Assessment of the Viability and Functionality of Landfill Gas Wellfield Flow and Gas Composition Automated Remote Monitoring System

Chiquita Canyon Landfill
Castaic, California
SCAQMD Facility No. 119219

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INTRODUCTION

Chiquita Canyon, LLC (Chiquita) operates an inactive municipal solid waste (MSW) landfill/solid waste disposal facility located in Castaic, California, under South Coast Air Quality Management District (South Coast AQMD) Facility No. 119219. The Reaction Committee prepared this report assessing the viability and functionality of five (5) pilot Landfill Gas Wellfield Flow and Gas Composition Automated Remote Monitoring Systems installed in accordance with Condition No. 75(f) of the Modified Stipulated Order of Abatement (Modified SOFA) (Case No. 6177-4) pertaining to the Chiquita Canyon Landfill (CCL, Facility, or Landfill) and the *Proposal to Assess the Viability and Functionality of Landfill Gas Wellfield Flow and Gas Composition Automated Remote Monitoring System* (Test Protocol) submitted to South Coast AQMD on August 29, 2025, and revised on September 19, 2025, in response to comments received from South Coast AQMD on September 9, 2025.

This report presents the assessment of the viability and functionality, as well as feasibility, of the selected instrumentation, equipment, telemetry equipment, and control components pilot tested for a remote monitoring system (RMS) for the automated remote measurement of landfill gas (LFG) flowrate and composition (methane, carbon dioxide, and oxygen) installed at five select LFG extraction wells from among the subset of wells identified in Condition No. 75 (b) through (c).

Condition No. 75(f) of the Modified SOFA requires:

> *By August 29, 2025, the Reaction Committee shall submit a proposal to assess the viability and functionality of adding gas flow rate and composition as monitoring parameters to at least five (5) units on the wells listed in this condition. The Proposal shall be submitted to Baitong Chen [bchen@aqmd.gov]; Nathaniel Dickel [ndickel@aqmd.gov]; Christina Ojeda [cojeda@aqmd.gov]. Respondent shall conduct the feasibility assessment. The Reaction Committee shall submit a final report to the South Coast AQMD (to Baitong Chen [bchen@aqmd.gov]; Nathaniel Dickel [ndickel@aqmd.gov]; Christina Ojeda [cojeda@aqmd.gov]) detailing the results of the feasibility study, and recommendations on further deployment of the remote monitoring system not later than 210 days from submittal of the feasibility proposal with a minimum of 3 months of data collection.*

Previous documentation prepared in accordance with Condition Nos. 66 and 75 of the Modified SOFA that address automated RMS equipment for LFG wells and wellheads, and which serve as references to this report and provide background information on the anticipated viability, functionality, and feasibility, of certain components, include the following:

- **LFG Wellfield Automated Remote Monitoring Plan, prepared by SCS Engineers, dated 4/19/24.** This Plan was prepared in accordance with a prior version of SOFA Condition 66 and identified the applicable operational parameters of LFG extraction wells and wellheads, outlined the purpose and objectives for the remote monitoring of these operational parameters, discussed specific monitoring instrumentation and equipment, and presented the Reaction Committee's recommendations for implementation of a remote monitoring system at the Landfill.

- **Response to South Coast Air Quality Management Stipulated Order for Abatement in Case No. 6177-4 Condition 66(a)(ii), prepared by SCS Engineers, dated 9/17/24.** This response outlined the anticipated issues and concerns associated with the design, specification, installation, and implementation of remote monitoring of the LFG wellfield and identified the six primary system components being considered. The response included evidence of communication with system, device, and component vendors/manufacturers and/or contractors, and also commented on supply chain and lead times.

- **Response to South Coast Air Quality Management Stipulated Order for Abatement in Case No. 6177-4 Condition 66(a)(iii), prepared by SCS Engineers, dated 10/11/24.** This response provided documentation of continued communications with vendors, manufacturers, and distributors of the RMS systems, devices, and components that had identified issues/concerns as described in the September 17, 2024 response discussed above.

- **Landfill Gas Well Selection for Installation of Remote Monitoring System Equipment, prepared by the Reaction Committee, dated 10/15/24.** This correspondence presented the Reaction Committee's determination on the locations for installation of the initial RMS equipment, which involved twenty (20) LFG wells to be equipped with temperature measurement instrumentation and associated telemetry equipment, in accordance with Condition 66(a)(v). This determination included a review of background information and a discussion of the criteria and field conditions that were considered by the Reaction Committee in selecting these locations.

- **Response to South Coast Air Quality Management Stipulated Order for Abatement in Case No. 6177-4 Condition 66(a)(iv), prepared by SCS Engineers, dated 10/30/24.** This correspondence noted no additional findings or solutions concerning the issues documented in the Condition 66(a)(ii) and (iii) submittals or prior submittals with respect to the original design of the remote monitoring system.

- **Proposal to Assess the Viability and Functionality of Landfill Gas Wellfield Flow and Gas Composition Automated Remote Monitoring System, prepared by the Reaction Committee, dated 1/31/25.** This Proposal presented the proposed Work Plan to conduct a field test, in accordance with Condition No. 66(vi), to assess the viability and functionality, as well as feasibility, of certain instrumentation, equipment, telemetry, and control components that may be suitable for an RMS for the automated remote measurement of temperature and pressure within LFG extraction wells with pumps located within the Reaction Area. The Proposal has not been approved by South Coast AQMD. Thus, the feasibility assessment outlined in that Proposal has not been conducted.

- **Proposal to Assess the Viability and Functionality of Landfill Gas Wellfield Flow and Gas Composition Automated Remote Monitoring System, prepared by the Reaction Committee, originally dated 8/29/2025 and revised on 9/19/2025.** This Proposal presented the proposed Test Protocol to conduct a feasibility assessment of the viability and functionality, as well as feasibility, of certain instrumentation, equipment, telemetry, and control components that may be suitable for a RMS for the automated remote measurement of landfill gas (LFG) flowrate and composition (methane, carbon dioxide, and oxygen) within five select LFG extraction wells from among the subset of wells identified in Condition No. 75 (b) through (c). This Proposal was modified and resubmitted on September 19, 2025, to address comments from South Coast AQMD received on September 9, 2025.

PILOT FEASIBILITY STUDY ASSESSING RMS FLOW AND GAS COMPOSITION INSTRUMENTATION, EQUIPMENT, AND CONTROLS

The Reaction Committee proposed to assess RMS flowrate and gas composition instrumentation through this pilot feasibility study, which involved procurement and installation of the referenced RMS instrumentation, equipment, and controls, and other components. The LFG flowrate and composition instrumentation was procured and installed at Wells CV-24066, CV-24076, CV-24088, CV-24126, and CV-24151, which are five (5) of the 19 wells identified in SOFA Condition No. 75(c). The data compiled during November 2025 through March 2026 was reviewed and analyzed as outlined in the Test Protocol to assess the viability, functionality, and performance as well as an assessment of the potential for future implementation of these components.

As described in the Test Protocol, the objectives of this pilot feasibility study were to:

- Assess the technical feasibility of installation of RMS components that enable measurement of LFG flowrate and composition into wellheads;
- Evaluate the viability, functionality, performance, and reliability of RMS instrumentation and equipment affiliated with LFG flowrate and composition under varying operational conditions;
- Assess and validate measurements and monitoring data received from RMS instrumentation;
- Identify potential criteria for selection of future well locations to be equipped with RMS components, if applicable, and
- Assess operational protocols for RMS components to be implemented beyond this pilot feasibility study.

ASSESS TECHNICAL FEASIBILITY OF INSTALLATION AND FUNCTIONALITY OF RMS FLOW AND GAS COMPOSITION INSTRUMENTS AND EQUIPMENT

The following components were selected and installed for this feasibility study based on the criteria previously outlined in the Reaction Committee's *Proposal to Assess the Viability and Functionality of Landfill Gas Wellfield Flow and Gas Composition Automated Remote Monitoring System*, submitted to the South Coast AQMD on August 29, 2025, and revised on September 19, 2025. The flow and gas composition components were incorporated into a fabricated stainless steel pilot system assembly as shown in Appendix C and Appendix E.

Component 1 - Flowrate Measurement

A delta-pressure flow element and associated differential pressure transmitter were utilized to measure and calculate flow rate. The device measures the differential pressure across a v-cone shaped flow element to yield a velocity value that is used, along with the cross-sectional area of the pipe, to calculate the flowrate. The v-cone flow element was selected as it provides an unrestricted annular space between the flow element and the pipe wall to all liquids to freely drain while providing the necessary pressure drop to measure flow.

- Differential pressure flow measurements – Dwyer 3100D
  - Differential pressure transmitter
  - Block and bleed transmitter manifold
  - Differential pressure flow element – McCrometer V-Cone
  - Process temperature rating = -40 to 257 degrees Fahrenheit

The flow elements were incorporated into a fabricated pilot system assembly that was mounted directly to existing flanges on the steel-cased well risers. The flow device is a wafer style mounted between flanges and was placed in a section that maintained their specified minimum upstream (3 pipe diameters) and downstream (1 pipe diameter) offset requirements. The pressure transmitter was mounted on the upper sampling portion of the assembly with stainless steel tubing connected to the flow element. The tubing was installed with positive drainage back to the flow element to prevent accumulation of moisture that could impact the delta-pressure measurement.

No issues were encountered with the installation of these flow measurement components. As discussed in later sections of this Report, the flow measurement components positioned in the five pilot wells have functioned reasonably well over the duration of this pilot feasibility study period.

Component 2 - Gas Composition Measurement

The gas composition measurement devices are comprised of two separate systems: one to measure methane and carbon dioxide using a nondispersive infrared (NDIR) sensor, and a second to measure oxygen using a tunable diode laser (TDL) sensor. Although the test protocol contemplated the use of either TDL or NDIR technology to measure methane and carbon dioxide, NDIR sensors were ultimately selected because they are employed within the field instrumentation (specifically the GEM and Elkins units) that have been utilized for LFG wellhead monitoring by the landfill gas industry for decades.

Methane and Carbon Dioxide:

- Multi-gas analyzers – Vaisala MGP261
  - CH_4: 0-100% by volume
  - CO_2: 0-100% by volume
  - Moisture: 1-100% RH
  - In-situ measurement
  - Nondispersive infrared (NDIR) sensor
  - 4-20 mA and Modbus RTU output
  - External pressure transmitter input
  - Rated C1D1, Group D for hazardous environment
  - Process temperature rating = -40 to 140 degrees Fahrenheit

Oxygen:

- Oxygen sensors – Endress + Hauser TRANSIC121LP
  - O_2: 0-25% by volume

- In-situ measurement
- Open-path tunable diode laser (TDL)
- 4-20 mA output
- Rated C1D1, Group D for hazardous environment
- Process temperature rating = -4 to 176 degrees Fahrenheit

The CH4/CO2 and O2 sensors were installed in the pilot system assembly on a parallel sample train, as shown in Appendix E, to minimize the impact of liquids and higher temperatures on these sensors. Mounting the O2 sensor to the sample train assembly proved to be more difficult than expected as the sensor has a custom flange that does not easily adapt to a standard pipe flange. The connection that was configured in the field to this custom flange supplied by the sensor manufacturer has resulted in air intrusion issues. For any future installation of these sensors, a custom fabricated stainless steel flange will need to be manufactured by ISCO or another pipe supplier to adequately seal these devices and restrict air intrusion. During the pilot feasibility study, alternative gaskets, o-rings, and mounting hardware were procured and installed to seek to improve the integrity of this connection and reduce the potential for air intrusion.

Both the CH4/C02 and O2 sensors have experienced periodic disruptions in functionality during the pilot study and continue to demonstrate poor reliability. There have been detrimental impacts from the LFG conditions the sensors were exposed to, impacts from the mechanical connections, and internal sensor errors that have affected their ability to provide reliable measurements. This is detailed in the later sections of this Report.

Components 3 & 4 - Industrial IIoT Device and Remote Input Cards

The cellular IIoT device and remote input card are utilized to collect data from the transmitters and send it back to the SCSRMC.com cloud-based Supervisory Control and Data Acquisition platform. The data is stored and automatically uploaded once every hour. If the data cannot be transferred at that time, it is stored locally on the cellular IIoT device. Once the connection between the IIoT device and the server is restored, the stored data will be automatically uploaded. The cellular IIoT device and remote input card utilized for the pilot study are the same devices that have been successfully utilized on previous devices at CCL and multiple other landfill sites.

- IIoT Device – Signal-Fire Ranger
  - Cellular M2M connectivity
  - Onboard inputs/outputs
  - Modbus RTU communications
  - Battery/line/solar powered options

- Remote Input Card – Horner Smartmod
  - Onboard analog inputs
  - Modbus RTU communications

These devices are incorporated into a remote monitoring panel that is mounted on the solar power system adjacent to the gas wells and pilot assemblies as shown in Appendix E. Sensors on the pilot assembly were wired back to the enclosure to send signals and data to the Ranger for transmission.

No issues were encountered with the installation of these IIoT and remote input card components. These devices functioned well over the pilot feasibility study period with the exception of Pilot 3. The Pilot 3 IIoT device failed on March 13, 2026, and would not power up. A replacement device was ordered and will be installed once received to bring this system back online.

Component 5 - Solar Power System

SCS has designed the solar power systems for this project to provide power to the sensors and the cellular IIoT devices at each location. The system is designed to operate for approximately seven (7) days without solar energy. Each system contains a 100 Ah field-replaceable battery. The solar power systems for this project to provide power to the sensors and the cellular IIoT devices at the five well locations have demonstrated the capability to offer reliable and consistent electrical power at CCL (and other landfills).

The solar powered systems are shown in Appendix E. They were designed for easy deployment and wiring by field personnel, and no installation issues were encountered during deployment. The systems have performed well during the pilot feasibility study and did not experience any outages or loss of power events.

ASSESSMENT OF PERFORMANCE, VIABILITY, AND RELIABILITY OF INSTRUMENTS UNDER VARYING REACTION AREA CONDITIONS

The reference documents identified in the Introduction Section of this Report raised issues and concerns associated with the viability, functionality, and feasibility of installation and operation of the RMS instrumentation, equipment, and controls at the Landfill. The insertion of Component 1 flowrate devices into the wellheads, as well as the conveyance of gas stream across the Component 2 gas composition sensors, presented potential short- and long-term risks, including but not limited to potential malfunctioning and/or failure attributable to the various conditions within the wells and wellheads and disturbances associated with well maintenance.

This pilot feasibility study attempted to evaluate the impacts of adverse conditions experienced at the five pilot wells on the instrumentation installed as part of this assessment where possible. Correlations and causation of performance failures that were directly attributed to adverse conditions (such as heat, moisture, solids formation, chemical incompatibility, etc.) were difficult to identify due to the high percentage of errors that were experienced by the Component 2 gas composition sensors during the pilot feasibility study. The following discussion presents an assessment of the impacts of the elevated temperatures, fouling and debris build-up, liquids, and chemical compatibility on the instrumentation.

Component 1 - Flowrate Measurement

The flow meter was installed in the primary 2-inch pipe segment of the pilot assembly and was directly exposed to the LFG (referred to as the “process stream”). The flow meter components including the outer flow tube and the internal v-cone were selected to be 316 stainless steel for resilient performance under these conditions. The v-cone size was selected to provide a large annular space and provide a flow measurement range from 10 to 90 scfm. This flow measurement method does have a turndown limitation of 10:1; therefore, elements can be sized based on individual flow requirements at a given well if a different range is needed.

Once installed within the pilot system assembly, these components are difficult to access for periodic inspection or cleaning because they are structural to the entire assembly and require supporting the parts and disassembling the pilot assembly to remove. For this reason, the well that exhibited the most frequent and extensive gas sensor fouling out of the five pilot wells was identified and the flow element was removed to inspect and assess. This was determined to be Pilot 2 (Well CV-24076) based on an inspection of the gas sensors. Well CV-24076 has been incorporated into the data-driven reaction area boundary (refer to "Monthly Reaction Committee Determination on Reaction Area Boundary", dated 2/10/26) and, thus, is characterized as an elevated temperature well.

- Potential for Elevated Temperatures:

  Pilot 1 (CV-24126) – temperatures ranged from 135 to 188 degrees F

  Pilot 2 (CV-24076) – temperatures ranged from 155 to 181 degrees F

  Pilot 3 (CV-24151) – temperatures ranged from 110 to 119 degrees F

  Pilot 4 (CV-24088) – temperatures ranged from 108 to 125 degrees F

  Pilot 5 (CV-24066) – temperatures ranged from 118 to 129 degrees F

  The ranges of temperatures observed at the five pilot wellheads presented above were recorded during the pilot study period (November 2025 through March 2026) and were less than the maximum rating for these devices.

