# Public Quarterly Report

**Date of Report:** 3rd Quarterly Report – June 30, 2025

**Contract Number:** 693JK32410007POTA

**Prepared for:** DOT-PHMSA, Basim Bacenty, basim.bacenty @ dot.gov, 713-272-2838; Andrea Ceartin, andrea.ceartin @ dot.gov, 406-577-6818

**Project Title: P3LD: Practical Protocols for Pipeline Leak Detection**

**Prepared by:** Colorado State University

**Contact Information:** Dan Zimmerle, PI/ dan.zimmerle@colostate.edu/ 970-581-9945/ Bryan Rainwater, Research Scientist / bryan.rainwater@colostate.edu / 970-459-0179; Wendy Hartzell / wendy.hartzell@colostate.edu / 970-491-8058

**For quarterly period ending:** June 30, 2025

## 1: Items Completed During this Quarterly Period:

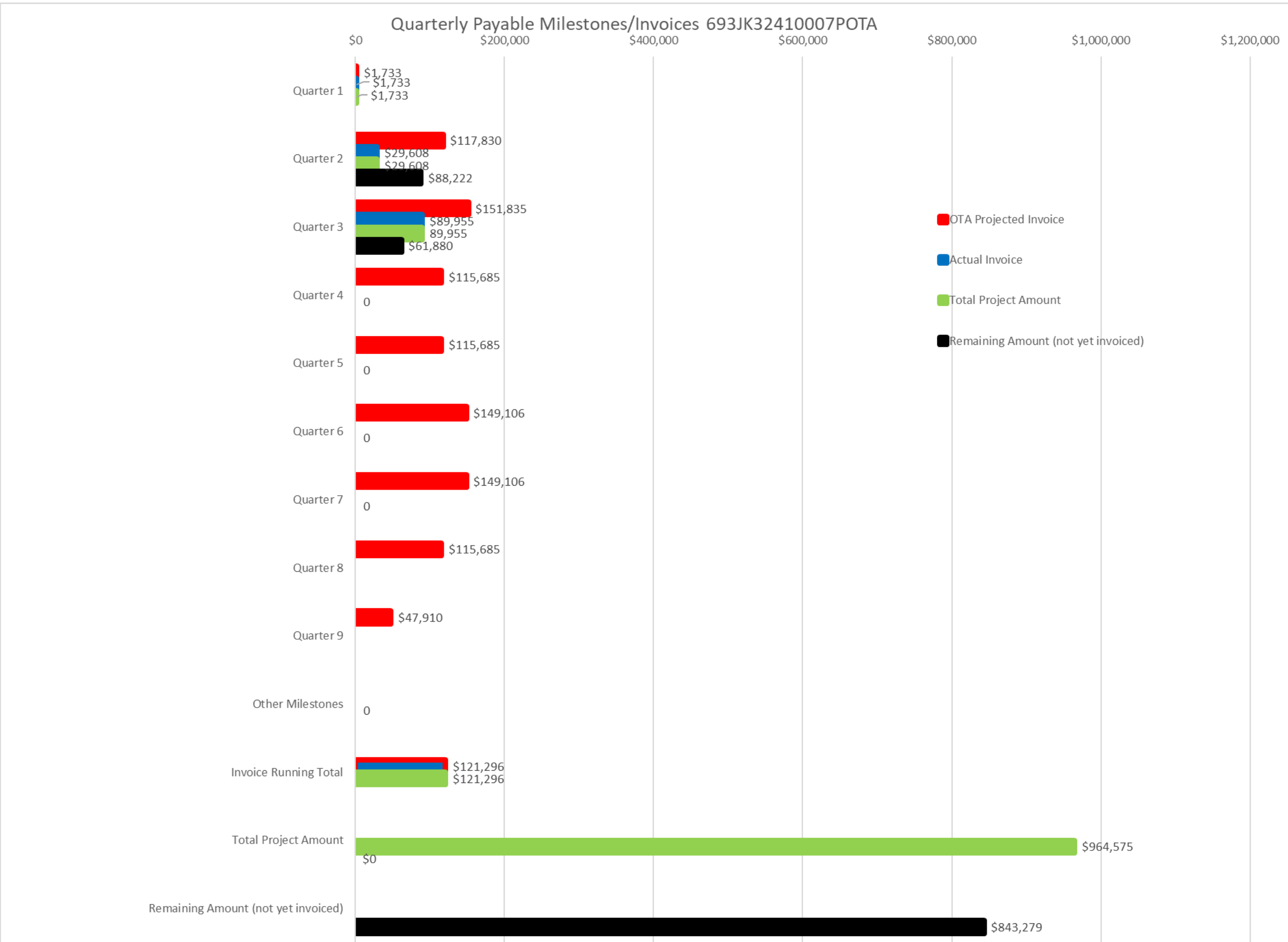
| *Item #* | *Task #* | *Activity/Deliverable* | *Title* | *Federal Cost* | *Cost Share* |
|---|---|---|---|---|---|
| 4 | 1 | Literature review | | $ 43,040 | ***$ 0*** |
| 7 | 4 | Identify Target Methods | | *$ 45,182* | ***$ 0*** |
| 11 | 7.1 | 3rd Quarterly Status Report | | $ 1,733 | ***$ 0*** |
| | | ***Third Payable Milestone*** | | ***$ 89,955*** | ***$ 0*** |

## 2: Items Not-Completed During this Quarterly Period:

| *Item #* | *Task #* | *Activity/Deliverable* | *Title* | *Federal Cost* | *Cost Share* |
|---|---|---|---|---|---|
| 9 | 3 | Pipeline Condition Report | | ***$36,150*** | ***$ 0*** |
| 10 | 5.1 | R1 METEC Testing | | ***113,952*** | ***$ 0*** |
| | | | | | |

Item 6 Pipeline Condition Report (Task 3) is expected to be completed in the next quarter (September 30). While R1 METEC Testing will be ongoing over nine months, the testing round is not set to start until July 7. We will invoice this first portion with the next quarterly submission. We expect cost share reporting to catch up once testing begins.

### 3: Project Financial Tracking During this Quarterly Period:




### 4: Project Technical Status –

*METEC Underground Testbed – Preliminary Pipeline Progress*

While reporting on developments on the buildout of the METEC underground pipeline testbed for which testing will be performed are not task driven and are not billable to this project, they are relevant and will motivate all future project progress. Furthermore, preliminary research of survey methods, fixed sensor designs, and pipeline standards necessary for the buildout are directly relevant to the literature review, pipeline reviews, and next generation survey methods of Task (1), (3), and (4) respectively.

After delays in receiving construction approvals, the build-out of the underground testbed started on May 1 and major digging and backfilling was completed by June 1 (see photo at right). Provided there are no unforeseen delays, the team expects the testbed to be operational by July 7.

*Figure 1 METEC of underground testbed Phase 1 construction complete.*

*Item 4. Task 1 Literature Review*

This literature review integrates insights from peer-reviewed literature, project reports, grey sources (e.g., blogs, videos), company websites and brochures, and interviews with industry stakeholders. It focuses on current sensing technologies used for detecting belowground natural gas (NG) pipeline leaks, outlining their technical capabilities and operational constraints across different survey platforms. A summary table (*Table 1*) highlights the specifications and deployment parameters for each method.

*Table 1* . Literature review summary table (see Attachment 1 for larger print version).

| Platform | Gas Sensing Technology and Technical Specifications | | | | Operational Parameters | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Sensing Technology | Sampling Rate Hz | Sensitivity – Based on instrument | Accuracy | Survey Speed mph | Number of passes | Height (AGL) m | Distance from ROW m | Detection Threshold ppm |
| **Stationary / Continuous** | MO Sensor, In Plume Laser, Tracer-correlation method, IR Imaging | 0.2-2 | 1.8 - 338 scfh @ 90% PoD | -44% to +93% error | Stationary | N/A | Up: 0–7<br>Down: 0–0.05 | Up: 0–150<br>Down: 0–4 | 2.1-2.2 |
| **Walking** | Ranged Laser,IR Imaging, In Plume Laser, Etalons, Catalytic Combustion | 1-10 | 5.6–19.5 scfh at 90% POD | Median loc. error ≈ 1 m (≈10 %) | All: 1-3 | All: 1-4 | Up: 0.05–2<br>Mid: 0.05–2<br>Down: 0.05 | Up/Mid: along pipeline<br>Mid: 0.05–2<br>Down: 0–15 m | Up/Mid: 2.2–10<br>Down: 2.2–500 |
| **Driving** | Ranged Laser; IR Imaging, In Plume Point Sensor, In Plume Laser | Up/Mid: 1–4 Hz<br>Down: 1–2 Hz | 0.01 scfh @ 90% POD | Median loc. Error = 0.4 - 31 m | Up/Mid: 2–10<br>Down: 11–34 | Up/Mid: 1–4<br>Down: 1–6 | Up/Mid: 0.5–3<br>Down: 0.1–3 | On-road ROW: < 15 m; downwind | Up/Mid: 2.2–10<br>Down: 2.2–500 |
| **UAV** | Range lasers, In plume lasers | 1-10 preprogrammed transects (rasters, funnels, vertical scans) | > 0.02 scfh | ±50% | All: 4–67 | N/A | All: 2-30 | All: 0-60 m | All: 2.1-3 or ~0–100 ppm·m |
| **Aircraft** | Ranged Laser, IR Imaging, In Plume Laser | 65–175 s/pass; | Based on instrument: 25 scfh with 90% PoD | 8.1 % - 68 % | Up/Mid: 70-115 | Up/Mid: 100–800 m swaths | 100-12,960 | Up/Mid: Swath widths: 100–1800 m; | 200-300 ppm background concentration |
| **Satellite** | IR Imaging, GHGSat WAF-P | Up: revisit 1–14 d<br>Down: 1–2 d | Up: 0.1–4.2 t/h<br>Down: down to 42 kg/h | Up: ± 0.3–8.8 t/h / Down: ± 50–66 % | 50 m × 50 m to 7 km × 5 km pixels | N/A | Up: 700–800 km<br>Down: 500–550 km | N/A; | Down: ≥ 100 kg $h^{-1}$ |

