

**Pine Cliff Energy Ltd.**

**Pilot alt-FEMP Program  
2024 Performance Report**

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Date: 31<sup>st</sup> March 2025

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## Executive Summary

Pine Cliff Energy Ltd. (Pine Cliff) is a conventional upstream oil and gas producer in Alberta. Pine Cliff is currently implementing a pilot alternative fugitive emissions management program (alt-FEMP) to cover two full compliance years starting in 2023 and ending December 2024. The alt-FEMP was approved by the Alberta Energy Regulator on April 21, 2023 and this report satisfies the requirements held within.

For methane detection, the pilot alt-FEMP utilized Perspectum Drone Inspection Services (Perspectum) drone-mounted optical gas imaging cameras (UAV-OGI) along with close-range quantitative optical gas imaging (QOGI) for follow-up surveys. The UAV-OGI screening detected all types of emissions at the site level. Upon the identification of an emission, ground-based QOGI was deployed to further localize and quantify the emission where fugitive emissions were differentiated from vented emissions and tagged for repair.

With the Pilot alt-FEMP Program screenings and surveys completed, Pine Cliff Energy Ltd. will continue to use the data collected to track progress towards methane reduction targets and inform areas of improvement. This report summarizes data collected during the alt-FEMP screenings, follow-up OGI surveys and Control Region OGI surveys. The schedule of the program was as followed:

Facilities	Site-Level Screening	OGI Surveys	Repairs
<b>Triannual Facilities</b> (subtype codes: 401, 601, 621)	UAV-based, site-level screening by Perspectum of all triannual alt-FEMP Region facilities.  Completed 3 times per year.	Upon detecting emissions during a screening, immediate QOGI follow-up surveys are conducted for fugitive emission localization and repair.	All identified fugitives will be tagged and repaired according to Directive 060.
<b>Annual Facilities</b> (remaining subtypes)	UAV-based, site-level screening by Perspectum of all annual alt-FEMP Region facilities.  Completed 1 time per year.	Upon detecting emissions during a screening, immediate QOGI follow-up surveys are conducted for fugitive emission localization and repair.	All identified fugitives will be tagged and repaired according to Directive 060.

## 1. Screening Data

Table 1 summarizes various statistics regarding the screening campaigns across the alt-FEMP. Please note emissions detected during the screenings can be a combination of fugitive, vented and sporadic operations-related emissions. The detailed screening data is provided in an Excel attachment with this report, and the tables summarizing each site's total and individual emissions detected during each screening are provided in Appendix B and C, respectively. The screening technology did not provide rates in 2024 (there was immediate OGI follow-up) and so statistics involving screening emission rates were not possible.

*Table 1. Combined summary of screening data for 2023 and 2024.*

<b><u>Parameter</u></b>	<b><u>2023</u></b>	<b><u>2024</u></b>
Number of sites screened	146	183
Number of screened sites with detections	7	109 <sup>a</sup>
Number of detections during screenings	7	363 <sup>a</sup>
Percentage of screened sites with detections (%)	4.8%	59.6%
Average emissions per screened site with a detection (m <sup>3</sup> /day)	30.1	N/A
Total emission rate identified (m <sup>3</sup> /day)	211.0	N/A
Number of sites followed-up on	7	14 <sup>a</sup>
Percentage of sites followed-up on vs. screened (%)	4.8%	7.7%
Number of follow-up sites with no screening detections	0	0
Number of follow-up emissions with emission source not detected by the screening technology	0	0
Average time between detection and follow-up to site (days)	0.0	0.0

Percentage of follow-up sites that recurred in 2024 (%)	N/A	42%
Number of emissions from the screenings that were followed-up on	7	17 <sup>a</sup>
Number of emissions from the screenings that were followed-up and identified as fugitive emissions	7	17
Total emission rate of fugitives identified and fixed for the calendar year (m <sup>3</sup> /day)	207.4	276.4

<sup>a</sup> Sites with screening detections (109) had the emissions localized to determine if fugitives were present or not. Only sites with detections determined to be fugitives were followed up on with QOGI (14 sites with 17 fugitives detected).

