PARSONS

TECHNICAL PROPOSAL

METHANE EMISSION QUANTIFICATION

CRFP 0313 – DEP2500000001

West Virginia Department of Environmental Protection
Office of Oil and Gas

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Date: August 15,2024

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PROJECT STATEMENT OF WORK, GOALS, AND GENERAL REQUIREMENTS

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SECTION 1:

PROJECT STATEMENT OF WORK, GOALS, AND GENERAL REQUIREMENTS

Parsons Environment & Infrastructure, Inc. (Parsons) is pleased to present this proposal to the West Virginia Department of Environmental Protection, Office of Oil and Gas (WVDEP-OOG) for methane detection and quantification services. We've structured our proposal around the requirements contained within Request for Proposal #0313-DEP2500000001 (RFP). Our oil and gas teams have over 18 years of experience locating, performing integrity analysis, conducting methane monitoring, and documenting various orphaned and abandoned wells with associated production facilities within the United States and Canada on both private and public lands.

Our comprehensive response to this RFP showcases our expertise in executing all aspects of orphan well projects. Parsons is well-positioned to deliver on the RFP's scope of services. Our commitment to safety, environmental stewardship, and effective project management positions us as a reliable and qualified partner for the successful execution of West Virginia's Methane Emission Quantification needs. In addition to methane emissions monitoring, Parsons team members are adept at locating abandoned well sites and completing all aspects of orphaned well investigation, plugging, remediation, and restoration, with a proven track record working with regulatory agency personnel.

Parsons leverages decades of experience in managing large-scale projects, emphasizing, not only technical proficiency, but also a keen understanding of critical path scheduling and stakeholder collaboration. Our proven success in executing projects of similar complexity across various states underscores our ability to navigate time-sensitive assessments and intricate project schedules. Our commitment to Safety, Health, and Environment (SH&E) excellence is evident in the comprehensive training provided to project personnel.

Parsons is the principal contractor providing screening and quantification of methane emissions for 444 orphan well sites and 60 associated facilities across the state of Michigan in compliance with the U.S. Department of Interior Orphan Wells Program Office's Guidelines laid out in the July 2023 document titled, "Assessing Methane Emissions from Orphaned Wells to Meet Reporting Requirements of the 2021 Infrastructure Investment and Jobs Act: Methane Measurement Guidelines" (BIL Guidelines). Through this experience, Parsons has developed workflows and processes to provide the maximum value for our clients, easing the compliance burden for federal guidance on methane emissions monitoring.

Our Central Michigan Oilfields Restoration project has successfully investigated and remediated over 1,000 oilfield sites and completed re-entry and abandonment of over 280 former oil wells for a private oil company client. In Canada, we've assessed/restored 800 well sites, including the development of risk-based and methane mitigating biotechnology alternatives to well plugging, and we've performed extensive methane migration and emission studies on 30 orphaned gas well sites in remote forested locations. Our unmatched experience and technological capabilities with orphaned and historically abandoned wells have made us an industry leader that continually brings innovation and modern yet cost-effective solutions to these oftentimes century-old wells.

Goals and Objectives

This proposal meets the requirements set forth within the RFP along with the referenced attached BIL Guidelines to address pre- and post-plugging methane emission detection, screening, and quantification services at the requested quantities of orphan well site locations.

The proposed technical objectives focus on close, detailed collaboration with our clients to select and employ innovative and sustainable approaches to solving their challenges while maintaining safety for crews.

Our BIL Guideline compliant technical approach is derived from directly applicable experience screening and quantifying methane emissions for our orphan well state agency client in Michigan. The lessons learned through our experiences have shaped our choice of equipment and workflow to provide the most efficient and effective method available. Our team members have wide-ranging knowledge of the necessary procedures for working on and around oil production facilities and can complete the proposed activities safely and effectively.

Project Staff

Parsons' proposed project team members have decades of experience in the oil and gas industry working for international, state, and federal agencies and global oil companies to mitigate and remediate impacts from gas and oil production. As a result, WVDEP will receive the full resources and technological innovation of a global consulting firm but will also realize the benefit of regional project staff with extensive methane and vapor sampling experience. **Table 1-1** lists the key team members that will be assigned to this project.

TABLE 1-1: PROJECT STAFF

1. Name	2. Years of Experience in Current Classification	3. Role(s) / Responsibilities	4. Direct / Subcontract / Contract	5. % of Work Time	6. Physical Location
Tom Drachenberg, PE (Key Contact)	25	Program Manager / Contract Administrator	Direct (FT)	5%	Syracuse, NY
Kyle Metz, MSc (Key Contact)	15	Project Manager	Direct (FT)	25%	Syracuse, NY
Ron Krawczyk, BEng (Key Contact)	18	Technical Director – Orphan Wells / Qualified Measurement Specialist	.Direct (FT)	15%	Breckenridge, MI

1. Name	2. Years of Experience in Current Classification	3. Role(s) / Responsibilities	4. Direct / Subcontract / Contract	5. % of Work Time	6. Physical Location
Glen Ulrich, PhD	31	Technical Director – Methane	Direct (FT)	5%	St. Louis, MO
Logan LaCross	5	Senior Geologist / Qualified Measurement Specialist	Direct (FT)	15%	Breckenridge, MI
Eric Helton, BSc	18	Qualified Measurement Specialist	Direct (FT)	50%	Cincinnati, OH

Tom Drachenberg, PE has extensive engineering and project management experience involving all phases of remediation, including site investigations, feasibility studies, predesign investigations, remedial design, and remedial action. Tom's broad experience includes efficiently executing small-scale projects involving in situ treatment technologies and leading large-scale, high-profile megaprojects involving sediment remediation and landfill assessments. Tom has also served as program manager for a standby orphan well plugging contract with NYSDEC, including responsibility for successful plugging of more than 80 wells.

Kyle Metz, MSc is a Petroleum Geologist and Project Manager with over 15 years of experience managing complex oil and gas projects involving new drill, active, idle, and abandoned/orphaned well investigation and remediation in multiple basins across the United States.

Ron Krawczyk, BEng is a Project Engineer with over 16 years of oil and gas experience with Parsons, primarily in the investigation, abandonment operations, and reclamation of early-era production wells and associated facilities in Michigan. Ron has managed numerous studies and projects involving soil gas detection, methane research, remote sensing with drone technologies, and magnetometry. Ron is the Technical Director of our various Orphan Well Projects including Michigan Orphan Well Methane Monitoring and is a Qualified Measurement Specialist.

Glenn Ulrich, PhD is a Technical Director specializing in contaminant fate and transport, technology development and application in the oil and gas industry, and the sustainable remediation of contaminants and methane. Glenn has published numerous peer-reviewed papers on methane biogenesis and has a patent pending for methane biodegradation systems.

Logan LaCross is a Senior Geologist with seven years of experience and is the primary Qualified Measurement Specialist and Field Leader on our Michigan Orphan Well Methane Monitoring Project and will provide any Qualified Measurement Specialist training.

Eric Helton, BSc is an environmental scientist with over 22 years of experience including vapor sampling and methane collection from landfill gas emissions, flare systems, and oil and gas facilities. Eric will be the primary Qualified Measurement Specialist on this project.

Strategic Approach

Based on the BIL Guidelines, Parsons will use a screening tool to rapidly classify sites into non-detect, detect and detected + may be high categories. Parsons has selected the Remote Methane Leak Detector–Complete Solution (RMLD-CS) system (specifications included in **Appendix A**), a tunable

diode laser adsorption spectroscopy (TDLAS) system as the primary screening tool for identifying leaks around the orphaned wellheads and associated production facilities in the most efficient manner possible. This instrument is lightweight, portable, rugged, and allows the measurement specialist to detect leaks from a safe standoff distance. It can operate effectively in a variety of field conditions including a wide temperature range, light rain, and fog.

This system has a measurement range of 0 – 50,000 ppm*m methane with a sensitivity of 5 ppm*m and can quickly identify methane leaks even below to the required 1 g/hr. threshold. These systems are intrinsically safe and are not subject to interference from other gasses. The unit also features a simple graphical user interface, with internal data logging, WiFi, GPS, and Bluetooth BLE capabilities for easy data capture, storage, and transfer.

For confirmation of non-detect sites (<1g/hr), and as a measurement tool for volatile organic compounds (VOC's), a handheld 5-gas detector will also be deployed with the crews that contains sensors for oxygen (O2), carbon monoxide (CO), hydrogen sulfide (H2S), and the lower explosive limit (LEL). The 5-gas detector is also equipped with a photo ionization detector (PID) which is an approved and proven measuring device for VOCs as per Unite States Environmental Protection Agency (USEPA) Method 21 and has a detection threshold of 1 ppm VOC. Deployed personnel will also be equipped with personal hydrogen sulfide (H2S) badge meters for safety purposes as that is our standard while working around potentially leaking oilfield equipment that may contain sour gas/crude.

To quantify methane emissions leaks in compliance with USEPA Method 21 and the BIL Guidelines, Parsons will deploy the SEMTECH HI-FLOW 2 (specifications included in **Appendix B**). This is the only system on the market to comply with OOOO and American Carbon Registry (ACR) methodologies and provides full measurement traceability for QA/QC along with rapid creation of time, date, and leak rate/concentration data that can easily be imported into site reports. The HI-FLOW 2 utilizes TDLAS for the accurate measurement of the fugitive methane with direct quantification of leaks in the 0.0005 to 25 cubic feet per minute (CFM) range with accuracy better than 5%. On our Michigan Orphan Well Methane Measurement project, it has proven to provide the most accurate and repeatable leak rate quantification results at and below the 1 g/hr threshold requirement in real-world field conditions.

The work process at each site will proceed as the below flow chart indicates and allows for the most consistent methodology and data reporting across the multitude of sites and conditions.

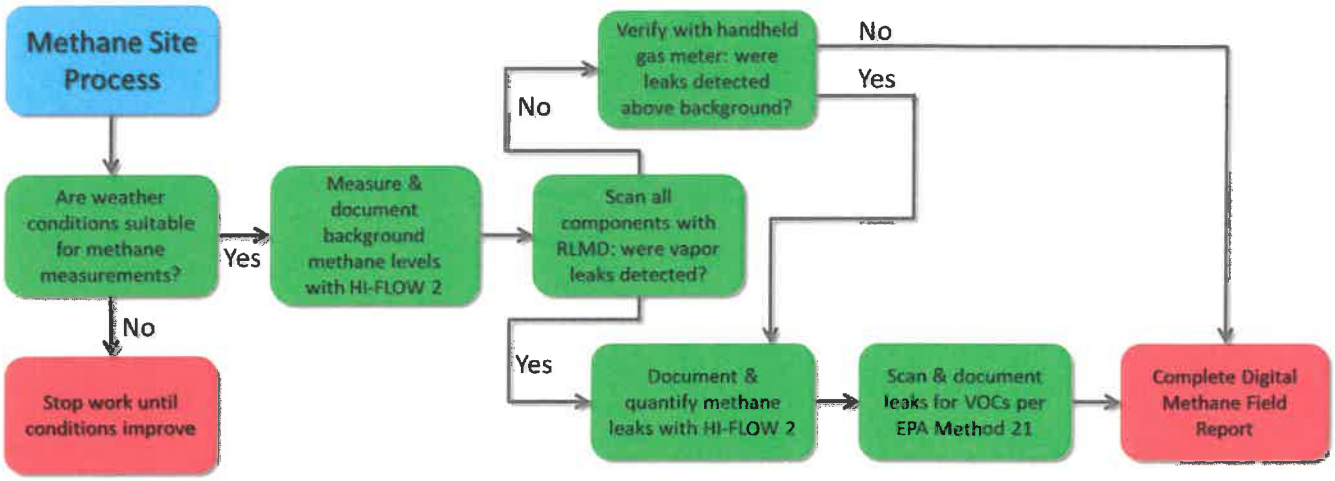

FIGURE 1-1: FLOW CHART OF PROCESS FOR METHANE QUANTIFICATION AT SITES

- A Parsons Methane Emissions Rate Qualified Measurement Specialist and Field Technician will mobilize to the site in which methane leak detection and quantification is required and will be equipped with all necessary measurement equipment.
- All measurement equipment will undergo documented bump checks and/or calibration at frequencies that each equipment manufacturer recommends.
- A handheld weather station and credible weather reports will be used to measure and record air temperature, most recent precipitation date and quantity in inches, wind direction, wind speed, and barometric pressure. Site work will not proceed during rain events nor during localized wind speeds greater than 15 miles per hour as above that threshold, detection limits rapidly decrease.
- Background methane concentration will be measured upwind of the potential methane point-source (wellhead) and documented using the SEMTECH HI-FLOW 2 system. Notes on potential natural sources of background methane such as neighboring wetlands will be made.
- The crew will approach the wellhead, facility, or infrastructure with the RMLD-CS and scan the site from a safe distance for the presence of any large leaks that should be immediately recognized due to potential safety concerns. If large leaks are not identified, crew will proceed closer for formal detailed inspection.
- The crew will collect photos of the site from each cardinal direction to be included in the site investigation report along with a photo of each identified leak location.
- All components of the wellhead and connected infrastructure will be scanned for vapor leaks with the RMLD-CS. This will proceed until each leak is documented.
- If no methane leaks are detected with the RMLD-CS, the well or facility components will be scanned using the handheld 5-gas meter as a verification of Non-Detect (ND) classification.
- If methane leaks are detected, they will be quantified and documented using the SEMTECH HI-FLOW 2 system and reported in ppm and resulting g/hr. leak rate units.
- Any found methane leaks will be tested with the handheld PID meter for VOCs per EPA Method 21 and documented.

- One in 20, or 5%, of measurements will be repeated and documented as duplicate for QA/QC purposes following the BIL Guidelines.
- All required documentation and photos will be collected and recorded to satisfy Site Report Requirements from the referenced BIL Guidelines and any other that the WVDEP deems necessary.
- The crew will proceed to the next site in the queue requiring methane leak detection screenings and quantification.

Parsons has completed a rigorous review of all available gas detection and Leak Detection and Repair (LDAR) technologies and have chosen our proposed methodology due to our extensive experience and the following technological constraints. Due to the presence of complete wellheads and associated piping typically present at orphan well sites, bagging and/or large flux chambers are not practical nor efficient to complete this scope of work as it would be onerous to completely encapsulate the existing infrastructure for accurate measurements. Based on Parsons' experience, methane concentrations at ground surface taken with handheld detectors directly correlate to methane measurements determined with flux chambers. We also found that subsurface methane flux rates vary greatly depending upon the time of year, the climatological conditions, and extent to which upward migrating methane is biodegraded. Based on Parsons's experience, we propose the option of accounting for methane leaking through soil using the RMLD with confirmation measurements at selected locations using a handheld detector. Parsons however does have various flux chambers available if the WVDEP-OOG later decides they are necessary and are compatible with the already mobilized equipment.

Infrared Optical Gas Imaging (IR OGI) camera systems are not recommended due to their inability to provide repeatable results in typical atmospheric conditions and are subject to interference from other gasses. High-volume samplers, such as the recommended SEMTECH HI-FLOW 2 require less training to deploy, provide more accurate/repeatable results, and are less weather dependent than IR OGI cameras. In addition, the RMLD provides the ability to quickly screen sites for leaks with a safe standoff distance, reducing the inherit risk for field personnel when screening for methane leaks.

While UAV (drone-based) detectors have greatly improved and are great screening tools for large facility and/or quantification of overall emissions, they are not proposed for this scope of work as they lack the ability to identify and/or quantify point-source leaks per the BIL Guideline threshold.

Scope of Services

- Parsons will attend a Project Kickoff Meeting to discuss project scope of work, billing, reporting, etc.
- Parsons will mobilize a Qualified Measurement Specialist, as described by the Federal Methane Guidance document, and Measurement Technician to each of the requested 200 orphaned well and/or facility sites. They will be equipped with personal Hydrogen Sulfide (H2S) badge meters, a 5-gas (with PID) meter, the RMLD-CS leak detection system, the SEMTECH HI-FLOW 2 leak quantification system, and a data collection tablet. The crew will also be equipped with a handheld weather station to document the required atmospheric conditions.
- The Parsons team will assess if the weather conditions are suitable for methane measurements. If so, the team will measure and documents the background methane concentrations before rapidly screening all well and facility locations, along with

associated infrastructure for the presence of methane. For sites where methane is not detected above background levels, no further action will be taken other than documenting the findings. For sites where methane is detected above background concentrations, Parsons will use the Quantifying Methane Emission Rates procedure as described in Part IV of the federal guidance document.