Leak detection success is closely tied to both environmental and operational factors. Key environmental variables include wind speed and direction, atmospheric stability, background methane ($CH_4$) concentrations, and soil or surface characteristics. Operational considerations such as sensor placement, sampling geometry, and survey speed also critically impact detection performance.

Each survey method presents unique advantages and limitations. Fixed sensors deliver real-time continuous data at a fixed location but are limited by wind conditions and require regular calibration. Walking surveys achieve high spatial resolution but are labor-intensive and lack the ability to track continuous flux. Driving surveys enable rapid coverage of larger areas but are susceptible to false positives, may overlook small or off-road leaks, and show uncertainties ranging from ±20% to 100%. Unmanned Aerial Vehicle (UAV) surveys provide low-altitude plume mapping with high flexibility, but short battery life (10–20 minutes), rotor-induced turbulence, and payload constraints result in detection uncertainties of ±15% to 100%. Aircraft surveys cover broad swaths (150 to 3,000 m) and produce detection curves but are constrained by high detection thresholds and dependence on controlled-release validation. Satellite platforms offer near-daily global coverage with pixel sizes between 25 m and 7 km, but their ability to detect emissions is limited to large sources due to coarse resolution, clear-sky requirements, and reliance on transport models.

Industry interviews revealed that real-world belowground leak detection faces additional hurdles. These include harsh environmental and terrain conditions (e.g., wet weather, permafrost, dense canopy, rugged landscapes), complex pipeline and gathering systems that hinder leak pathway identification, and subsurface gas migration patterns that deviate from standard atmospheric models. Operators also face difficulties in developing validated protocols for extreme conditions (e.g., snow, high heat, altitude, hydrogen blends), ensuring sufficient sensor resolution and positioning, and conducting surveys in remote or restricted-access areas.

Collectively, these challenges point to a pressing need for more resilient, field-tested approaches, improved sensor technologies, and versatile detection strategies capable of adapting to the complexities of real-world underground gas leak scenarios.

*Item 7. Task 4 Identify Target Methods*

Based on a comprehensive review of peer-reviewed literature and structured interviews with leak detection and quantification (LDAQ) operators and program managers, three next-generation approaches for methane leak detection have been identified. These methods represent current advancements in field-deployable technologies and operational strategies aimed at improving detection sensitivity, coverage, and efficiency. The approaches include:

1. **Walking Surveys**, which involve ground-based technicians systematically inspecting pipelines using handheld methane sensors. This method remains a baseline of leak detection due to its proximity to the source and high spatial resolution.
2. **Advanced Mobile Leak Detection (AMLD) Technologies – including:**
    a. **Driving Surveys**, and
    b. **Unmanned Aerial Vehicle (UAV)** Surveys, which utilize sensors mounted on mobile platforms like cars and drones to detect, locate, and quantify NG leaks.

These next-generation techniques are being actively evaluated for their detection performance, operational feasibility, and integration potential within existing LDAQ programs. This information was presented at the TAP meeting on June 24, 2025, and more detail is found in the slides, included here has Attachment 2.

**5: Project Schedule –**

Minor programmatic issues include delays in issuance of billing accounts for which time can be spent on the project. Future reports will evaluate the effect on project timeline. For now, the **Pipeline Condition Report** is delayed another quarter due to the delayed issuance of the SMU subaward contract. Updates on the **Round 1 Testing** are also delayed due to the aforementioned construction delays. We expect cost share reporting to catch up as well in accordance with the corresponding testing scheduled and fees incurred. We will continue to monitor the need to push out deliverable deadlines due to these delays and keep PHMSA informed.

Our intentions for Q4 will be to complete the Pipelines Condition Report and operate Testing Round 1, experiment tracking and data collection.

**6. Attachments**

1. *Literature Review Summary Table*
2. *June 24, 2025, Technical Advisory Panel Meeting slides.*

*Attachment 1. Literature Review Summary Table*

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METEC
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SMU. | LYLE SCHOOL OF ENGINEERING

# PHMSA – METEC Pipeline Projects

## Practical Protocols for Pipeline Leak Detection (P3LD)
## Partnership to Advance Pipeline Leak Detection Methods (P4)

## Technical Advisory Panel Meeting

June 24, 2025


**CSU**
PI: Daniel Zimmerle
Co-PI: Bryan Rainwater

**SMU**
Co-PI: Kate Smits
Post Doc: Venkata Rao

# Non-conflict Statement

- As a reminder to our members, please refrain from sharing any competitively sensitive information with other members or with the researchers.

# Antitrust Guidelines

- No discussion or sharing of any company’s confidential or proprietary information;
- No discussion or agreements, either explicit or implicit, regarding prices of particular products or services provided by or received by a company;
- No forecasting of prices for goods or services;
- No discussion of any company’s purchasing plans for particular products or services;
- No discussion of any company’s specific merger/divestment plans, market allocation, production information, refinery runs, inventories and costs (only publicly available information should be discussed or shared);
- No agreement or discussion regarding the purchase or sale of a product or service—purchasing and selling decisions are independent company decisions;
- No sharing or discussion of specific company compliance costs, unless information is publicly available;
- No discussion of how individual companies intend to respond to potential economic scenarios or government action;
- No disparaging remarks regarding vendors, products, services.

# Agenda

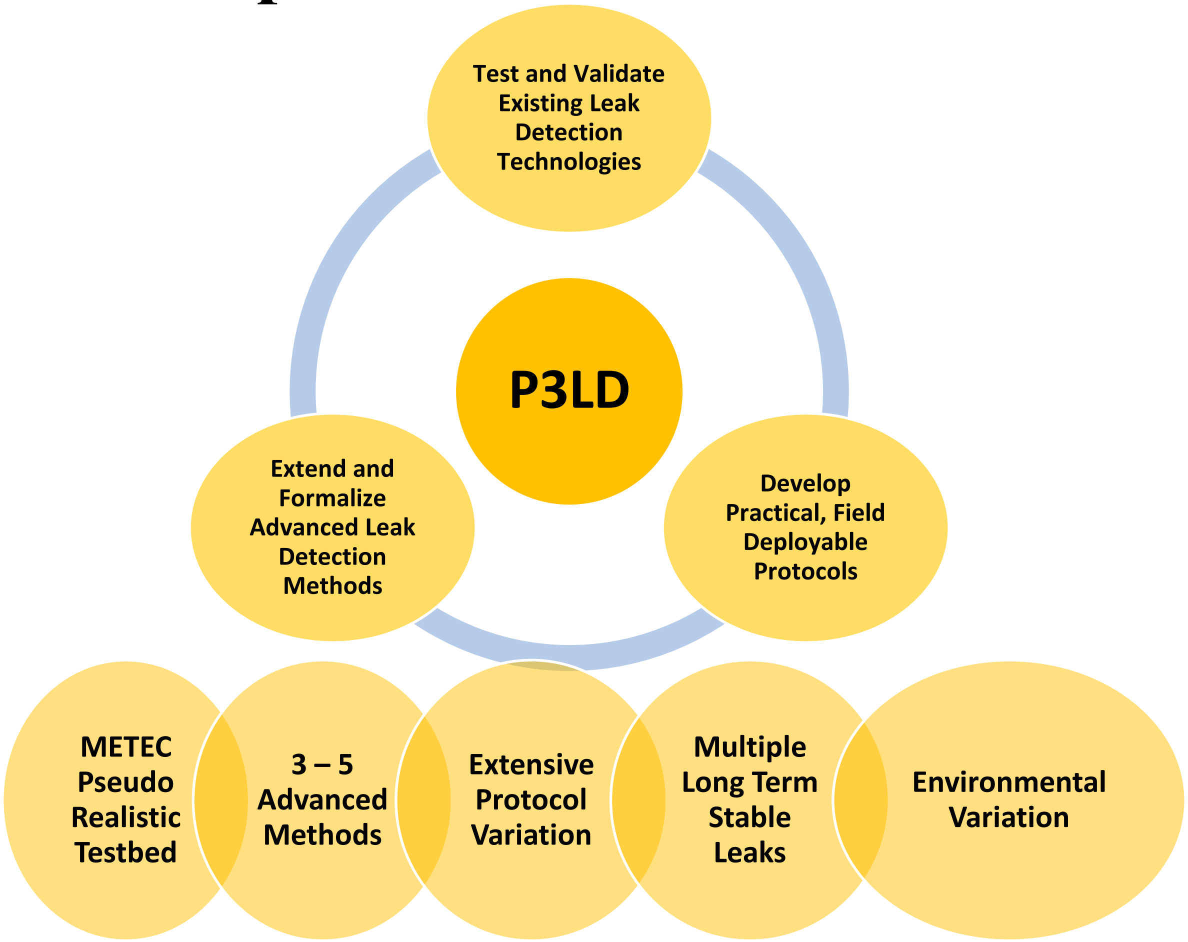
1) Pipeline buildout and project updates
2) Literature review/interviews with stakeholders
3) TAP feedback/discussion on P3LD 3-5 advance methods and conditions of interest
4) P4 Testing Round 1 and October Showcase Updates

Source: Department of Transportation's Pipeline and Hazardous Materials Safety Administration.