- Fouling and Debris Build-up:

  As noted above, only the flow element for Pilot 2 was removed for inspection and evaluation. Photos of the removed meter showing the flow tube and mounted v-cone element are shown in Appendix D. There was a notable thin black dry residue coating the internal surfaces. There was no significant thickness to the residue, and the annular space was not obstructed by it.

  Overall, the flow meter appeared to perform as intended in this environment, for this limited time period. The larger unrestricted annular space between the flow tube and element minimized fouling and build up. The residue coating that was observed will likely increase in thickness over time and will likely require routine scheduled maintenance.

- Liquids:

  As noted above, only the flow element for Pilot 2 was removed for inspection and evaluation. There was a very small section on the back side of the flow element that appeared to be liquid combining with the black residue observed that thickened into a resin as shown in photographs presented in Appendix D. This small patch of resin observed during this limited time period did not appear to restrict the annular space in the flow meter and likely had a negligible effect on flow measurements.

- Chemical Compatibility:

  As noted above, only the flow element for Pilot 2 was removed for inspection and evaluation. There did not appear to be any adverse effects related to chemical compatible in the form of pitting, corrosion, or deterioration of the internal 316 stainless steel surfaces, during this time period.

Overall, the flow meters performed appropriately over the duration of the pilot study period and have provided consistent measurements that the Reaction Committee believes to be accurate. These instruments have not required excessive cleaning or abnormally frequent routine maintenance to maintain functionality for the duration of this study period, which is advantageous since they are laborious and difficult to remove from the pilot system assembly.

Component 2 - Gas Composition Measurement

As stated above, correlations and causation of performance failures experienced by the Component 2 gas composition sensors that were directly attributed to adverse conditions were difficult to identify due to the frequent occurrence and extended duration of errors noted during the pilot feasibility study.

The CH_4/CO_2 and O_2 sensors were located in a parallel sample train as shown in Appendix E to minimize the impact of liquids and higher temperatures on these sensors.

- Elevated Temperatures:

  Temperatures shown above were measured in the top on the well casing and may not represent temperatures to which the sensors positioned within the pilot system assembly were exposed. The maximum temperature ratings of the CH_4/CO_2 and O_2 sensors are 140 degrees F and 176 degrees F, respectively.

  Pilot 1 and Pilot 2 had a potential to be exposed to temperatures above the temperature ratings for both sensor devices while the remaining pilots were well below the ratings. Maintenance pictures for the gas composition sensor probes are included in Appendix D. Pilot 1 did not appear to show any negative physical effects from elevated temperatures. Pilot 2 did have significant dark staining on the PTFE filters and on the stainless steel surfaces. It is difficult to conclude whether the dark discoloration was attributable to elevated temperatures or chemical compatibility.

  The impact of elevated temperatures on the RMS data collected cannot be determined at this time due to the high percentage of sensor diagnostic errors that were observed during testing. However, it is reasonable to expect that sensor performance, reliability, and accuracy could potentially be diminished by exposure to elevated temperatures for extended periods of time.

- Fouling and Debris Build-up:

  Maintenance photos taken during the pilot study period are provided in Appendix D for each of the gas composition sensors located at the pilot wells.

  Pilot 1 (CV-24126):
  - CH_4/CO_2 Sensor – minimal impact from fouling or debris

  - O_2 Sensor – minimal impact from fouling or debris

Pilot 2 (CV-24076):

- CH4/CO2 Sensor – showed significant discoloring that stained the stainless steel housing and PTFE filter; optic was discolored

- O2 Sensor – showed significant discoloring that stained the stainless steel filter and PTFE filter; solids were observed on the stainless filter as well; optic was discolored

Pilot 3 (CV-24151):

- CH4/CO2 Sensor – please note that the PTFE filter was not installed on this sensor while in operation, there was some minor debris on the sensor tip noted around the optic, optic was slightly discolored

- O2 Sensor – no debris or scaling observed on the PTFE filter; no scaling was observed on the stainless filter; optic was not discolored

Pilot 4 (CV-24088):

- CH4/CO2 Sensor – the PTFE filter had a significant white/yellow scaling on inside and outside of the filter element; some discoloration and film noted on the optic

- O2 Sensor – the PTFE filter had yellow scaling on the outside of the filter element with some slight black discoloration; slight black discoloration noted on the stainless filter and sensor housing, some discoloration on the optic

Pilot 5 (CV-24066):

- CH4/CO2 Sensor – the PTFE filter had a significant white scaling on the outside of the filter element; no debris or scaling noted on the stainless housing;

- O2 Sensor – the PTFE filter had a significant white scaling on the outside of the filter element; no debris or scaling noted on the stainless housing; optic had some particulate noted

Overall, the parallel sampling assembly appeared to limit the exposure of the sensors to suspended solids that may have been in the process streams. There was some scaling noted on several PTFE filters, and a significant accumulation of solids on Pilot 2. It is reasonable to expect that Pilot 2 sensor performance, reliability, and accuracy could potentially be diminished by the extent of scaling and fouling that occurred during the pilot feasibility study.

- Liquids:

Pilot 1 (CV-24126):

- liquids were not observed on either sensor

Pilot 2 (CV-24076):

- liquids were not observed on either sensor

Pilot 3 (CV-24151):

- there was notable water drop stains on CH_4/CO_2 sensor housing; liquid droplets were observed on the inside of the O_2 PTFE filter, on the stainless filter, and on the optic

Pilot 4 (CV-24088):

- there were notable liquids on both the CH_4/CO_2 and O_2 sensor filters and optics; liquid was noted to be dripping from the O_2 mounting flange and the O_2 optic appeared to be partially submerged in liquid; the O_2 sensor mount was modified to help mitigate liquid accumulation on the sensor as a test The O_2 sensor appeared to function better following this modification as described in the data validation section below and shown in Appendix A.

Pilot 5 (CV-24066):

- liquids were not observed on either sensor

Notable liquids were identified at 2 of the 5 pilot wells. Elevated temperatures in Pilot 1 and Pilot 2 may have minimized the formation of condensation. Notable moisture was observed in Pilot 3 and Pilot 4. The impact of moisture on the RMS data collected cannot be determined at this time due to the high percentage of sensor diagnostic errors that were observed during testing. However, it is reasonable to expect that Pilot 3 and Pilot 4 sensor performance, reliability, and accuracy could potentially be diminished by exposure to high-moisture environments. Due to the sensitive nature of the instruments, any obstructions on the optics of the sensors could potentially impact measurement accuracy and reliability.

- Chemical Compatibility:

Pilot 1 (CV-24126):

- no notable impacts from chemical compatibility observed on the sensors

Pilot 2 (CV-24076):

- there was significant discoloring that stained the stainless housings and PTFE filters; there did not appear to be any pitting or degradation of these materials beyond the fouling and debris observed

Pilot 3 (CV-24151):

- no notable impacts from chemical compatibility observed on the sensors

Pilot 4 (CV-24088):

- no notable impacts from chemical compatibility observed on the sensors

Pilot 5 (CV-24066):

- no notable impacts from chemical compatibility observed on the sensors

The internal components of the sensors that were in contact with the process include Type 316 stainless steel, PTFE, and glass (optics and sensor covers). In general, there did not appear to be an impact on these materials from constituents in the landfill gas except for Pilot 2. It is difficult to determine if the noted impacts to Pilot 2 were associated with chemical compatibility, elevated temperatures, solids, or a combination of these factors.

VALIDATION OF DATA RECEIVED FROM RMS

Following the installation of the RMS pilot components, data was collected via cellular IIot devices at 1-hour intervals and made available for remote monitoring and data logging during the study. This data included measured operational parameters (gas composition, flow rate, process temperature, and process vacuum/pressure), sensor diagnostics, and component communications status. This data was then compared to manually gathered measurements obtained by portable field instrumentations at the pilot well locations to validate the RMS data collected.

The expectation when the study was initiated was to monitor these points weekly to validate the RMS data; however, due to the increasing number of diagnostic errors associated with this equipment, the focus transitioned to troubleshooting the gas composition components to address and improve functionality. A portable handheld gas analyzer, such as a GEM-5000, was used to collect data at each of the RMS pilot locations on a weekly (Pilots 1 and 2) or bi-weekly (Pilots 3-5) basis for the data validation efforts. The following sections include a data validation discussion and results of the gas composition and flow rate components.

Gas Composition Measurement

The gas composition data collected by the RMS was difficult to validate due to the frequent occurrence and extended duration of sensor errors that were observed during testing. Additionally, when error flags were not present, there was often a high degree of variance between the manual GEM measurements and the RMS sensor composition values. There were several instances when select RMS data without error designation correlated with the general timeframe of manual GEM measurements to provide some comparison; however, it was very limited and resulted in a very low percentage of comparable readings.

The 1-hour RMS data was initially filtered for measurement values with no error flags, and the filtered results were compared to the manual GEM readings. A summary of the flagged errors and remaining valid readings is provided in Figure 1.

Figure 1. Summary of Sensor Errors

Location	Comms Status	O2 Sensor Status	CH4 Sensor Status	CO2 Sensor Status	CH/CO2 Analzyer Status	No Errors from any Sensors
Pilot 1 (CV-24126)						
Total Measurements:	3429	3429	3429	3429	3429	3429
Reliable Measurements:	3425	3332	2656	2825	2740	2548
Percent Reliability:	100%	97%	77%	82%	80%	74%
Pilot 2 (CV-24076)						
Total Measurements:	3429	3429	3429	3429	3429	3429
Reliable Measurements:	3032	2254	535	534	493	447
Percent Reliability:	88%	66%	16%	16%	14%	13%
Pilot 3 (CV-24151)						
Total Measurements:	3177	3177	3177	3177	3177	3177

Reliable Measurements:	3167	1671	1645	1645	1670	737
Percent Reliability:	100%	53%	52%	52%	53%	23%
Pilot 4 (CV-24088)						
Total Measurements:	3429	3437	3437	3437	3437	3437
Reliable Measurements:	3260	2013	404	401	443	371
Percent Reliability:	95%	59%	12%	12%	13%	11%
Pilot 5 (CV-24066)						
Total Measurements:	3429	3438	3438	3438	3438	3438
Reliable Measurements:	3411	483	161	161	168	91
Percent Reliability:	99%	14%	5%	5%	5%	3%

Pilot 1 (CV-24126)

The data comparison for manual GEM versus automated RMS gas composition values is provided in Appendix A – Pilot 1 data.

- Oxygen – Pilot 1 did not have many O2 sensor errors; however, the recorded measurements exhibited values that were likely influenced by ambient air intrusion around the sensor flange during much of the study. There was an inverse relationship between O2 and measured well vacuum observed during two events, shown on Appendix B – Exhibit 1, where the well pressure went positive and the O2 value declined. This may be indicative of air intrusion on the sampling assembly, or a limited flow or restricted flow path to the sample assembly under vacuum conditions.

- Methane / Carbon Dioxide – Pilot 1 had the least amount of CH4/CO2 sensor errors compared to the other pilot wells. Similar to the O2 sensor, these sensors appeared to respond to one of the positive pressure events shown on Appendix B – Exhibit 1. There were errors on the CH4/CO2 sensors during the second noted positive pressure event, and the concentrations did not change.

Pilot 2 (CV-24076)

The data comparison for manual GEM versus automated RMS gas composition values is provided in Appendix A – Pilot 2 data.

- Oxygen – The O2 sensor on Pilot 2 recorded an error 33% of the time and exhibited elevated concentrations from 16 to 20% when no errors were present on the sensor. The GEM data consistently showed lower O2 concentration values from 0 to 3% over the same time periods. There were no positive pressure events observed during the test period to evaluate if the concentration changed under positive pressure conditions based on data shown in Appendix B – Exhibit 2. The O2 sensor did go into alarm around January 5, 2026, and the alarm cleared following servicing of the unit on March 19, 2026. The sensor went back into an error state on March 25, 2026, only six (6) days after being serviced. This sensor was observed to be severely impacted by the LFG with discoloration, solids buildup, and liquids present when inspected. This is an elevated temperature well.

- Methane / Carbon Dioxide – Pilot 2 had CH4/CO2 sensor errors 86% of the time during the study. The values recorded do not align with the manual GEM measurements. This sensor was also severely impacted by exposure to the LFG similar to the O2 sensor.

Pilot 3 (CV-24151)

The data comparison for manual GEM versus automated RMS gas composition values is provided in Appendix A – Pilot 3 data. Pilot 3 stopped recording measurements around March 13th when the cellular IIoT malfunctioned and would not power up.

- Oxygen – The O2 sensor on Pilot 3 recorded an error 47% of the time and had positive results following servicing of the sensor on January 20, 2026, as shown in Appendix B – Exhibit 3. The lower O2 values recorded after the unit was serviced were between 0.2 and 1.17% compared to the GEM readings that were all 0% (non-detect).

- Methane / Carbon Dioxide – Pilot 3 had CH4/CO2 sensor errors 47% of the time during the study. The sensor appeared to function correctly without errors and with reasonable concentrations during 5 of the comparison GEM readings between November 13, 2025 and January 6, 2026. On or about January 6, 2026, the sensor did not record a measured value (other than "0.0") and entered a "sensor failure" error state. While the sensor failure error was resolved after servicing on February 6, 2026, the sensor did not record a measured value (other than "0.0"), indicating that it remained non-functional. During the period of February 6 through March 13, 2026, the sensor intermittently triggered the sensor failure error state but continued to record the default measured concentration value of "0.0" for both constituents. On March 13, 2026, the IIoT device failed and the measured concentration value and error status were no longer recorded.

Pilot 4 (CV-24088)

The data comparison for manual GEM versus automated RMS gas composition values is provided in Appendix A – Pilot 4 data.

- Oxygen – The O2 sensor on Pilot 4 recorded an error 41% of the time and had positive results following servicing of the sensor on January 20, 2026, as shown in Appendix B – Exhibit 4. The lower O2 values recorded after the unit was serviced were between -0.13 and 0.16% compared to the GEM readings that were all 0% (non-detect) during the same period.

- Methane / Carbon Dioxide – Pilot 4 had CH4/CO2 sensor errors 87% of the time during the study and has not functioned correctly up until it was recently serviced in March. The unit has been reporting what appears to be reliable and accurate data without known errors since March 19, 2026.

Pilot 5 (CV-24066)

The data comparison for manual GEM versus automated RMS gas composition values is provided in Appendix A – Pilot 5 data.

- Oxygen – The O2 sensor on Pilot 5 recorded an error 86% of the time and has not shown improvement with sensor cleaning servicing.

- Methane / Carbon Dioxide – Pilot 5 recorded CH4/CO2 sensor errors 95% of the time during the study and has not functioned correctly up until it was recently serviced on March 25, 2026. The unit reported reasonable readings for only five (5) days and returned to an error state.

Flow Measurement

Flow measurement using differential pressure (DP) has been a successful method in landfill gas applications across the industry when instituted in suitable circumstances. DP measurements collected by the RMS system were used to calculate flow rates using the manufacturer's data curves for the selected v-cone elements. Recorded DP and calculated flow values have shown to be stable (meaning consistent and deemed reliable and generally accurate) during the testing period and do not appear to be adversely affected by condensation or liquids that may be present in the pilot system assembly. The V-cone element was selected for this reason to provide an unrestricted annular space around the flow element and pipe to allow liquids to pass through.

A demonstration test and comparison of flowrate values was conducted at the conclusion of the pilot feasibility study period between the DP transmitters and a handheld manometer that depicted little to no difference in the compared DP measurements. This suggests the DP transmitters were accurate and did not drift over the study period.

Figure 2. Manual DP Reading Comparison

Location	Date	Manometer Inlet (in. w.c.)	Manometer Outlet (in. w.c.)	Manometer Delta (in. w.c.)	DP Sensor (in. w.c.)	Manometer vs. DP (in. w.c.)
GP-1 (CV-24126)	3/24/2026	-9.6	-10	0.4	0.5	-0.1
GP-2 (CV-24076)	3/24/2026	-1.9	-7	5.1	5.2	-0.1
GP-3 (CV-24151)	3/24/2026	-3	-3.1	0.1	0	0.1
GP-4 (CV-24088)	3/24/2026	-1.8	-2.1	0.3	0.3	0
GP-5 (CV-24066)	3/24/2026	-1.7	-2.4	0.7	0.7	0

COMPONENT INSPECTION AND CLEANING

The gas composition components were inspected at various times during the study period to address issues. The following is a chronology of the issues and field support efforts related to component inspection and other errors detected.

11/7/25

- SCS contacted the Vaisala vendor to obtain a programming cable due to all the erroneous data being recorded.
- There was a communications issue with the sensors that required the vendor's software to address the issue.

11/13/25

- Pilot 4 analyzers were taken offline to evaluate O2 sensor issue.
- The O2 display showed E-31 error resulting in a high value of 26% O2 recorded in the electronic database platform.
- SCS contacted tech support and received instructions and purchased items to carefully clean the O2 optics.
- Sensor filter was observed to be saturated with condensate, and liquids were trapped under the sensor filter impacting the optics.