- All measurement equipment and field methodologies will be pre-approved by the WVDEP-OOG prior to mobilization into the field.
- All methane emission rate measurements shall be made within the certified operating conditions of the measurement equipment used in the field and be capable of detecting methane emissions of 1 gram/hour or lower.
- The measurement equipment shall have documented precision and accuracy throughout the quantification range of 30% or better.
- Documentation of measurement traceability will be supplied to the WVDEP-OOG. These will include calibration certificates, specifications, Standard Operating Procedures (SOP's), and field QA/QC duplicate measurements.
- Random QA/QC duplicate methane emission rate measurements will be collected at 5% of the overall well and facility locations where leaks are detected.
- Per recommendations in the BIL guidance document, Parsons will collect post-plugging methane emissions rates from the requested 200 plugged and abandoned well sites where methane was detected above background levels during the initial surveys prior to plugging.
- Parsons will use the above-described technical approaches to evaluate both the concentration and flow rate of methane emissions in the grams per hour (g/hr) unit. Parsons will screen well heads, cellars, well casings, piping, valves, tanks, and other associated surface equipment to evaluate the location for methane emission leaks.
- When infrastructure is present (wellhead or other infrastructure or surface equipment), per the guidance document, Parsons will use the field methods described in the EPA Method 21 - Determination of Volatile Organic Compound Leaks document.
- The combination of methane detection devices Parsons has proposed within the above technical approaches can detect methane at or below the low-level threshold of 1 g/hr. The methane emissions rate will be determined by: V(methane) = C(methane) * V. Where V(methane) is the methane specific flow rate from the orphan well is equal to C(methane) is the measured concentration of methane times V, the total flow measured from the orphan well. All methane emission rate measurement values will be reported in grams per hour (g/hr).
- Per the BIL guidance document under the section On-Site Methane Emissions Rate Quantification – What to Record, Parsons will record and document items at each well and facility location. A deliverable report as described in the below section will be submitted to the WVDEP-OOG upon completion for each well and facility site.
- Parsons will provide the WVDEP-OOG with a site report that includes photos, narrative description of the measurement methods used and supporting information, documentation of each methods' performance demonstrated with equipment used in the field, documentation of calibrations and maintenance of equipment, documentation of training and experience of the measurement specialists, and results of QA/QC emission measurements.

Reporting

Parsons proposes the use of a digital data collection tool (**Figure 1-2**) for this project. The reports for each site can easily be configured into ArcGIS and used in conjunction with ESRI's Collector for ArcGIS application, or similar, for collecting all the required field data associated with the Federal Guidance Document. Parsons will work with the WVDEP-OOG staff to determine proper data reporting formats that will allow seamless integration with the Federal database and will report all emissions measurements in this format.

Typically, with implementation of digital data collection tools on other projects, cost reductions associated with efficient data processing, reduced data transcriptions, reduced errors and re-work have seen anywhere from 10% to 20% in cost savings. These cost savings measures have been captured as part of our proposal reflected in our costs. Individual Site Reports will be created from this digitally collected data as described in the section below.

The following are the specific features of Parsons' data collection digital tools that will help the project during the repeated methane site surveys:

- Map-centric data collection tool with the capability of using web maps, working offline and high accuracy GPS system, that allows field teams to capture site reconnaissance observations/photographs and conduct field assessments while seamlessly transferring the knowledge to other project team members by uploading this information instantaneously.
- Live tracking and documenting field notes at node points to associate collected leak information with the site. This information will then be output into a specified final format to create individual site reports along with available specialized reports for other uses and/or integration into the Federal database.
- Field crews can use the app in the field to navigate and verify they are at the proper well location.
- Compatibility with Android, Apple, or Windows-based smartphones and tablets allows our entire project team to be able to use this application right away.

FIGURE 1-2: DIGITAL DATA COLLECTION APP

Site Report

Parsons will provide the WVDEP-OOG with a summary report (**Appendix C**) of each well and facility site that underwent methane quantification measurements utilizing the below framework as described within the BIL guidance document:

1. Site information including well name, API number, site type, well status, prior owner, state permit number (if applicable), administrative unit, and name of measurement specialist and technician.
2. The date and time of the measurement(s).
3. Using on-site equipment or a credible weather report, record: air temperature, wind speed/direction, most recent precipitation date, barometric pressure, and known H2S concentration.
4. Location of the well. Using mapping datum WGS84, record latitude and longitude in decimal degrees (five to seven decimal places).
5. The condition of the well by taking digital photos from four directions and at each identified leak location.
6. Record the background concentration and the upwind location at which the background concentration was measured.
7. The type of measurement equipment and methodology utilized.
8. The type of measurement made (methane or total hydrocarbon).
9. The well classification (not detected, detected, or detected + may be high).
10. Record the highest concentration of methane or total hydrocarbons observed (in ppm)
    a. Note if methane concentrations are greater than or equal to 1000 ppm anywhere in the well vicinity.
11. The place(s) where the well is leaking
12. Note gas smells
13. Note if gas venting is audible
14. Note if gas venting is observed or felt as movement of the air or nearby vegetation or as bubbles in nearby surface waters.
15. For wells that have no detectable emissions (less than 1 g/hour) as determined using a binary method, record:
    a. the emissions rate as less than 1 g/hour.
    b. the measurement equipment and method used.
16. For quantitative methods: record the total methane emitted from the well over time. Units should be in grams/hour (g/hr) of methane or total hydrocarbons. (Note: field forms will include unique identifier and leak rate for each leak, but this does not necessarily need to be carried forward to the database entry form).
17. Number of leaks if multiple leaks are present from a single well due to the presence of legacy infrastructure and/or soil emissions.
18. Note any uncertainty in the measurement, e.g., by making multiple measurements at the site, including concerns related to site conditions.

19. Equipment calibration data.
20. Comments by measurement specialist noting any site access difficulties, active fluid leaks, remediation concerns, damage, etc.

SECTION TWO

PAST PERFORMANCE AND EXPERIENCE

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METHANE EMISSION QUANTIFICATION

SECTION 2:

PAST PERFORMANCE AND EXPERIENCE

The Parsons team brings unmatched experience in executing large complex projects involving addressing the risks that orphaned oil and gas wells can pose to human health and the environment. This experience encompasses not only our extensive well abandonment project examples but highlights our experience screening and quantifying methane emission rates within the BIL Guidelines. In this section, we summarize several project examples which demonstrate this experience. **Client references are included in this section.**

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY (EGLE) STATEWIDE ORPHAN WELL METHANE MONITORING & QUANTIFICATION

Since 2023, Parsons has been providing DOI Orphan Well Methane Measurement Guidance-compliant methane monitoring and quantification services for the Michigan Department of the Environment, Great Lakes, and Energy's (EGLE) Oil, Gas, and Mineral Division's Orphan Well Program. For this project, Parsons developed an efficient screening and quantification methodology to address potential methane emissions from the state's 444 documented orphan wells and additional associated 60 production-related facilities. Utilizing the latest Mad- in-America compliant Tunable Diode Laser Absorption Spectroscopy (TDLAS) methane-specific detection and quantification tools, our BIL-qualified measurement specialists have been able to detect methane leaks as low as one part per million (PPM) above background and have documented numerous leak quantification results in field conditions below the one gram per hour detection threshold.

FIGURE 2-1 - PARSONS BIL-QUALIFIED MEASUREMENT SPECIALIST PERFORMING METHANE LEAK QUANTIFICATION FROM AN ORPHANED WELL CASING CUTOFF AT SURFACE

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PROJECT MANAGER
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PROJECT DURATION
2023 to Present

PROPOSED TEAM'S INVOLVEMENT
Ronald Krawczyk
Logan LaCross

VALUE
$385,000

SERVICES PROVIDED
- Site queue logistics
- Landowner engagement
- Leak detection
- Leak quantification
- Digital reporting
- Pre- and post-plug measurements

Efficient Methodology

Field crews utilize a two-step methodology to first scan for leaks, then if found, perform quantification of those leaks using DOI Orphan Well Methane Measurement Guidelines and United States Environmental Protection Agency (USEPA) Method 21 procedures. Parsons selected TDLAS-based instrumentation that provides accurate and repeatable results without the potential interference from motion and/or other gasses that IR OGI cameras are subject to. Sites are screened using a Remote Methane Leak Detector (RMLD) and any identified leaks are then quantified using a SEMTECH HI-FLOW 2 mass sampling device.

Digital Data Capture & Reporting

Field crews then use Parsons-developed in-field digital reporting methods to record the well site location, measured meteorological data, leak detection results, applicable leak rates, and site photographs. These digital reports are sent directly to office-based team members to perform quality assurance reviews before the crews leave the field operations area. Measured leak data is automatically captured within a master database file that is provided to the state for easy upload into the DOI's leak database.

ALBERTA ABANDONED WELLS METHANE VENTING STUDIES

Parsons developed and authored a new protocol for an Abandoned Wells Venting Program that was accepted by the Alberta Energy Regulator. The program initially involved locating wells leaking methane. Eight oil and gas wells identified as suffering integrity failure and releasing fugitive gases, either from inside (i.e., surface casing vent flow [SCVF]) and/or outside the well casing (i.e., gas migration [GM]) are being evaluated with a view of better understanding the environmental impacts and risks associated with fugitive gas leakage. The program is exploring alternative actions to re-abandonment including monitored or enhanced biodegradation of leaking methane. The program, which has run since 2015, was extended for a further period of five years as of February 2021. The program involves quantifying methane and carbon dioxide emissions and variability thereof, characterizing methane behavior and transport through soils, quantifying the extent of methane biodegradation, and assessing gas leakage influences on shallow groundwater and vegetation.

Much of the program work is new, and we have been flexible and innovative in creating and implementing the program for the client and the Alberta Energy Regulator. Parson's field personnel have logged over 6,000 hours with no safety incidences while working in remote locations and inclement weather.

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PROJECT MANAGER
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PROJECT DURATION
2016–Present

PROPOSED TEAM'S INVOLVEMENT
Glenn Ulrich

VALUE
>$3.5 million

SERVICES PROVIDED
- Environmental management
- Protocol Development
- Site investigation
- Project Management

Wellhead and Site Preparation

Two wells were left cut and capped below grade. Six wells were constructed as vent sites where leaking gas has been vented at known (measured) rates below grade for several years to simulate gas migration from a leaking well.

Installation of the vent cells required excavating around the wellbore (**Figure 2-2**), logging soil stratigraphy and soil sampling, connecting a vent pipe to the bore, and configuring new wellheads for periodic measurement of leak rates and casing pressures. The area around the wellheads was returned to existing conditions to recreate natural vegetation. A series of soil gas monitoring probes were installed outward from the wells leaking below grade and the vent sites based on recommendations listed in AER Directive 020 A solar powered weather station and soil probes were installed at two sites for continual monitoring. Groundwater monitoring wells and probes were installed to monitor groundwater dissolved methane concentrations and redox conditions.

FIGURE 2-2 - VENT SITE CONSTRUCTION. A critical element of these sites is that the methane leak rate is known and measured allowing for comparisons of methane going in versus coming out of the ground

Well and Vent Methane Monitoring

Regular site assessment activities include lease inspections, vent rate and casing pressure measurements, monitoring and sampling of soil gas concentrations (methane, carbon dioxide, and oxygen) at surface and in monitoring probes using hand-held instruments, methane flux (emissions) measurements using static and dynamic flux chambers, groundwater sampling, and vegetation assessments. Gas samples from the SCVF and grab samples from monitoring probes and flux chambers are periodically collected for detailed gas composition analysis and isotopic analysis for fingerprinting gas origins and composition alteration attributed to biodegradation.

Results

Project findings provide more detail than previously held regarding factors controlling fugitive gas migration, environmental impacts, and fugitive gas fate at well sites:

- Consolidation of data and understanding thereof through various field and analytic activities. These include shallow drilling for soil and methane distribution characterization using a membrane interface probe system, attainment of custom-built static flux chamber measurements to quantify fluxes of GHG's to the atmosphere, application of approaches to estimate the extent methane biodegradation and evaluation of conditions that influence methane biodegradation.
- Development of conceptual models integrating methane distribution around the vents at sites relative to geological heterogeneities and weather conditions, shallow soil gas concentrations, flux, and estimated extents of biodegradation (**Figure 2-3**) leading to a better understanding of methane fate and transport around leaking wells.

- Constraining the extent of biodegradation occurring in soils through a soil gas composition and mass balance approach.
- Considerable spatio-temporal variability in soil CH4 (i.e. fluctuating between higher and lower concentrations) is observed despite relatively stable vent rates. A lack of understanding of this variability is problematic as it means that sub-optimal decisions will be made on how to manage certain wellsite's. Progress towards understanding key climactic parameters and soil properties and their role in controlling GHG emissions and the rates and extent of methane biodegradation have been made.

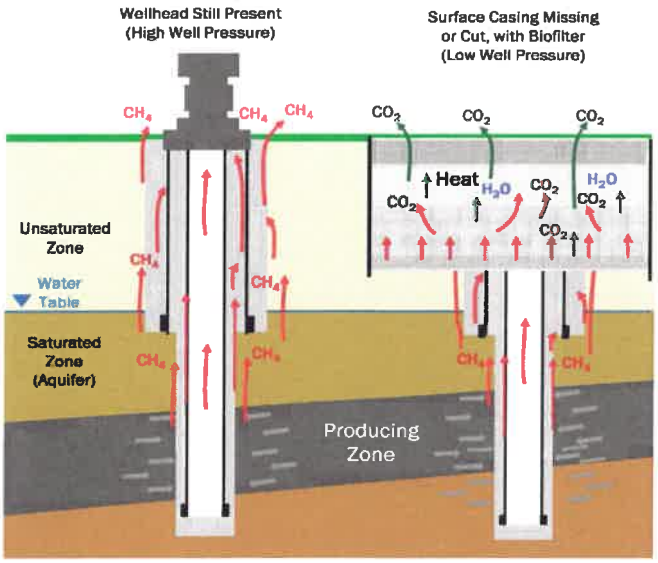

FIGURE 2-3 - CONCEPTUAL METHANE BIOFILTER INSTALLED OVER A LEAKING WELL

NYSDEC STATEWIDE ORPHANED WELL PLUGGING CONSTRUCTION OVERSIGHT

Since 2018, Parsons has supported the New York State Department of Environmental Conservation (NYSDEC) Division of Mineral Resources (DMR) in the management and execution of their orphaned well plugging and abandonment (P&A) program. During this time, Parsons and its plugging sub-contractor have plugged approximately 80 of New York's highest priority wells across the state. In this role, we've successfully leveraged all aspects of our extensive environmental experience, including project management, cost estimating, project scoping and solicitation of bids, subcontract procurement and negotiation, stakeholder engagement and property access permissions (e.g., property owners and utility providers), regulatory interactions, permitting, GIS and mapping services, construction scheduling and sequencing, site preparation, construction management and oversight, site restoration, and reporting.

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PROJECT MANAGER
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PROJECT DURATION
2018 to 2022

PROPOSED TEAM'S INVOLVEMENT
Proposed Team's Involvement
Tom Drachenberg – Program Manager

VALUE
$10 million

SERVICES PROVIDED
- Program management
- Well plugging and reclamation
- Environmental permit compliance
- Landowner liaison

Innovative Approaches that Contributed to Project Quality, Safety, and/or Cost or Schedule Saving

FIGURE 2-4 - PARSONS AND ITS SUB-CONTRACTOR MOBILIZED ON THE ROBINSON WELL, A SITE WITH CHALLENGING ACCESS IMMEDIATELY

Since inception, Parsons' efficient and comprehensive project & program management approach has led to a streamlined process for advancing well sites through closure. With New York's highest-risk wells being prioritized for this project, this has directly resulted in more rapid resolution of ongoing risk to human health and the environment from these wells. The Bischof well serves as an example of Parsons' responsiveness and efficiency. This inactive well, situated in a dense commercial area, was struck by felled tree limbs, and began leaking gas. Although not a well originally identified and scoped to Parsons, our team immediately engaged to resolve the significant risk to public safety. Parsons team successfully obtained access from the property owner, secured a power line relocation, mobilized, and plugged the leaking well in less than three weeks.