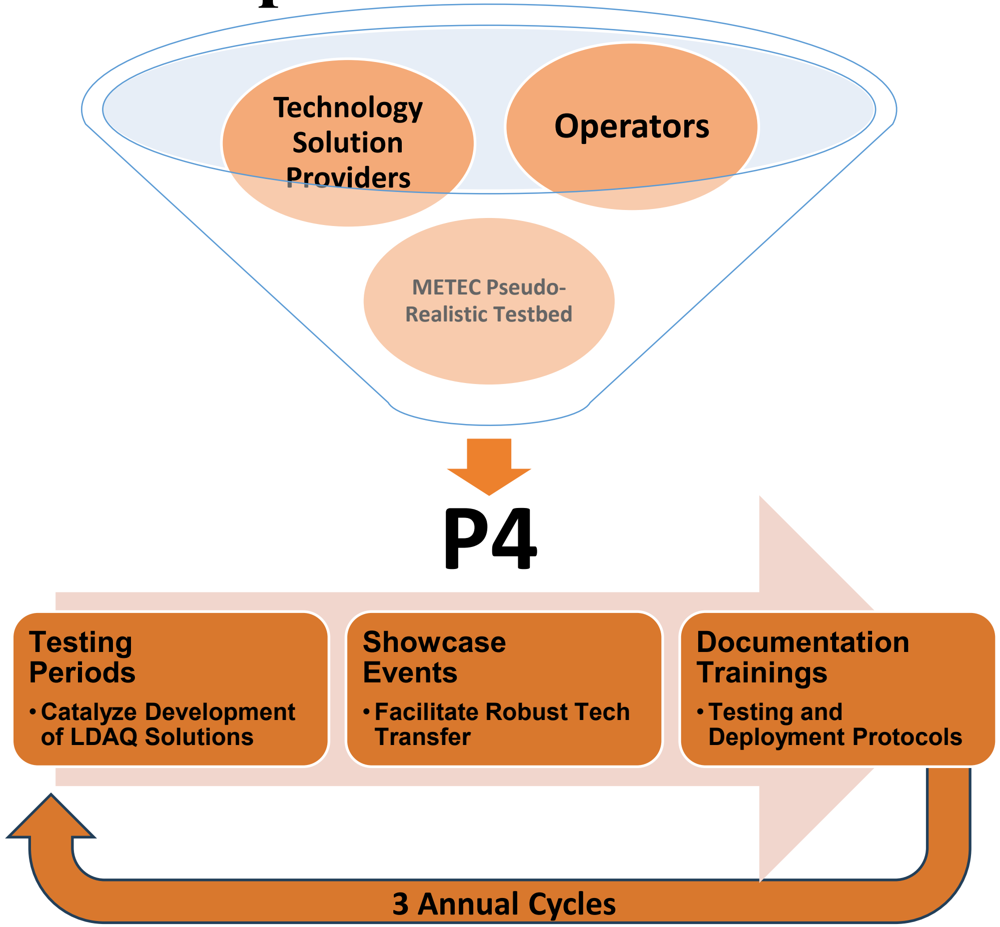
# P3LD/P4 Future TAP Split

PHMSA mission: to protect people and the environment from the risks of hazardous materials transportation