## 2. Follow-up Data

Table 2 summarizes statistics regarding the OGI follow-up surveys of the alt-FEMP region conducted after a screening campaign. The raw detailed follow-up data is provided in an Excel attachment with this report.

OGI has the capability to localize emissions to a source-level. Also, the OGI operator can normally determine the emission type. Table 3 shows the emission source equipment types for all identified fugitive emissions including the number and volume of emissions for each equipment type.

Table 2. Summary of OGI follow-up data.

<b>Year</b>		<b>2023</b>	<b>2024</b>
Number of sites followed-up on for the year		7	14
Percentage of screened sites followed-up on (%)		4.8%	7.7%
Percentage of sites with screening detections followed-up on (%)		100%	100%
Percentage of follow-up sites with OGI detections		100%	100%
Number of follow-up surveys where no emissions were found		0	0
Average time between detection and follow-up to site (days)		0	0
Percentage of follow-up sites that are recurring (for the calendar year – following-up on a site more than once)		N/A	42%
Identified emission source types per follow-up per screening campaign (vent, fugitive, methane slip, other)		Fugitives	Fugitives, Vents, and Slip
Number of detections by emission source type (n)	<b>Fugitives</b>	10	17
	<b>Vents</b>	0	222 <sup>a</sup>
	<b>Slip</b>	0	124 <sup>a</sup>
	<b>Total</b>	10	363
Volume of detections by emission source type (m <sup>3</sup> /day)	<b>Fugitives</b>	207.4	317.6
	<b>Vents</b>	N/A	N/A

	<b>Slip</b>	N/A	N/A
	<b>Total</b>	207.4	317.6
Average emissions per follow-up site (m <sup>3</sup> /day)		29.6	22.7
Identified emission source equipment types per follow-up per screening campaign (e.g., tank, compressor seal)		4	7
Number of recurring leaks observed (if the leak occurred more than once per year)		N/A	0

<sup>a</sup> Vents and slip were noted in the screening data (part of the 363 screening detections) and were not quantified. Those detections have been recorded here in order to be parsed out.

*Table 3. Number and volume (m<sup>3</sup>/d) of emission detections by equipment type.*

Identified emission source equipment types	2023		2024	
	Number of detections by equipment type	Volume of detections by equipment type (m <sup>3</sup> /d)	Number of detections by equipment type	Volume of detections by equipment type (m <sup>3</sup> /d)
controlled tank				
dehydrator			1	0
flare stack				
header				
heater			1	12.4
meter				
other			2	26.9
pig sender/receiver				
pipeline - aboveground				
pipeline - buried				
pneumatic instrument	8	183.4		
pneumatic pump	1	19.8		
reciprocating compressor				
screw compressor			1	35.0
separator			3	65.2
surface casing vent				
sweetening process treater				
uncontrolled tank			2	0
vent stack				
wellhead	1	4.2	7	178.2
<b>Total</b>	<b>10</b>	<b>207.4</b>	<b>17</b>	<b>317.6</b>

## 3. Emissions Summary

### 3.1 Screening Summary

Figure 1 shows the distribution for site-total methane emission rates detected during screening campaigns in 2023, capturing all types of methane emissions (fugitives, vents, methane slip and others). The graph allows one to discern how many site-total emission measurements reported emission rates within a certain range (e.g. emissions with rates between 0 and 100 m<sup>3</sup>/day where individual emissions on a single site from one screening are summed).

Figure 2 shows the distribution for individual emission rates detected during the 2023 screening campaigns. Screening technologies are generally unable to determine the type of methane emission measured (fugitives, vents, methane slip and others), however with immediate OGI follow-up inspections, the emission type could be tied to a screening detection. The graph allows one to discern how many individual emission measurements had an emission rate within a certain range (e.g., emissions with rates between 0 and 100 m<sup>3</sup>/day).

In 2024, screening detections were not quantified (only upon the immediate follow-up) and thus there was no data to add to that from 2023.