PERMITTING EXPERIENCE NYSDEC WELL PLUGGING PROGRAM

- USACE Section 404 dredge/fill Nationwide Permit
- Historical Preservation Act Section 106 compliance
- ECL Article 24 Freshwater Wetlands permitting
- Section 401 Water Quality Certification
- Endangered Species Act compliance
- NYS Threatened and Endangered species clearances
- NYS Pollutant Discharge Elimination System (SPDES)
- NYSDOT work permits
- Utility right of way agreements & relocations
- Various local municipal permits

INTERNATIONAL OIL COMPANY – MID-MICHIGAN OILFIELD REMEDIATION, CLOSURE, AND RESTORATION

Parsons is managing remediation of 1,012 former oilfield sites, including more than 678 former oil wells, tank battery sites, and spill areas across numerous oilfields throughout the State of Michigan. We provide program management, investigation, remedial engineering, and construction oversight services and have restored more than 28,000 acres of land to nearly original condition under the requirements of USEPA Region 5, the Michigan Department of the Environment, Great Lakes, and Energy (EGLE), and the Michigan Department of Natural Resources regulatory programs.

Specific aspects of Parsons' role and responsibility in this program include the following:

- Assessment, remediation, and management of crude oil-impacted soil, surface water, and groundwater
- Well locating services, inventory, and reporting
- UAV-based geotechnical surveys for remote detection of wellbores where casing had been pulled.
- Well site assessments, cost estimating, and technical approach planning (e.g., site civil work and site restoration requirements)
- Landowner outreach and access agreement negotiation

- Permit identification, preparation, and submittal, including the submission of more than 90 USACE Joint Applications for Permit
- Decommissioning and demolition of operating and abandoned oilfield infrastructure, including surface facilities, removal of 30 miles of pipelines, steel and transite (asbestos) flow lines, compromised and harvested well casings, and cellars
- Re-entering, drilling to approximately 800 feet (a depth adequate to protect the drinking water aquifers), re-casing, cementing, and re-abandoning 225 former oil wells
- Primary regulatory interaction with EGLE and Michigan Department of Natural Resources to achieve site closures and secondary wetland, stream diversion, and flood plain regulatory permitting required to perform the work
- Construction and use of a 360,000-square-foot land farm capable of treating more than 100,000 cubic yards (CY) of crude oil-impacted soil annually and using the remediated soil as backfill on the project sites. Over 1.5 million CY of soil sustainably bioremediated.
- Construction and management of a 1-million-gallon leachate collection pond.
- Use of a phytoremediation plot to treat approximately 320 barrels per day of leachate water and installation and operation of a Class II UIC disposal well that has disposed of 2,245,833 barrels (94.3 million gallons) of chloride-impacted water to date, saving the project more than $600,000 per year.

CLIENT REFERENCES

Mr. Tim Bertram, Geologist
bertramt@michigan.gov
989-412-3631
Ms. Valerie Matherne, Operations Lead
Valerie.Matherne@Chevron.com
985-259-3601

PROJECT MANAGER

Sean Phelps
Sean.Phelps@parsons.com
805-335-4308

PROJECT DURATION

2006 to Present

PROPOSED TEAMS INVOLVEMENT

Proposed Teams Involvement
Ronald Krawczyk
Sean Phelps

VALUE

$3 million/year

SERVICES PROVIDED

- Program management
- Site assessment
- Soil remediation
- Oil well P&A
- Disposal well operations, maintenance, and monitoring
- Groundwater management
- Decommissioning and demolition
- Excavation and hauling
- Ex situ landfarming
- Ex situ phytoremediation
- Remediated soil reuse
- Permitting and compliance
- Regulatory negotiation and permitting
- Site access agreements
- Site restoration

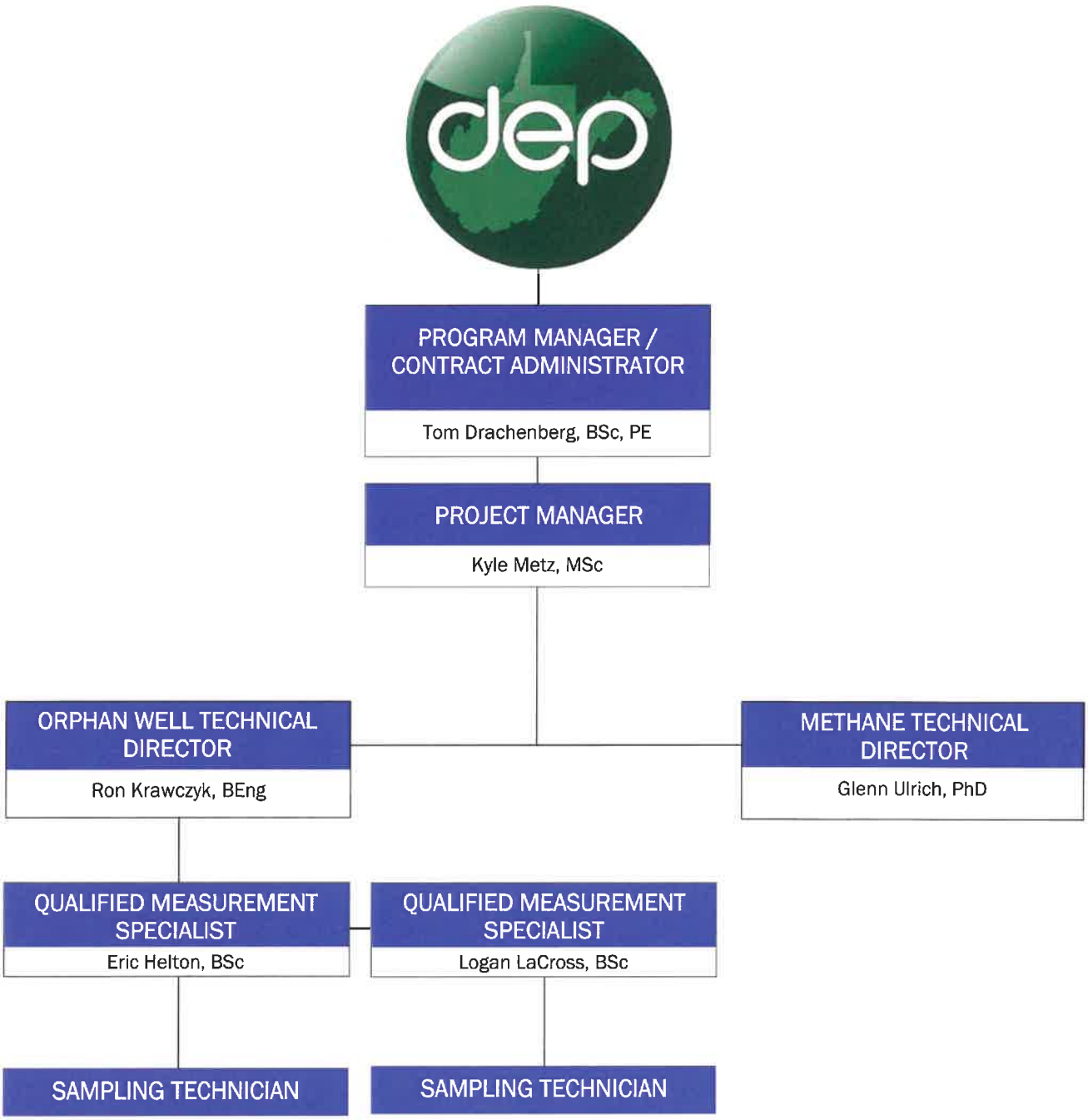
SECTION THREE

ORGANIZATION CHART

CRFP 0313-DEP2500000001
METHANE EMISSION QUANTIFICATION

SECTION 3:

ORGANIZATION CHART



SECTION FOUR

QUALIFICATIONS AND EXPERIENCE

CRFP 0313-DEP2500000001
METHANE EMISSION QUANTIFICATION

PARSONS

SECTION 4:

PERSONNEL QUALIFICATIONS AND EXPERIENCE

TOM DRACHENBERG, PE

PROGRAM MANAGER

Tom has extensive engineering and project management experience involving all phases of remediation, including site investigations, feasibility studies, predesign investigations, remedial design, and remedial action. Tom's broad experience includes efficiently executing small-scale projects involving in situ treatment technologies and leading large-scale, high-profile megaprojects involving sediment remediation and landfill assessments. Tom has also served as program manager for a standby engineering contract with a state agency, including responsibility for successful execution of more than 60 projects.

Tom has been responsible for assembling and managing large multidisciplinary teams; performing extensive proposal scoping and budgeting; completing many engineering analyses and technical documents; presenting complex technical topics to client management groups; preparing for and leading numerous large project meetings consisting of experts, academia, clients, and regulatory agencies; and interacting with and making presentations to community members through client outreach programs.

Tom has experience dealing with New York State Department of Environmental Conservation, US Environmental Protection Agency, US Army Corps of Engineers, and New York State Department of Health regulations for assessments and environmental investigations at federal and industrial sites and has experience dealing with Resource Conservation and Recovery Act and Comprehensive Environmental Response, Compensation, and Liability Act guidance.

YEARS OF EXPERIENCE
25

EDUCATION
- Bachelor of Science, Environmental Engineering, Clarkson University, New York, 2000

REGISTRATIONS
- Professional Engineer, 086020, New York

CERTIFICATIONS
- Project Manager Certification, Parsons

PROFESSIONAL AFFILIATIONS
- Western Dredging Association, Conference Participation and Presentation, 2016-2018

Work Experience

Project Manager. New York State Department of Environmental Conservation, Inactive Landfill Initiative, Statewide New York. (2020 to 2024). Parsons performs site characterizations and investigations under Title 12, known as the Inactive Landfill Initiative. The program is the first of its kind and addresses critical drinking water contamination concerns associated with emerging contaminants from inactive landfills, including PFAS and other chemicals of concern, such as volatile organic compounds, semi-volatile organic compounds, and metals. Parsons has supported the Inactive Landfill Initiative since 2017, helping conceive, develop, and implement the program in conjunction with the New York State Department of Environmental Conservation's Division of Materials Management. More than 385 inactive landfills cross the state have been investigated, thousands of samples collected, and results evaluated to better understand the risks to human health based on a variety of landfill characteristics. Tom's responsibilities include developing an overall project approach to efficiently support the Division of Materials Management on a state-wide basis; assembling a multidisciplinary team to execute the initiative; establishing a sampling program to evaluate multiple analytes, including the emerging contaminants perfluorinated compounds and 1,4-dioxane; developing project deliverables, including a project

field sampling plan, a quality assurance protection plan, and a landfill prioritization ranking system; managing a procurement process to procure numerous subcontractors capable of executing the extensive field program; conceptualizing and implanting a large-scale residential sampling program; and developing geographic information system and data management procedures and systems to manage the large quantities of data produced by the project.

Program Manager. New York State Department of Environmental Conservation, Corning International Study Area Remedial Construction Oversight, Corning, New York. (2020 to 2024). Parsons is providing third-party field oversight and on-site monitoring during remedial investigation and remedial construction. Oversight tasks include observing technical work to ensure consistency with approved project work plans, designs, safety plans, and other documents, along with New York State Department of Environmental Conservation standards, criteria, and guidelines, and future outreach activities associated with the remediation project. Tom is responsible for overseeing all Parsons' activities on the project.

Project Manager. Confidential Multinational Conglomerate Corporation, Linden Chemicals and Plastics Operable Unit 2 In Situ Remediation, Syracuse, New York. (2018 to 2022). Parsons provided remedial construction related to remediation action steps to address the deep soil and groundwater, soil and groundwater sampling, and site closure reporting for the Operable Unit 2 site. The scope included assessing the conditions of the current subsurface and the injection wells and providing additional potassium persulfate in 5 to 10 wells to assess the enhanced anaerobic bioremediation response. Tom's responsibilities during the design phase included managing a remedial contractor procurement process to select the remedial contractor for the project, including preparing request for proposal documents and evaluating bids; completing remedial design activities, including excavation and backfill design drawings and specifications; designing and managing a predesign investigation consisting of collecting soil and groundwater samples and modifying the remedial design approach to reflect predesign investigation data, including supporting the New York State Department of Environmental Conservation in issuing an environmental site design (record of decision modification); and preparing design deliverables. Responsibilities during the remedial action phase included overseeing construction, coordinating quality assurance/quality control efforts to monitor remedial contractors progress, tracking the budget, preparing client and agency reports, and evaluating remedy effectiveness.

Project Manager. New York State Department of Environmental Conservation, Inactive Landfill Inventory, Statewide New York. (2017 to 2020). Parsons assisted with taking inventories at 1,600 inactive landfills in the state and evaluating potential groundwater and environmental impacts of perfluorinated compounds and 1,4-dioxane (emerging contaminants) to drinking water sources and other potential sensitive receptors. The project was a critical high-profile project for the client, being executed by direction of the New York State Governor, under an expedited timeline. Tom's responsibilities included developing an overall project approach to provide efficient support on a statewide basis; developing preliminary budgetary estimates to support agency funding processes; assembling a multidisciplinary team to execute the initiative; establishing a sampling program to evaluate multiple analytes, including emerging contaminants, perfluorinated compounds, and 1,4-dioxane; developing project deliverables, including a project field sampling plan, a quality assurance protection plan, and a landfill prioritization ranking system; managing a procurement process to procure numerous subcontractors capable of executing the extensive field program; and developing geographic information system and data management procedures and systems to manage the large quantities of data produced by the project.

Program Manager. New York State Department of Environmental Conservation, Eastman Business Park RCRA Facility Investigation and Corrective Measures Study, Rochester, New York. (2015 to 2020). The project involved a 4-mile-long stretch of the Lower Genesee River impacted by silver and other contaminants resulting from operations at a former business park. The project site included impacted channel sediments and adjacent wetland areas, encompassed an active industrial navigational channel and numerous large marinas, and involved multiple stakeholders. Parsons performed remedial investigation activities, including a bathymetry and side scan sonar survey, a sediment investigation, surface water sampling, adjacent wetland and floodplain

assessments, aquatic habitat assessments and tissue sampling, a toxicity study, human health and ecological risk assessments, and sediment transport modeling. Tom's responsibilities included scoping and managing field remedial investigation activities, managing ecological and human health risk assessments and impact assessments, evaluating remedial investigation data, developing remedial action objectives and preliminary remediation goals, and managing the preparation of a remedial investigation report.

Project Manager. Confidential Multinational Conglomerate Corporation, Linden Chemicals and Plastics Operable Unit 2 In Situ Chemical Oxidation Injection, Syracuse, New York. (2003 to 2018). Parsons completed a feasibility study evaluating alternatives for reducing volatile organic compounds in Operable Unit 2. Alternatives evaluated included enhanced biodegradation, in situ chemical oxidation, air sparging, and hydrologic containment. Field pilot studies were conducted to assess subsurface fracturing in unconsolidated soils and in situ chemical oxidation to remediate volatile organic compounds in groundwater. Based on the results of the pilot study, the New York State Department of Environmental Conservation issued a record of decision that called for in situ chemical oxidation to address deep soils and groundwater and an unspecified in situ biological treatment process to address shallow soils. Tom served as project manager for the remedial design and remedial action phases of the project. Responsibilities during the design phase included managing the remedial contractor procurement process to select the remedial contractor for the project, including preparing request for proposal documents and evaluating bids; completing remedial design activities, including excavation and backfill design drawings and specifications; designing and managing a predesign investigation consisting of collecting soil and groundwater samples; modifying the remedial design approach to reflect predesign investigation data, including supporting the New York State Department of Environmental Conservation with issuing an explanation of significant differences (record of decision modification); and preparing design deliverables. Responsibilities during the remedial action phase included overseeing construction, coordinating quality assurance/quality control efforts to monitor remedial contractors progress, tracking the project budget, preparing client and agency reports, and evaluating remedy effectiveness. A reevaluation of the remedial approach is currently underway, following several years of in situ chemical oxidation injection activities.