11/20/25

- Pilot 4 O2 sensor cleaned and returned to service, error cleared, and measurement was near zero.
- The error returned in less than 24 hours.

1/20/26

- Pilot 4 gaskets were replaced and the manifold was modified with 45-degree elbow to allow the O2 sensor to drain liquid away from the optics. This was only completed on Pilot 4 to assess the effectiveness before modifying the other locations.
- Pilot 4 O2 sensor error cleared and was functional for a longer period of time, approximately 1/21 to 3/18 without elevated or erroneous readings.

2/6/26

- Gathered error codes from all CH4/CO2 analyzers in the field.
- Adjusted communications settings on analyzers to improve communications.
- Error codes that were thought to be related to communications did not clear after a couple weeks of operation so the manufacturer was contacted for additional troubleshooting support.

2/24/26

- Met with Vaisala vendor to troubleshoot error codes and sent error information for further evaluation and recommendations.

3/11/26

- Vaisala provided limited support via email and said the error codes suggested issues with the sensors and the process and recommended cleaning to see if the error codes would clear.

3/17/26 – 3/20/26

- All of the O2 and CH4 analyzers were cleaned in the field and returned to service.
- Pilot 2, Pilot 4, and Pilot 5 returned to service with no errors after cleaning and replacing gaskets.
- Pilot 2 and Pilot 5 continue to display ambient air conditions requiring further troubleshooting.
- Pilot 4 appeared to be performing reasonably well since it was serviced.
- The IIoT device on Pilot 3 stopped communicating on 3/13/26. The IIoT device was found powered off and would not power back up. SCS verified voltage to the unit, tried a different power source, and still could not power the unit on. A replacement IIoT device was ordered to replace the failed component.

3/26

- Pilot 2 was inspected and a leak was found on the HDPE flange mount for the O2 sensor. The flange was repaired and the O2 value dropped to expected values.
- Pilot 2 v-cone flow element was removed to inspect for buildup or impact by the LFG. This well was selected because it is an elevated temperature well that had demonstrated the most degradation on the exposed analyzer components when inspected and serviced. SCS did not remove the v-cone flow elements from the other locations as it requires significant effort to mechanically remove and reinstall.
- Pilot 2 sample assembly was modified to add a 2" tee and sample port so that a sample could be obtained with the GEM in the upper assembly to measure the actual gas to which the analyzer sensor was being exposed. Prior to this, the analyzer measurements were compared to the values obtained from the wellhead port.

3/26

- Installed remaining sampling tees on Pilots 1, 3, 4, and 5.
- Pilots 1, 2, and 5 O2 sensor gaskets and o-rings were inspected and replaced, and HDPE flange inspected and resealed to try to minimize air intrusion in the sample assembly.

ASSESSMENT OF FUTURE RMS IMPLEMENTATION

For purposes of assessing potential actions involving deployment of RMS components as part of any future RMS implementation at the Chiquita Canyon Landfill, the Reaction Committee considered the results of the study and weighed the following considerations related to feasibility, functionality, and viability:

- Feasibility and Functionality:

  - Did the results of this pilot study demonstrate that the selected instrumentation, sensors, and associated equipment proved to be reliable and maintained a high level of functionality (i.e., low frequency and duration of errors and downtime)?

  - Were the recorded measurements deemed to be accurate and precise?

  - Did the techniques employed in configuring the pilot system assembly, position of the sensors and devices, and connection to the well and lateral piping demonstrate that such an RMS can be readily utilized at the pilot wells?

  - Can personnel accomplish appropriate operations, maintenance, and monitoring activities?

  - Is the intensive maintenance cycle on a larger number of wellheads feasible?

- Viability:

  - Did the results of this pilot study demonstrate that the selected instrumentation, sensors, and associated equipment proved to be beneficial and useful in managing landfill gas collection system infrastructure?

  - Did the RMS offer expedited access to operational parameters that enable critical decisions to be made?

  - Did the pilot study demonstrate that routine and non-routine O&M efforts can be curtailed to offer customized, curated, and "concierge service-oriented" for distressed assets and, thereby be more efficient and effective?

  - Did the RMS offer a significant advancement in automation that resulted in reducing risks from a human health and safety perspective?

With respect to Component 1 – Flowrate Measurement, the pilot study demonstrated excellent feasibility and viability. The flow meters at the five pilot wells remained functional, reliable, and were deemed to provide reasonable accurate values and afforded good correlation during data validation efforts. They are somewhat difficult and laborious to service and clean, but some minor changes to the flange connections would likely resolve this issue and allow them to be more readily serviced when installed independently. It is recognized that some de minimis flow that travels through the upper branch of the pilot assembly is being "missed" at the flowmeter.

Furthermore, introduction of a flowmeter offered value to comprehensive wellfield management and enabled targeted O&M troubleshooting. The benefit and usefulness of the data that was obtained from the flowmeter, which is the foundation of demonstrating viability, was sufficiently proven during the study. The access to real-time data on the extent to which the wells were "flowing gas" offered value in managing landfill gas collection system infrastructure and enabled expedited critical decisions to be made. The extraction of LFG, regardless of concentrations or temperature in an ETLF region, is an imperative, thus O&M efforts were rendered more efficient and effective because they were directed at low-flow wells. Furthermore, the flowrate element of the RMS resulted in reducing risks from a human health and safety perspective because field technicians did not need to approach and physically monitor each pilot well to identify which wells were impacted by low-flow conditions.

With respect to Component 2 – Gas Composition Measurement, the pilot study demonstrated poor feasibility and functionality and only marginal viability, as described in more detail above. The gas composition sensors utilized an “in-situ” arrangement that is substantially different from the LoCI or Apis products utilized at other landfills since the composition measurements on the pilot wells are being obtained on the raw LFG in an “unconditioned” environment versus the other technique which involves extracting and conditioning a sample stream. This in-situ arrangement was required for the sensors to be intrinsically safe with the environment in which they are installed, while the LoCI and Apis products do not meet the same rating. The pilot study demonstrated these sensors generally did not remain functional for extended periods of time, so there was poor reliability of the data due to the frequent errors. The sensors often did not record values that were believed to be accurate and had generally poor correlation during data validation efforts (except for brief periods at Pilot 3 and Pilot 4). This may be attributed in part to air intrusion circumstances while under vacuum. Elevated temperatures were encountered above the maximum temperature ratings and various types of fouling and debris build-up created a concern with accuracy of the optical elements. Liquids were somewhat problematic but less than expected. There was little to no documented problems with chemical compatibility.

During the pilot feasibility study, considerable time and efforts were expended to observe the sensor devices and gather information to provide to vendors on the errors and evaluate options to modify the sample assemblies to minimize air intrusion and drain liquids. An apparent communication issue with the CH_4/CO_2 sensors was identified that affected the data. Once that was resolved, it was recognized that there were multiple error conditions on each sensor and SCS personnel continued working with the manufacturer to troubleshoot; however, despite these efforts, the reliability was relatively poor throughout the study period.

The benefit and usefulness of the data that was obtained from the gas composition sensors when they did function, which is the foundation of demonstrating viability, was not proven during the study. The access to real-time gas concentrations did not appear to offer value in managing landfill gas collection system infrastructure and did not offer expedited critical decisions to be made. The gas constituents in an ETLF region are known to be atypical and reaction gas is considered “poor quality”, thus O&M efforts were not rendered more efficient and effective. Furthermore, the gas composition element of the RMS did not necessarily result in reducing risks from a human health and safety perspective.

Based on this pilot study, real-time measurements of raw landfill gas composition at Chiquita do not appear feasible at this time.

PILOT FEASIBILITY STUDY CONCLUSIONS

This pilot feasibility study was conducted on a subset of wells for a limited time period and therefore is not necessarily indicative of future performance or the likelihood of continuing operating conditions for the RMS components being evaluated. Chiquita should consider installation of these flow meters on select wells in close proximity to the data-driven Reaction Area boundary that are deemed essential to maintain LFG extraction at sufficient rates to mitigate the ETLF conditions and control fugitive emissions. Chiquita should not consider any additional installation of gas composition sensors, for the reasons described above, but should continue efforts to improve and operate the existing sensors at the five pilot wells to evaluate if feasibility, functionality, and viability can be improved.

Please contact either of the undersigned if you have questions or require additional information.

Sincerely,

Robert E. Dick, PE, BCEE
Senior Vice President
SCS Engineers

Patrick S. Sullivan, BCES, CCP
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cc: Baitong Chen, South Coast AQMD
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Kevin Green, Chiquita Canyon Landfill
Dylan Smith, Chiquita Canyon

APPENDIX A – PILOT DATA COMPARISON TABLES

Pilot 1 - CV24126

RMS 1-HOUR DATA ALIGNED WITH GEM DATA

Date	Time	CH4	CO2	O2	Flow Rate	DP	Vacuum (inWc)	Temperature (°F)	O2 Errors	CH4 Status	CO2 Status	Status Bits	No Errors All Sensors (0 = Good)
11/4/2025	14:00	0.25	0.55	19.58	1.85	0.00	0.10	179.31	0	2	4	3145731	1
11/9/2025	7:00	0.01	0.00	20.92	64.57	4.58	-0.62	172.56	0	0	0	0	0
11/17/2025	8:00	0.00	0.34	20.78	65.54	4.72	-1.78	178.93	0	0	0	0	0
11/24/2025	11:00	0.00	0.00	20.92	44.36	2.16	-3.11	186.93	0	2	4	3145731	1
12/1/2025	10:00	0.01	0.00	21.03	36.58	1.47	-8.39	185.59	0	0	0	0	0
12/9/2025	7:00	0.00	0.00	20.96	26.31	0.76	-9.43	188.48	0	0	0	0	0
12/15/2025	9:00	0.01	0.06	20.99	24.46	0.66	-1.78	188.71	0	2	0	0	2
12/19/2025	11:00	0.02	0.44	20.96	30.73	1.04	-4.00	187.75	0	0	0	0	0
12/21/2025	9:00	0.00	0.00	20.91	28.28	0.88	-3.58	188.92	0	0	0	0	0
12/29/2025	13:00	0.01	0.00	20.98	34.40	1.30	-4.85	186.06	0	0	0	0	0
1/5/2026	8:00	0.00	0.18	20.91	31.12	1.07	-10.74	188.15	0	0	0	4194304	1
1/13/2026	8:00	0.02	0.01	20.93	31.98	1.13	-8.09	186.13	0	0	0	0	0
1/20/2026	8:00	21.98	78.02	-0.06	0.00	0.00	3.72	97.96	0	2	2	2097155	1
1/26/2026	8:00	0.03	0.00	21.08	21.85	0.52	-8.69	187.84	0	2	0	0	2
2/2/2026	10:00	0.01	0.00	21.03	24.01	0.63	-7.14	186.48	0	0	0	0	0
2/9/2026	8:00	0.02	0.00	21.00	24.22	0.64	-6.49	186.71	0	0	0	0	0
2/17/2026	9:00	0.01	0.00	21.02	25.72	0.73	-2.94	186.13	0	2	0	0	2
2/23/2026	10:00	0.02	0.00	20.97	21.42	0.50	-0.57	185.42	0	0	0	0	0
3/3/2026	14:00	0.02	0.00	-0.04	1.31	0.00	10.07	135.49	0	4	4	3670019	1
3/9/2026	13:00	0.06	0.17	20.76	25.89	0.74	-5.38	187.23	0	0	0	0	0
3/18/2026	14:00	0.00	0.35	26.63	20.89	0.48	-8.89	187.68	1	4	2	2621443	1

MANUAL GEM READINGS DATA

Record Date	CH4 [%]	CO2 [%]	O2 [%]	Bal Gas [%]	Init Temp [°F]	Adj Temp [°F]	Init Stat Press ["H2O]	Adj Stat Press ["H2O]
10/31/2025 1:12:26 PM	4.9	80.2	0.0	14.9	184.1	179.9	0.05	0.16
11/4/2025 1:39:34 PM	4.5	73.9	0.0	21.6	174.0	187.8	0.13	-0.06
11/4/2025 1:40:29 PM	4.4	85.0	0.0	10.6	188.3	188.2	-0.11	-0.08
11/9/2025 7:18:44 AM	11.4	60.8	0.1	27.7	175.8	175.8	-0.17	-0.17
11/17/2025 8:01:58 AM	18.1	67.4	0.0	14.5	180.2	180.2	-0.77	-0.69
11/24/2025 10:40:27 AM	1.3	90.9	0.0	7.8	190.0	190.2	-2.03	-2.05
12/1/2025 10:16:20 AM	1.8	76.1	0.0	22.1	188.8	188.1	-11.11	-10.40
12/1/2025 10:18:34 AM	1.8	77.8	0.0	20.4	189.0	188.3	-9.65	-9.62
12/1/2025 1:24:33 PM	9.1	47.7	0.0	43.2	187.4	187.2	-11.57	-6.50
12/9/2025 7:13:26 AM	2.8	83.8	0.0	13.4	188.8	188.4	-8.60	-8.78
12/15/2025 9:49:53 AM	0.8	97.8	0.0	1.4	189.7	190.0	-0.81	-0.98
12/19/2025 10:45:47 AM	0.6	85.4	0.0	14.0	189.7	189.5	-10.34	-6.53
12/21/2025 9:13:11 AM	5.3	84.0	0.0	10.7	189.7	190.4	-4.64	-4.53
12/29/2025 12:44:03 PM	3.8	86.1	0.0	10.1	189.5	190.2	-5.51	-6.76
1/5/2026 7:37:55 AM	0.8	73.4	0.0	25.8	189.9	190.1	-6.04	-6.12
1/13/2026 7:48:19 AM	3.1	78.1	0.0	18.8	188.7	190.0	-5.03	-5.03
1/20/2026 7:47:46 AM	0.8	85.7	0.0	13.5	101.6	100.0	4.56	4.67
1/20/2026 7:48:20 AM	0.7	84.1	0.0	15.2	100.3	99.2	4.28	4.38
1/26/2026 7:50:39 AM	0.9	87.4	0.0	11.7	188.4	189.5	-7.66	-7.66
2/2/2026 10:00:53 AM	8.5	82.2	0.0	9.3	189.7	189.8	-6.69	-7.04
2/9/2026 12:52:55 PM	0.6	92.1	0.0	7.3	189.0	189.2	-10.68	-10.96
2/17/2026 8:58:39 AM	0.8	79.8	1.2	18.2	187.8	188.6	-1.00	-0.99
2/23/2026 10:15:17 AM	3.7	86.3	0.0	10.0	174.5	174.3	7.06	7.09
2/23/2026 10:15:47 AM	3.9	88.4	0.0	7.7	172.5	171.1	6.76	6.76
3/3/2026 1:40:05 PM	18.9	75.8	0.0	5.3	187.7	188.0	-5.82	-5.11
3/9/2026 1:30:49 PM	1.8	79.2	0.0	19.0	188.6	188.3	-4.91	-4.92
3/18/2026 2:05:50 PM	8.6	87.0	0.0	4.4	188.4	187.9	2.60	1.77
3/18/2026 2:05:55 PM	8.6	87.0	0.0	4.4	188.4	187.9	2.60	1.77
3/18/2026 2:07:15 PM	8.3	87.0	0.0	4.7	187.9	188.4	0.26	-0.13

CH4/CO2 Analyzer Errors Key

Status Bits	Error Bits	Bit	Description
1572867	0, 1, 19, 20	0	Firmware checksum mismatch.
2097152	21	1	Device settings corrupted.
2097154	1, 21	19	CH4 measurement out of range.
2097155	0, 1, 21	20	CO2 measurement out of range.
2621440	19, 21	21	H2O measurement out of range.
3145728	20, 21	22	Td measurement out of range.
3145730	1, 20, 21	24	Infrared source temperature too high.
3145731	0, 1, 20, 21		
3670016	19, 20, 21		
3670019	0, 1, 19, 20, 21		
3670023	0, 1, 2, 19, 20, 21		
4194304	22		
4194306	1, 22		
4194307	0, 1, 22		
16777216	24		

CH4/CO2 Errors Key

Bit	Sensor Status Description
2	Not Reliable
4	Under Range
6	Not ready, Under Range
8	Over Range
128	Sensor Failure
256	Measurement Not Ready