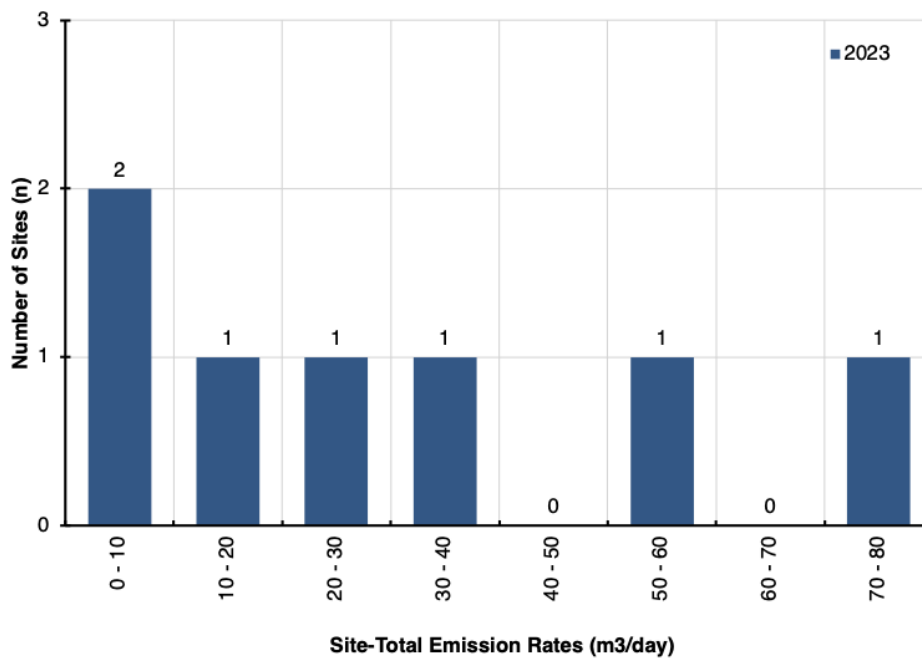


Figure 1: Distribution of site-total emission rates measured during screening campaigns.



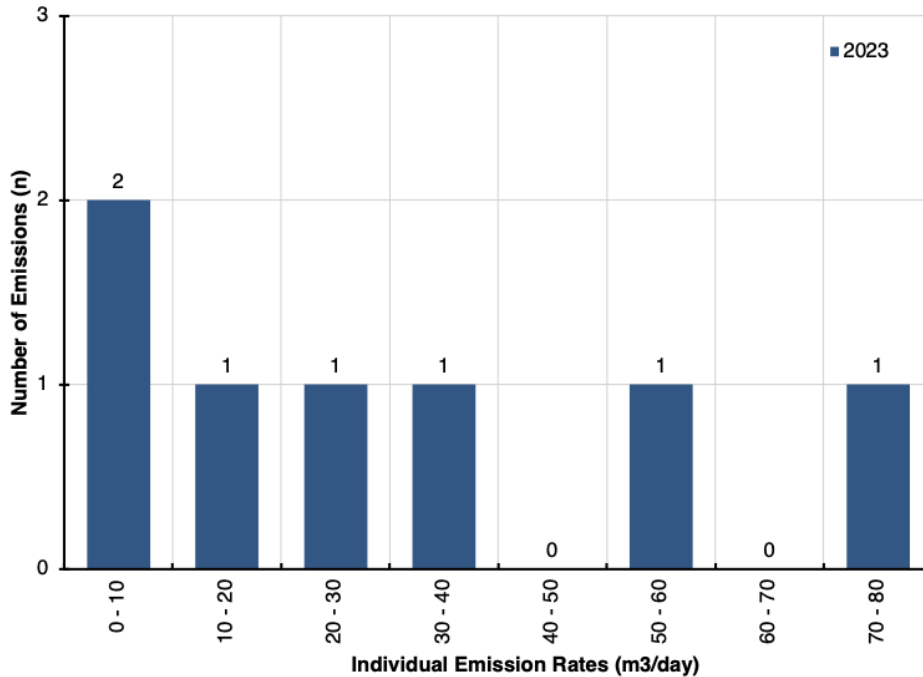


Figure 2: Distribution of individual emissions, by rate, measured during screening campaigns.