Engineering Manager. Confidential Multinational Conglomerate Corporation, Onondaga Lake Capping, Syracuse, New York. (2003 to 2016). Parsons provided construction services for installation of an innovative isolation cap that incorporated bulk activated carbon into sand to increase the adsorption capacity of the cap. The cap included specific layers dedicated to chemical isolation of contaminants, erosion protection, and habitat restoration, which provided significant cost savings compared to more traditional methods for constructing a reactive cap. Siderite was added to sand in some areas to reduce the pH of groundwater migrating upward through the cap into the lake. Work included dredging more than 2 million cubic yards of sediment from the lake bottom, placing more than 200 acres of sediment cap, and dewatering dredged sediments in an on-site containment facility. During the feasibility study phase, Tom's responsibilities included providing support during preparation of the feasibility study report, assisting with remedial alternatives development, estimating corresponding sediment dredge volumes and capping volumes, conducting and authoring various engineering evaluations, assisting with modeling of underwater capping, and authoring various project reviews, proposals, and an agency-required progress report. Provided technical support during the proposed remedial action plan and record of decision negotiations and supported a. During the design phase, responsibilities included supporting a predesign investigation for the site, including scope of work and budget development, proposal preparation, work plan development, and field oversight of several field activities. Served as task manager for an air quality evaluation for the project, including assessing, modeling, and bench testing various emission sources; characterizing odor emissions; modeling sources to determine off-site impacts; evaluating mitigation criteria; and recommending mitigative alternatives. Responsibilities also included coordinating a large team of various experts; developing a pioneering evaluation procedure; conceptualizing, planning, and managing innovative bench study activities; managing installation and maintenance of two 10-meter meteorological monitoring stations; interpreting data results; preparing and submitting a dispersion modeling protocol; managing multifaceted chemical and dispersion modeling activities; and developing, evaluating, and bench

testing emission mitigation technologies. Led a technical team in preparing for and making presentations at numerous regulatory meetings and client presentations. Served as task manager for the operations design task that consisted of conceptual design of predredging, dredging, sediment transportation, dewatering, water treatment, and odor control activities. Responsibilities included scoping, budgeting, and managing remedial design activities; coordinating a complex, 30-plus person technical design team consisting of subcontractors, national experts, and client representatives; conducting and documenting various design evaluations; leading two technical design subgroups; preparing and reviewing conceptual design document components; and communicating and negotiating critical design topics with regulatory agencies. Served as task manager for the operations design task that consisted of developing the conceptual design for predredging, dredging, sediment transportation, dewatering, water treatment, and odor control activities. Responsibilities included evaluating dredged material and developing a detailed design of a sediment dewatering approach, including specifying dewatering equipment, pumps, piping networks, geotextile tubes, and a polymer injection system. Responsibilities also included design of a 4-mile-long slurry pipeline for hydraulic conveyance of the dredge slurry, including siting the pipeline route; designing underground crossing components, secondary containment and leak-detection systems, and a booster pump system; and providing overall design calibration of the dredging, conveyance, and dewatering systems. During the remedial action phase, served as project engineer during construction of the slurry pipeline and sediment dewatering systems. Responsibilities included providing construction oversight, responding to requests for information, reviewing shop drawings, coordinating design modifications to address changing field conditions, specifying and procuring remedial process equipment, managing a team of quality control engineers overseeing day-to-day construction activities, and preparing as-built drawings. Served as project engineer, quality manager, and operations manager during implementation of the remedial action. Responsibilities included executing a complex construction quality assurance project plan to ensure proper installation of more than 400 acres of a multilayer amended sediment cap and dredging and dewatering more than 2 million cubic yards of sediment. Reviewed contractor survey data; certified dredging progress; prepared and submitted dredge management unit completion packages; managed geotextile tube operations to ensure compliance with design requirements; developed and designed innovative odor management strategies to mitigate odors emanating from remedial processes; conceptualized a capping approval process to demonstrate compliance with design specifications; managed quality control/quality assurance, including contractor, Parsons, and third-party quality assurance activities; provided timely management of cap layer and cap management unit approvals to ensure remedial activity efficiency; provided constant coordination with on-site state regulatory agency representatives to ensure regulatory approval of activities; assembled and managed a large quality control team consisting of up to 15 team members providing quality control oversight on a 24/6 basis; developed a management structure and system to manage the massive quantities of data generated; prepared annual construction summary reports; and served as certifying engineer for the construction completion report.

Project Engineer. Confidential Global Chemical Manufacturing Company, Pompton Lakes Works, Pompton Lake Study Area Acid Brook Delta Technical Support, Pompton Lakes, New Jersey. (2016). Parsons provided environmental engineering services for dredging and upland disposal of approximately 100,000 cubic yards of mercury-impacted sediment located in a shallow lake in a residential neighborhood. Tom's responsibilities included developing and managing the quality assurance process to independently verify that the remedial contractor achieved project goals for dredging and cap placement.

Project Manager. Georgia-Pacific Wood Products, LLC, Former Alabama River Cellulose Mill Site Effluent Spill Basin, Perdue Hill, Alabama. (2014 to 2016). Parsons provided design and construction services for an effluent settling pond for the largest white pulp and paper mill in the United States. Tom's responsibilities included scoping and managing a geotechnical investigation; managing detailed design deliverables, including drawings, specifications, and permitting documents; and managing the construction subcontractor responsible for excavation and stabilization of soft sediments and pulp production byproducts, earthwork, and installation of a reinforced concrete basin.

Environmental Engineer. Confidential International Oil Company, Atlantic Richfield Hastings-on-Hudson Operable Unit 2, Hastings-on-Hudson, New York. (2003 to 2005). Parsons provided services for remediation of polychlorinated biphenyl– impacted sediment in an estuarial river setting. The project site featured deep polychlorinated biphenyl contamination in the nearshore area, with significant debris and dredging obstacles, upland stability concerns, and significant tidal velocities and fluctuations. Tom's responsibilities included scoping and managing field remedial investigation activities; evaluating remedial investigation data; assessing dredging, capping, and turbidity control technologies for incorporation into remedial alternatives; developing remedial alternatives; researching and recommending state precedent turbidity monitoring criteria and requirements; and preparing a feasibility study.

Environmental Engineer. Confidential Multinational Conglomerate Corporation, Geddes Brook Interim Remedial Measure Engineering Services, Syracuse, New York. (2003 to 2004). Parsons provided engineering services for remediation of a 10-acre mercury-impacted stream. Tom's responsibilities included preparing design documents and their associated components.

Environmental Engineer. Confidential International Oil Company, Former Refinery Resource Conservation and Recovery Act Remediation, Central New Jersey. (2001 to 2003). Parsons provided engineering services for this Resource Conservation and Recovery Act closure project that involved remedial design and construction of a 3-acre landfill closure, a 400-linear-foot Waterloo barrier wall, and an 800-foot-long soil- bentonite cutoff wall using slurry techniques. The capping systems included a multilayer soil and geosynthetic system and surface water drainage controls constructed to direct water away from existing operational areas. New closure monitoring wells were installed around the unit to monitor post-closure conditions, and a closure certification report was completed and submitted to regulatory agencies. The design consisted of an extensive subsurface soil investigation and laboratory testing program; solidification of a 5-acre lagoon using cement, slope stability, settlement, and infiltration analyses; design drawings; and technical specifications. The design was developed and implemented in accordance with New Jersey Department of Environmental Protection technical regulations. Tom's responsibilities included overseeing excavation, in situ stabilization, and landfill activities; interacting with and directing subcontractors; confirmatory sampling; daily reporting; performing a landfill slope stability analysis; implementing strict client health and safety programs; addressing client concerns; and assisting with authoring the closure document.

Environmental Engineer. Haseley Construction Company Inc., Sharkey Landfill Superfund Site, Parsippany, New Jersey. (2001 to 2002). Parsons provided engineering and design services for construction of landfill caps at the Sharkey Superfund Site. Tom prepared a design report for the Sharkey Landfill Superfund Site, including developing and screening remediation alternatives, designing riverbank protection, preparing design drawings, sizing and selecting design materials, evaluating slope failure potential involved with design, and estimating cost.

Environmental Engineer. Consolidated Edison Company of New York, Inc., Arthur Kill Site Remedial Investigation/Feasibility Study, Staten Island, New York. (2001 to 2001). Parsons collected data, evaluated alternatives, and negotiated a record of decision for remediation of sediments in wetlands and Hudson River shoreline contaminated with polychlorinated biphenyls. Tom prepared a feasibility study, including developing and screening potential remediation alternatives. Supported a proposed remedial action plan and record of decision negotiations; prepared a remedial design work plan; scoped, budgeted, and managed predesign investigation activities; and evaluated predesign investigation data. Prepared a subsequent remedial technology alternative evaluation to identify remedial technologies appropriate for unique site conditions, prepared various design documents and evaluations, negotiated turbidity compliance criteria and monitoring requirements, and prepared required a permit application for sediment dredging.

Presentations

- "Development, Design and Implementation of an Innovative Approach for Incorporating Activated carbon into a 450-Acre Amended Sediment Cap," presented at the Ninth International Conference on Remediation and

Management of Contaminated Sediments, New Orleans, Louisiana, 2017 (co-presenters E. Glaza, T. Drachenberg, M. Crystal, W. Hague, and P. LaRosa).

- "Character of Ecological Impact from Silver in Lower Genesee River Sediment," poster presented at the Ninth International Conference on Remediation and Management of Contaminated Sediments, New Orleans, Louisiana, 2017 (co-presenters C. Kriegner, M. Rondinelli, M. Vetter, T. Drachenberg, and L. Thomas).
- "Bioaccumulation of Heavy Metals in Mussels in the Lower Genesee River," poster presented at the Ninth International Conference on Remediation and Management of Contaminated Sediments, New Orleans, Louisiana, 2017 (co-presenters M. Rondinelli, C. Kriegner, M. Vetter, T. Drachenberg, and L. Thomas).
- "Successful Completion of a 450-Acre Amended Sediment Cap: Onondaga Lake," poster presented at the Ninth International Conference on Remediation and Management of Contaminated Sediments, New Orleans, Louisiana, 2017 (co- presenters T. Drachenberg, E. Glaza, W. Hague, B. Rule, M. Crystal, and P. LaRosa).
- "Lower Genesee River RFI Investigation Overview," presented at the Ninth International Conference on Remediation and Management of Contaminated Sediments, New Orleans, Louisiana, 2017 (co-presenters L. Thomas, M. Vetter, T. Drachenberg, K. Fields, S. Bupp, K. Dean, M. Rondinelli, C. Kriegner, and T. Towey).
- "Multiple Lines of Evidence for Assessing Benthic Impacts in the Lower Genesee River," poster presented at the Ninth International Conference on Remediation and Management of Contaminated Sediments, New Orleans, Louisiana, 2017 (co- presenters M. Rondinelli, C. Kriegner, M. Vetter, T. Drachenberg, and L. Thomas).
- "Metal Concentrations among Different Trophic Guilds of Fish Collected from the Lower Genesee River," poster presented at the Ninth International Conference on Remediation and Management of Contaminated Sediments, New Orleans, Louisiana, 2017 (co-presenters C. Kriegner, M. Rondinelli, M. Vetter, T. Drachenberg, and L. Thomas).
- "Onondaga Lake Dredging and Dewatering: Years 1 to 3 Performance and Lessons Learned on a 2M CY Dredging Program," presented at the Eighth International Conference on Remediation and Management of Contaminated Sediments, New Orleans, Louisiana, 2015 (co-presenters B. Hague, L. Somer, A. Steinhoff, P. Blue, T. Drachenberg, B. Rule, and K. Foley).
- "Assessment, Protection, and Mitigation for Historic Cultural Resources on a Large- Scale Sediment Remediation Project," poster presented at the Eighth International Conference on Remediation and Management of Contaminated Sediments, New Orleans, Louisiana, 2015 (co-presenters J. McAuliffe, T. Drachenberg, E. Glaza, S. Bupp, and C. Sabick).
- "Development and Implementation of a Construction Quality Assurance Program for Dredging and Capping Activities on Onondaga Lake," presented at the Eighth International Conference on Remediation and Management of Contaminated Sediments, New Orleans, Louisiana, 2015 (co-presenters J. Detor, R. Brown, D. Smith, T. Drachenberg, R. Mohan, B. Hague, and L. Sommer).
- "Coordination, Communication and Protection of the Public for a Major Sediment Remediation Project," presented at the Seventh International Conference on Remediation of Contaminated Sediments, Dallas, Texas, 2013 (co-presenters T. Drachenberg, E. Glaza, J. McAuliffe, M. Distler, P. Alberti, and C. Leary).

KYLE METZ

PROJECT MANAGER / KEY PERSONNEL / CONTRACT REPRESENTATIVE

Kyle spent the bulk of his career at large exploration and production companies focused on identifying, quantifying, and extracting oil and gas resources in geologically complex reservoirs. His experience includes subsurface mapping, seismic interpretation, stratigraphic correlation, structural analysis, petrophysical interpretation/calculation, risk analysis, well site supervision of subcontractors (e.g. mud loggers, MWD/LWD hands, wireline loggers, directional drillers), geosteering, permitting, reserve calculations, mineral remoteness opinions, base of freshwater (BFW) and underground source of drinking water (USDW) determinations, and generating well plugging plans.

Kyle has authored and contributed to numerous reports on field- and/or state-wide decommissioning costs. His contributions include building large state- and basin-wide well databases, determining operating expenses and regional plugging costs/considerations.

Kyle has been the primary project geologist on numerous wild cat exploration wells in Oklahoma, the Sacramento Basin, the San Joaquin Basin, the LA Basin, the Deepwater Gulf of Mexico, and Kurdistan, Iraq where his duties included planning the geologic well operations, designing/managing data acquisition, predicting critical formation tops for casing, coring, and total depths.

YEARS OF EXPERIENCE

- Total: 15
- With Parsons: <1

EDUCATION

- Master of Science, Geology, Louisiana State University, 2010
- Bachelor of Science, Geosciences, Texas Tech University, Texas, 2007

CERTIFICATIONS/TRAINING

- HAZWOPER 40-hour

COMPUTER/SOFTWARE SKILLS

- ESRI GIS Products
- Subsurface Interpretation Software: Petra, Petrel, Geographix, Decision Space, Kingdom
- Enverus, IHS Markit
- Neuralog
- SQL, Openworks, Studio
- Microsoft Office Suite

Work Experience

Consultant, Spaziani GeoServices, L.L.C. 2022 – 2024. Projects included developing a subsurface and geospatial database defining reservoir presence, quality, continuity, mineral ownership, and typical gas-unit size/shape, providing subsurface expertise for litigation. Additional projects include building databases of OPEX, Production volumes, and well counts/status for all wells/fields in California, Colorado, Ohio, West Virginia, and Pennsylvania. These databases and associated figures were used in reports quantifying the total asset retirement obligations for the given states. Smaller projects include field-wide base of freshwater and underground source of drinking water interpretations used to create well plugging programs for numerous fields in California.

Geological Advisor, California Resources Corporation, 2017 – 2022. Projects included leading a multidisciplinary team of geoscientists and engineers to build, risk and rank an inventory of 60+ executable prospects, resulting in potential resource additions exceeding 1.3 billion barrels of oil equivalent, and lead operations geologist on 18 exploration/development wells, coordinating permitting, well design, and data acquisition efforts leading to a successful drilling campaign with the top three producing wells in the program. Additional projects included facilitating farm-out presentations to potential partners for high-risk exploration prospects, and coordinating the regulatory burden on underground injection control permits for the Ventura Basin, resulting in securing >$30 million dollars of funding for drilling exploratory prospects and helping to ensure a $102 million asset sale.