Pilot 2 - CV24076

RMS 1-HOUR DATA ALIGNED WITH GEM DATA

Date	Time	CH4	CO2	O2	Flow Rate	DP	Vacuum (inWc)	Temperature (°F)	O2 Errors	CH4 Status	CO2 Status	Status Bits	No Errors All Sensors (0 = Good)
11/3/2025	12:00	0.00	0.00	20.80	0.00	0.00	-1.12	160.12	0	0	0	0	0
11/6/2025	10:00	2.38	17.42	26.56	69.82	5.36	-1.70	160.05	1	2	2	2097155	1
11/10/2025	14:00	2.38	17.42	17.33	73.05	5.87	-0.10	165.72	0	2	4	3145731	1
11/20/2025	9:00	2.38	17.42	20.04	67.07	4.95	-1.92	159.42	0	8	4	3670019	1
11/25/2025	9:00	2.38	17.42	20.13	65.73	4.75	-1.85	159.87	0	2	4	3145731	1
12/3/2025	10:00	2.38	17.42	19.88	68.20	5.11	-2.20	160.12	0	2	8	3145731	1
12/9/2025	9:00	2.38	17.42	19.56	70.86	5.52	-1.12	162.10	0	4	4	3670019	1
12/16/2025	11:00	2.38	17.42	19.62	67.99	5.08	-0.70	165.48	0	4	4	3670019	1
12/18/2025	14:00	2.38	17.42	16.08	66.85	4.91	-0.46	167.34	0	4	4	3670019	1
12/22/2025	13:00	2.38	17.42	19.80	53.74	3.18	-4.06	158.62	0	2	4	3145731	1
12/23/2025	9:00	2.38	17.42	20.05	58.23	3.73	-5.57	157.07	0	4	4	3670019	1
1/5/2026	8:00	0.00	0.00	26.56	61.77	4.20	-7.25	155.35	1	2	4	3145731	1
1/21/2026	10:00	0.00	0.00	26.56	31.58	1.10	-1.76	168.89	1	4	4	3670019	1
2/3/2026	8:00	0.00	0.00	26.55	46.93	2.42	-4.86	165.13	1	4	4	3670019	1
2/11/2026	8:00	0.00	0.00	26.56	56.00	3.45	-2.20	174.56	1	4	4	3670019	1
2/17/2026	10:00	0.00	0.00	26.56	51.66	2.93	-1.40	177.78	1	4	4	3670019	1
2/24/2026	14:00	0.00	0.00	26.56	47.91	2.52	-0.41	180.37	1	4	4	3670019	1
3/3/2026	9:00	0.00	0.00	26.56	48.87	2.63	-4.50	171.32	1	4	4	3670019	1
3/11/2026	15:00	0.00	0.00	26.56	46.68	2.40	-3.64	172.80	1	4	4	3670019	1
3/12/2026	9:00	0.00	0.00	26.56	49.08	2.65	-0.49	181.52	1	4	4	3670019	1
3/16/2026	10:00	0.00	0.00	18.42	54.19	3.23	-1.28	179.83	0	4	4	3670019	1

MANUAL GEM READINGS DATA

Record Date	CH4 [%]	CO2 [%]	O2 [%]	Bal Gas [%]	Init Temp [°F]	Adj Temp [°F]	Init Stat Press ["H2O]	Adj Stat Press ["H2O]
10/31/2025 1:47:25 PM	11.4	68.2	3.9	16.5	153.5	159.3	-1.03	-0.45
10/31/2025 2:38:05 PM	14.4	71.9	0.0	13.7	159.5	161.6	-0.46	-0.43
11/3/2025 11:51:21 AM	13.6	78.4	0.0	8.0	152.9	152.6	-0.39	-0.41
11/6/2025 10:26:34 AM	20.0	76.1	0.0	3.9	161.5	161.5	-0.34	-0.30
11/10/2025 1:38:47 PM	32.8	56.4	0.2	10.6	149.8	150.2	-0.27	-0.25
11/20/2025 8:39:01 AM	17.8	74.9	0.5	6.8	150.5	150.0	-1.12	-1.11
11/25/2025 9:12:43 AM	17.1	80.1	0.0	2.8	159.2	159.4	-0.87	-0.91
12/3/2025 10:22:25 AM	24.8	75.1	0.1	0.0	149.9	150.9	-0.96	-0.95
12/9/2025 8:42:44 AM	28.4	70.5	0.5	0.6	146.8	147.1	-0.46	-0.47
12/16/2025 10:48:59 AM	34.1	65.9	0.0	0.0	161.4	161.5	-0.43	-0.44
12/18/2025 1:57:11 PM	19.3	75.9	0.0	4.8	166.9	163.6	-0.14	-3.15
12/18/2025 2:09:46 PM	25.4	65.6	2.2	6.8	160.8	161.5	-3.89	-3.90
12/22/2025 1:01:41 PM	15.4	67.0	2.6	15.0	156.3	157.0	-3.05	-3.01
12/23/2025 8:42:59 AM	11.9	73.7	3.2	11.2	152.9	154.2	-4.58	-4.73
12/23/2025 8:44:53 AM	11.9	73.9	3.2	11.0	152.8	153.6	-4.75	-4.74
12/30/2025 9:15:13 AM	13.4	70.3	2.8	13.5	154.0		-6.11	-6.11
1/5/2026 8:34:17 AM	12.8	62.8	3.6	20.8	155.0	154.5	-6.42	-6.39
1/12/2026 1:14:37 PM	22.5	75.8	0.3	1.4	159.6	159.6	-6.95	-6.98
1/21/2026 10:11:43 AM	28.2	65.4	0.0	6.4	168.6	168.7	-0.94	-0.90
1/28/2026 9:02:28 AM	13.9	78.0	0.9	7.2	165.3	165.3	-2.16	-2.16
2/3/2026 8:15:33 AM	23.3	76.6	0.1	0.0	164.8	164.7	-4.22	-4.30
2/11/2026 7:55:53 AM	12.2	77.0	0.3	10.5	170.5	170.4	-1.27	-1.21
2/17/2026 9:39:12 AM	9.8	76.2	0.0	14.0	175.5	175.8	-0.62	-0.65
2/24/2026 1:45:16 PM	7.9	80.4	1.0	10.7	177.3	179.2	-2.55	-1.48
2/24/2026 1:46:18 PM	12.1	72.1	1.5	14.3	178.9	179.0	-1.79	-1.77
3/3/2026 8:34:23 AM	11.7	73.3	0.8	14.2	171.3	171.3	-3.54	-3.51
3/11/2026 3:10:42 PM	3.4	0.7	20.3	75.6	172.0	172.1	0.02	0.00
3/11/2026 3:11:28 PM	3.6	0.7	20.3	75.5	172.0	173.2	0.00	0.00
3/12/2026 9:06:59 AM	8.8	75.6	0.0	15.6	181.7	181.7	-0.98	-0.94
3/16/2026 9:54:07 AM	8.8	85.0	0.0	6.2	178.9	178.9	-0.59	-0.58

CH4/CO2 Analyzer Errors Key

Status Bits	Error Bits	Bit	Description
1572867	0, 1, 19, 20	0	Firmware checksum mismatch.
2097152	21	1	Device settings corrupted.
2097154	1, 21	19	CH4 measurement out of range.
2097155	0, 1, 21	20	CO2 measurement out of range.
2621440	19, 21	21	H2O measurement out of range.
3145728	20, 21	22	Td measurement out of range.
3145730	1, 20, 21	24	Infrared source temperature too high.
3145731	0, 1, 20, 21		
3670016	19, 20, 21		
3670019	0, 1, 19, 20, 21		
3670023	0, 1, 2, 19, 20, 21		
4194304	22		
4194306	1, 22		
4194307	0, 1, 22		
16777216	24		

CH4/CO2 Errors Key

Bit	Sensor Status Description
2	Not Reliable
4	Under Range
6	Not ready, Under Range
8	Over Range
128	Sensor Failure
256	Measurement Not Ready

Pilot 3 - CV24151

RMS 1-HOUR DATA ALIGNED WITH GEM DATA

Date	Time	CH4	CO2	O2	Flow Rate	DP	Vacuum (inWc)	Temperature (°F)	O2 Errors	CH4 Status	CO2 Status	Status Bits	No Errors All Sensors (0 = Good)
11/3/2025	12:00	7.01	8.46	19.05	27.11	0.81	-1.09	114.61	0	0	0	0	0
11/10/2025	13:00	12.22	18.65	19.88	0.00	0.00	-14.61	119.64	0	0	0	0	0
11/13/2025	12:00	39.70	51.29	3.92	13.76	0.21	-4.79	117.64	0	0	0	0	0
11/25/2025	9:00	0.00	0.00	26.59	14.95	0.25	-7.03	106.69	1	2	2	2097155	1
11/25/2025	13:00	36.70	56.82	26.59	13.63	0.20	-5.49	111.51	1	0	0	0	1
12/4/2025	10:00	36.02	56.51	26.59	15.28	0.26	-7.32	107.04	1	0	0	0	1
12/19/2025	16:00	34.65	55.23	26.59	12.39	0.17	-4.16	114.44	1	0	0	0	1
1/6/2026	6:00	50.15	49.85	26.59	1.85	0.00	-4.16	101.09	1	2	2	2097154	1
1/6/2026	10:00	0.00	0.00	26.59	1.85	0.00	-4.27	103.23	1	2	2	2097155	1
1/26/2026	14:00	0.00	0.00	0.47	0.00	0.00	-6.48	107.77	0	128	128	16777216	1
2/3/2026	13:00	0.00	0.00	1.17	0.00	0.00	-6.17	108.31	0	128	128	16777216	1
2/17/2026	12:00	0.00	0.00	0.63	0.00	0.00	-4.90	103.28	0	0	0	0	0
3/13/2026	11:00	0.00	0.00	0.21	0.00	0.00	-1.29	100.64	0	0	0	0	0

MANUAL GEM READINGS DATA

Record Date	CH4 [%]	CO2 [%]	O2 [%]	Bal Gas [%]	Init Temp [°F]	Adj Temp [°F]	Init Stat Press ["H2O]	Adj Stat Press ["H2O]
10/31/2025 2:10:10 PM	37.7	60.7	0.0	1.6	**118.9**	**119.1**	**-8.76**	**-4.46**
10/31/2025 2:11:23 PM	39.1	57.7	0.0	3.2	**119.1**	**119.0**	**-4.00**	-4.02
11/3/2025 12:21:04 PM	43.4	56.6	0.0	0.0	**104.6**	**107.5**	-2.06	-1.44
11/10/2025 12:53:58 PM	55.8	44.2	0.0	0.0	**109.7**	**109.9**	-14.77	-14.77
11/10/2025 1:22:08 PM	49.5	50.5	0.0	0.0	**112.9**	**113.1**	-13.86	-13.87
11/13/2025 12:18:24 PM	43.5	50.3	0.1	6.1	**104.7**	**104.6**	-4.12	-4.11
11/25/2025 9:17:30 AM	39.8	56.1	0.0	4.1	**107.5**	**107.5**	-6.80	-6.80
12/4/2025 9:43:31 AM	41.0	54.9	0.0	4.2	**87.9**	**88.0**	-6.88	-6.88
12/19/2025 4:26:17 PM	37.2	62.8	0.0	0.0	**108.0**	**106.9**	-5.75	-2.72
1/6/2026 10:03:53 AM	50.7	46.1	0.0	3.2	**108.1**	**108.1**	-1.02	-1.06
1/26/2026 1:44:24 PM	40.6	59.4	0.0	0.0	**112.6**	**110.9**	-3.28	-3.29
2/3/2026 1:08:44 PM	42.1	57.9	0.0	0.0	**106.3**	**107.8**	-2.81	-2.82
2/17/2026 12:21:37 PM	41.3	58.0	0.0	0.7	**90.9**	**89.5**	-3.41	-2.56
3/13/2026 1:50:47 PM	53.5	46.5	0.0	0.0	**117.8**	**117.9**	0.04	-0.20
3/13/2026 1:51:52 PM	54.4	45.6	0.0	0.0	**118.2**	**118.0**	-0.25	-0.25
3/18/2026 10:44:51 AM	46.8	49.4	0.0	3.8	**110.5**	**111.0**	-2.65	-2.62

CH4/CO2 Analyzer Errors Key

Status Bits	Error Bits	Bit	Description
1572867	0, 1, 19, 20	0	Firmware checksum mismatch.
2097152	21	1	Device settings corrupted.
2097154	1, 21	19	CH4 measurement out of range.
2097155	0, 1, 21	20	CO2 measurement out of range.
2621440	19, 21	21	H2O measurement out of range.
3145728	20, 21	22	Td measurement out of range.
3145730	1, 20, 21	24	Infrared source temperature too high.
3145731	0, 1, 20, 21		
3670016	19, 20, 21		
3670019	0, 1, 19, 20, 21		
3670023	0, 1, 2, 19, 20, 21		
4194304	22		
4194306	1, 22		
4194307	0, 1, 22		
16777216	24		

CH4/CO2 Errors Key

Bit	Sensor Status Description
2	Not Reliable
4	Under Range
6	Not ready, Under Range
8	Over Range
128	Sensor Failure
256	Measurement Not Ready

Pilot 4 - CV24088

RMS 1-HOUR DATA ALIGNED WITH GEM DATA

Date	Time	CH4	CO2	O2	Flow Rate	DP	Vacuum (inWc)	Temperature (°F)	O2 Errors	CH4 Status	CO2 Status	Status Bits	No Errors All Sensors (0 = Good)
11/3/2025	13:00	0.00	0.08	20.50	0.00	0.00	-2.01	121.26	0	0	0	0	0
11/10/2025	0:00	27.55	48.79	12.09	23.54	0.61	-3.91	119.43	0	0	0	0	0
11/25/2025	11:00	0.00	0.00	26.53	31.66	1.10	-8.74	117.85	1	4	4	1572867	1
12/7/2025	9:00	0.00	0.00	26.52	32.62	1.17	-10.27	116.96	1	2	4	3145731	1
1/8/2026	9:00	0.00	0.00	26.52	1.85	0.00	-3.50	113.03	1	4	4	3670019	1
1/9/2026	13:00	0.00	0.00	26.52	0.00	0.00	-3.19	108.12	1	2	4	3145731	1
1/16/2026	8:00	0.00	0.00	26.53	0.00	0.00	-5.48	116.35	1	4	2	2621443	1
2/3/2026	10:00	0.00	0.00	0.16	0.00	0.00	-3.14	110.80	0	4	4	3670019	1
2/21/2026	10:00	0.00	0.00	-0.03	0.00	0.00	-3.81	109.44	0	2	4	3145731	1
3/3/2026	14:00	0.00	0.00	0.02	0.00	0.00	0.03	112.14	0	2	2	2097155	1
3/19/2026	14:00	0.00	0.00	-0.13	12.04	0.16	-0.54	125.71	0	2	2	2097155	1

MANUAL GEM READINGS DATA

Record Date	CH4 [%]	CO2 [%]	O2 [%]	Bal Gas [%]	Init Temp [°F]	Adj Temp [°F]	Init Stat Press ["H2O]	Adj Stat Press ["H2O]
10/31/2025 2:48:28 PM	37.9	62.1	0.0	0.0	**125.4**	**125.0**	**-4.72**	**-2.95**
10/31/2025 2:49:59 PM	40.0	58.1	0.0	1.9	**124.4**	**124.2**	**-2.82**	-2.82
11/3/2025 12:45:13 PM	43.2	56.8	0.0	0.0	**111.8**	**112.5**	-1.67	-1.69
11/10/2025 1:06:17 PM	51.5	48.5	0.0	0.0	**101.5**	**101.7**	-2.06	-2.06
11/25/2025 10:46:29 AM	44.5	55.5	0.0	0.0	**114.7**	**114.1**	-5.71	-5.72
12/7/2025 9:31:00 AM	42.0	54.8	0.0	3.3	**122.2**	**122.1**	-9.28	-9.25
12/19/2025 4:39:01 PM	38.7	61.3	0.0	0.0	**114.9**	**112.1**	-6.78	-3.65
1/8/2026 9:32:27 AM	47.6	50.0	0.0	2.5	**113.8**	**113.3**	-1.87	-1.87
1/9/2026 1:26:28 PM	46.7	49.2	0.0	4.1	**105.7**	**108.8**	-1.27	-1.28
1/16/2026 8:05:54 AM	46.0	51.3	0.0	2.7	**115.2**	**115.4**	-4.99	-5.01
2/3/2026 10:02:42 AM	44.7	55.3	0.0	0.0	**114.9**	**116.4**	-2.15	-2.14
2/21/2026 10:23:49 AM	49.7	49.4	0.0	0.9	**98.6**	**99.2**	-2.10	-1.94
3/3/2026 1:52:42 PM	45.1	54.9	0.0	0.0	**106.4**	**108.4**	-0.11	-0.35
3/3/2026 1:54:16 PM	46.6	53.4	0.0	0.0	**108.9**	**108.9**	-0.47	-0.45
3/19/2026 1:57:09 PM	52.8	47.2	0.0	0.0	**111.9**	**111.9**	-0.13	-0.13