Fugitive emissions were determined immediately after screening detection but were quantified during the follow-up OGI. See Figure 5 for the distribution of fugitives.

### 3.2 OGI Survey Summary

Figure 3 shows the emission rate distribution for site-total emissions detected during OGI survey campaigns of the alt-FEMP region, aggregating all methane emissions measured during that OGI campaign. The graph allows one to discern how many site-total emission measurements, by OGI, reported an emission rate within a certain range.

Figure 4 below shows the emission rate distribution for individual emissions detected during OGI survey campaigns. The graph allows one to discern how many individual OGI measurements had an emission rate within a certain range.

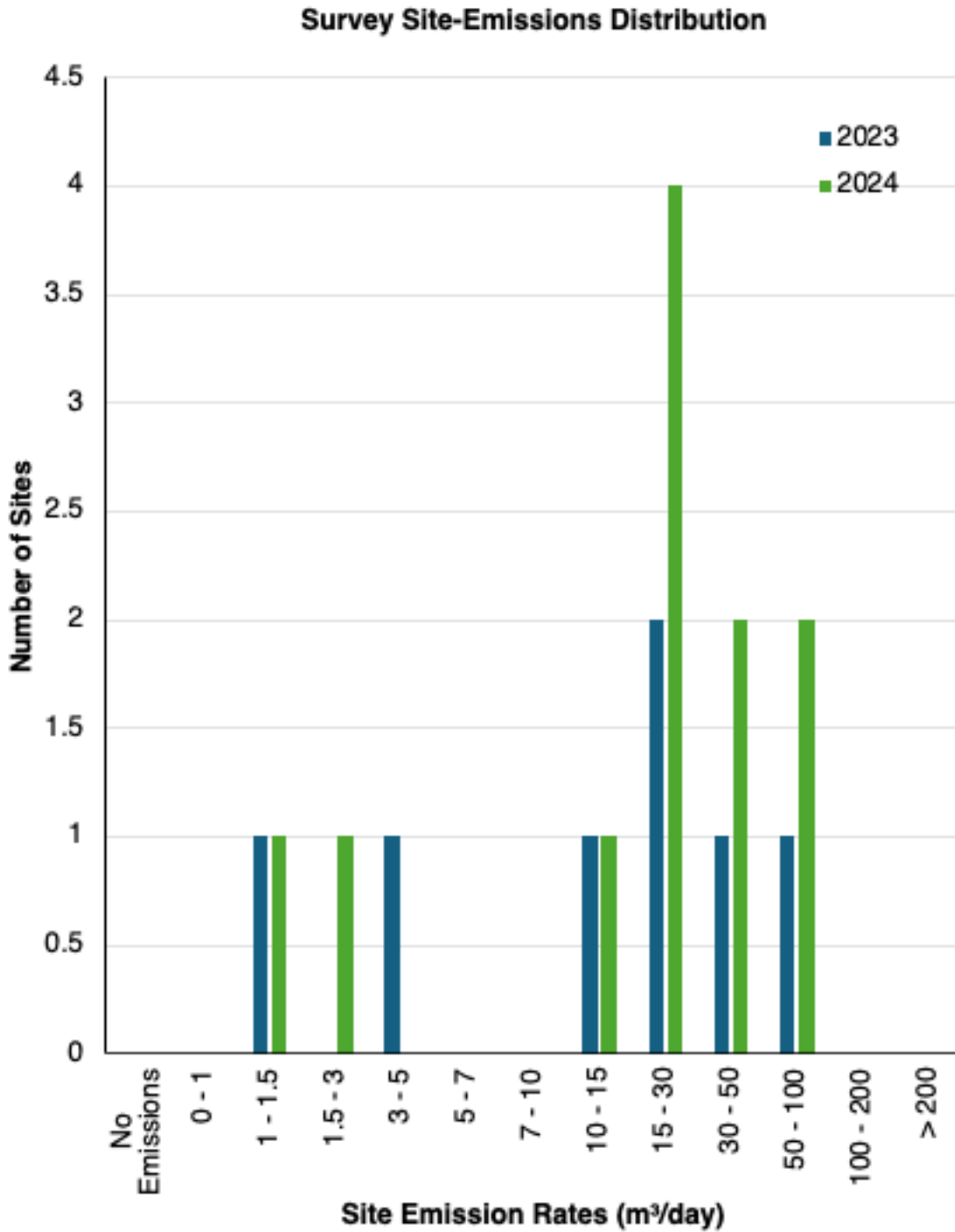


Figure 3: Distribution of site-total emission rates measured during OGI survey campaigns (e.g. follow-up and independent campaigns) of the alt-FEMP region.