Geologist, ODNR – Division of Geological Survey, 2016 – 2017. Projects included developing a stratigraphic framework for the early- to mid-Paleozoic formations across the Appalachia Basin, generating a consistent set of structure and isopach maps identifying ethane storage candidates, leading to a 2017 report to the US Congress. Additionally, Kyle created a chronostratigraphic framework for Middle-to-Late Devonian strata and

mapped major cycles of organic-rich shale deposition across eastern Ohio. This framework was integrated with source rock analyses to identify areas of greater potential for resource extraction and carbon sequestration.

Geologist, Marathon Oil Company, 2010 – 2015. Projects included creating 3D static models through integration of 2D/3D seismic surveys, well log data, and interpreted environment of deposition to characterize lithofacies, petrophysical properties, and fracture characteristics, resulting in more accurate resource estimations for economic models and corporate decision making. Additional projects included acting as lead operations geologist, planning, permitting and providing well-site operations for dozens of wells across multiple basins including onshore North America, Deep-water Gulf of Mexico, and Kurdistan, Iraq.

Selected Publications

- Purvis et al. (2024), Rocky Mountain Highs and Lows: Decommissioning Colorado's Two Oil Industries. Carbon Tracker: Reports (CarbonTracker)
- Purvis et al. (2023), There will be blood: Decommissioning California's Oilfields. Carbon Tracker: Reports (CarbonTracker)
- Metz, K. M. (2020), CCUS in the LA Basin: Waking up a Sleeping Giant. California Resources Corporation: Forward Forum, 2020.
- Metz, K. M. (2019), Thin-Skinned vs. Thick-Skinned Structural Styles in the San Emigdio Trend: Building an Innovative Structural Model in a Prolific Play Trend. California Resources Corporation: Subsurface Technical Conference, 2019.
- Lee, M. & Metz, K. M. (2019) Jacalito Rhythm Prospect: An Ideal Testing Ground for New Completion Technology. California Resources Corporation: Subsurface Technical Conference, 2019.
- Metz, K. M. (2018), Basement Lineaments: Influence on Sediment Fairways, Deposition, and Trend Segmentation – Southern San Joaquin Basin, CA. California Resources Corporation: Geoscience Technical Conference, 2018.
- Bargnesi, E.B., et al. (2018), Pore Pressure Analysis, Prediction, and Application for Drilling and Production Optimization. California Resources Corporation: Geoscience Technical Conference, 2018.
- Carter, K.M. & Patchen, D.G. ED (2017), A Geologic Study to Determine the Potential to Create and Appalachian Storage Hub for Natural Gas Liquids: Final Report. Appalachian Oil and Natural Gas Research Consortium (ASH)
- Metz, K.M. & Erenpreiss, M.S. (2017), Structural Contour and Isopach Maps of Devonian Shales in Eastern Ohio: Columbus, Ohio Department of Natural Resources, Division of Geological Survey Map Series PG-6, scale 1:500,000. (ODNR Publication Catalog)
- Metz, K. M. (2017), Unconventional Resource Potential of Organic-Rich Devonian Shale Formations, Eastern Ohio, USA. Joint Northeastern and North-Central Annual GSA Section Meeting, 2017. (ODNR Publication Catalog)
- Metz, K.M. (2010) Metamorphic rocks in the Sawtooth Mountains, Idaho, USA: a window into the Precambrian basement of southwest Laurentia. Louisiana State University, Thesis. (LSU Theses)

RONALD F. KRAWCZYK JR., BENG

ORPHAN WELL TECHNICAL DIRECTOR/QUALIFIED MEASUREMENT SPECIALIST/KEY PERSONNEL

Ron's experience includes plugging and abandonment operations of early-era production wells involving casing and wellhead design/installation; site construction; magnetic wellbore locating; methane migration and quantification studies; historical P&A risk analysis; oil well drilling and re-plugging operations oversight; drilling rig health & safety; writing plugging instructions and reports; class II disposal well and remediation system operations, upgrades, maintenance, and troubleshooting; underground utility design and installation; abandoned oil production site Phase I and II investigations; remediation excavation site management; soil, groundwater, gas sampling, and field sample test kit processing. He has experience with floodplain and elevation surveying, GPS, and geographic information systems; oilfield surface facility mapping; underground utility locating; performing geophysical and magnetic surveying; providing geotechnical drilling and soils logging oversight; subcontractor management and equipment inspections; field crew and subcontractor health and safety oversight; Li-Cor soil gas testing; hot work fire watch; lock-out/tag-out; confined space entry; and field staff and temporary employee technical training.

Ron has created geographic and topological maps using AutoCAD, GPS, geographic information system data, survey data, and aerial historical photographs. His experience includes creating, implementing, modifying, and monitoring stormwater pollution prevention plans; planning facility modifications for proper stormwater and wastewater management; designing, operating, maintaining, and repairing wastewater collection systems and retention ponds; remediation system design, installation, troubleshooting, and upgrades; process control network installation and security protocol management; corresponding and meeting with state and department of environmental quality regulators; preparing soil erosion and sedimentation control permits and plans; performing wetland delineations; invasive species monitoring and reporting. He has authored US Army Corps of Engineers joint permit applications, performed floodplain surveying and hydraulic analysis, design and installation of temporary waterway bypass pumping systems, design and monitoring remediation and mitigation sites, coordinating with professional engineers on projects, permits, stream diversions, and oil tool designs. Ron has written standard operating procedures; management of change documents; operation and maintenance manuals including controls, piping, and instrumentation diagrams; hazard analysis documents; general technical reports; and proposal documents.

YEARS OF EXPERIENCE

- Total: 20
- With Parsons: 18

EDUCATION

- Bachelor of Engineering, Mechanical Engineering, Saginaw Valley State University, Michigan, 2017

CERTIFICATIONS/TRAINING

- HAZWOPER 40-hour
- HAZWOPER Supervisor 8-hour
- Technical Staff Trainer
- High-Hazard Safety Trainer
- Qualified Gas Testing
- Hydrogen Sulfide Awareness
- Asbestos Awareness
- Wetland Delineation
- Hazmat/RCRA/DOT
- Confined Space Entry
- Fall Protection/Aerial Equipment
- CPR/AED/First Aid
- Industrial Stormwater
- Construction Stormwater
- Underground Utility Location

COMPUTER/SOFTWARE SKILLS

- RBDMS Databases & Reporting
- Various State Oil & Gas Databases
- AutoCAD Civil 3D
- Solid Edge/SOLIDWORKS
- Autodesk Inventor
- MATLAB/Simulink
- ESRI GIS Products
- Trimble Siteworks
- Geometrics MagMap
- Li-Cor Soil Flux Pro
- ABB Data Manager Pro
- Microsoft Project/Visio
- Industrial Control Systems
- SCADA units

Ron's management experience includes planning and dispatching daily tasks and responsibilities for field personnel, providing employee health and safety training and oversight, providing process and procedure verification and training, management of change, planning and scheduling subcontractor and vendor services. He has organized client and regulatory meetings and proposals, written monthly status reports, created quarterly

project status update presentations, obtained property owner license agreements, conducted premobilization meetings with property owners and subcontractors, verified invoices and quotations, documented and implemented cost savings utilizing Lean/Six-Sigma principles, and managed implementation of new technologies while providing employee technical and process training.

Technical Director. Michigan EGLE Statewide Orphan Well Methane Monitoring & Quantification, Michigan, United States, 02/2023-Current. Parsons provides state-wide methane emissions studies and leak detection of 444 orphan wells and 60 associated facilities. Parsons developed an efficient and accurate approach utilizing TDLAS methane specific sensors to identify and quantify methane leaks to below 1 gram/hour thresholds as required by DOI guidance along with USEPA Method 21 VOC surveys. Parsons developed an automated field data capture and reporting system creating a master database for DOI reporting and interface with the state's ESRI ArcGIS Online system.

Project Engineer/Technical Director. Confidential International Oil Company, Mid-Michigan Oilfield Remediation, Closure, and Restoration, Michigan, United States. 09/2006-Current. This project was part of a program in which Parsons managed remediation of more than 970 former oilfield sites, including former oil wells, tank battery sites, and spill areas in central Michigan. Parsons also provided program management, investigation, remedial engineering, and construction oversight services and restored more than 9,225 acres of land to nearly original condition under US Environmental Protection Agency and Michigan Department of Environmental Quality and Department of Natural Resources requirements.

Technical Director. Arizona Department of Environmental Quality – Orphan Well Program. Arizona, United States. 1/5/2024-6/30/2024. Parsons is providing UAV-based Magnetometer and LiDAR surveys to locate orphan and undocumented wells encompassing 3,500+ acres across 89 separate areas located state-wide utilizing our proven magnetometer data processing methodology. Also provided are individual site survey reports, detected well bore anomaly coordinates, well anomaly classification, terrain hill shading, elevation contours, and integration of collected survey data into the state's ESRI ArcGIS Online system.

Project Engineer. Confidential International Oil Company, Turn-Key Orphan Well Investigation and Re-abandonment, West Branch, Michigan, United States. 12/2020-06/2023. Provided turn-key investigation and re-plugging of a leaking historical oil well. Conducted initial investigation, contractor selection/mobilization, cost estimations, health & safety management, landowner interface, rig pad design, floodplain surveying and permitting, soil erosion permitting, plugging instructions, well site management of plugging and abandonment operations, and final site restoration.

Project Engineer. Confidential International Oil Company, Orphan Well Methane Studies and Mitigation, Calgary, Alberta Canada. 06/2021-05/2022. This project was the study of leaking methane at over 800 well sites. Assisted development of risk-based and biotechnology alternatives to well re-plugging and abandonment. Responsible for design and installation of methane monitoring and bioremediation systems at well site locations.

Project Engineer. Texas Government Land Office, Bolivar Island Coastal Restoration, Galveston County, Texas, United States. 02/2022-05/2022. This project was coastal orphan well investigation, decommissioning, and beach restoration following heavy hurricane erosion on the Gulf of Mexico. Provided technical direction, work plans, operating procedure review, health, safety, and contractor management. Work scope involved the assessment of and re-abandonment of exposed documented and undocumented orphan well casings onshore and beyond the surf line.

Project Engineer. New York Department of Environmental Conservation Orphan Well Program 06/2022-12/2022. This project involved the Program Management of the State's Orphan Well Abandonment funds and involved location, assessment, access agreements, permitting, contracting of oilfield services, well site management, and site restoration of over 80 wells. Provided technical direction, work plans, operating procedure review, health, safety, and contractor management.

GLENN A. ULRICH, PHD

TECHNICAL DIRECTOR

Glenn is a technical director specializing in contaminant fate and transport, technology development and application in the oil and gas industry, and the sustainable remediation of contaminants and methane. He's skilled at the integrated interpretation of geology, hydrology, microbiology, geochemistry, and contaminant distribution/behavior and applying these fundamentals to help solve problems in the oil and gas Industry. His responsibilities include technology development, designing field applications, and reporting.

Glenn has significant experience with methane in the oil and gas industry, including biogenic methane exploration, enhancing methane production in depleted reservoirs, and fugitive methane emissions from oil and gas wells. He has developed a methane biodegradation technology to address methane emissions from leaking natural gas production and transmission infrastructure, landfills, and other sources of this greenhouse gas.

Work Experience

Technical Director. Major O&G Company. Development of Alternative Technologies for Oil and Gas Wells Leaking Natural Gas. 2015 to Current. The purpose of this program has been to measure, monitor and characterize the effects of methane being released due to well integrity failure on the environment (i.e. soil, groundwater, vegetation and flux to atmosphere), and to develop/apply natural and enhanced methane attenuation alternatives to well plugging. The program, which has run since 2015 in close coordination with the Alberta Energy Regulator, was extended for 5 years to generate important new insights on well integrity failure, fugitive gas migration, environmental impacts and fate, and alternative technologies to address methane leaks. The program involves quantifying methane and carbon dioxide emissions and variability thereof at leaking well sites, characterizing methane behavior and transport through soils and groundwater, quantifying the extent of methane biodegradation, and assessing gas leakage influences on shallow groundwater and vegetation. Much of the program work is new, and we have been flexible and innovative in creating and implementing the program for the client and the Alberta Energy Regulator.

Glenn is responsible for steering the technical scope of the project, field sampling methods, and the interpretation and reporting of results. Project findings provide more detail than previously held regarding factors controlling fugitive gas migration, environmental impacts and fugitive gas fate at well sites.

Parsons' Internal R&D. 2020-Current. Glenn has led laboratory research in Parsons' Syracuse laboratory to develop biofilters for sustained passive methane biodegradation around leaking wells,

YEARS OF EXPERIENCE

- Total: 30
- With Parsons: 11

EDUCATION

- Doctorate/PhD, Microbiology, University of Oklahoma, 1999
- Bachelor of Science, Microbiology, Mississippi State University, Mississippi, 1992

AWARDS

- A.I. Levorsen Memorial Award for Best Paper, entitled entitled Active Biogenesis of Methane in Ft. Union Coals of Wyoming's Powder River Basin, American Association of Petroleum Geologists 51st Annual Meeting, Rocky Mountain Division, 2005
- President's Certificate for Excellence in Oral Presentation, entitled Active Biogenesis of Methane in Wyoming's Powder River Basin, American Association of Petroleum Geologists Annual Meeting, 2005

Publications/Presentations/Patents Focused on Methane

- "Active Methanogenesis and Acetate Utilization in Powder River Basin Coals, United States," International Journal of Coal Geology, 76: 138-150, 2008 (coauthors G.A. Ulrich and S. Bower).
- "Active Biogenesis of Methane in Ft. Union Coals of Wyoming's Powder River Basin," AAPG Rocky Mountain Section, 51st Annual Meeting, 2005 (coauthors Glenn Ulrich, Roly Debruyn, Mark Finkelstein, and Jeffrey Weber).

landfills, and other methane sources. Over 50 blends of materials have been tested in static bottle tests followed by flow through column testing. Several biofilter materials and mixtures stimulated methane biodegradation to rates that support field application of the technology. A methane biofilter pilot test is planned for this summer.

Natural Gas Exploration and Production Company, Powder River Basin in Wyoming. Founding Scientist. Luca Technologies, Golden, CO. Prior to Parsons, Glenn was the lead scientist for Luca Technologies exploring reservoirs where microorganisms are generating methane through methanogenesis in real time, and helped develop full-scale in-situ processes for stimulating biogenic methane creation and production in coal bed methane and oil reservoirs with a team of microbiologists, hydrogeologists, reservoir engineers, and oil and gas executives. Responsibilities included laboratory and field research program development, field implementation design, reporting, staff training and management, marketing support, and regulatory compliance. Glenn lead the design and evaluation of biogeochemical surveys for 20 oil reservoirs and 40 coal and shale gas fields; laboratory testing; design and interpretation of large field tests (often millions of gallons/well); design of reservoir-scale microbial stimulations; and the integrated interpretation of complex data sets encompassing the geology, hydrology, microbiology, geochemistry, methane production, and water production over large project areas (several square miles). Accomplishments included identifying reservoirs across the world where methanogenesis is currently actively generating methane. Techniques for stimulating the microbial generation of methane were developed in the laboratory and tested in the field. At roughly the same time, fracking was discovered and implemented to substantially increase the production of existing natural gas.