CH4/CO2 Analyzer Errors Key

Status Bits	Error Bits	Bit	Description
1572867	0, 1, 19, 20	0	Firmware checksum mismatch.
2097152	21	1	Device settings corrupted.
2097154	1, 21	19	CH4 measurement out of range.
2097155	0, 1, 21	20	CO2 measurement out of range.
2621440	19, 21	21	H2O measurement out of range.
3145728	20, 21	22	Td measurement out of range.
3145730	1, 20, 21	24	Infrared source temperature too high.
3145731	0, 1, 20, 21		
3670016	19, 20, 21		
3670019	0, 1, 19, 20, 21		
3670023	0, 1, 2, 19, 20, 21		
4194304	22		
4194306	1, 22		
4194307	0, 1, 22		
16777216	24		

CH4/CO2 Errors Key

Bit	Sensor Status Description
2	Not Reliable
4	Under Range
6	Not ready, Under Range
8	Over Range
128	Sensor Failure
256	Measurement Not Ready

Pilot 5 - CV24066

RMS 1-HOUR DATA ALIGNED WITH GEM DATA

Date	Time	CH4	CO2	O2	Flow Rate	DP	Vacuum (inWc)	Temperature (°F)	O2 Errors	CH4 Status	CO2 Status	Status Bits	No Errors All Sensors (0 = Good)
11/3/2025	13:00	3.98	8.55	12.50	20.69	0.47	-0.59	128.93	0	0	0	0	0
11/24/2025	13:00	0.00	0.00	26.60	19.01	0.40	-1.35	125.73	1	2	4	3145731	1
12/4/2025	8:00	0.00	0.00	26.58	19.01	0.40	-2.20	118.63	1	4	2	2621443	1
12/17/2025	8:00	0.00	0.00	26.57	19.24	0.41	-2.04	120.39	1	2	2	2097155	1
1/8/2026	9:00	0.00	0.00	26.56	18.51	0.38	-2.20	119.83	1	8	2	2621443	1
1/16/2026	9:00	0.00	0.00	26.58	19.37	0.41	-1.48	120.20	1	4	2	3670019	1
2/6/2026	14:00	0.00	0.00	0.00	19.06	0.40	-0.76	125.12	0	2	4	3145731	1
2/24/2026	15:00	0.00	0.00	-6.25	19.67	0.43	-1.29	126.98	0	4	4	3670019	1
3/3/2026	9:00	0.00	0.00	26.56	18.74	0.39	-2.64	120.53	1	4	2	2621443	1
3/16/2026	9:00	0.00	0.00	26.58	19.32	0.41	-2.11	120.13	1	4	2	2621443	1

MANUAL GEM READINGS DATA

Record Date	CH4 [%]	CO2 [%]	O2 [%]	Bal Gas [%]	Init Temp [°F]	Adj Temp [°F]	Init Stat Press ["H2O]	Adj Stat Press ["H2O]
10/31/2025 3:04:14 PM	31.7	59.3	0.0	9.0	**118.9**	**119.7**	**-0.32**	**-0.05**
10/31/2025 3:09:25 PM	27.6	65.5	0.0	6.9	**120.4**	**120.5**	**-0.05**	-0.11
11/3/2025 1:30:46 PM	33.2	63.9	0.0	2.9	**112.6**	**112.3**	-0.15	-0.39
11/24/2025 12:45:56 PM	30.5	61.4	0.0	8.1	**115.6**	**116.2**	-0.79	-0.73
12/4/2025 8:28:01 AM	30.2	56.8	0.0	13.0	**89.0**	**89.8**	-1.30	-1.27
12/17/2025 7:42:44 AM	26.6	63.5	0.0	9.9	**92.5**	**92.8**	-1.27	-1.12
1/8/2026 8:36:20 AM	41.5	49.6	0.0	8.9	**118.7**	**118.5**	-0.97	-1.00
1/16/2026 8:53:03 AM	31.2	65.1	0.0	3.7	**117.6**	**116.8**	-1.04	-1.04
2/6/2026 1:29:15 PM	33.5	63.5	0.0	3.0	**109.4**	**109.5**	-0.23	-0.23
2/24/2026 3:25:13 PM	21.6	56.2	0.0	22.2	**114.9**	**114.9**	-1.03	-1.03
3/3/2026 8:56:29 AM	21.5	55.2	0.0	23.3	**109.9**	**111.3**	-1.94	-1.91
3/16/2026 8:54:36 AM	23.0	55.0	0.2	21.8	**111.8**	**112.0**	-1.75	-1.75

CH4/CO2 Analyzer Errors Key

Status Bits	Error Bits
1572867	0, 1, 19, 20
2097152	21
2097154	1, 21
2097155	0, 1, 21
2621440	19, 21
3145728	20, 21
3145730	1, 20, 21
3145731	0, 1, 20, 21
3670016	19, 20, 21
3670019	0, 1, 19, 20, 21
3670023	0, 1, 2, 19, 20, 21
4194304	22
4194306	1, 22
4194307	0, 1, 22
16777216	24

Bit	Description
0	Firmware checksum mismatch.
1	Device settings corrupted.
19	CH4 measurement out of range.
20	CO2 measurement out of range.
21	H2O measurement out of range.
22	Td measurement out of range.
24	Infrared source temperature too high.

CH4/CO2 Errors Key

Bit	Sensor Status Description
2	Not Reliable
4	Under Range
6	Not ready, Under Range
8	Over Range
128	Sensor Failure
256	Measurement Not Ready

APPENDIX B – GAS COMPOSITION AND VACUUM TRENDS

Exhibit 1. PILOT 1 GAS COMPOSITION VS. VACUUM TREND

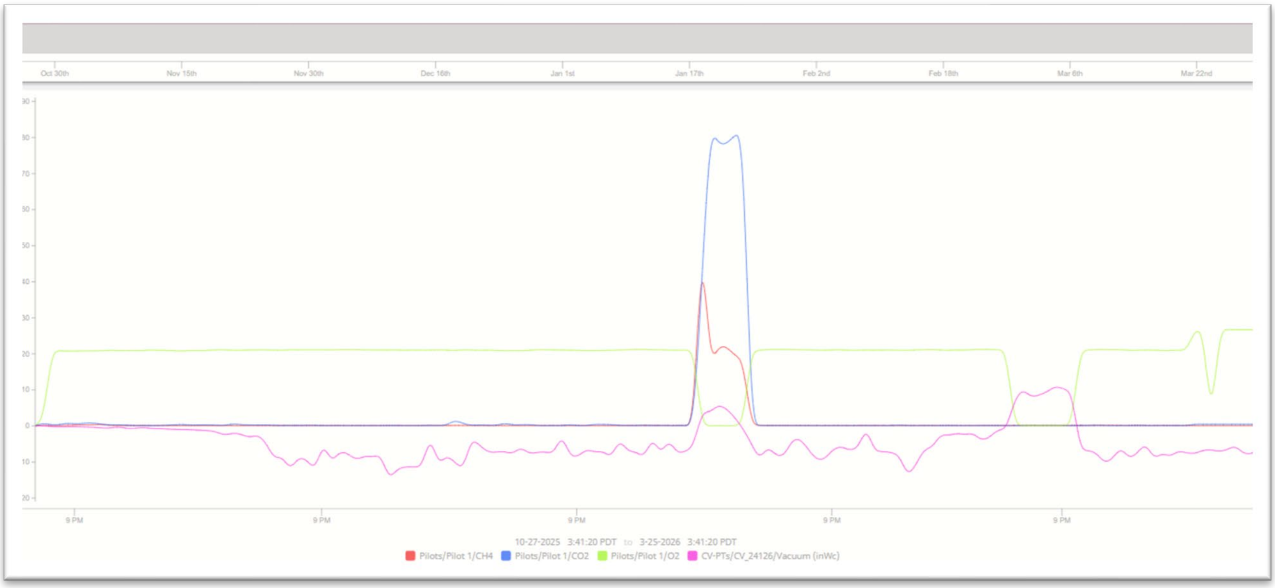
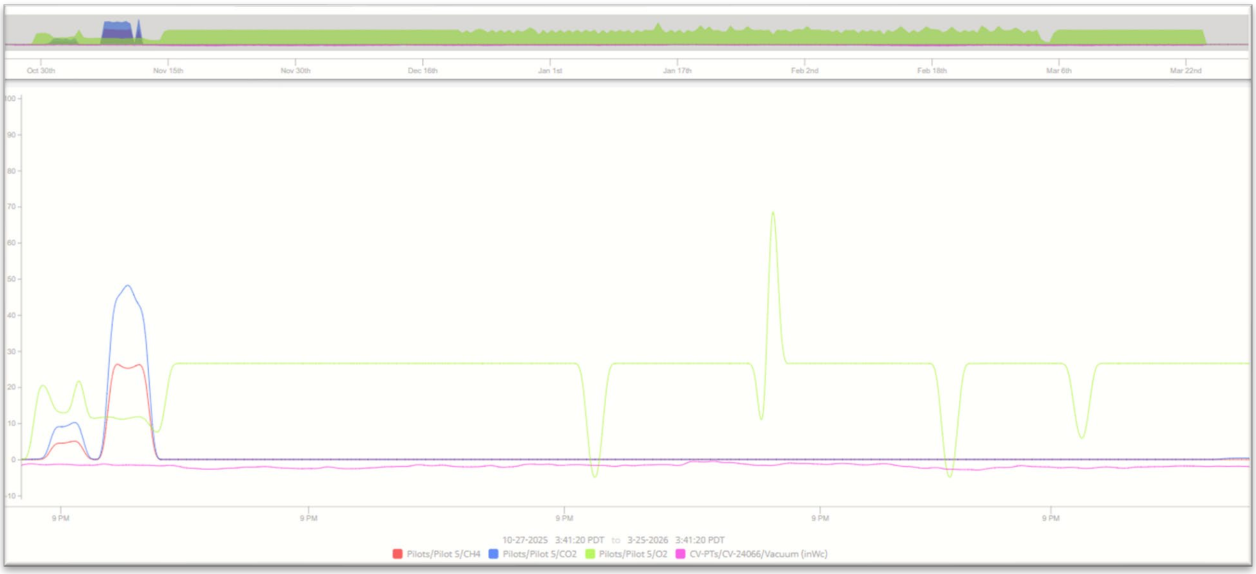


Exhibit 2. PILOT 2 GAS COMPOSITION VS. VACUUM TREND

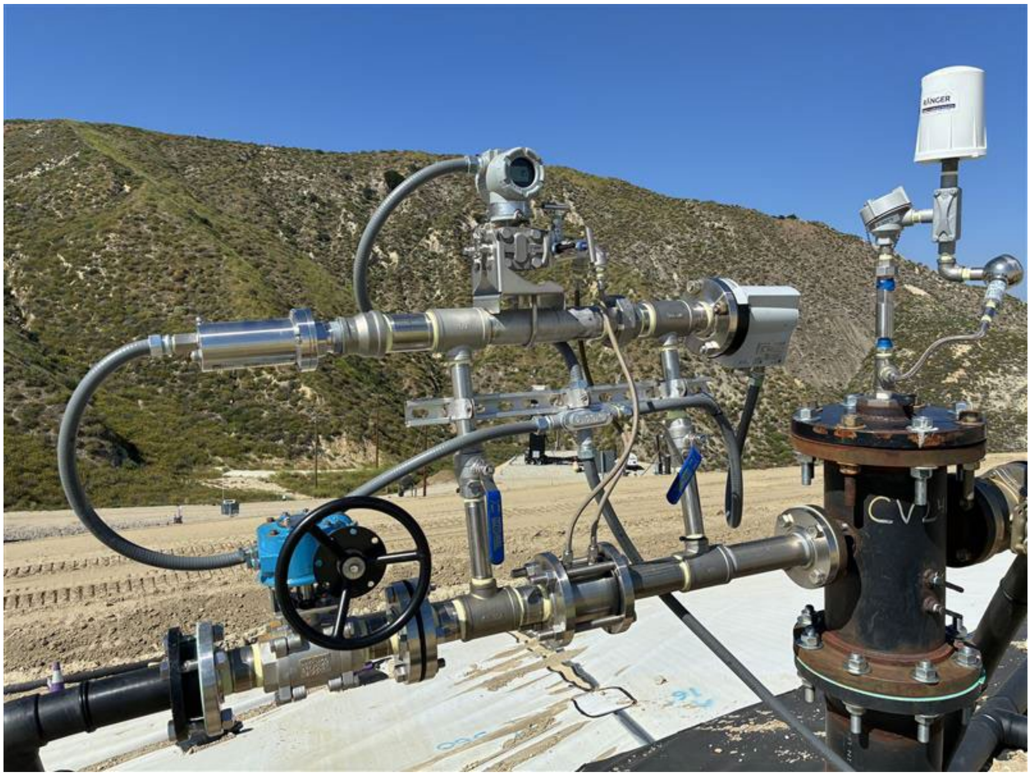
Exhibit 3. PILOT 3 GAS COMPOSITION VS. VACUUM TREND

Exhibit 4. PILOT 4 GAS COMPOSITION VS. VACUUM TREND

Exhibit 5. PILOT 5 GAS COMPOSITION VS. VACUUM TREND



APPENDIX C – PILOT SYSTEM PHOTOS



Pilot 1 – Pilot Well System

Pilot 2 – Pilot Well System

Pilot 3 – Pilot Well System

Pilot 5 – Pilot Well System

Pilot 4 – Pilot Well System

APPENDIX D – MAINTENANCE PHOTOS

Pilot 1 – CH4/CO2 Probe

Pilot 1 – CH4/CO2 Probe Optic

Pilot 1 – O2 Probe with Filters Removed

Pilot 1 – O2 Probe Optic

Pilot 2 – O2 Probe with PTFE Filter

Pilot 2 – O2 Probe with SS Filter

Pilot 2 – O2 Probe Optic

Pilot 2 – CH4/CO2 Probe with PTFE Filter

Pilot 2 – CH4/CO2 Probe PTFE Filter Cap

Pilot 2 – CH4/CO2 Probe Optic

Pilot 2 – CH4/CO2 Probe Sensors

Pilot 3 – CH4/CO2 Probe missing Cover

Pilot 3 – CH4/CO2 Probe Optic

Pilot 3 – O2 Probe PTFE Filter

Pilot 3 – O2 Probe PTFE Filter

Pilot 3 – O2 Probe with SS Filter

Pilot 3 – O2 Probe Optic

Pilot 4 – O2 Probe with PTFE Filter

Pilot 4 – O2 Probe with SS Filter

Pilot 4 – O2 Probe Optic

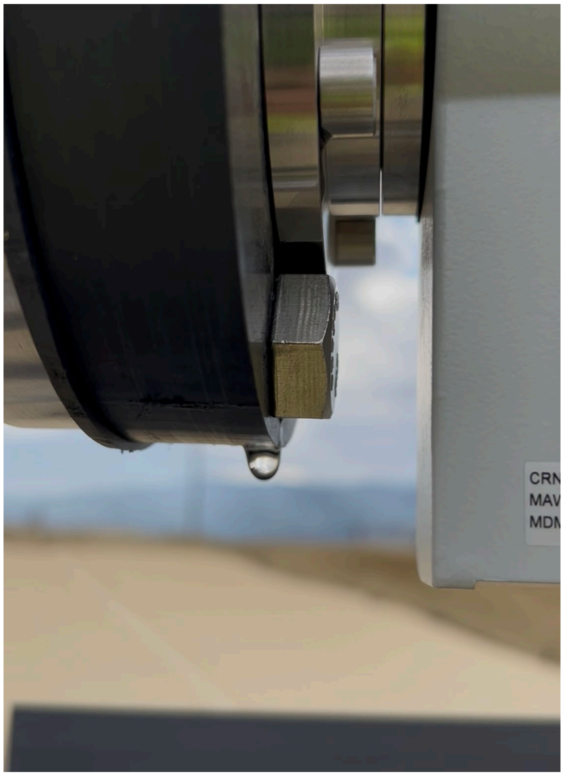
Pilot 4 – CH4/CO2 Probe with PTFE Filter