## P3LD: Practical Protocols for Pipeline Leak Detection




## P4: Partnership for Practical Pipeline Protocols



# Study Team: Joint team from CSU & SMU

## CSU Team:

**Dan Zimmerle**
***PI**-METEC Director*

**Bryan Rainwater**
***Co-PI***
*Research Scientist*

**Ryan Brouwer**
*METEC Site Manager*

**Robert Beauchamp**
*METEC Program Coord.*

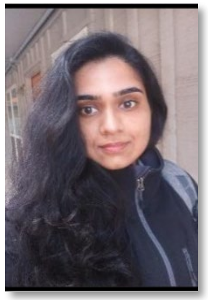
**Wendy Hartzell**
*Project Manager*

**Julian Zenner**
*Graduate Student*

## SMU Team:

**Kate Smits**
**Co-PI-**
Professor

**Venkata Rao**
Post Doc



**Navodi Jayarathne**
Post Doc

**Isuru Bandara**
Graduate Student

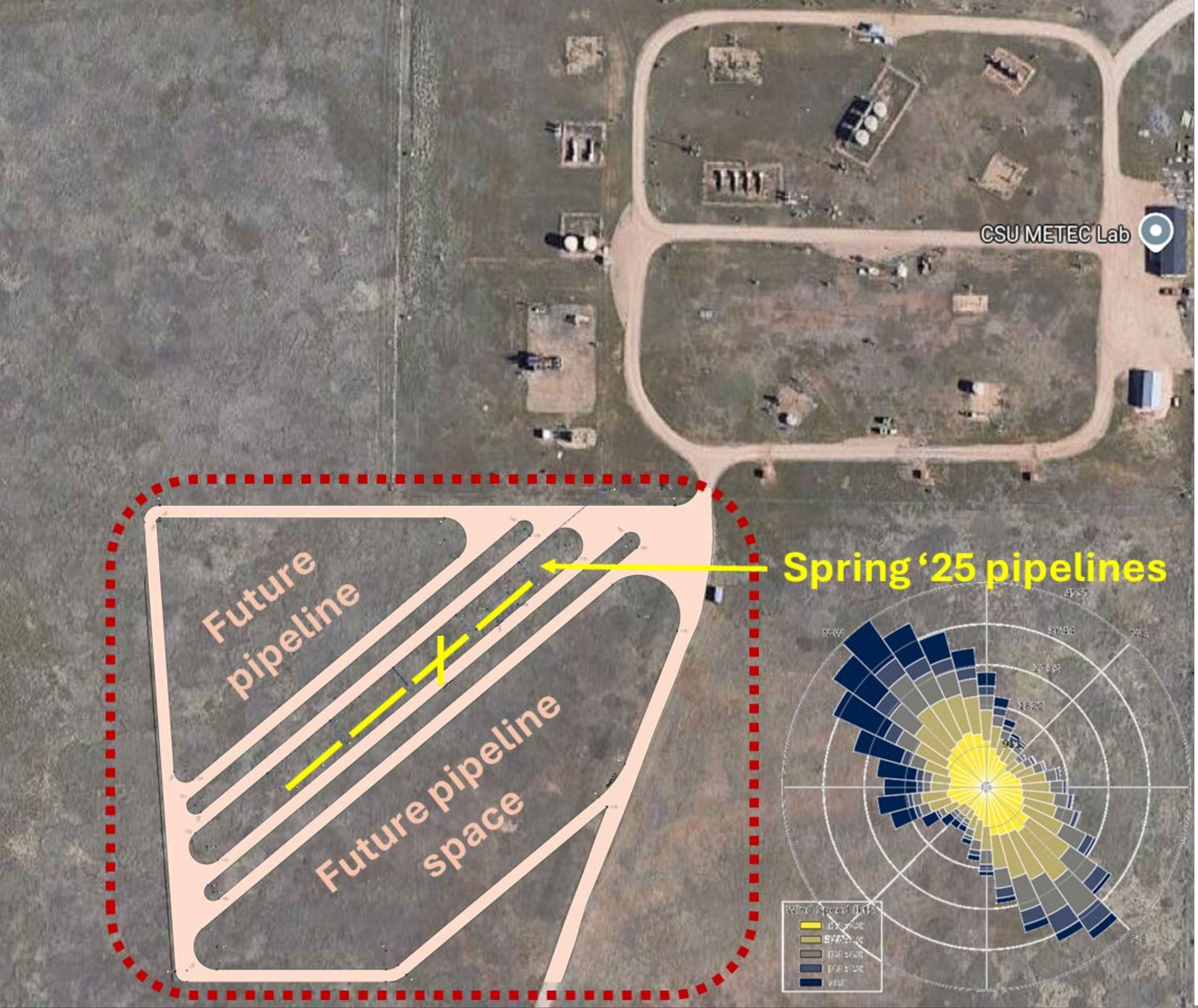
**Joelle Uribe**
Graduate Student

**Sergio Escudero**
Graduate Student

# 1) Testbed build out, timelines

# Methane Emissions Technology Evaluation Center (METEC)

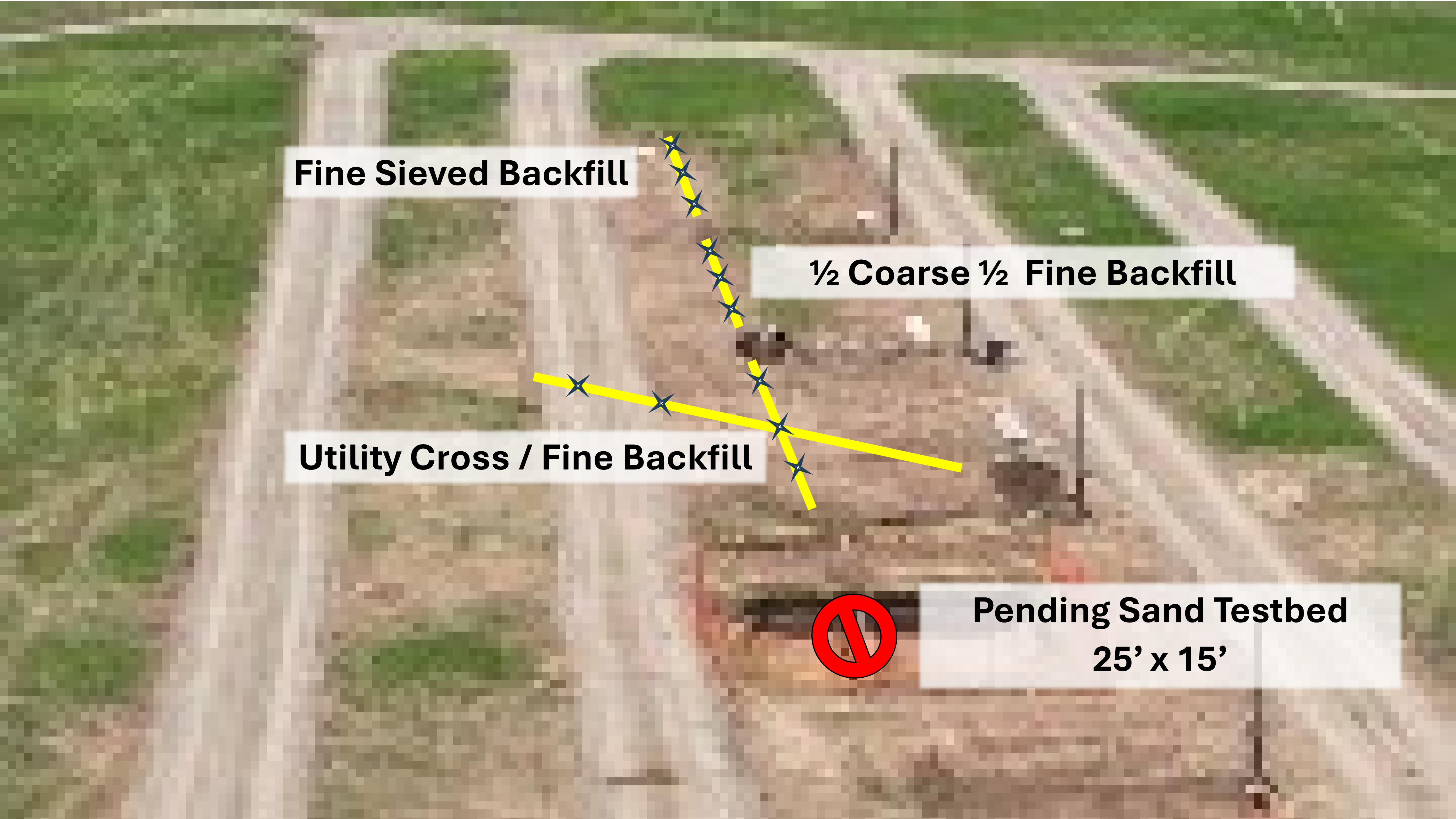
## Pipeline Testbed Off-Site Move & Rebuild

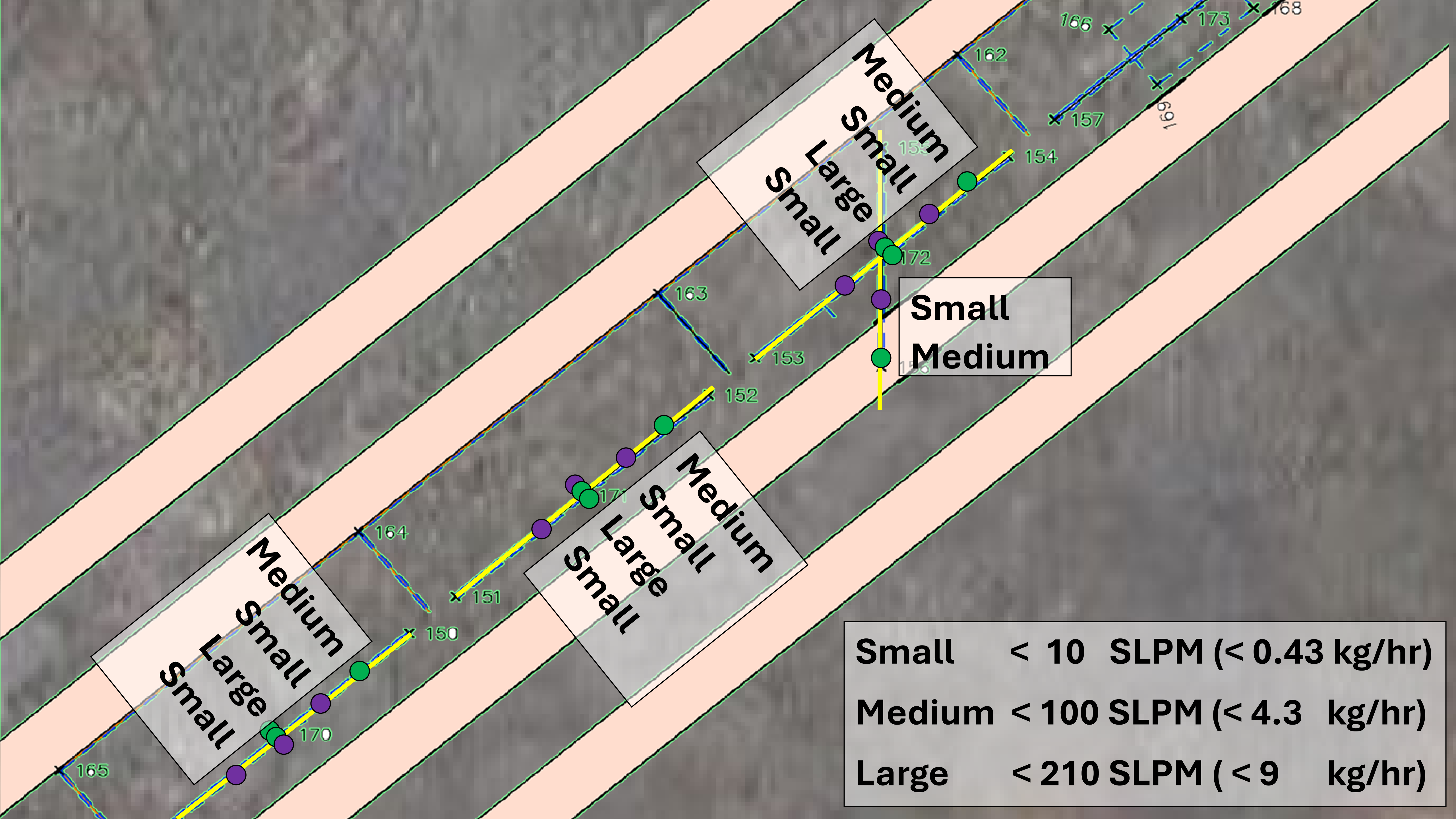



# P3LD/P4 on the METEC Testbed

- Controlled leak testbeds
  - Long-term testing independent of above ground METEC operation
  - Primarily cross-wind
  - ~100m, ~20 independently controllable leaks
- Expansions Planned (over next 2 years):
  - Triple the Pipeline sections
  - Add variation (movable obstructions, pipe/soil properties, sensor systems, testing automation)


Driving Surveys


Fine Sieved Backfill
½ Coarse ½ Fine Backfill
Utility Cross / Fine Backfill
Pending Sand Testbed
25’ x 15’