- "Active Biogenesis of Methane in Wyoming's Powder River Basin," AAPG Energy Minerals Division Annual Meeting, 2005 (coauthors Glenn Ulrich, Mark Finkelstein, Jeffrey Weber, and Roly Debruyn).
- Patent Pending "System and Method for Methane Biodegradation". U.S. Patent Application Serial No. 17/647,655
- "Biogenic Fuel Gas Generation in Geological Hydrocarbon Deposits," US Patent 7426960, 9/23/2010 (Robert S. Pfeiffer, Gary Vanzin, Glenn Ulrich, Verlin Dannar, Roland P. DeBruyn, and James B. Dodson).
- "Biogenic Fuel Gas Generation in Geological Hydrocarbon Deposits, US Patent 12/129,441, 6/11/2010 (Robert S. Pfeiffer, Gary Vanzin, Glenn Ulrich, Verlin Dannar, Roland P. DeBruyn, and James B. Dodson).
- "Chemical Amendments for the Stimulation of Biogenic Gas Generation in Deposits of Carbonaceous Material," US Patent 7696132, 4/13/10 (Robert S. Pfeiffer, Glenn Ulrich, and Shelley Haveman).
- "Biogenic Fuel Gas Generation in Geological Hydrocarbon Deposits," US Patent 7640978, 1/5/2010 (Robert S. Pfeiffer, Gary Vanzin, Glenn Ulrich, Verlin Dannar, Roland P. DeBruyn, and James B. Dodson).
- "Thermoacetogenium phaeum Consortium for the Production of Materials With Enhanced Hydrogen Content," US Patent 7416879, 8/26/2008 (Robert S. Pfeiffer, Glenn Ulrich, and Gary Vanzin).

ERIC L. HELTON

Technician V

Eric Helton has 20+ years of experience providing field support and oversite to a large variety of environmental and construction projects throughout the United States, including West Virginia. He has provided oversight for wellbore installation and development and has experience with low- and high-flow sampling techniques. Additionally, Eric has years of experience monitoring, measuring, and capturing explosive gas (methane) emissions and collecting vapor samples.

YEARS OF EXPERIENCE

- Total: 22
- With Parsons: 6

EDUCATION

- Bachelor of Science, Environmental Science, University of Cincinnati, Ohio, 2003

COMPUTER/SOFTWARE SKILLS

- Microsoft Word
- Microsoft Excel
- Microsoft PowerPoint
- AutoCAD

Work Experience

Field Technician. Various Clients/projects, 05/2019-08/2024, Employer: Parsons. The Circleville Works Facility Enhanced in Situ Bioremediation project is part of a master services agreement in which Parsons serves as an integral part of a collaborative team for the client's corporate remediation group. Parsons designed a low-cost, full-scale application using enhanced in situ bioremediation based on a successful pilot test to treat 1,1-dichloroethene (1,1-DCE) and vinyl chloride in groundwater. Parsons then optimized the design by reducing injection well installations and optimizing the substrate mixture with both fast-acting lactate and slow-release emulsified vegetable oil substrates to extend the longevity of the application to reduce the need for additional injections. Parsons has also introduced dairy whey for a portion of the application as an alternative lower-cost, longer-lasting substrate to the previously proposed sodium lactate. Bioaugmentation is used to ensure that vinyl chloride is completely degraded to ethene. Initial results indicate that 1,1-DCE has been degraded within the treatment area from more than 2,000 µg/L to less than 5.0 µg/L within nine months, without an increase in vinyl chloride. Parsons also conducts lagoon sediment sampling, performs bathymetric surveys to characterize sediment and surface water, documents the application's effectiveness as the final remedy for the site, and evaluates long-term monitoring program optimization at the site, thereby reducing site groundwater sampling frequency and locations and generating significant short- and long-term cost savings to the client. Performing various tasks including installation of both monitoring and injection wells, along with well development, ground water sampling, and soil classification and sampling.

Parsons has served as program manager since January 2013 on the client's comprehensive operations, maintenance, and monitoring (OM&M) program at 10 sites in Massachusetts, Maryland, North Carolina, New Jersey, New York, and West Virginia. This endeavor includes implementing specified OM&M tasks, processing and paying associated direct costs, identifying and implementing remedial process optimizations, and executing approved cost reduction proposals for three-year periods. In addition, the scope requires submitting regular monitoring reports, providing records retention, and performing system curtailment. Parsons also performs quarterly technical evaluations of collected site treatment system data to verify optimal performance of groundwater treatment systems; performs annual and semiannual analyses of groundwater data collected at each of the 10 sites to determine and monitor groundwater contaminants trends; employs programmable logic controller remote access software to monitor and manipulate groundwater treatment systems from remote locations; develops and maintains a state-of-the-art database for historical and current analytical data from nine sites; develops, maintains, and strictly adheres to emergency response plans and health and safety plans for each site; and conducts periodic safety evaluations at each site. Operate, maintain, and repair all aspects of the water treatment plant process and monitor and maintain wellfield pumps.

Parsons provided turnkey landfill management services to maintain a landfill that produced impacted groundwater that had historically seeped from the toe of the landfill slope, resulting in stressed vegetation and surface contamination. A groundwater collection trench and wet well were installed to collect the groundwater, and a storage tank was added in the late 1990s to facilitate transfer of the collected groundwater to tank trucks for transportation and off-site disposal. Parsons was responsible for operation of the groundwater collection system. Work included evaluating alternatives to the existing leachate collection system to mitigate leachate generation and designing and constructing the selected alternative; designing and installing a 2.3-acre improved landfill cap consisting of a high-density polyethylene membrane, drainage swales with V-notch flumes, and passive soil gas vents over an existing clay cap to reduce the volume of leachate produced; investigating options for improvements to leachate handling and disposal, such as adding new leachate storage facilities and telemetry and SCADA system controls, improving access roads and secondary containment, and providing on-site treatment using traditional and biological processes; and designing an impermeable cover system with associated drainage features to replace the existing stormwater management system. Primary chemicals of concern were cyanide and fluoride. Duties included groundwater sampling and leachate collection system OM&M.

Plant Operator/Well Field Technician. Montauk Energy, 09/2016-03/2019, Employer: Montauk Energy. Performed operation and maintenance duties associated with the landfill gas collection system which included two utility flares, one enclosed flare, and a high btu plant. Also assisted with the operation of the High BTU plant as well as completed gas well installations and several HDPE piping and construction projects.

Field Technician. Environmental Management Services, 03/2006 – 03/2016, Employer: Shaw Environmental. Managed the operation and maintenance of several landfill gas collection systems including several landfill gas to energy operations. Knowledge of operation and maintenance of Caterpillar 3516 and 3520 and Genbacher 316 and 320 generators used in landfill gas to energy settings. Performed explosive gas monitoring, surface emission monitoring, tuning of landfill gas wells, gas collection pipe repair and small construction projects, routine landfill gas flare operation and maintenance, blower repairs, and troubleshooting of system and/or flare problems. Extensive experience with several kinds of pumps and blowers including pneumatic, electric, diaphragm, liquid ring, and transfer pumps, as well as fan and rotary blowers. Performed soil and groundwater-related tasks. Extensive experience in monitoring well installation, Geoprobe investigations, groundwater, air, and soil sampling, building, installing, operating and maintaining dual-phase extraction (DPE) remediation systems and site assessments. Also completed several Biological sampling studies, mainly fish, for East Kentucky Power at several of their generation plants. During this time was also involved in the design and construction of several slurry walls to mitigate seeping and/or runoff of leachate into surface water. Projects included sites throughout Ohio, Kentucky, Indiana, Pennsylvania, Maryland, Tennessee, Illinois, New York, Michigan, Missouri, and West Virginia.

Hydrogeologist, 09/2003-01/2006, Employer: Handex Environmental. Performed soil and groundwater-related tasks. Extensive experience in monitoring well installation, Geoprobe investigations, groundwater, air and soil sampling, operation and maintenance of dual-phase extraction (DPE) remediation systems and site assessments. Sites were located throughout Ohio, Kentucky, Indiana, and Pennsylvania.

LOGAN E. LACROSS

SENIOR GEOLOGIST

Logan LaCross is a senior geologist with more than six years of experience in the environmental remediation, engineering and design space focusing on oil and gas projects. Logan has provided oversight for orphan well abandonment operations, site reclamation/restoration, and contaminated soil excavations. Most recently, Logan is the lead Qualified Measurement Specialist for Parsons' Michigan EGLE Methane Monitoring project where he has sampled methane emissions from over 400 sites and trained three field technicians to the Qualified Measurement Specialist level as per the BIL Guidelines

YEARS OF EXPERIENCE

- Total: 5
- With Parsons: 3

PROJECT SPECIFIC QUALIFICATIONS

- Qualified Measurement Specialist

COMPUTER/SOFTWARE SKILLS

- gINT
- Surfer
- AutoCAD
- ArcGIS
- Forms On Fire
- EQuIS
- Microsoft Office Suite

Work Experience

Qualified Measurement Specialist. Michigan EGLE Statewide Orphan Well Methane Monitoring & Quantification, Michigan, United States, 02/2023-Current. Parsons provides state-wide methane emissions studies and leak detection of 444 orphan wells and 60 associated facilities. Parsons developed an efficient and accurate approach utilizing TDLAS methane specific sensors to identify and quantify methane leaks to below 1 gram/hour thresholds as required by DOI guidance along with USEPA Method 21 VOC surveys. Parsons developed an automated field data capture and reporting system creating a master database for DOI reporting and interface with the state's ESRI ArcGIS Online system.

Senior Geologist. Confidential International Oil Company, Mid-Michigan Oilfield Remediation, Closure, and Restoration, Central and Northern Michigan, United States. 04/2021-08/2024. Employer: Parsons. Parsons manages remediation of more than 1,000 former oilfield sites, including 675 former oil wells, tank battery sites, and spill areas in central and northern Michigan. Parsons also provides program management, investigation, remedial engineering, and construction oversight services and has restored more than 20,500 acres of land to nearly original condition under the requirements of the US Environmental Protection Agency; the Michigan Department of Environment, Great Lakes, and Energy; and the Michigan Department of Natural Resources. Logan is responsible for overseeing excavation and sampling, well abandonment, well installation and sampling, flow-line mapping, and confined space hot work; writing and contributing to closure reports; updating analytical tables; surveying TOC elevations; using Trimble to map excavations; and conducting test hole inspections.

Senior Geologist. Confidential International Oil Company, Operations, Maintenance, and Monitoring Services, Nationwide United States. 08/2020-07/2024. Employer: Parsons. Parsons is providing operations, maintenance, and monitoring services for nearly 200 sites in 19 states across the United States. Services can include active remediation encompassing proven physical techniques such as soil vapor extraction, thermal oxidation, and air sparging; long-term monitoring optimization; site maintenance; and innovative remedial processes such as injection of various in situ chemical oxidation or biological enhancement substrates, along with many other tasks as required by the client. Logan is responsible for overseeing the sampling of more than 40 retail sites using low-flow sampling (peristaltic and bailer only), no-purge sampling (HydraSleeves), soil vapor sampling (EZ-Cans), and soil sampling during drilling and excavations. Responsibilities include sampling on a pipeline; checking and maintaining oil/water separators and pumps; interacting with property owners and project managers for access agreements and maintaining good work relationships; contributing to writing closure, FAR, and SSR reports; updating data tables; and helping kickoff the EQuIS program as a test subject.

Geologist. Wood Environment and Infrastructure Solutions. 07/2018-07/2020. Logan used a small fishing boat to travel up the Kalamazoo River and collect soil samples from the floodplains by driving 3-foot Lexan (polycarbonate) tubing into the ground. After collecting the samples for two weeks, work involved processing

floodplain and sediment samples from the river bottom a processing station. The tubing was cut down opposite sides and split open lengthwise, then the sediment was photographed, logged, homogenized, and packed into sample bags.

Geologist. Wood Environment and Infrastructure Solutions. 07/2018-07/2020. Logan recorded weekly site visits to soil vapor extraction system trailers, including one on a chlorinated site (former dry cleaners in Alpena, Michigan) and another on a gas station site. Recorded flow and pressure for both systems at all extraction points and their main blowers. Sampled the sites monthly with Drager tubes following industry standard operating procedures. Helped write the installation report for the chlorinated sites soil vapor extraction system and calculated the amount of volatile organic compounds in pounds removed from soil vapor in total.

Geologist. Wood Environment and Infrastructure Solutions. 07/2018-07/2020. Logan was exposed to an in situ thermal remediation system on a trichloroethylene/ tetrachloroethylene site in Dansville, Illinois. Performed the groundwater sampling around the site and surveyed newly installed wells on the site.

Geologist. Wood Environment and Infrastructure Solutions. 07/2018-07/2020. Logan installed several soil sampling points to the appropriate depth (15 feet or less) using a hand auger and assembled the sample point by connecting the screen to the Teflon tubing, filling the hole with filter sand, and sealing with bentonite. Installed several sub-slab points by drilling through concrete with a hammer drill and driving a Cox-Colvin Vapor Pin with a silicon sleeve into the hole and sealing it properly.

APPENDIX A

REMOTE METHANE LEAK DETECTOR – COMPLETE SOLUTION (RMLD-CS) SPECIFACATIONS

CRFP 0313-DEP2500000001 METHANE EMISSION QUANTIFICATION

Heath
Your Safety Our Commitment

RMLD-Complete Solution

RMLD CS™

Remote Methane Leak Detector Complete Solution

Recognize the potential for increased safety, significant productivity gains and time-savings with the RMLD-CS™. Remote detection allows utility services personnel and first responders to quickly scan an area for suspected gas leaks at a safe distance.

The **HEATH** Remote Methane Leak Detector - Complete Solution (RMLD-CS) is a highly advanced technology, capable of detecting methane leaks from a remote distance utilizing the same TDLAS (tunable diode laser absorption spectroscopy) technology as the current RMLD. This instrument eliminates the separate receiver and transceiver, combining them into one hand-held instrument that is lightweight, portable and field rugged. The RMLD-CS makes it possible to detect leaks without having to travel the entire length of the pipe line, thus creating safer surveys in areas that may be difficult to reach such as busy roadways, yards with dogs, fenced off areas and other hard to access places. It operates under a variety of field conditions including a wide temperature range, light rain and fog. Its rugged design will stand up to normal field use and operating conditions and its sensitivity or range is not affected by reasonable amounts of dust on the instrument's window.

FEATURES:

- ✓ Intrinsically safe
- ✓ Rechargeable/replaceable battery
- ✓ Dual battery charger
- ✓ Mobile App support
- ✓ Ergonomic housing
- ✓ Lightweight
- ✓ Graphical user interface
- ✓ Internal data logging
- ✓ WiFi
- ✓ GPS
- ✓ Bluetooth BLE
- ✓ Color camera and display

7/23

9030 Monroe Road, Houston TX 77061
713-844-1300
www.heathus.com
info@heathus.com

certified WBENC WOMEN'S BUSINESS ENTERPRISE

SPECIFICATIONS

General

Weight
3 lbs (approx.)

Carry Case Dimensions
21" x 17.5" x 9.5"

Display
3.5" color LCD, 320 x 240 resolution

Power

Battery
Removable, Rechargeable
Lithium-ion pack, 10.8 VDC at 3.2Ah

Battery Run Time
8 hours at 32° F (approx.)

Battery Charger
External, 110-240 VAC, 50/60 Hz Universal

Dual Bay, Delivers 12W at 25°C per battery

Charge Time
2-3 hours full charge (approx.)

