the larger holistic decision support framework being developed in collaboration with GTI, Lumina Decision Systems, and University of Maryland. This will place the results of the leakage and subsidence analysis in the larger context of the suite of risks faced by utility integrity management planners, allowing them to more effectively mitigate risk with limited resources.

2. Task 4.3.1
    a. In the second quarterly report a causal Bayesian network for vintage plastic pipe lifetime prediction was presented. The causal structure was based on the work on the slow-crack-growth failure mode of vintage plastic pipe that leads to breach of the wall and a leak that can pose both safety and environmental hazards that was presented in [1]. The third quarterly report outlined the process for transitioning from a detailed causal model for the likelihood of a threat event occurring to a full risk model that can be integrated into a situational awareness framework that can guide operator response and mitigative actions.
    b. The Stanford team report on their attempts to link ground subsidence, measured by satellite imagery, to bend-induced leaks in distribution system pipelines. The Stanford team are using machine learning statistical techniques to explore correlations and have so far found a seemingly null correlation.
    c. There is good potential to use the causal modeling approach described in this task report to inform and enhance the machine learning approach, or to reverse the sequencing of approaches and use machine learning to better inform causal models.
    d. To assist in evaluating the potential of the candidate approaches for analyzing historic data, identifying the most relevant data inputs, understanding the impact of data quality and developing predictive approaches, we provide a detailed example of using causal modeling approaches to simulating system performance in the following sections.
    e. The simulation addresses:
    f. Installation date

g. Year of manufacture of the pipe
h. Pipe material quality
i. Operating temperature
j. Operating pressure
k. Secondary stresses due to pipe bending
l. The simulation output is tbe the expected leak profiles of the system over the first 100 years of system operation.
m. Future work will focus on calibrating the simulation parameters to best match historical leak records.
n. The calibrated simulation can be developed into a tool to predict future system performance and to guide mobile leak surveys to optimize the leak survey process with respect to global and local utility objectives.

3. Task 4.3.2
    a. A comprehensive framework for feeding causal modeling insights into a situational awareness framework is presented.
    b. The workflow for assessing the quality of decisions is presented.
    c. In the upcoming quarters we will expand on this example in consultation with the TAP members and develop more detailed demonstrations of the full process including the impact of data and information quality on the actions taken.

5: Project Schedule

- Project is on schedule and budget.
- An update meeting with the TAP will be scheduled on the first convenient data in October or November.

End of report