Medium
Small
Large
Small
Small
Medium
Medium
Small
Large
Small
Medium
Small
Large
Small
Small < 10 SLPM (< 0.43 kg/hr)
Medium < 100 SLPM (< 4.3 kg/hr)
Large < 210 SLPM ( < 9 kg/hr)
150
151
152
153
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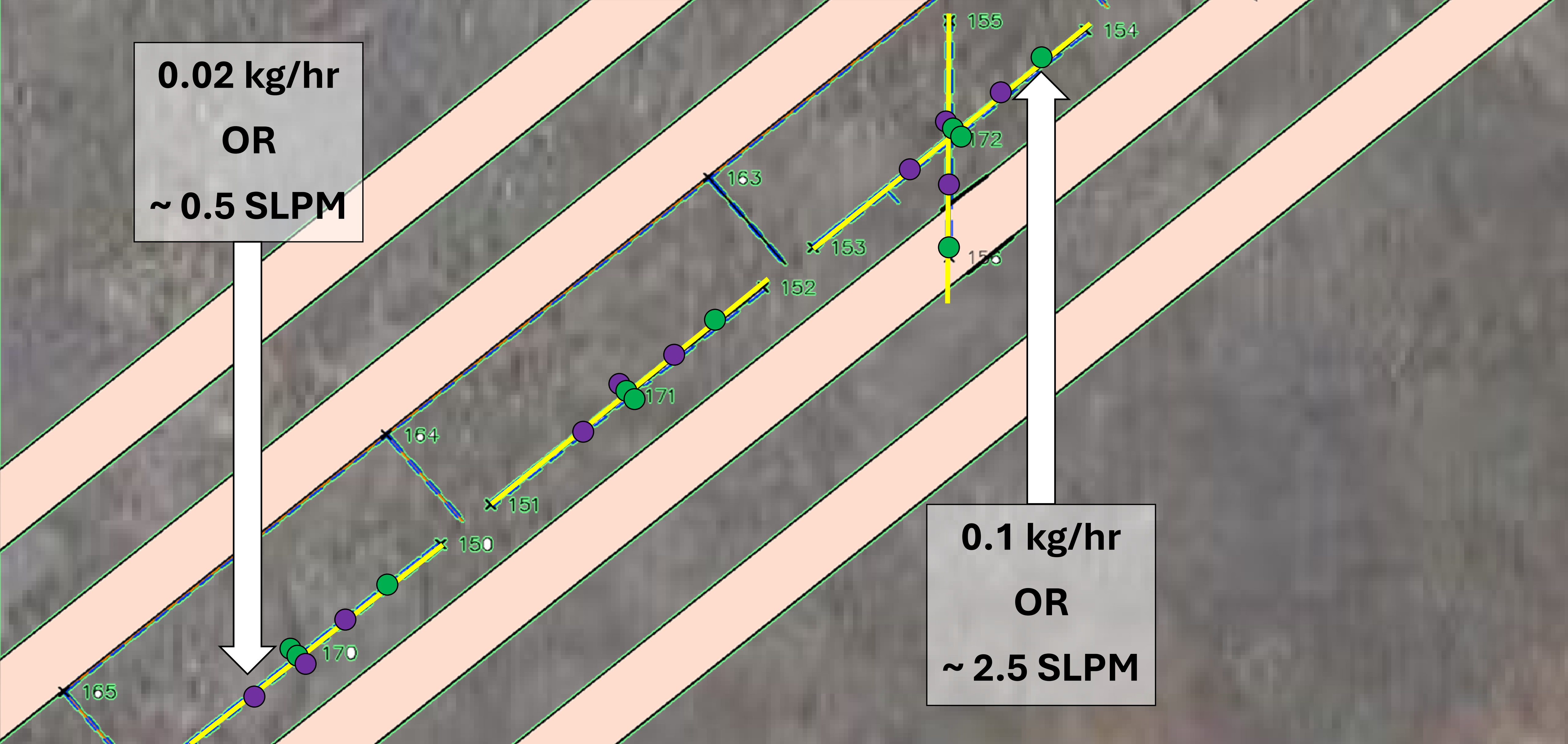
# Constant (Reference) Leaks (Both Projects)

Jul 7, ‘25 → Mar 1, ‘26



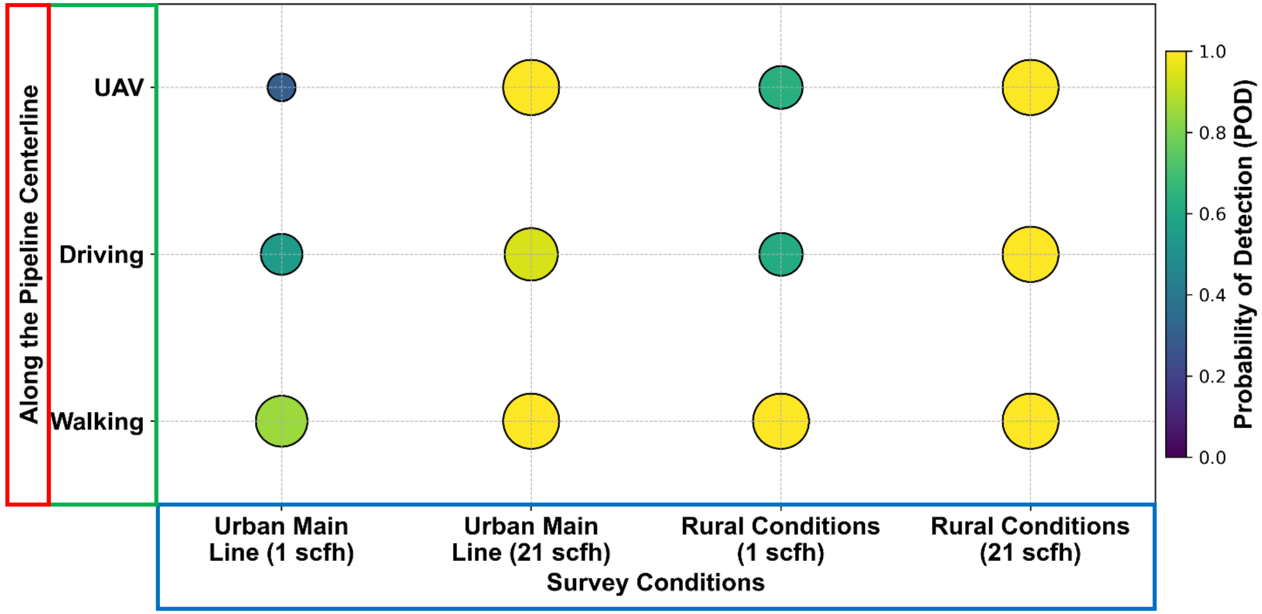
# 2) Review Current & Emerging Pipeline LDAQ Methods

# $P^3$LD Objectives

Extend and formalize advanced leak detection methods for natural gas (NG) and $H_2$ blends by:

1. Assessing current methods and formulating approaches to select the right method(s) ***for the operating and environmental conditions***
2. Develop practical, field-deployable protocols for 3-5 advanced methods

**Develop controlled testing protocols advanced methods, and various operating & environmental conditions**




**field with operators**

Venkata Rao et al., *in review*

**Provide recommendations for integration into LDAQ practices**

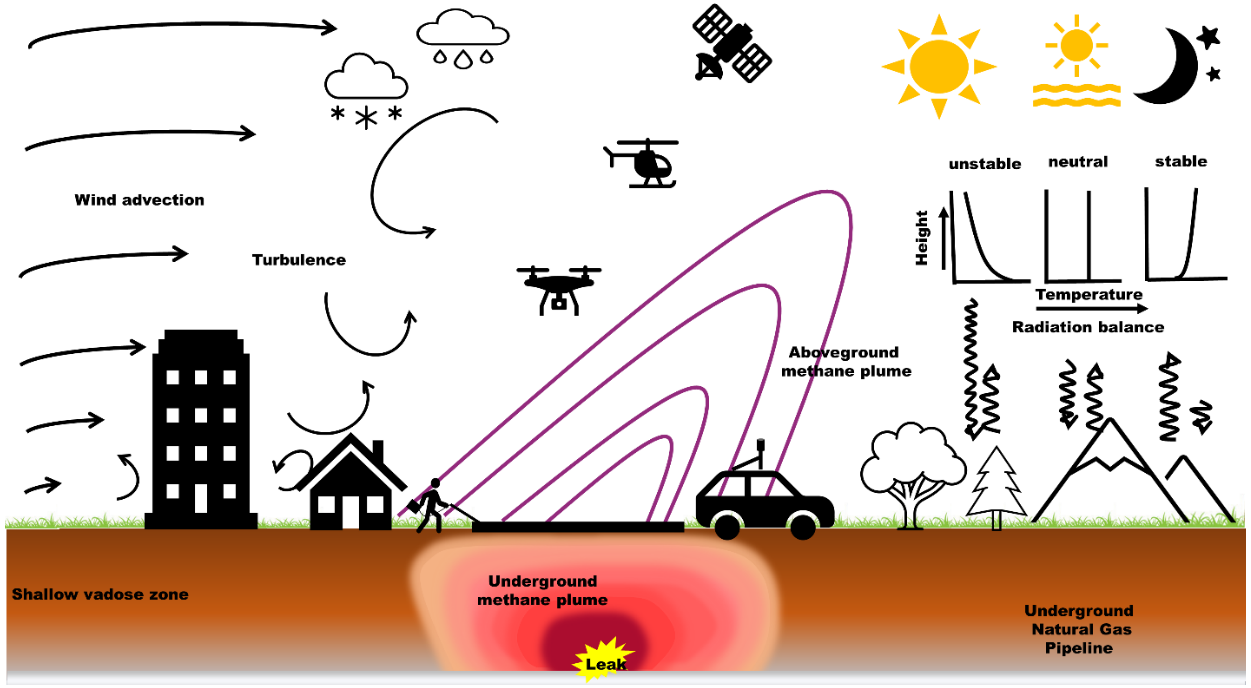
# Task 1: Review Current & Emerging Pipeline LDAQ Methods