Pilot 4 – CH4/CO2 Probe Optic

Pilot 5 – O2 Probe with PTFE Filter

Pilot 5 – O2 Probe Optic

Pilot 5 – CH_4/CO_2 Probe with PTFE Filter



Pilot 4 – Liquid dripping from O2 flange

Pilot 4 – Liquid dripping from O2 sensor

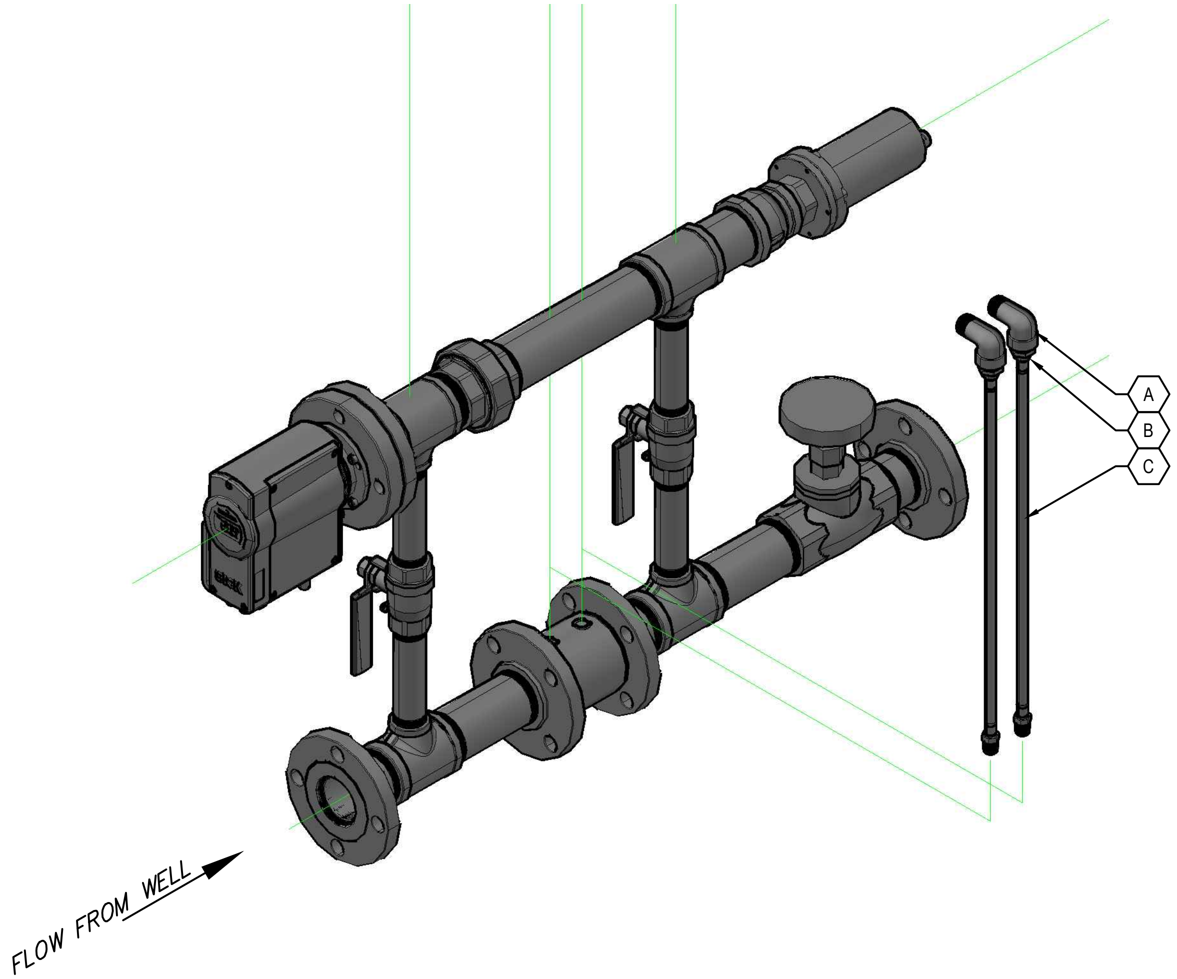
Pilot 4 – Water line on O2 Sensor Optic

Pilot 4 – CH4/CO2 Probe Optic

Pilot 2 – V-Cone Front View 3/25

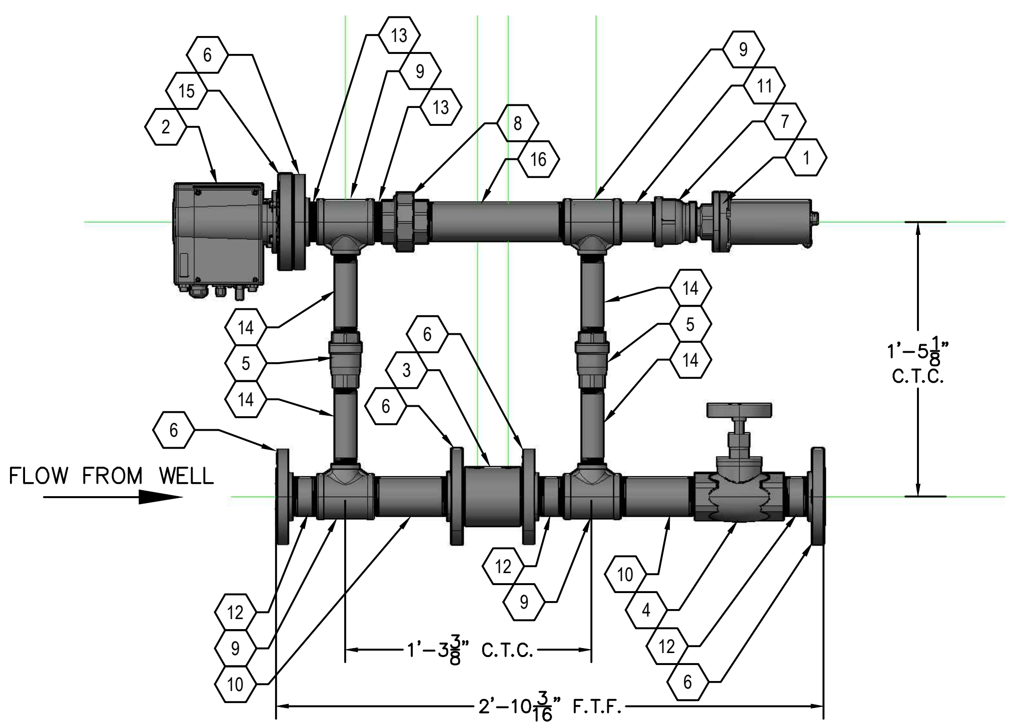
Pilot 2 – V-Cone Back View 3/25

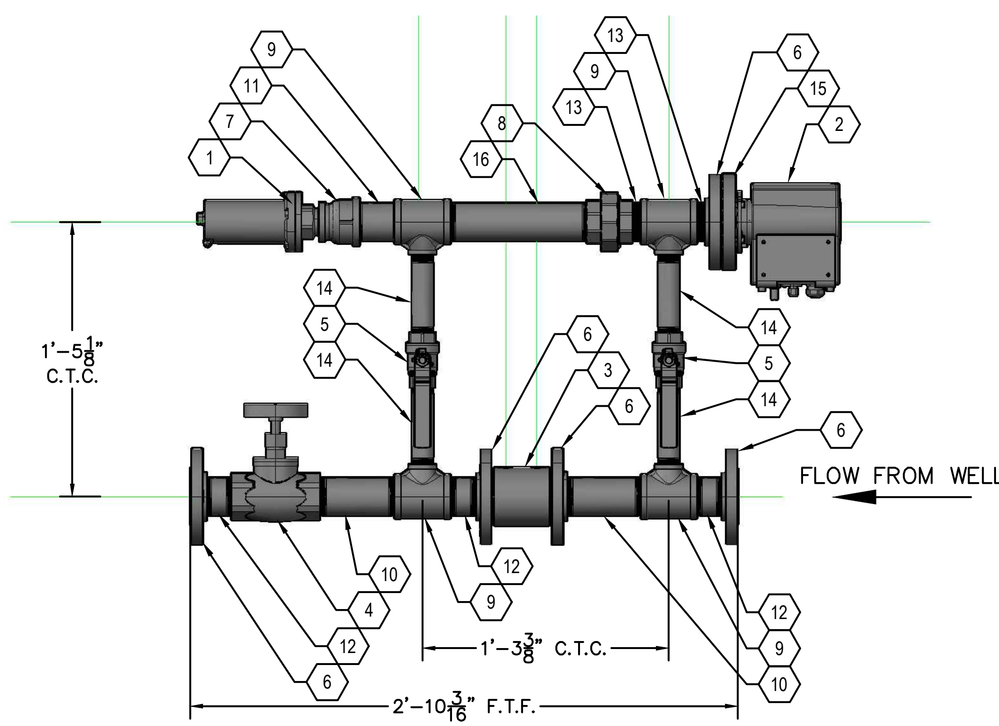
APPENDIX E – PILOT ASSEMBLY DRAWING

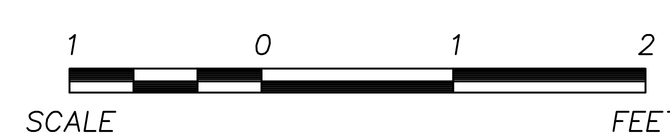


EQUIPMENT

ID	QNTY	ITEM	ORDER #
1	1	CH4/CO2 SENSOR, 1-1/2" NPT (MALE)	VAISALA MGP260 SERIES
2	1	O2 SENSOR, CUSTOM ADAPTER MOUNT	E+H TRANSIC121LP
3	1	FLOW ELEMENT, (2) PORTS 1/4" NPT (FEMALE)	WAFER-CONE MODEL VH
4	1	FLOW CONTROL V-NOTCH BALL VALVE 2" NPT (FEMALE)	FLOTITE 300 STAINLESS STEEL
5	2	STAINLESS STEEL 1" ON-OFF BALL VALVE NPT (FEMALE)	McMASTER-CARR 8209N15
6	5	STAINLESS STEEL 2" PIPE FLANGE NPT	McMASTER-CARR 44685K16
7	1	STAINLESS STEEL PIPE REDUCER 2"x1-1/2" NPT (FEMALE)	McMASTER-CARR 4464K551
8	1	STAINLESS STEEL 2" PIPE UNION NPT (FEMALE), METAL SEAT	McMASTER-CARR 4464K492
9	4	STAINLESS STEEL 2" PIPE REDUCING TEE 2"x2"x1" NPT	McMASTER-CARR 4464K935
10	2	STAINLESS STEEL 2" PIPE 6" NIPPLE NPT	McMASTER-CARR 4830K288
11	1	STAINLESS STEEL 2" PIPE 4" NIPPLE NPT	McMASTER-CARR 4830K286
12	3	STAINLESS STEEL 2" PIPE 3" NIPPLE NPT	McMASTER-CARR 4830K285
13	2	STAINLESS STEEL 2" PIPE 2" NIPPLE NPT	McMASTER-CARR 4830K281
14	4	STAINLESS STEEL 1" PIPE 6" NIPPLE NPT	McMASTER-CARR 4830K228
15	1	CPVC 2" PIPE BLIND FLANGE	McMASTER-CARR 6826K376
16	1	STAINLESS STEEL 2" PIPE 10" NIPPLE NPT	McMASTER-CARR 4830K291
	5	VITON GASKET 2" PIPE 150 CLASS FLANGE, 1/8" THICK	McMASTER-CARR 9473K616
	3	STAINLESS STEEL BOLT SET 2" PIPE 150 CLASS FLANGE	McMASTER-CARR 94368A125
	5	STAINLESS STEEL BOLT , 5/8"-11 UNC, 5-1/2" LONG	McMASTER-CARR 92186A816
	1	STAINLESS STEEL HEX NUT, 5/8"-11 UNC (PACK OF 10)	McMASTER-CARR 94804A351
A	2	STAINLESS STEEL 90° ELBOW ADAPTER 1/2" NPT (FEMALE x MALE)	McMASTER-CARR 4464K38
B	2	STAINLESS STEEL BUSHING ADAPTER 1/2" x 1/4" NPT (MALE x FEMALE)	McMASTER-CARR 4464K265
C	2	STAINLESS STEEL BRAIDED PTFE HOSE 1/4" NPT (MALE), 20" LONG	McMASTER-CARR 4552K102







REV.	DATE	CK. BY
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2	-	-
3	-	-
4	-	-
5	-	-
6	-	-

SHEET TITLE

WELLHEAD ASSEMBLY

PROJECT TITLE

CLIENT

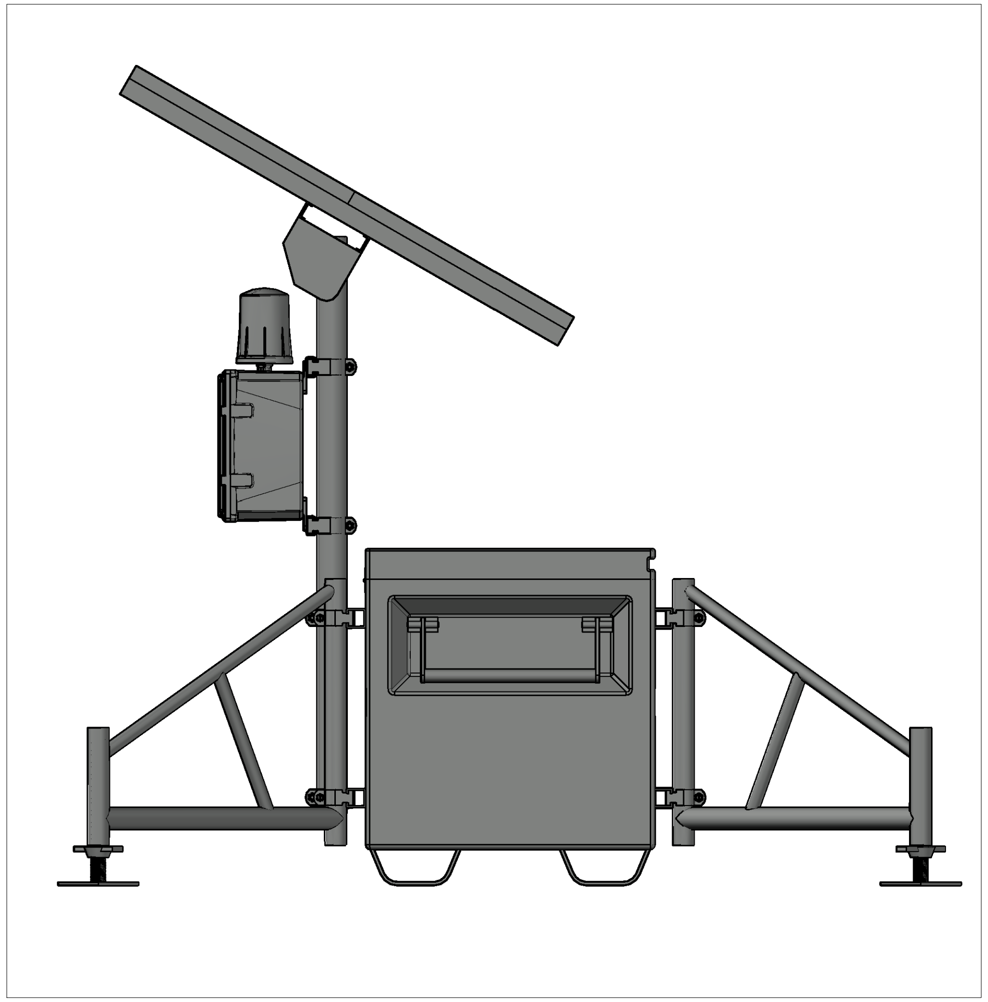
SCS ENGINEERS
7311 W. 130th St, Ste. 100
Overland Park, Kansas 66213
PH. (913) 681-0030 FAX. (913) 681-0012