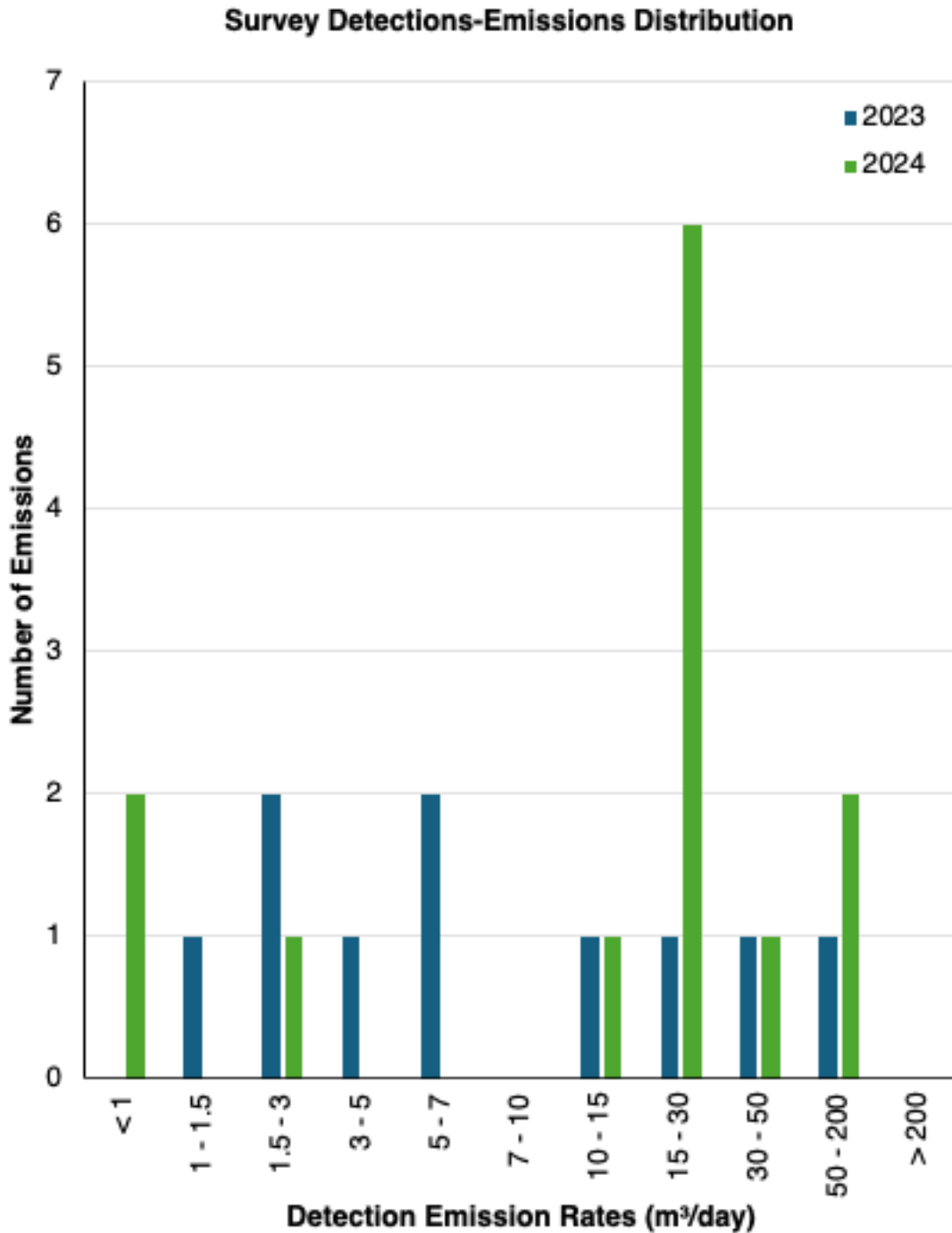


Figure 4: Distribution of individual emissions, by rate, measured during OGI survey campaigns (e.g. follow-up and independent campaigns) of the alt-FEMP region.



Figure 5 below shows the emission rate distribution for individual fugitive emissions detected during OGI survey campaigns. The graph allows one to discern how many individual fugitive emission measurements reported an emission rate within a certain range.