## Objective:

Review and document current and emerging LDAQ effort applicability to diverse pipeline conditions in distribution, gathering and transmission

## Purpose:

Results used to assist with research and development efforts for P$^3$LD & P4 projects




Tian *et al.*, 2024

# Approach

Literature Review

- PHMSA-sponsored projects reports (9)
- Peer reviewed papers and reports (60)
- Internal operation documents (12)
- Related videos
- Company websites and brochures
- Published specifications
- Blogs

Conversations with Technical Advisers (14)

- R&D program managers and engineers
- Operator area managers
- Technicians
- Solution Providers

**Focus on next-generation methods** which are in, or are likely to be in, active deployment by pipeline operators in distribution, gathering, and transmission

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# Operational Parameters Used in Pipeline LDAQ

| Survey Type | Walking | Driving | Unmanned Aerial Vehicle (UAV) | Aircraft |
|---|---|---|---|---|
| Platform | Pedestrian | Truck | UAV | Helicopter/Fixed wing aircraft |
| Detection threshold (ppm) | 5 - 10 | 5 - 10 | 0.05 enhancement | Not reported |
| Survey Speed (mph) | 2 - 5 | 2 - 50 | 5 - 40 | 2 - 123 |
| Passes Performed (#) | 1 - 2 | 2 - 6 | 1 - 2 | Not reported |
| Height of Measurement (ft) | 0 | 1.64 - 10 | 3 - 147 | 15 - 3000 |
| Distance downwind from centerline (ft) | 0 - 65 | 0 - 32 | 0 - 150 | Not reported |
| Wind Speed Limit (mph) | 14 - 30 | 14 | 4 - 29 | 12 - 18 |
| Number of Passes | 1 – 4 | Up/Mid: 1 – 4<br>Down: 1 – 6 | NA | Not reported |

Up: Upstream, Mid: Midstream, Down: Downstream

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# Technical Specifications & Operational Parameters

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Up: Upstream, Mid: Midstream, Down: Downstream

# Environmental/Operational Considerations, Limitations by Method

| Platform | Environmental considerations | Operational considerations | Limitations |
|---|---|---|---|
| **Stationary / Continuous** | • Wind speed/direction & stability<br>• Ambient T, RH (>5% and <95%) & pressure<br>• Solar/precipitation extremes<br>• Surface/soil properties | • Sensor height/placement & inlet depth<br>• Gas density/composition & release rate<br>• Background $CH_4$ stability<br>• T/RH calibration | •Single-site/test-bed only, real-world variability<br>• Requires ideal wind & periodic recalibration |
| **Walking** | • Wind speed/direction & stability<br>• Surface/soil properties<br>• Terrain/vegetation type<br>• Seasonal biogenic $CH_4$ variability | • $\Delta CH_4$ threshold & spatial window (0–30 m)<br>• Sampling rate (≈1 Hz) & pace (2–3 mph)<br>• GPS precision (± 3 m) | • Labor-intensive, snapshot surveys<br>• Few samples; terrain-specific<br>•No continuous flux quantification; limited atmospheric transport modeling |
| **Driving** | • Wind speed/direction & turbulence<br>• Road surface, traffic stops & urban noise<br>• Solar angle/temperature (optical sensors) | • Vehicle speed & # of passes (2–8)<br>• Threshold choice<br>• Inlet height | • Often limited to controlled-release conditions<br>• False-positives 0–70 %;<br>• Small/off-road leaks under-detected<br>• Quant. ± 20–100 %; traffic constraints |
| **UAV** | • Wind speed/direction (1–5 m/s) & turbulence<br>• Atmospheric stability class (3F–5D)<br>• Solar/precip; no rain/clouds<br>• Rotor wash & surface reflectivity | • Flight pattern & altitude (2–25 m)<br>• GPS error & sensor pre-heat<br>• Optical path length (mini-RMLD vs. open-path)<br>• Background $CH_4$ concentration | • Short endurance (10–20 min); payload limits<br>• Underestimates small leaks<br>• High quant. uncertainty (± 15–100 %) |
| **Aircraft** | • Wind speed/direction & boundary-layer dynamics<br>• Atmospheric stability & turbulence<br>• Temperature, humidity, cloud/solar angle<br>• Platform motion & noise | • Altitude & swath geometry (150–3 000 m)<br>• Wind-dependent sensitivity breakpoint (~3 m/s)<br>• Scan speed/pattern | • High MDLs; misses small leaks<br>• Quant. uncertainty 30–68 %<br>• Limited to test-bed releases; temporal mismatches with real plumes |
| **Satellite** | • Cloud cover, surface albedo & aerosols<br>• Solar angle & viewing geometry<br>• Wind-field & plume transport modeling | • Pixel size & overpass geometry (25 m–7 km)<br>• Revisit frequency (daily–multi-day)<br>• Background algorithm thresholds | • Snapshot only, no intra-day data<br>• Very high MDLs; coarse resolution<br>• Strong dependence on clear-sky & transport-model accuracy |

# Key Challenges and Interests

## Operators


1. **Impact of diverse operating conditions on leak detection success**
2. **Subsurface migration**
3. **Leak quantification with minimal data**
4. **State of the art (new and existing technology)**

## Solution Providers


Validate and refine technologies for leak detection and quantification for belowground leak scenarios

# Key TAP interests that expand off of previous APPLIED project

**Diverse Conditions**

- **Snow, permafrost, rain**, vegetation, urban canyon effects, terrain
- **Pavement**
- **Gas blends (Hydrogen),** gas composition

- **Diurnal patterns** and how to incorporate into (1) **detection success** and (2) **quantification**
- **Quantification** for belowground leaks using existing tools (minimal ‘extra’ data collection)
- Impact of **multiple passes**
- **Defining sensitivity** e.g. “90% detection success of a 5-10 kg/hr leak” (~260- 530 scfhr)