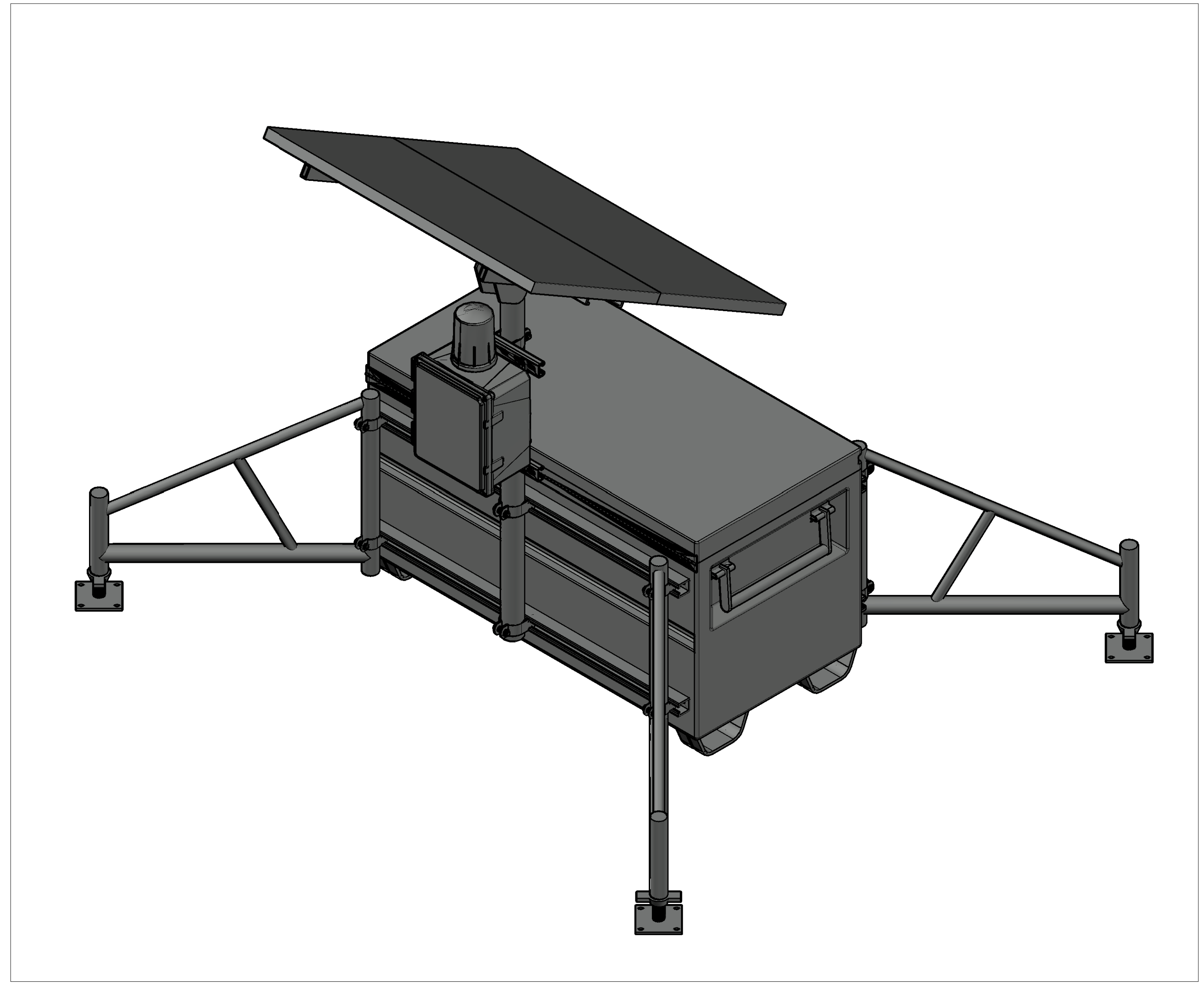
PROJ. NO. 27222111
DSN. BY: GJM
DWN. BY: GJM
CHK. BY: SAD
Q/A RVW BY: DPH
PROJ. MGR. SAD

CADD FILE: ASSEMBLY.DWG

DATE: 10/3/25

DRAWING NO. 1 of 1





NO.	REVISION	DATE
1		
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3		
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SHEET TITLE: SOLAR SKID DETAIL

PROJECT TITLE: PILOT MONITORING STATION

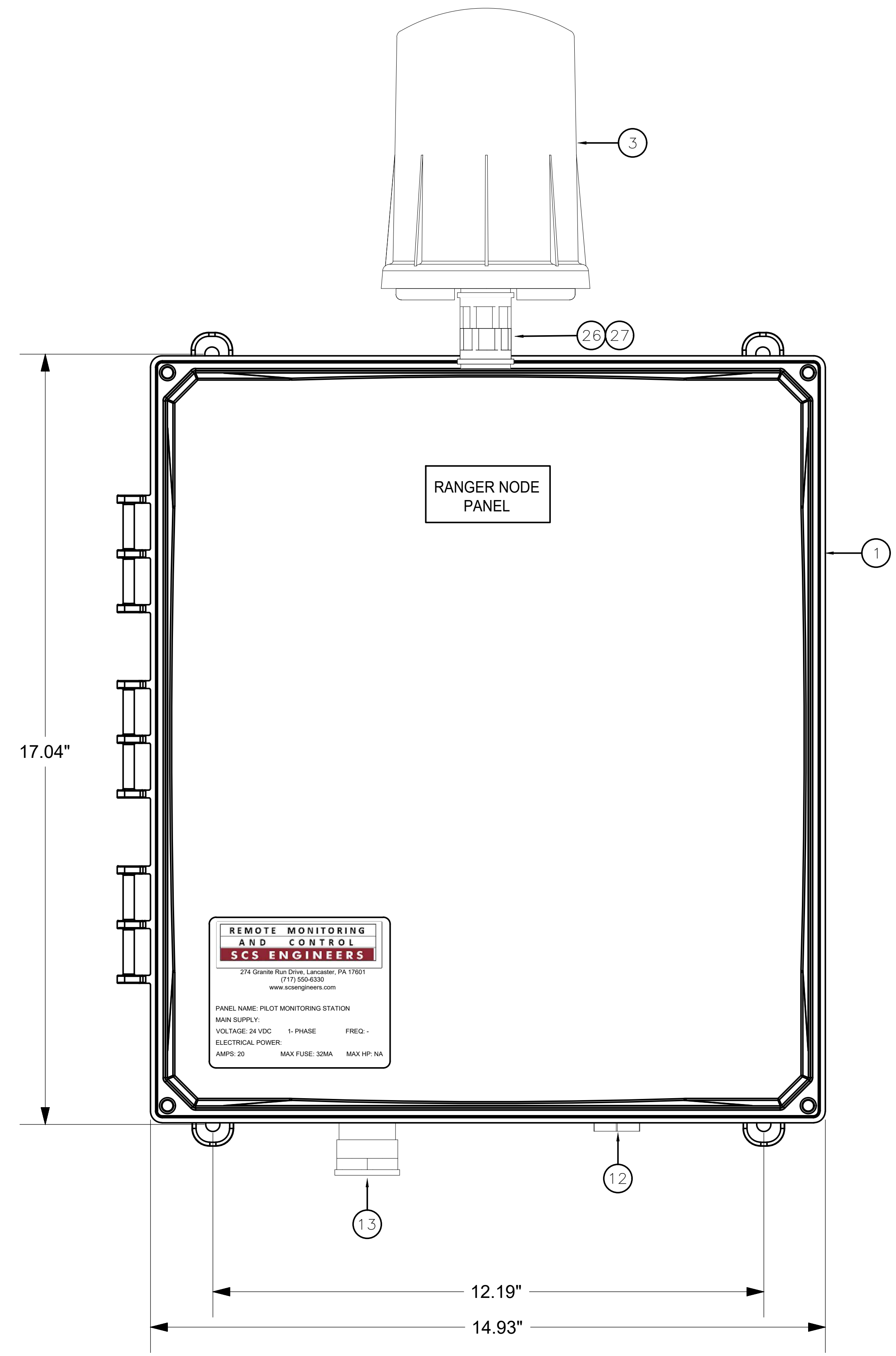
CLIENT: CHIQUITA LANDFILL

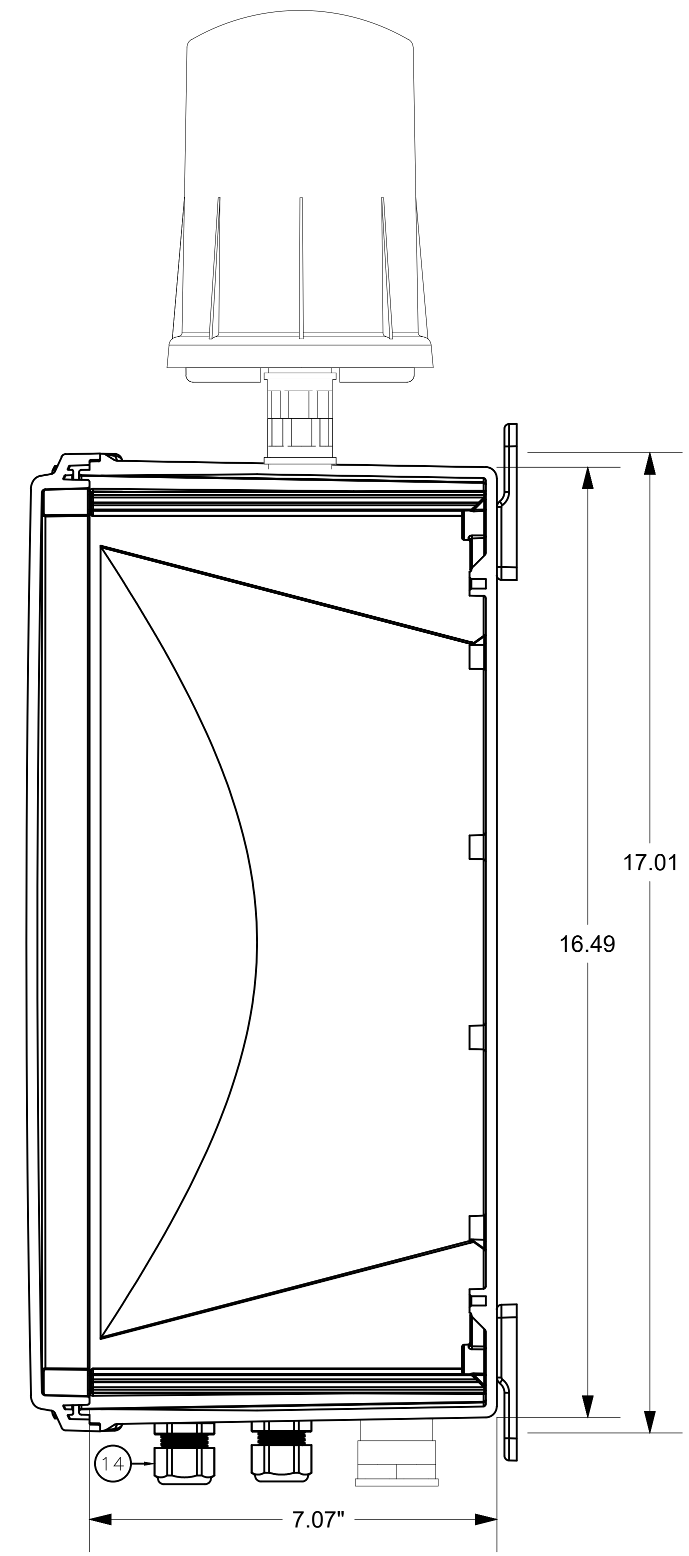
SCS ENGINEERS
ENVIRONMENTAL CONSULTANTS
274 GRANITE RUN DRIVE
LANCASTER, PA 17601
PH. (717) 550-6330

PROJ. NO. 07224127.00 | DWN. BY: GJM | ACAD FILE:
DSN. BY: GJM | CHK. BY: SAD | APP. BY:

DATE: OCTOBER 9, 2025

SCALE: NONE





NO.	REVISION	DATE

SHEET TITLE: PANEL EXTERIOR

PROJECT TITLE: PILOT MONITORING STATION

CLIENT: CHIQUITA LANDFILL

SCS ENGINEERS
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PROJ. NO. 07224127.00
DSN. BY: GJM
DWN. BY: GJM
CHK. BY: SAD
ACAD FILE:
APP. BY:

DATE: OCTOBER 9, 2025

SCALE: NONE

APPENDIX F – DEVICE DATA SHEETS

MGP261 Multigas Probe

For methane, carbon dioxide, and humidity measurement

Features

- Compact in situ probe with CH_4, CO_2, and H_2O vapor measurement
- Excellent long-term stability and repeatability with proprietary infrared technology — no calibration gases needed
- Direct installation into process: no sample treatment needed
- Certified for Ex Zone 0/1
- Probe heating eliminates condensation in wet processes
- Corrosion-resistant stainless steel housing (IP66)
- Standalone probe with digital Modbus RTU over RS-485 or 3 analog outputs (4–20 mA)
- Compatible with Vaisala Insight PC software

Vaisala CARBOCAP® MGP261 Multigas Probe for Methane, Carbon Dioxide, and Humidity Measurement is designed for in situ measurements in demanding biogas processing conditions where repeatable, stable, and accurate measurement is essential. MGP261 is Ex-certified for use in Ex Zone 0 (parts inserted into process) and Ex Zone 1 (parts outside the process). The probe belongs to the Vaisala MGP260 series product family.

Up to three measurements in one compact unit

MGP261 measures the main components of biogas and landfill gas: methane (CH_4), carbon dioxide (CO_2), and humidity. These gases make up the bulk of biogas, and measuring all three parameters gives you a 100 % picture of the process. MGP261 measures CH_4, CO_2, and humidity in vol-% units, or alternatively dewpoint temperature (T_d) in degrees Celsius.

Methane measurement for biogas quality and process control

Methane concentration measurement tells you the calorific value of the gas produced in real time. With internal temperature measurement for compensation purposes and an option for external pressure or temperature compensation input, the patented CARBOCAP® measurement gives unparalleled stability and reliability without calibration gases. Application areas include anaerobic digestion and landfill gas monitoring, activated carbon filter monitoring in biogas treatment process, and CHP engine feed gas monitoring.

Direct in situ measurement without sample treatment

MGP261 measures gases directly in the process pipeline without a need for moisture removal. This simplifies the measurement both in situ and as part of an extractive system with optional flow through cell accessory. The heated optical elements provide reliable measurements even in most demanding process conditions with condensate in the process gas.

MGP261 is Ex-certified for use in Ex Zone 0 (parts inserted into process) and Ex Zone 1 (parts outside the process). The electronics and optics of the IP66-rated instrument are protected by encapsulation in a potting compound to ensure maximum resistance to weather, dust, and ingress of process gases in the probe. Materials exposed to process gas are carefully selected for good chemical resistance against hydrogen sulfide: they include stainless 316L steel and polytetrafluoroethylene (PTFE).

Technical data

Measurement performance

Property	Methane CH_4	Carbon dioxide CO_2	Water vapor H_2O
Sensor	CARBOCAP®	CARBOCAP®	CARBOCAP®
Measurement unit	Volume-%	Volume-%	Volume-%, dew point °C
Measurement range	0–100 vol-%	0–100 vol-%	0–25 vol-%, −10 ... +60 °C (14 ... +140 °F)
Accuracy at +25 °C (+77 °F) and 1013 hPa [1) 2)]	• 0–40 vol-%: **±2 vol-%** • 40–70 vol-%: **±1 vol-%** • 70–100 vol-%: **±2 vol-%**	• 0–30 vol-%: **±2 vol-%** • 30–50 vol-%: **±1 vol-%** • 50–100 vol-%: **±2 vol-%**	0–25 vol-%: **±0.5 vol-%**
Repeatability [2)]	±0.5 vol-% at 60 vol-%	±0.3 vol-% at 40 vol-%	±0.1 vol-% at 2.5 vol-%
Temperature dependence, compensated	Compensated, 0–100 vol-%: ±0.1 % of reading/°C	Compensated, 0–100 vol-%: ±0.1 % of reading/°C	Compensated, 0–25 vol-%: ±0.1 % of reading/°C
Temperature dependence, uncompensated	Uncompensated, 0–100 vol-%: -0.9 % of reading/°C	Uncompensated, 0–100 vol-%: -0.9 % of reading/°C	Uncompensated, 0–25 vol-%: -0.4 % of reading/°C
Pressure dependence, compensated	Compensated, 0–100 vol-%: ±0.015 % of reading/hPa	Compensated, 0–100 vol-%: ±0.01 % of reading/hPa	Compensated, 0–25 vol-%: ±0.06 % of reading/hPa
Pressure dependence, uncompensated	Uncompensated, 0–100 vol-%: +0.2 % of reading/hPa	Uncompensated, 0–100 vol-%: +0.2 % of reading/hPa	Uncompensated, 0–25 vol-%: +0.2 % of reading/hPa
Long-term stability	±2 vol-%/year	±2 vol-%/year	±2 vol-%/year
Start-up time [3)]			30 s
Warm-up time [4)]			2 min [5)]
Response time (T_{90})			90 s [6)]
Response time with flow-through adapter			90 s at ≥ 0.5 l/min [6)] (recommended: 0.5–1 l/min)

1) *Excluding cross-interferences to other gases.*
2) *Accuracy specification at 25 °C (+77 °F) and 1013 hPa including non-linearity, calibration uncertainty, and repeatability; temperature and pressure compensated.*
3) *Time to first reading*
4) *Time to specified accuracy*
5) *At +20 °C (+68 °F) ambient temperature*
6) *With standard PTFE filter*

Inputs and outputs

Operating voltage	18–30 V DC
Power consumption	Typical: 3 W Maximum: 6 W
Digital output	RS-485 (Modbus RTU)
Analog output	3 × 4–20 mA scalable, isolated
Analog output load	Minimum: 0 Ω Maximum: 500 Ω
Analog output accuracy	±0.2 % of full scale at 25 °C (77 °F)
Analog output temperature dependence	0.005 %/˚C (0.003 %/°F) full scale
Analog input (optional)	1 × 4–20 mA (Ex ia) for external pressure or temperature sensor [1)]

1) *The optional analog input is galvanically isolated and provides power for the connected external pressure sensor.*

Compliance

Electromagnetic compatibility (EMC)	EN 61326-1, industrial environment
Compliance marks	CE, China RoHS, RCM
Ex approval marks	EU (ATEX), international (IECEx), US/CAN (cMETus), Japan (CML), UK(UKEX), Korea (KCs) [1)]
Ex classification	Ex II 1/2 (1) G Ex eb mb [ia] IIB T3 Ga/Gb -40 °C ≤ Tamb ≤ +60 °C Class I, Division 2, Groups C, D; T3