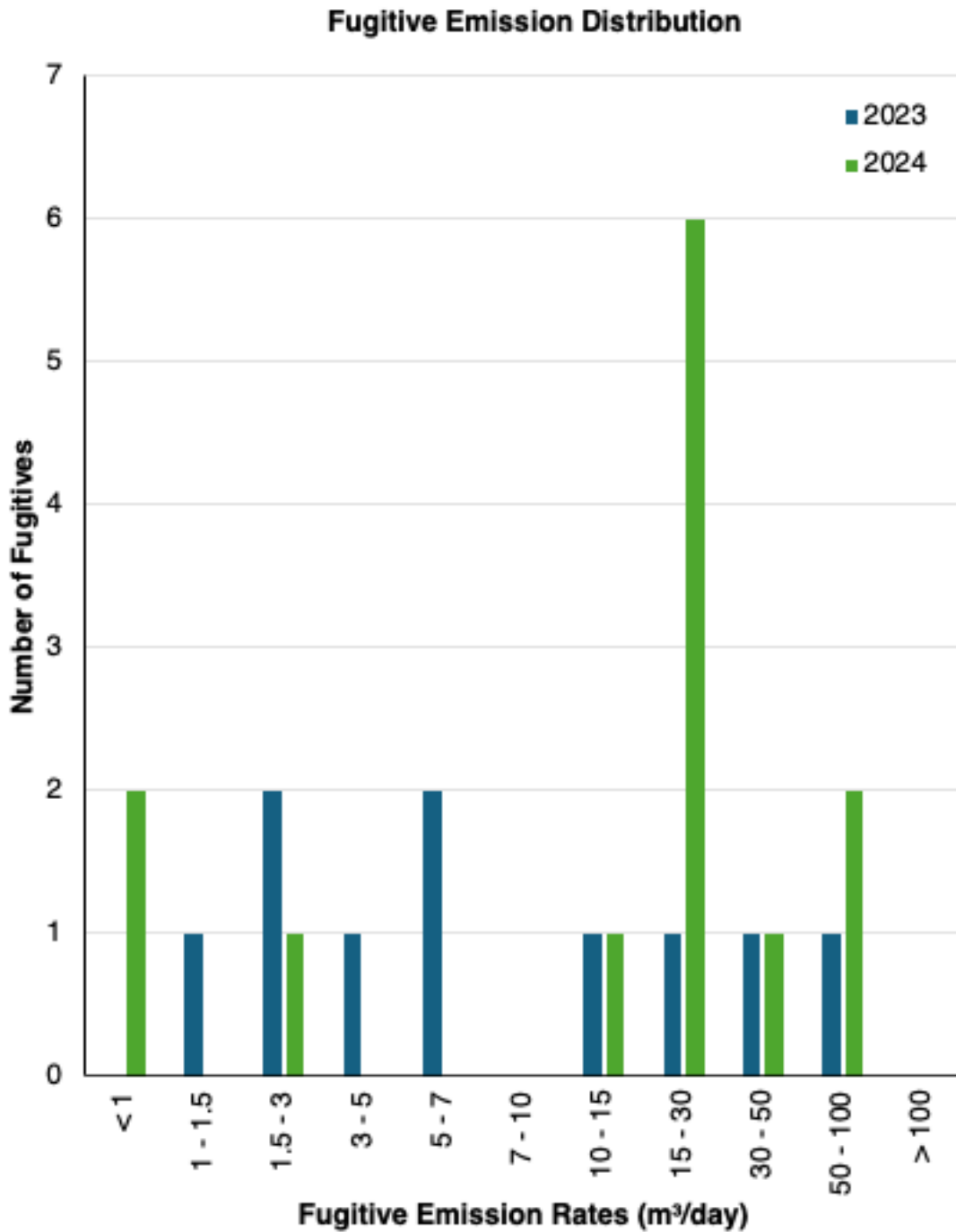


Figure 5: Distribution of fugitive emissions, by rate, measured during OGI survey campaigns (e.g. follow-up) of the alt-FEMP region.



### 3.3 Control vs. alt-FEMP Summary

Table 4 compares several metrics related to the sites surveyed and emissions detected via OGI surveys in the alt-FEMP vs. Control regions for 2024. The average rates in the table are calculated per site per survey (e.g. the control site was surveyed six times in the two years and the average of these six was taken).

*Table 4. Comparison of the alt-FEMP and Control regions in 2024.*

Item	alt-FEMP Region	Control Region
Number of sites surveyed	14	4
Number of sites in region with emissions detected via OGI	14	4
Percentage of sites in region with emissions detected via OGI (%)	100%	100%
Number of sites in region with fugitives detected via OGI	17	5
Percentage of sites in region with fugitives detected via OGI (%)	14	4
Number of fugitives and vents detected via OGI in region	100%	100%
Number of fugitives detected via OGI in region	17	5
Number of vents detected via OGI in region	#N/A	#N/A
Total emission rate for region's detected emissions (m <sup>3</sup> /day)	318	280
Total emission rate for region's detected fugitives (m <sup>3</sup> /day)	318	280
Total emission rate for region's detected vents (m <sup>3</sup> /day)	#N/A	#N/A
Average emission rate per site with emissions (m <sup>3</sup> /day)	22.7	70.1
Average fugitive rate per site with fugitives (m <sup>3</sup> /day)	22.7	70.1

Average emission rate for region's detected fugitives (m <sup>3</sup> /day)	18.7	56.0
Number of region's fugitives repaired in a given year	15	5
Percentage of region's fugitives repaired in a given year (%)	88%	100%
Average Time to Repair (days)	56	58

#### 4. Emission Reduction Summary

The fugitive emission data collected during the alt-FEMP was used to generate the as-found “measured fugitive emission distribution”. This consisted of all fugitive emissions recorded during surveys of both the alt-FEMP. Figure 6 shows a comparison of the as-found “measured fugitive emission distribution” to the “assumed fugitive emission distribution” employed in the modelling initially used to design the approved alt-FEMP. Additionally, the minimum detection limit (MDL) at 90% probability of detection (PoD) for the screening technology is displayed for reference.

A default Directive 060 FEMP program and the executed Pine Cliff Energy Ltd. program were re-modelled using the as-found fugitive distribution using the AroFEMP software (Arolytics). The traditional default FEMP was predicted to emit 14% less than the alt-FEMP. As can be seen in Figure 6, the as-found distribution would need supplementation for proper re-modelling of the programs. The as-found distribution also contained many less large fugitive emissions.