Detection/Measurement System

Detection Method
Tunable Diode Laser Absorption Spectroscopy (TDLAS)

Detection Distance
100 ft (30m) nominal - may vary due to background type and conditions

Measurement Range
0 to 50K PPM-M

Sensitivity
5 PPM-M at distances from 0 to 100 ft (30m)

Beam Size
Conical in shape with a 22" diameter at 100 ft (55cm at 30m)

Lasers

IR Laser
Class I

Green Spotter
Class 2(II) <5mW @ 510-530 nm
Spot size is 7mm at 15M

Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007

Laser Eye Safety Warning
Do not stare into beam or view directly with optical instrument

Color Camera

Aperture
f/2.6

FOV
94DEG (at 6.0mm image circle)

GNSS Compatibility

GPS
GLONASS
Beidou
Galilieo

Communication

USB Dual Mode – flash drive and communications
USB Port Max Rating: Um = 5V, In = 5 A
Bluetooth 4.2 BLE

WiFi b/g

Alarms

Digital Methane Detection (DMD)
Audible tone and visual alerts when detection threshold exceeded

Adjustable Detection Alarm Level
1 to 999 PPM-M

Alarm Response Time
Typically 0.1 - 0.2 seconds

Real Time (RT)
Continuous beep rate relative to concentration from 10-1000 PPM-M

System Fault & Warnings
Audible alarm and visual indication on the display

Testing

Built-In Self-Test
Verifies operation and adjusts laser wavelength for maximum sensitivity

Test Gas Cell
Integrated within carrying case

Operating Conditions

Operating Temperature
0° to +122° F (-17° to 50° C)

Humidity
5 to 95% RH, non-condensing

Altitude
Up to 2000M

Environment of Use
Pollution degree 2 or better
Outdoor use

Regulatory

Ingress Protection
IP54 (water splash and dust resistant)

Compliance
EMC (EN61000-6-2, EN6100-6-4)

Low Voltage Directive
(2014/35/EU)

Radio Equipment Directive
(2014/53/EU)

ETSI EN 301 489-1 v2.2.0
EN 61326-1:2013
47 CFR Part 15 & ICES-003

Ordinary Location Safety

UL 61010-1
CAN/CSA-C22.2 No 61010-1-12

Hazardous Location Safety

Class I, Zone 2, AEx ic op is IIA T4 Gc
Class I, Division 2, Group D Intrinsically Safe

Ordering Information

RMLD-CS - HPN 105301
Includes carry strap, case, battery charger, power supply, USB cable, one battery pack, gas calibration test cell

IS Battery Pack - HPN 105727
Li-ion replacement battery

Battery Charger Base
HPN 105358

Battery Charger Cable
HPN 105359
Charges two batteries at one time

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Houston TX 77061 713-844-1300
www.heathus.com info@heathus.com

APPENDIX B

SEMTECH HI-FLOW 2 SPECIFACATIONS

CRFP 0313-DEP2500000001
METHANE EMISSION QUANTIFICATION

SEMTECH® HI-FLOW 2

For over 50 years, Sensors, Inc. has built a reputation for gas and particulate measurement products under the SEMTECH® brand in the automotive industry.

Our fugitive methane analyzer is the latest entry in **S**ensors **E**missions **M**easurement **Tech**nology (SEMTECH®) family.

Sensors' fugitive methane analyzer brings to bear our emission measurement experience into the oil and gas industry with a focus on leak detection and repair (LDAR).

"While advocates of natural gas often promote its abundancy and "green" credentials, its primary component (methane) is a powerful greenhouse gas. With 2-3% of methane lost due to leakages, the accurate quantification of fugitive methane is receiving significant attention across all stakeholders, and more accurate techniques are required for climate governance." – Sensors' Dr. David Booker, CTO

Sensors, Inc. is proud to present the latest in direct quantification of leaks in the 0.0005 to 25 CFM range with accuracy better than 5%. This device uses state-of-the-art flow and gas sensing technologies that are integrated into a handheld unit for accurate measurement during established LDAR programs.

For ultimate flexibility, the SEMTECH® HI-FLOW 2 is separated into:

Sampler - Handheld device with a high-volume vacuum sampling fan and total flowrate monitor (as shown above)

Analyzer - Portable control module (which can be carried, placed on the floor, or mounted to a backpack) housing the gas sensor technologies, control electronics, and battery pack

The combination of these two components (with a variety of sampling adapters) allows the entire fugitive methane emission to be captured, diluted, and quantified accurately.

HEATH CONSULTANTS

Your Safety...Our Commitment

SEMTECH® HI-FLOW 2 preliminary fugitive methane analyzer performance:

SPECIFICATIONS (Preliminary)	
Total Flow Rate*	5-30 CFM (Upper limit dependent on accessories)
Measurable Leak Rate*	0.0005 to 25 CFM
Accuracy	<5% of full scale or 20% of point, whichever is higher
Power	Fan speed dependent, @ max flow, 50W
Warm up time	< 5 minutes
Storage temperature	Dry –10 to 60 °C ambient
Operating environment	-10 to 45°C ambient
Dimensions (W x D x H) Electronics and Gas Module	30 x 30 x 8.75 cm 12 x 12.0 x 3.5 in.
Dimensions (W x D x H) Handheld Unit w/o extension	61 x 19 x 12.7 cm 24 x 7.5 x 10.5 in.
Weight (Electronic and Gas Module)^	8.2 kg. 18.1 lbs.
Weight (Handheld Unit)	<2.5 kg. < 5.5 lbs.
Data transmission	Ethernet

*Inlet restrictions on the HI-FLOW 2 Handheld sampling unit will reduce the maximum achievable flow.
^Weight assuming full battery pack installed for 8+ hours of continuous operation.

By utilizing Tunable Laser Absorption Spectroscopy (TDLAS) for the accurate measurement of the fugitive methane, the dynamic range for concentrations can accurately span 4 to 5 orders of magnitude and moreover without any cross-interference from other gases present in the captured leak. Coupled with an accurate measurement of the extracted flow (methane leak and ambient air) the volume- and mass-based leak rate of the fugitive methane can be determined with high accuracy over a wide range (for example 0.0005 to 25 CFM).

Designed for intuitive and convenient operation

- Modern Wi-Fi web-based GUI interface with manual override and LED status indicators
- Up to 200 Whr battery pack for uninterrupted daily operation
- Lightweight and flexible umbilical connections between various components to access those hard-to-reach places
- Detachable shoulder strap

As we enter our final product engineering and certification processes, we welcome your valued input at info@sensors-inc.com

HEATH CONSULTANTS
Your Safety...Our Commitment

9030 Monroe Road, Houston TX 77061
Ph: 713-844-1300
www.heathus.com
info@heathus.com

Rev 20220308

Innovation.
Built on Experience.

QUANTIFICATION OF FUGITIVE METHANE EMISSIONS UNDER THE AUSPICES OF THE NEW EPA NSPS SUBPART OOOOB RULE

The Use of High-Volume Samplers – Equipment Selection and User Recommendations.

BY: DR. DAVID R. BOOKER, CHIEF TECHNICAL OFFICER – SENSORS, INC.
APRIL 2024

ABSTRACT

This paper offers a summary of how to meet the new NSPS' OOOOb rule for effectively quantifying Fugitive Methane. A brief review of the recommended technology (Sensors, Inc.'s SEMTECH HI-FLOW 2) is included. Methods on how to keep your high-volume sampler in compliance via linearity checks, quality checks, and leak rate determination methods is also covered.

BACKGROUND

It is widely accepted that methane is a potent greenhouse gas that occurs from both natural and anthropogenic (human-caused) sources. Consequently, more attention on the mitigation of methane emissions to help combat climate change concerns in the oil and gas market is being demanded by stakeholders, regulators, and NGO's.

Not surprisingly, the allowable methodologies for quantification of these fugitive methane leaks have recently been defined in a final rule by the USEPA (Signed 2nd December 2023[1]). This updated New Source Performance Standard (NSPS) all-encompassing rule (40 CFR Part 60) covers what needs to be measured, how it should be measured, when it should be measured and, moreover, sets performance requirements for the devices / instruments that can be used.

In the all-encompassing regulatory text, the approved "high-volume sampler" technique appears 22 times in the 1690-page document. Such as:

> "A high-volume sampler according to methods set forth §60.5405c."

> "You must use a high-volume sampler to measure emissions of the reciprocating compressor rod packing or centrifugal compressor dry or wet seal vent in accordance with...".

Unregulated measurements using high-volume samplers have been carried out for over 20 years, and the Bacharach sampler, until it became obsoleted in 2015, was the *de facto* standard. This device used two low-cost sensors (based on catalytic oxidation and thermal conductivity) to cover the leak concentration ranges, with an orifice plate flowmeter to determine the leak rate. The measurement was not methane specific, but moreover, was found to have significant issues associated with interferences and switching between the sensors[2] and has since been withdrawn from the market.

Not surprisingly, the new regulation partially addresses these performance-based issues by specifying that the sensor(s) MUST have minimal interference, < 2.5% for the sum of responses to other compounds in the gas matrix. This is generally very difficult to achieve using low-cost sensors such as thermal conductivity, catalytic

oxidation, metal oxide or non-dispersed infrared sensors and will, in the author's opinion, drive the use of best available techniques not entailing excessive cost (BATNEEC)[5]".

> "The methane sensor(s) must be selective to methane with minimal interference, less than 2.5 percent for the sum of responses to other compounds in the gas matrix"
> – NSPS OOOOb

Recently these issues were highlighted in a CARB-funded project with Colorado State University - Methane Emissions Test and Evaluation Center, to design an open-source high-flow sampler. In their final report[4], they concluded that their open-source unit (again using low-cost sensors) and the obsoleted Bacharach device had issues when non-methane hydrocarbons (NMHC) were present in the leaking gas.

> "...These corrections have been challenging and often require taking supplementary measurements, such as gas samples for speciation with gas chromatography."
> – METEC report

For the other "prototype units" also tested during the study, they also reported that

> "the XXX and XXX instruments show similar deviation when NMHCs are introduced, while the Sensors instrument exhibits behavior that is more methane-specific." – METEC Report

SEMTECH HI-FLOW 2 SAMPLER

SEMTECH HI-FLOW 2 sampler and analyzer

The SEMTECH HI-FLOW 2 analyzer utilizes BATNEEC[5] (via a Tunable Diode Laser Absorption Spectroscopy (a.k.a. TDLAS)) to minimize gas interferences and quantifies methane leaks rates with a very-high degree of confidence over 4-5 orders of magnitude (0.0005-25 CFM). Pre-shipment compliance tests include interference tests, signal-to-noise tests, and accuracy tests, as well as rigorous linearity tests at half the margin allowed under the NSPS' OOOOb rule (2.5% by point rather than 5% as specified in the rule). Each sampler is supplied with a NIST traceable compliance certificate for both the flow measurement device and the gas analyzer module. (Examples are attached at the end of this document.)

KEEPING YOUR HIGH-VOLUME SAMPLER IN COMPLIANCE WITH NSPS' OOOOB

For valid NSPS' OOOOb Leak Rate Determinations, you must collect at least three separate one-minute measurements and determine the average leak rate. The relative percent difference of these three separate samples should be **less than 10 percent**.

The leak rate according to the following equation:

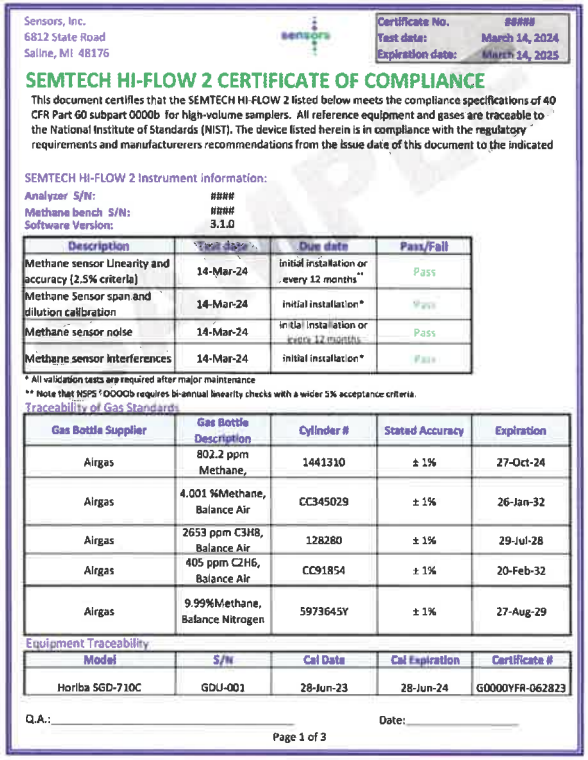
$$Q = V\left(\frac{CH4_S - CH4_B}{1000000}\right)$$

Where:

- $CH4_B$ = background methane concentration, ppmv (1-minute averaged sample)
- $CH4_S$ = methane sample concentration, ppmv
- V = Average flow rate of the sampler, scfm
- Q = Methane emission rate, scfm

Note that the measured natural gas flow determined must not exceed 70.0 percent of the manufacturer's reported maximum sampling flow rate.

SEMTECH HI-FLOW 2 ANALYZER EXAMPLE CALIBRATION CERTIFICATE



Sensors, Inc.
6812 State Road
Saline, MI 48176

Certificate No.	#####
Test date:	March 14, 2024
Expiration date:	March 14, 2025

SEMTECH HI-FLOW 2 CERTIFICATE OF COMPLIANCE

This document certifies that the SEMTECH HI-FLOW 2 listed below meets the compliance specifications of 40 CFR Part 60 subpart 0000b for high-volume samplers. All reference equipment and gases are traceable to the National Institute of Standards (NIST). The device listed herein is in compliance with the regulatory requirements and manufacturerers recommendations from the issue date of this document to the indicated

SEMTECH HI-FLOW 2 Instrument information:

Analyzer S/N:	####
Methane bench S/N:	####
Software Version:	3.1.0

Description	Test date	Due date	Pass/Fail
Methane sensor Linearity and accuracy (2.5% criteria)	14-Mar-24	initial installation or every 12 months**	Pass
Methane Sensor span and dilution calibration	14-Mar-24	initial installation*	Pass
Methane sensor noise	14-Mar-24	initial installation or every 12 months	Pass
Methane sensor interferences	14-Mar-24	initial installation*	Pass

* All validation tests are required after major maintenance

** Note that NSPS ⁱ OOOOb requires bi-annual linearity checks with a wider 5% acceptance criteria.

Traceability of Gas Standards

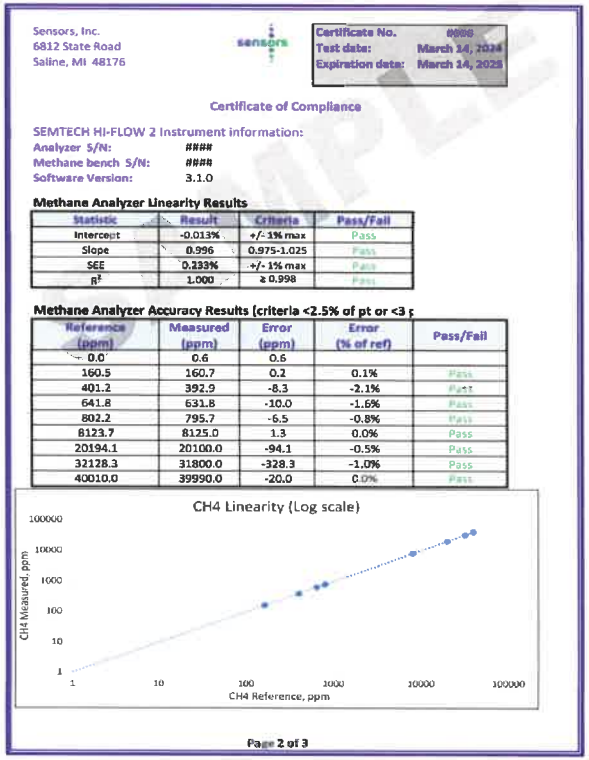
Gas Bottle Supplier	Gas Bottle Description	Cylinder #	Stated Accuracy	Expiration
Airgas	802.2 ppm Methane,	1441310	± 1%	27-Oct-24
Airgas	4.001 %Methane, Balance Air	CC345029	± 1%	26-Jan-32
Airgas	2653 ppm C3H8, Balance Air	128280	± 1%	29-Jul-28
Airgas	405 ppm C2H6, Balance Air	CC91854	± 1%	20-Feb-32
Airgas	9.99%Methane, Balance Nitrogen	5973645Y	± 1%	27-Aug-29

Equipment Traceability

Model	S/N	Cal Date	Cal Expiration	Certificate #
Horiba SGD-710C	GDU-001	28-Jun-23	28-Jun-24	G0000YFR-062823

Q.A.:_____ Date:_____

Page 1 of 3



Sensors, Inc.
6812 State Road
Saline, MI 48176

Certificate No.	#####
Test date:	March 14, 2024
Expiration date:	March 14, 2025

Certificate of Compliance

SEMTECH HI-FLOW 2 Instrument information:

Analyzer S/N:	####
Methane bench S/N:	####
Software Version:	3.1.0

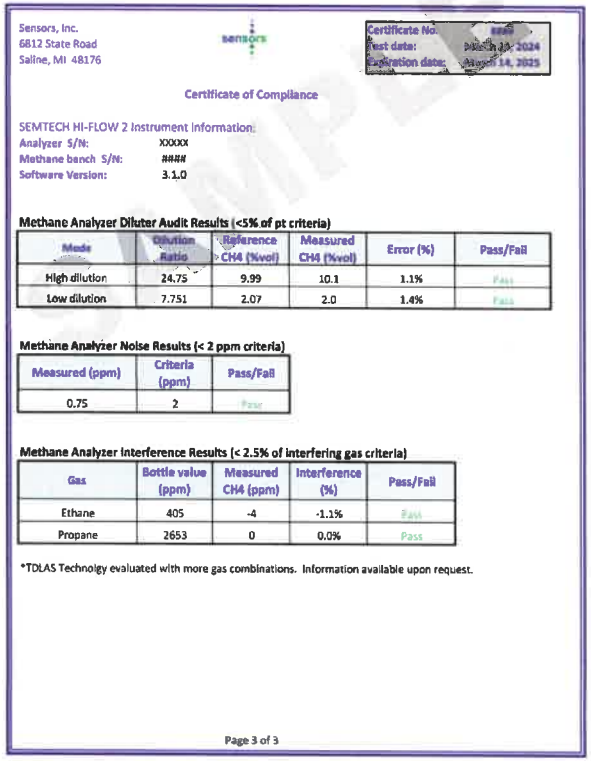
Methane Analyzer Linearity Results

Statistic	Result	Criteria	Pass/Fail
Intercept	-0.013%	+/- 1% max	Pass
Slope	0.996	0.975-1.025	Pass
SEE	0.233%	+/- 1% max	Pass
R^2	1.000	≥ 0.998	Pass

Methane Analyzer Accuracy Results (criteria <2.5% of pt or <3 p

Reference (ppm)	Measured (ppm)	Error (ppm)	Error (% of ref)	Pass/Fail
0.0	0.6	0.6		
160.5	160.7	0.2	0.1%	Pass
401.2	392.9	-8.3	-2.1%	Pass
641.8	631.8	-10.0	-1.6%	Pass
802.2	795.7	-6.5	-0.8%	Pass
8123.7	8125.0	1.3	0.0%	Pass
20194.1	20100.0	-94.1	-0.5%	Pass
32128.3	31800.0	-328.3	-1.0%	Pass
40010.0	39990.0	-20.0	0.0%	Pass

Page 2 of 3



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Saline, MI 48176

Certificate No.	#####
Test date:	March 14, 2024
Expiration date:	March 14, 2025

Certificate of Compliance

SEMTECH HI-FLOW 2 Instrument information:

Analyzer S/N:	XXXXX
Methane bench S/N:	####
Software Version:	3.1.0

Methane Analyzer Diluter Audit Results (<5% of pt criteria)

Mode	Dilution Ratio	Reference CH4 (%vol)	Measured CH4 (%vol)	Error (%)	Pass/Fail
High dilution	24.75	9.99	10.1	1.1%	Pass
Low dilution	7.751	2.07	2.0	1.4%	Pass

Methane Analyzer Noise Results (< 2 ppm criteria)

Measured (ppm)	Criteria (ppm)	Pass/Fail
0.75	2	Pass

Methane Analyzer Interference Results (< 2.5% of interfering gas criteria)

Gas	Bottle value (ppm)	Measured CH4 (ppm)	Interference (%)	Pass/Fail
Ethane	405	-4	-1.1%	Pass
Propane	2653	0	0.0%	Pass

*TDLAS Technolgy evaluated with more gas combinations. Information available upon request.

Page 3 of 3

Sensors, Inc.
6812 State Road
Saline, MI 48176

Certificate No.	#####
Test date:	March 14, 2024
Expiration date:	March 14, 2025

SEMTECH HI-FLOW 2 CERTIFICATE OF COMPLIANCE

This document certifies that the SEMTECH HI-FLOW 2 flow module listed beow meets the compliance specifications of 40 CFR Part 60 subpart 0000b for high-volume samplers. All reference equipment are traceable to the National Institute of Standards (NIST). The device listed herein is in compliance with the regulatory requirements and manufacturerers recommendations from the issue date of this document to the indicated date for each verfication (exceptions - see note).

SEMTECH HI-FLOW 2 Instrument information:
Hand-held S/N: #####

Description	Test date	Due date	Pass/Fail
Flowmeter linearity and accuracy	14-Mar-24	Initial installation or every 12 months	Pass
Temperature accuracy	14-Mar-24	initial installation or every 12 months	Pass
Pressure accuracy	14-Mar-24	initial installation or every 12 months	Pass

*All validation tests are required after major maintenance

Equipment Traceability

Model	S/N	Calibration Date	Calibration Due	Certificate #
EFM-CAL2	109-SF01	31-Jan-24	1-May-24	9983
Meriam Instruments Z50MC2-2	1206000062	30-Jan-24	30-Jan-25	24SENI-0005
477AV-6-NIST	DPM-014	6-Jun-23	6-Jun-24	0629BL
THM-022	B56349	7-Dec-23	7-Dec-24	23314498

Technician:_____ Date:_____

Q.A.:_____ Date:_____

Sensors, Inc.
6812 State Road
Saline, MI 48176

Certificate No.	#####
Test date:	March 14, 2024
Expiration date:	March 14, 2025

Certificate of Compliance

SEMTECH HI-FLOW 2 Instrument information:
Hand-held S/N: #####

HI-FLOW 2 Flowmeter Linearity Results

Statistic	Result	Criteria	Pass/Fail
Intercept	-0.208%	+/- 1% max	Pass
Slope	1.003	0.975-1.025	Pass
SEE	0.273%	+/- 1% max	Pass
R^2	1.000	≥ 0.998	Pass

HI-FLOW 2 Flowmeter Accuracy Results (<2.5% of pt criteria)

Reference Flow (SLPM)	Measured Flow (SLPM)	Error (SLPM)	Error (%)	Pass/Fail
0	0.0	0		
352	350.7	-1	-0.27%	Pass
499	496.7	-2	-0.47%	Pass
671	666.6	-4	-0.60%	Pass
850	850.2	1	0.06%	Pass
1043	1047.0	4	0.40%	Pass

HI-FLOW 2 Flowmeter Temperature Accuracy Results (<2% of pt criteria)

Reference Temp (deg C)	Measured Temp (deg C)	Error (%)	Pass/Fail
28.00	25.80	-0.73%	Pass

HI-FLOW 2 Flowmeter Pressure Accuracy Results (<2% of pt criteria)

Reference Press (mbar)	Measured Press (mbar)	Error (%)	Pass/Fail
107.97	108.01	0.03%	Pass

REFERENCES

[1] https://www.epa.gov/controlling-air-pollution-oil-and-natural-gas-operations/epas-final-rule-oil-and-natural-gas

[2] J.I. Connolly, R.A. Robinson, T.D. Gardiner, Assessment of the Bacharach Hi Flow® Sampler characteristics and potential failure modes when measuring methane emissions, Measurement, Volume 145,2019.

[3] introduced in 1984 with Directive 84/360/EEC and applied to air pollution emissions from large industrial installations.

[4] https://energy.colostate.edu/wp-content/uploads/sites/28/2022/08/FACF_High_Flow_Final_Report_ada.pdf

[5] BATNEEC: Best Available Technology Not Entailing Excessive Costs

SEMTECH

HI-FLOW 2

NSPS Subpart OOOOb is here.

sensors

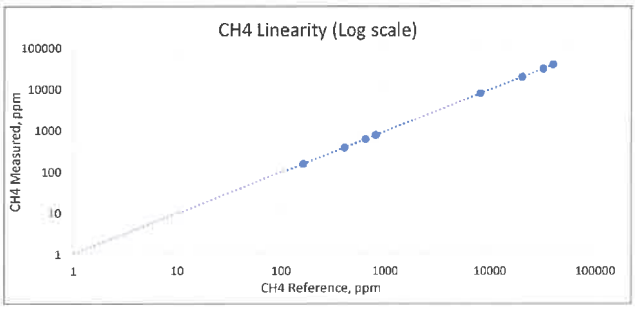
Are you ready to meet the demands of fugitive methane quantification?

Be sure you (& your high flow sampler) are OOOOb ready (& compliant)!

SEMTECH HI-FLOW 2 meets these demands.

White Paper available upon request.

OOOOb demands[1]:	SEMTECH HI-FLOW 2 delivers:
Training	
"The fugitive emissions monitoring plan" and "the records of each monitoring survey" requires "training, and experience of the operator(s) performing the survey"	Complete training offered through HI-FLOW 2 distributors' experienced personnel.
Measures Large and Small Leaks with Confidence	
"The flow measurement sensor must have a measurement range over the entire expected range of flow rates sampled." "The methane sensor(s) must have a measurement range over the entire expected range of concentrations."	The HI-FLOW 2 provides direct quantification of leaks over very large dynamic range (0.0005 to 25 CFM). Best in class.
Keeping your HI-FLOW 2 in Compliance	
"You must collect at least three separate one-minute measurements and determine the average leak rate." "Prior to and at the end of each testing day, challenge each sensor at two points, a low point, and a mid-point, using methane gaseous calibration cylinder standards." "At each point, the difference between the cylinder value and the sensor reading must be less 5 percent of the respective calibration gas value. If the post-test calibration check fails at either point, invalidate the data from all tests performed subsequent to the last passing calibration check."	The HI-FLOW 2 web-based software generates OOOOb-compliant reports. The HI-FLOW 2 field test campaigns have demonstrated easy compliance to the OOOOb 10% requirement. The HI-FLOW 2 has a 100% margin (2.5% manufacturer's criteria) compared to 5% OOOOb. Internal software utilities for user linearity performance validation/compliance. ONLY two reference gas bottles required to meet the OOOOb 2 points per gas sensor requirement.
Annual Integrity Requirements	
"Flow measurement sensors … must be calibrated on an annual basis." "Initially and on a semi-annual basis, determine the linearity at four points through the measurement range for each methane sensor using methane gaseous calibration cylinder standards."	The HI-FLOW 2 flowmeter is calibrated initally and annually, as shown in Sensors' calibration certificates.



Methane Analyzer Linearity Results

Statistic	Result	Criteria	Pass/Fail
Intercept	-0.013%	+/- 1% max	Pass
Slope	0.996	0.975-1.025	Pass
SEE	0.233%	+/- 1% max	Pass
R^2	1.000	≥ 0.998	Pass

Methane sensors are calibrated initally and annually for linearity and accuracy to 2.5% and then checked six months later to 5% criteria.

Description	Test date	Due date	Pass/Fail
Methane sensor Linearity and accuracy (2.5% criteria)	14-Mar-24	initial installation or every 12 months**	Pass
Methane Sensor span and dilution calibration	14-Mar-24	initial installation*	Pass
Methane sensor noise	14-Mar-24	initial installation or every 12 months	Pass
Methane sensor interferences	14-Mar-24	initial installation*	Pass

* All validation tests are required after major maintenance

Design Requirements

"The methane sensor(s) must be selective to methane with minimal interference, less than 2.5 percent for the sum of responses to other compounds in the gas matrix. You must document the minimal interference though empirical testing or through data provided by the manufacturer of the sensor."

The HI-FLOW 2 meets NIST traceable certification to <2.5%.

Methane Analyzer Interference Results (< 2.5% of interfering gas criteria)

Gas	Bottle value (ppm)	Measured CH4 (ppm)	Interference (%)	Pass/Fail
Ethane	405	-4	-1.1%	Pass
Propane	2653	0	0.0%	Pass

[1] ENVIRONMENTAL PROTECTION AGENCY 40 CFR Part 60 [EPA–HQ–OAR–2021–0317; FRL–8510–01– OAR] RIN 2060–AV16 Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review
Federal Register / Vol. 89, No. 47 / Friday, March 8, 2024 / Rules and Regulations
https://www.govinfo.gov/content/pkg/FR-2024-03-08/pdf/2024-00366.pdf

HI-FLOW 2 is a robust, portable, battery powered, high volume sampler for the accurate quantification of fugitive methane emissions.

The combination of the Analyzer and the Sampler (with a variety of sampling adapters) allows the entire fugitive methane emission to be captured, diluted, and quantified accurately.

By utilizing Tunable Diode Laser Absorption Spectroscopy (TDLAS) combined with an innovative sampling system, accurate concentration measurements of fugitive methane over 4 to 5 orders of magnitude can be performed without any cross-interference from other gases present in the captured leak.

Analyzer - Portable control module (which can be carried, placed on the floor, or mounted to a backpack) housing the gas sensor technologies, control electronics, and battery pack.

Sampler - Handheld device with a high-volume vacuum sampling fan and total flow rate monitor

For over 50 years, Sensors, Inc. has built a reputation for gas and particulate measurement products under the SEMTECH brand in the automotive industry. Sensors' fugitive methane analyzer brings to bear our emission measurement experience into the oil and gas industry with a focus on leak detection and repair (LDAR).

SPECIFICATIONS	
Total Flow Rate*	5-30 CFM (upper limit dependent on accessories)
Measurable Leak Rate*	0.0005 to 25 CFM (0.015 to 700 lpm)
Leak Rate Accuracy	<5% of full scale or 15% of point, whichever is lower
Dimensions (W x D x H) Electronics and Gas Module	12 x 12 x 5.7 in. (30 x 30 x 14.5 cm)
Dimensions (W x D x H) Handheld Unit w/o extension	26.3 x 7.5 x 10.5 in. (66.8 x 19 x 12.7 cm)
Weight (Electronic and Gas Module)^	17.5 lbs. (7.9 Kg)
Weight (Handheld Unit)	10.8 lbs (4.9 Kg)
Data transmission	Wi-Fi

*Inlet restrictions on the handheld sampling unit will reduce the maximum achievable flow.

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PH: +49 (0) 2104-14188-0, Email: sales@sensors-europe.eu

REV 06-04-24

APPENDIX C

SAMPLE SITE REPORT

CRFP 0313-DEP2500000001
METHANE EMISSION QUANTIFICTION

Site Report – Orphan Well Methane Monitoring

1 Site Information

Site Name:	Orphan Well 1-23	**Prior Owner:**	Defunct Operator
API Number:	XX-XXX-XXXXX-00-00	**State Permit Number:**	XXXXX
Site Type:	Oil Well	**Location (Lat/Long):**	41.82XXXX/-85.94XXXX
Well Plugging Status:	Not Plugged	**Quadrants:**	NE-NE-SW
Date of Survey:	12-Jul-2024	**Administrative Unit:**	Gov't Unit 1
Measurement Specialist:	Logan LaCross	**Time:**	08:33
Technician:	Gabriel Mata		

2 Atmospheric Conditions

Air Temperature:	67	**Barometric Pressure:**	30.07
Wind Direction:	SE	**Wind Speed:**	3
Recent Precipitation Date:	10-Jul-2024	**Precipitation amount:**	0
Known H2S PPM:	0		

3 Background

Instrument #1:	SEMTECH HI-FLOW 2	**Serial Number:**	F23547694
Calibration Date:	12-Jul-2024	**Instrument Type:**	High Volume Methane
Instrument #2:	RMLD-CS	**Serial Number:**	8212323002
Calibration Date:	12-Jul-2024	**Instrument Type:**	Remote Methane Detector
Instrument #3:	MultiRAE	**Serial Number:**	14418
Calibration Date:	12-Jul-2024	**Instrument Type:**	5-gas

Nearby Natural Methane Sources:
None

Background Readings:

Location	Methane (ppm)	VOC (ppm)	Instrument:
Field outside well pad	0	0	HF2/5-gas

4 Emissions

Location	Methane (ppm)	VOC (ppm)	Leak Rate (g/hr)	Instrument:
Wellhead	71.95	49	2.57	HF2/5-gas
Total of All Leaks:			2.57	

QA/QC Duplicates

Location	Methane (ppm)	VOC (ppm)	Leak Rate (g/hr)	Instrument:
Wellhead	78.64	51	2.57	HF2/5-gas

5 Photos

Photo: 1

North

Photo: 2

South

Photo: 3

East

Photo: 4

West

Photo: 5

Wellhead Leak Location

6 Comments

Type	Comment
General	Observations high concentrations, site access issues, observed leakage, odors, offsite gas migration, remediation concerns, etc.