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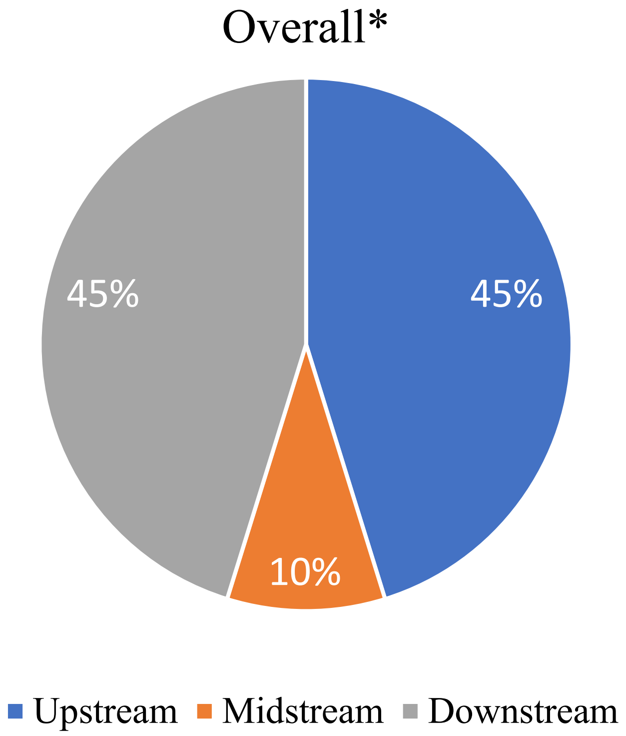
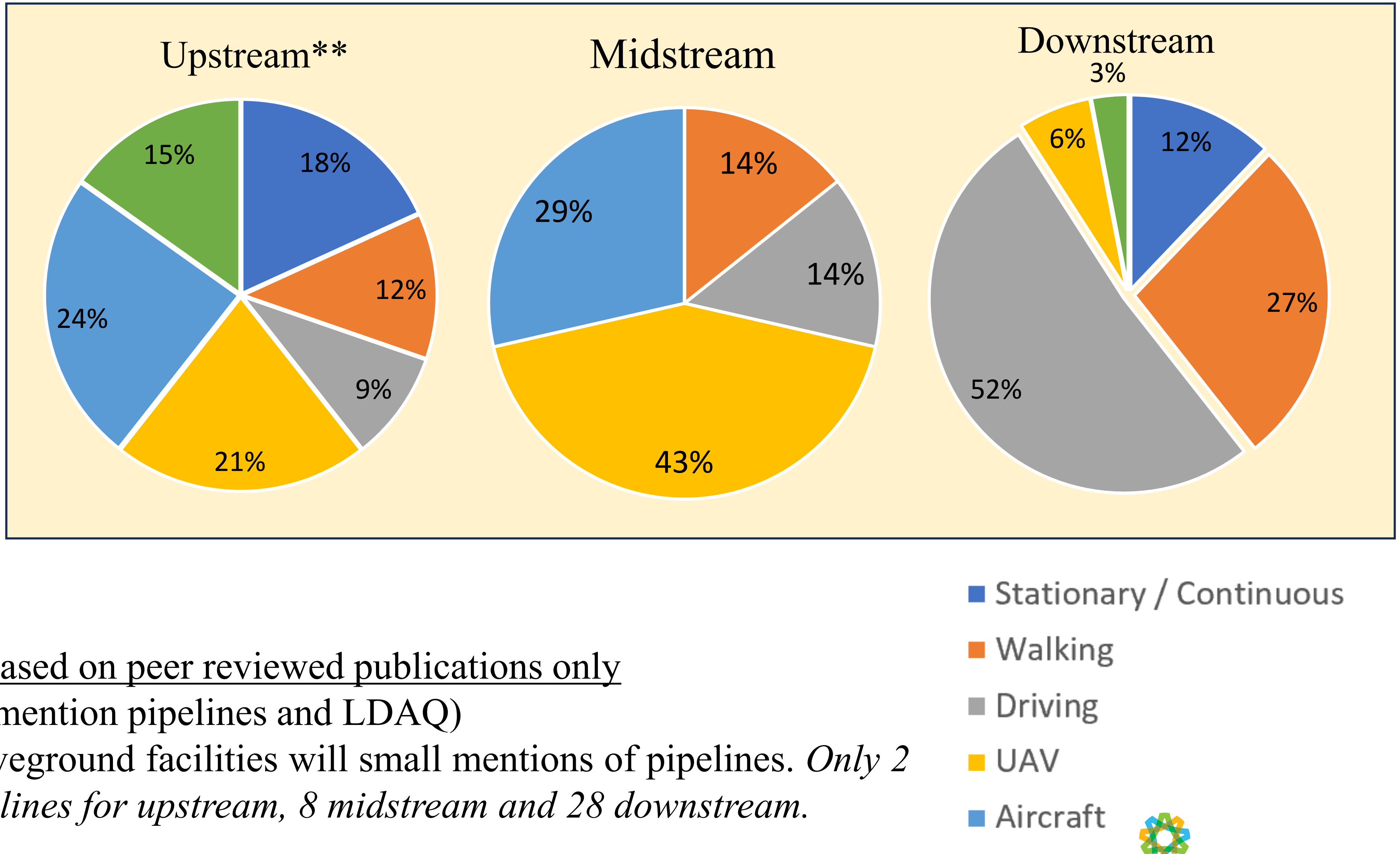
# Literature availability based on survey method: *almost none for belowground pipelines*




*Summary of literature published based on peer reviewed publications only (60 publications found to date that mention pipelines and LDAQ)

**Upstream mainly studies on aboveground facilities will small mentions of pipelines. *Only 2 literature sources available on pipelines for upstream, 8 midstream and 28 downstream.*

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# Next Steps for Review (P3/P4)

1. Finalize Leak Detection report (will be made available to the TAP)
2. Focus on quantification methods for belowground natural gas pipeline leaks
3. Pipeline Condition review to summarize the current pipeline portfolio, ROW conditions, and deployment challenges
4. Use findings to inform experimental design for P3 Protocols Project (next slide)

# Experimental Design For Controlled Experiments

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# Approach

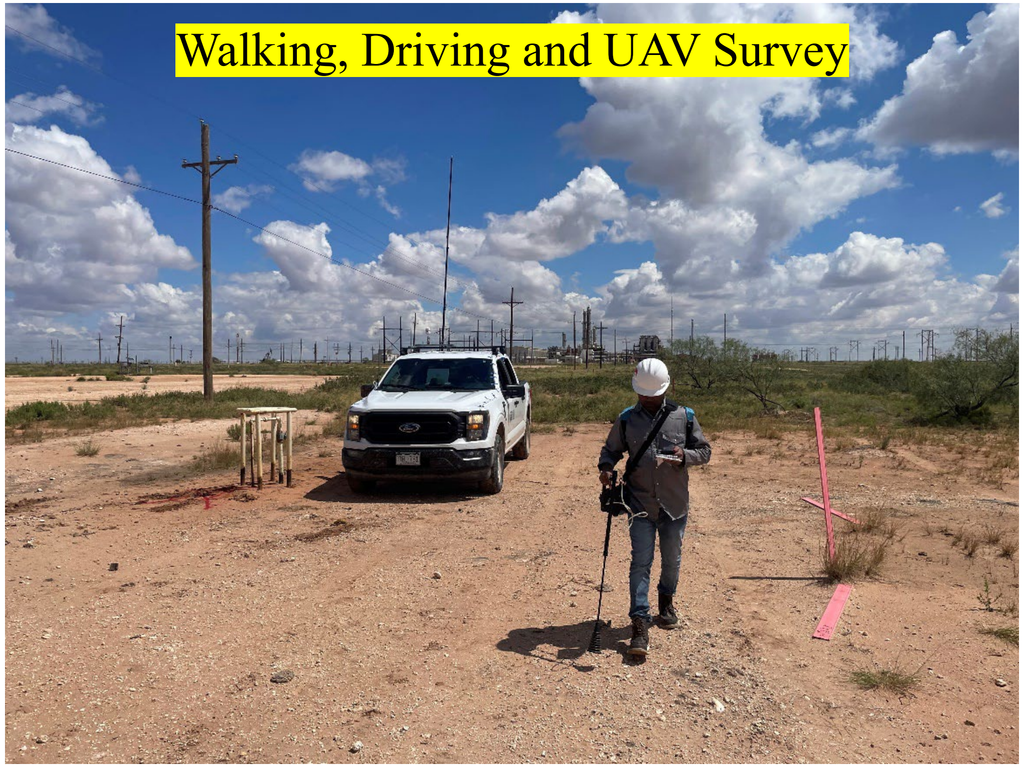
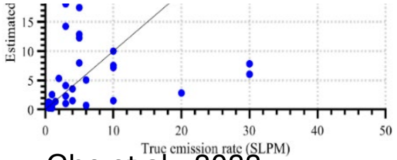



Photo: Protocol Implementation in the Permian Basin during APPLIED project (V. Rao)

**Plan view of survey routes**

- Controlled experiments at METEC pipeline testbed facility
- 2, 9- month cycles over project with experimental 'windows' within each cycle
- Select one constant leak rate for extended period (0.5 slpm), leaks at 1-3 locations
- Execute LDAQ experimental testing protocol
  - Walking, driving, UAV or $UAV_{sim}$
  - For each cycle and experimental 'window'
  - Morning, noon, night




Cho et al., 2022

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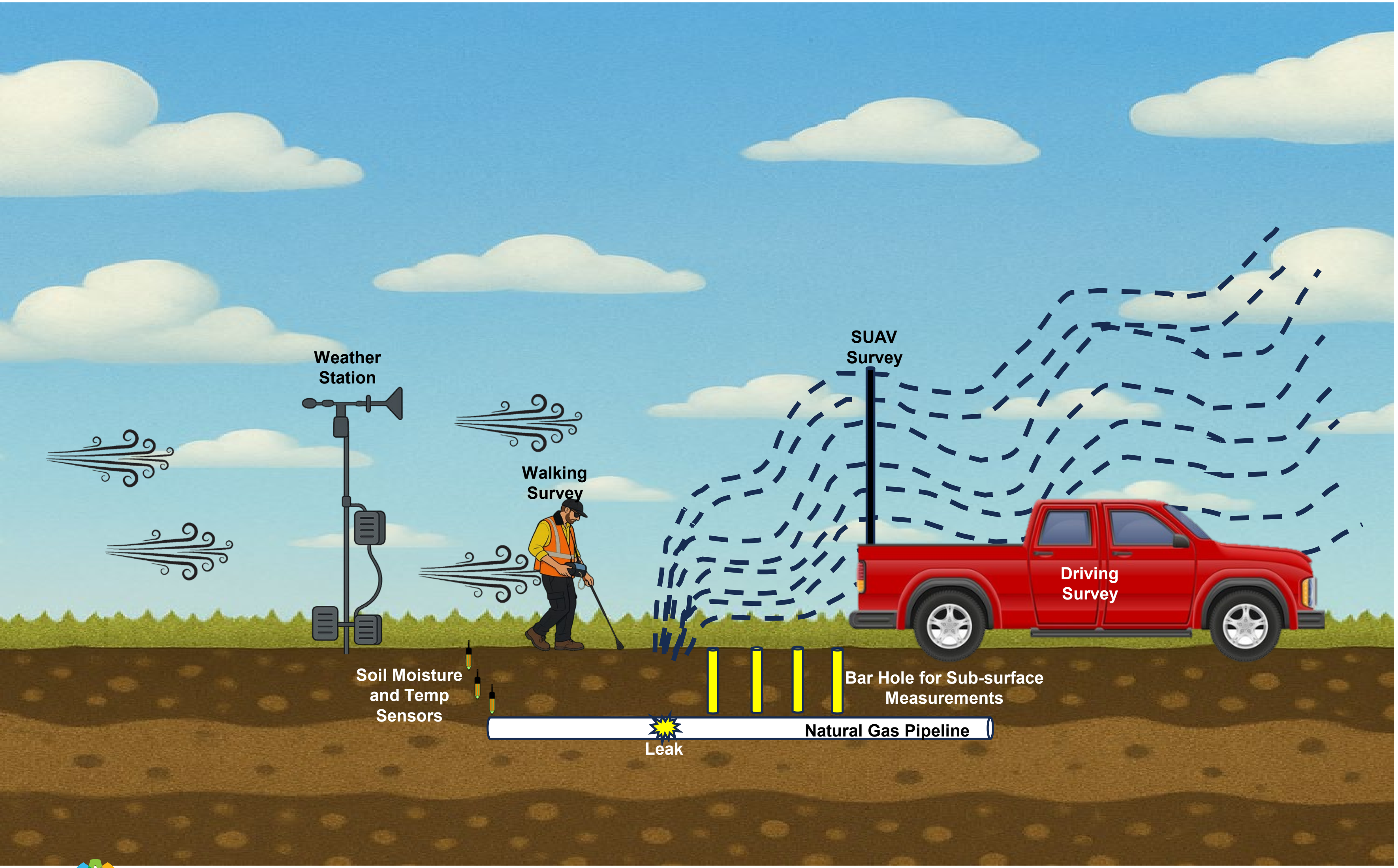
# Controlled Experiments Data Collection