1) *See product documentation for full Ex classifications for each region.*

Operating environment

Operating temperature range	−40 ... +60 °C (−40 ... +140 °F)
Operating humidity range	0–100 %RH
Storage temperature range	−40 ... +60 °C (−40 ... +140 °F)
Storage humidity range	0–90 %RH
Process pressure range	−500 ... +500 hPa
Process temperature range	+0 ... +60 °C (+32 ... +140 °F)
Process flow range	0–20 m/s

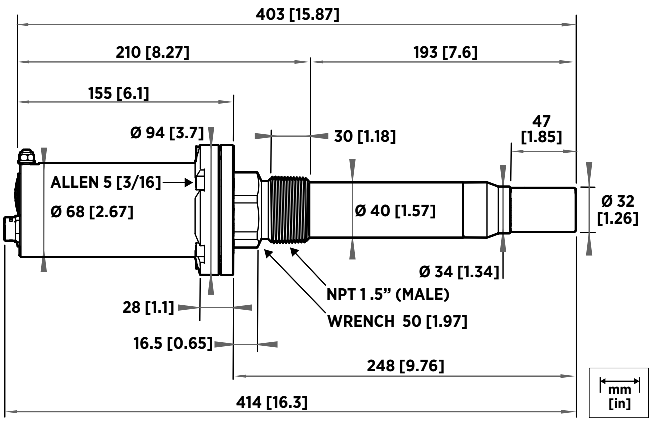
Mechanical specification

Weight	3 kg (6.6 lb)
Thread type	1.5" male NPT
Mechanical pressure tolerance	20 bar(g)
Cable lead-throughs	1 × M16×1.5 2 × M20×1.5
IP rating	IP66
Materials	
Probe body	AISI316L stainless steel, PPS
Filter cap	Sintered PTFE

Options and accessories

Configuration cable (RS-485/USB) [1)]	257295
Flow-through adapter	258877
Sintered PTFE filter (includes O-ring)	DRW249919SP
NPT 1.5" thread test plug	257525SP

1) *Vaisala Insight software for Windows® available at www.vaisala.com/insight*



MGP261 dimensions

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Operating Instructions
TRANSIC121LP

Laser Oxygen Transmitter

Endress+Hauser
People for Process Automation

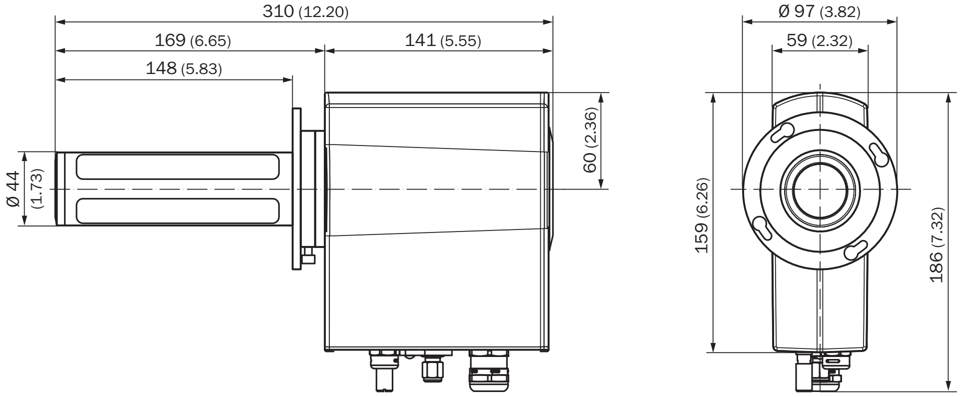
10.3.4 TRANSIC121LP inputs and outputs

Interfaces	
Voltage supply Allowed input range	11 ... 36 V DC PELV
Power input Maximum Typical	 6 W at 80 °C 3 W at 25 °C
Maximum power consumption U_{in} = 11 VDC U_{in} = 24 VDC	 550 mA 250 mA
Analog output Maximum load Precision Temperature dependence	0/4 ... 20 mA, source 500 Ω ±0.05% of full-scale value ±0,005% / °C
Serial output (2-wire, not isolated)	RS-485
Alarm/control relay	30 VAC, 1 A/ 60 VDC, 0.5 A
Serial output (NOTE: Only for maintenance)	RS-232C
Connections	Screw terminals, 0.5...1.5 mm^2 RJ45 connection for RS-232C
Display	7-segment LCD
LED	Two-colored: Red/green
Resistance between signal ground and ground	10 MΩ

10.3.5 Dimensions and mechanics

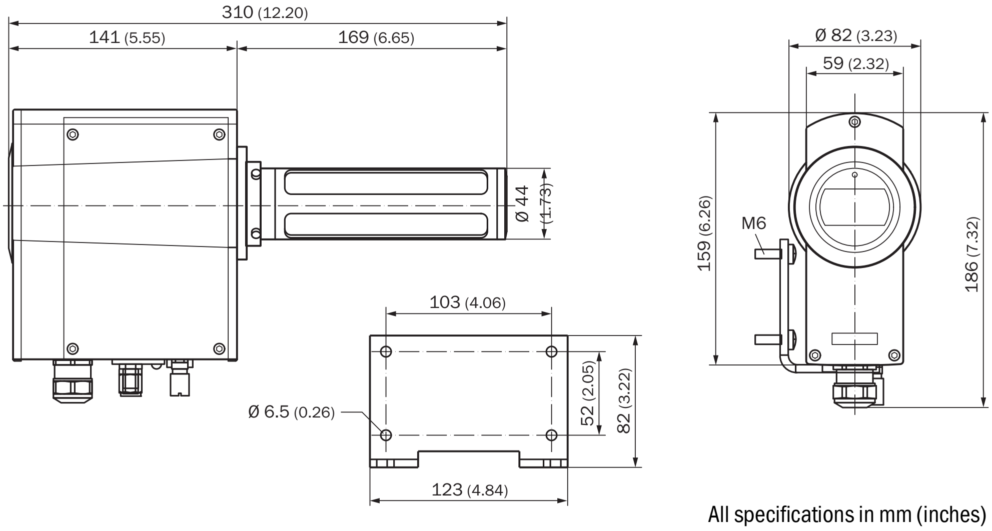
Dimensions	TRANSIC121LP transmitter
Transmitter dimensions (H × W × D)	306 × 184 × 74 mm^3 (12.05 x 7.24 x 2.91 $inch^3$)
Weight	2.2 kg (4.85 lbs)
Enclosure material	G-AlSi10Mg (DIN 1725)
Enclosure classification	IP66
Flange	Can be attached to DIN/ANSI standard flanges. Minimum flange sizes: ● DIN EN 1092 DN50: Fitted with M16 DIN 933 or similar ● ANSI ASME B16.5 (150) 2.5": Fitted with UNC 3/4"-10 or similar
Cable bushing	● Cable gland M20×1.5 ● Conduit screw fitting 1/2" NPT
Filter	● Stainless steel mesh, holes 0.31 mm, wire thickness 0.2 mm ● Hydrophobic PTFE filter, average pore size 8 µm
Materials with sample gas contact	● AISI 316 L(1.4404) ● FKM or Kalrez® Spectrum 6375 ● PTFE, SiN, MgF_2, quartz ● Polymer coating

Fig. 45: TRANSIC121LP with flange adapter for process measurements



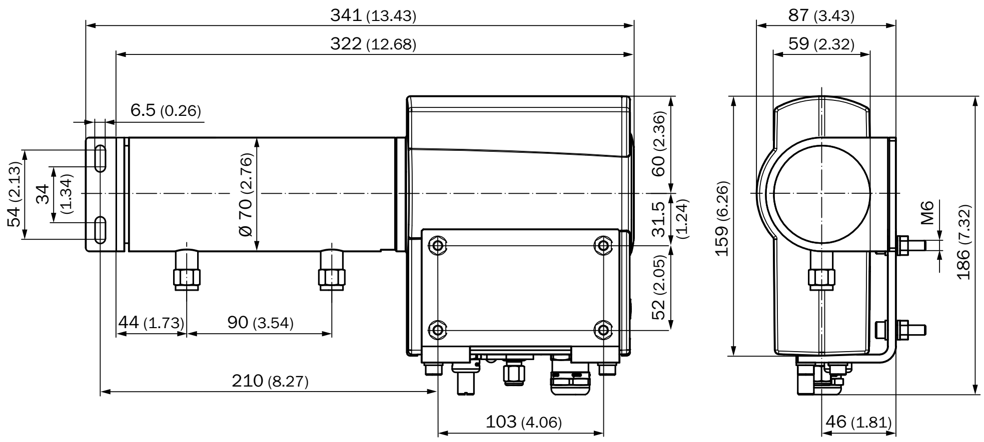
All specifications in mm (inches)

Fig. 46: TRANSIC121LP with wall bracket for ambient measurements



All specifications in mm (inches)

Fig. 47: TRANSIC121LP with wall bracket and sample gas cell, suitable for PS=10 bar *(150 psi)*



All specifications in mm (inches)

10.3.2 Measured value recording

Measuring ranges (scalable) ● Version for process measurement ● Version for ambient gas measurement	 0 ... 21% O_2 2 ... 21% O_2
Precision	±0.2% O_2
Temperature dependence in T-range	±2% of measured value, max. dT/dt 1 °C/min
Stability	Zero point drift ±0.1% O_2 / year
Measurement response time (T_{63}/T_{90}) in *still* air – without filter – with stainless steel mesh – with stainless steel mesh and PTFE	 10 s / 20 s 10 s / 25 s 30 s / 70 s
Operating pressure range	0.8 ... 1.4 bar(a) (11.6 ... 16.5 psi)
Start time	2.5 min
Warming up time (according to specification)	3 min

Display	7-segment LCD
LED	Two-colored: Red/green

10.3.3 Ambient conditions

Operation location	● Outdoors or indoors. ● No direct sunlight. Use a weatherproof cover when necessary.
Operating temperature range[1] – for probe (installed in process) – for electronics (housing) – for TRANSIC121LP (ambient air measurement)	 −20 ... 80 °C (−4 ... 176 °F) −20 ... 60 °C (−4 ... 140 °F) −20 ... 60 °C (−4 ... 140 °F)
Storage temperature range	−40 ... 80 °C (−40 ... 176 °F)
Operating pressure range (measuring condition)	0.8 ... 1.4 bar(a), (11.6 ... 16.5 psi)
Air humidity	100% r.h. non-condensing
Altitude	Up to 2000 above sea level
Electrical compliance	In accordance with DIN EN 61010-1
EMC	In accordance with DIN EN 61326-1
Safety information	Laser product of protection class 1 (IEC 60825-1:2014-05); for information on eye-safe use of the TRANSIC121LP, see Page 9.

[1] MDMT specification for Canada, see “Technical limit values for Canada”, page 93.

Wafer-Cone®

SPECIFICATION SHEET

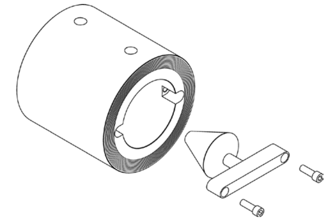
MODEL VH

Designed for Flanged Pipelines

Patent 5,814,738

DESCRIPTION AND GENERAL PERFORMANCE SPECIFICATIONS

The Wafer-Cone flowmeter is a differential pressure type flow measurement device. A cone is positioned in the center of the pipe to increase the velocity of the flowing fluid and create a differential pressure. This pressure difference can be measured and used to accurately interpret flowrate. Wafer-Cone flowmeters can be ordered with either a flanged transmitter direct mount or threaded taps for remote mounting.



Typical performance specifications:

- Accuracy: ±1.0% of rate *
- Turndown: 10:1
- Repeatability: ±0.1%
- Standard Betas: 0.45 through 0.85
- Headloss: % of Dp, varies with beta ratio
- Installation: 1-3 diameters upstream and 1 diameter downstream

Unique Features:

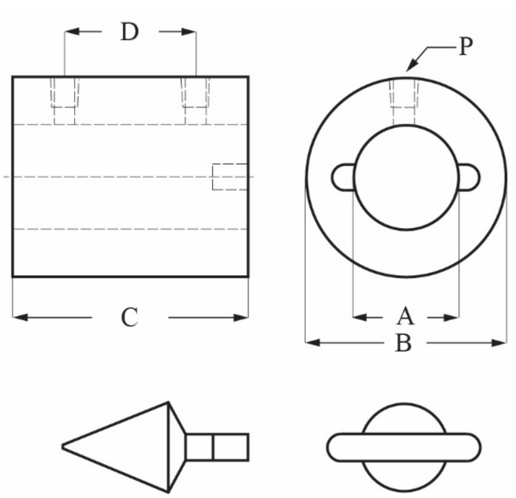
- No Welding (on remote mount option)
- Interchangeable Wafer-Cone Elements

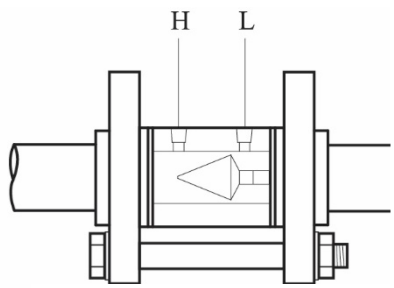
Options:

- Gas or Oil Flow Calibration

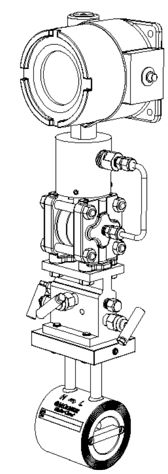
* Each Wafer-Cone is sized for the intended application. Specific performance ratings must be obtained through the sizing process.

MODEL VH





Remote Mount Wafer-Cone



Direct Mount Wafer-Cone

DIMENSION TABLE

	Remote And Direct Mount (Inches)					Remote And Direct Mount (Milimeters)					Pressure Ports	
Model	Size inch	A inch	C inch	D inch	B inch	Size mm	A mm	C mm	D mm	B mm	P NPT inch	P RC inch
VH01	1”	0.957	2.25	1.25	2.00	25	24,31	60	31.8	50.8	1/8	1/8
VH0C	1½”	1.500	3	1.7	2.88	40	38,10	80	43.2	73.5	1/8	1/4
VH02	2”	1.939	3.38	1.88	3.62	50	49,25	85	47.6	91.9	1/4	1/4
VH0D	2½”	2.323	4	2.5	4.12	65	59,00	100	63.5	104.6	1/4	1/4
VH03	3”	2.900	4.75	2.75	5.00	80	73,66	120	69.9	127.0	1/4	1/4
VH04	4”	3.826	6	3.5	6.19	100	97,18	150	88.9	157.2	1/4	1/4
VH06	6”	5.761	9.5	6.0	8.50	150	146,33	240	152.4	215.9	1/4	1/4

*Other sizes, lengths and tap specifications are available.

www.mccrometer.com

3255 WEST STETSON AVENUE • HEMET, CALIFORNIA 92545 USA

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MODEL NUMBER CONFIGURATION VH

Type	Size		-	Materials		Body Style		Bore		Fittings		Face Style	
VH	01	1”		**A**	**S316L Cone**	**1**	**Universal Body Style***	**S**	**Standard**	**N**	**NPT**	**3**	**Serrated**
	0C	1½”								F	Flanged (direct mount)		
	02	2”					*Universal body used for ANSI 150-2500# Class,DIN 2576, 2633, 2635 and JIS 10K						
	0D	2½”											
	03	3”											
	04	4”											
	06	6”											

NOTES
1. Bold items in table above are standard construction.
2. Combinations of two different materials can also be specified.
3. Plastic materials limited to sizes 1” to 3”. For other sizes please consult factory.
4. Direct mounting is limited to sizes 1” to 3”. For other sizes please consult factory.

Examples:

Model	Description
VH01-A1SN3	Wafer-Cone 1” line size, S316, ANSI Style, NPT Pressure Ports, Serrated Face
VH02-A1SF3	Wafer-Cone 2” line size, S316, ANSI Style, Transmitter Flanged For Direct mounting, Serrated Face

ABBREVIATION

NPT	National Pipe Taper

Design Pressure Limits

1500 psig: -50F to 600F
103 bar: -46C to 315C
Contact factory if other design limits are required.

Technical questions can be answered through a local representative or through our application engineers.

MANUFACTURING STANDARDS

Specific customer requirements can be complied with upon request.

Each meter is shipped with a centering device.

Non-destructive testing can include:

- Hydrostatic Pressure Testing
- Positive Material Inspection
- Dye Penetrant Weld Inspection (“F” Fittings Option Only)

ACCESSORIES

- Accessory Kit: gaskets, long bolts, and nuts
- Alternate cone for different flow range/differential.

REPRESENTED BY:

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