- **Methane Concentration Data** - Walking, Driving, UAV surveys
- **Meteorological Data** – on site weather station
- **Geolocation Data** - High-precision RTK-GPS for each method
- **Subsurface Methane Concentration Data** - (limited locations) using bar holes & DPIR
- **Surface Methane Concentration Data** – gridded pattern using DPIR
- **Soil Moisture and Soil Temperature Data** - temporarily installed environmental sensors

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# P3LD Experimental Plan

**Objectives:** Assessing the Influence of Diverse Operating Conditions on Leak Detection Effectiveness

**Soil Moisture and Type Experiments (Dry Conditions)**

| Day | No. of Testbeds | Leak Rate (SLPM) |
|---|---|---|
| Day 1 | 3 Testbeds | 0.5 |
| Day 2 | 3 Testbeds | 0.5 |
| Day 3 | 3 Testbeds | 0.5 |
| Day 4 | 3 Testbeds | 0.5 |
| Day 5 | 3 Testbeds | 0.5 |

**Surface Condition Experiments**

| Day | Leak Rate (SLPM) | Surface Conditions |
|---|---|---|
| Day 1 | 0.5 | Snow |
| Day 2 | 0.5 | Snow |
| Day 3 | 0.5 | Snow |
| Day 4 | 0.5 | Pavement |
| Day 5 | 0.5 | Pavement |

**Soil Moisture and Type Experiments (Wet Conditions)**

| Day | No. of Testbeds | Leak Rate (SLPM) |
|---|---|---|
| Day 1 | 3 Testbeds | 0.5 |
| Day 2 | 3 Testbeds | 0.5 |
| Day 3 | 3 Testbeds | 0.5 |
| Day 4 | 3 Testbeds | 0.5 |
| Day 5 | 3 Testbeds | 0.5 |

These experiments are designed to evaluate how the following factors influence leak detection success:

- Snow cover, vegetation, and paved surfaces
- Soil Moisture levels
- Soil Type (METEC features four testbeds)
- Diurnal (day-night) fluctuations
- Multiple passes

**Note:** The study team will conduct one week of experiments at the same leak rate across multiple testbeds to collect data under diverse operational conditions. Diurnal measurements will be conducted depending on weather conditions.

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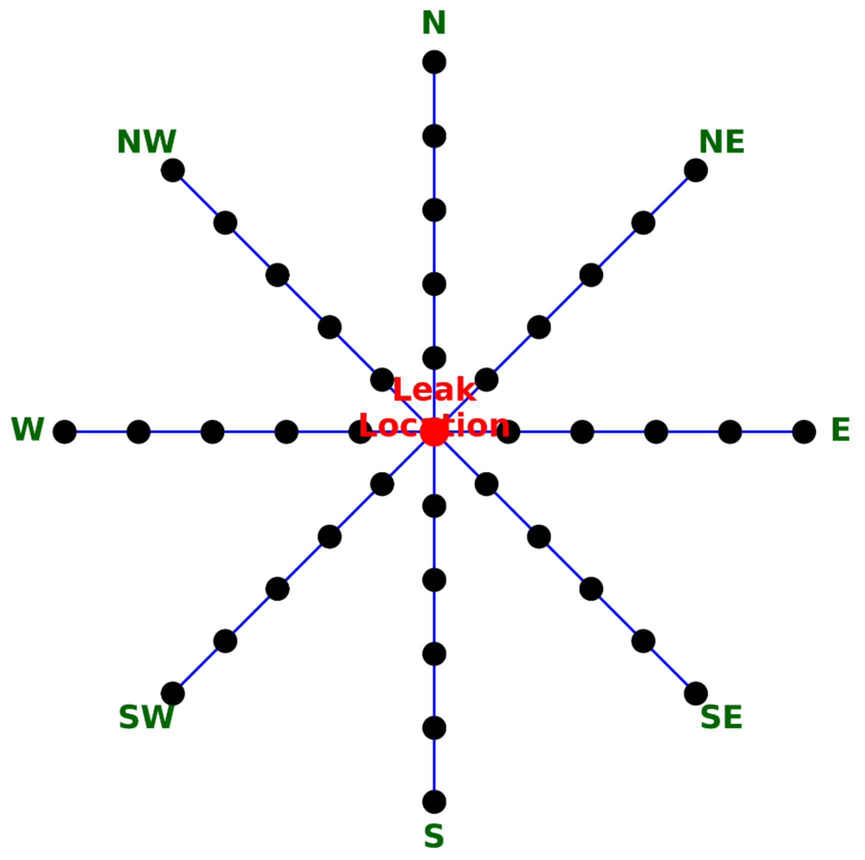
# Parallel Leak Quantification Data Collection to Test and Refine Methods

**Data Collection:**

- Concentration data will be collected at surface and downwind wind locations
- Meteorological data

**Methods:** Multiple approaches will be used to quantify the leaks, for example:

  - Dimensionless Number Approach (DINA), Cho et al (2020)
  - EPA Other Test Method 33A (OTM 33A)
  - Hole-in-pipe Methods:
    - Ebrahimi-Moghadam et al, 2018
    - Liu et al, 2021




Example schematic representation of surface measurements

# Phase II: Comparing leak estimates on upstream pipeline leaks

- Initial Results from Texas Field Work

| Estimation Method | $CH_4$ Leak Rate (SCFH) | Total Gas Leak Rate (SCFH) |
|---|---|---|
| Hole in pipe (full break)[a] Liu et al, 2021 | 12,300 | 15,900 |
| Hole in pipe (5 mm)[b] Liu et al, 2021 | 960 | 1,247 |
| Hole in pipe (5 mm)[b] Ebrahimi-Moghadam et al, 2018 | 570 | 740 |
| DINA (dry) [c] Cho et al (2020) | 6 | 7.8 |
| DINA (wet) [c] Cho et al (2020) | 1.5 | 1.95 |
| OTM-33a | 2,400 | 3,117 |

*a ) Full break determines upper (i.e., maximum) limit for leak size*
*b) Assumed a 5mm orifice size for hole in the pipe based on provided photos from pipe repair*
*c) Varied soil moisture from dry (25%) to wet (54%)*

Uribe, et al., 2025 *(in preparation)*



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# 3) P4 Testing Round 1 and Showcase update

# Anticipated schedule

- Need a commitment on participation in ~3 weeks (July 1)
- Site operational (July 7)
  - Long-term emissions and data collection begins
- METEC staff and project team works with Solution Developers in ‘1st deployment window’
  - Onsite safety briefing required
  - Pre-testing intake on deployment protocols
  - Testing conducted
  - Post-testing review on site use and deployment protocols
- Repeat every 3 months with next cohort of solution developers

# 1st Solution Showcase Preliminary Design & Timing

- **When**: Tuesday, October 7, 2025
- **Hours**: 8:00 am - 4:30 pm
- **Where**: Energy Institute & METEC, Colorado State University, Fort Collins CO
  - The Showcase is a $CH_4$ Connection Conference Pre-Conference Event

***Summary Agenda:***

Morning – Panel Discussions and Presentations; opportunities to network

- **Panel Discussion**: Advance leak detection survey methods
- **Presentation**: Latest research on environmental conditions
- **Panel Discussion**: Pipeline Leak Quantification – Successes, Challenges, Opportunities

Afternoon – Demonstrations of solutions at METEC on underground pipelines

- **Solution developers display, describe, and demo solutions**. Active leaks on pipelines are will be available for real-time demonstrations

# Thank You

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