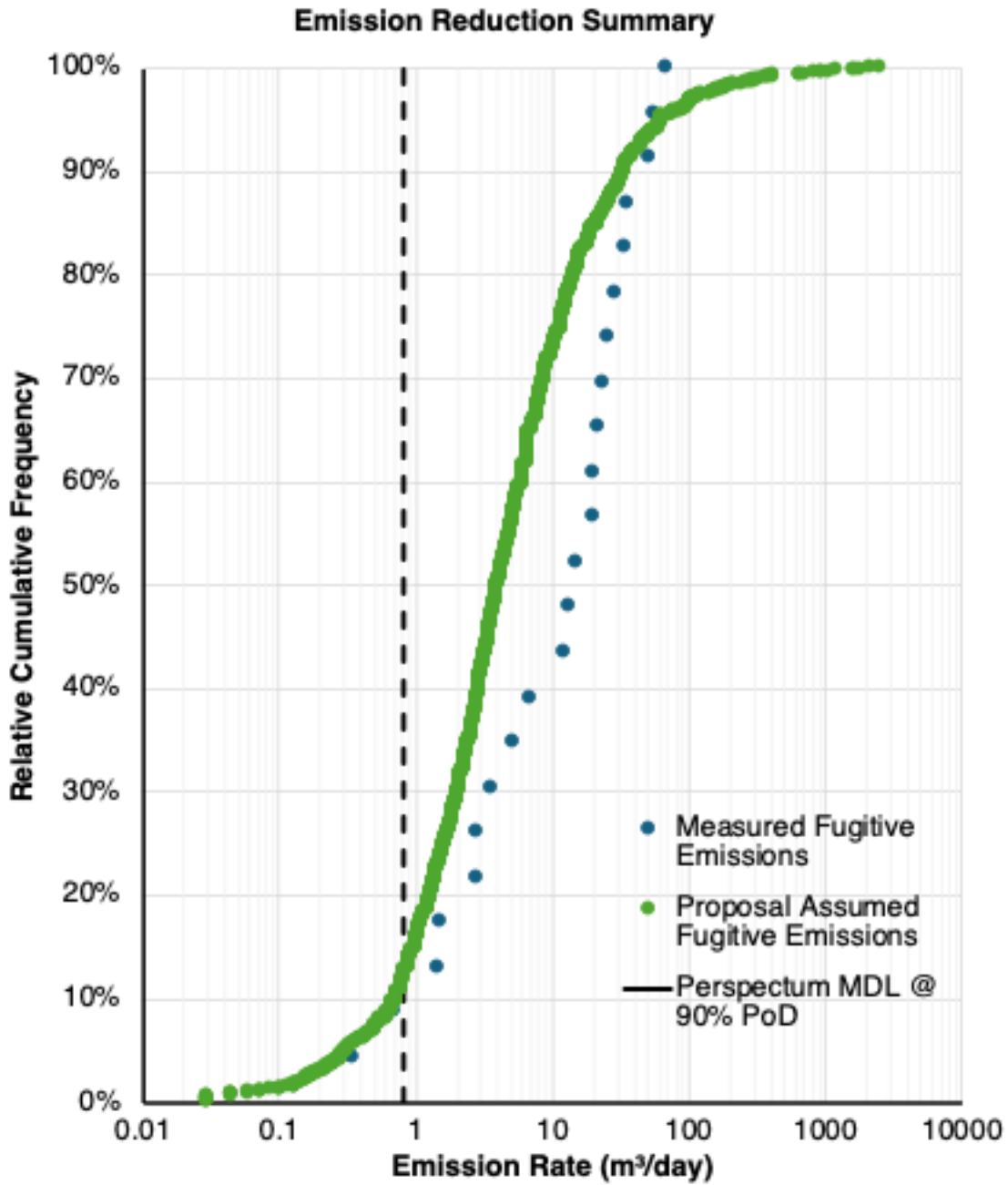


Figure 6. Comparison of relative cumulative frequencies for the “as-found” measured fugitive emissions versus the proposal-assumed fugitive emissions.

## 5. Technology Limitations

The drone-mounted OGI has all-season capability in that it can function on snow-covered terrain. Our field-testing has also proven the OGI capable of identifying the smallest of industry standard, buried pipeline leaks. UAV OGI mounted platform cannot safely operate in winds higher than 40kph, high wind speeds could destabilize the aircraft. Temperatures below -10 degrees Celsius could cause ice buildup on the propellers. The UAV uses fully electric motors to drive the propellers, due to this design any precipitation could cause a failure in these motors. Sources of high electromagnetic/signal interference such as high-tension power lines, cell towers or antenna arrays can interfere with video feed/control inputs between the UAV and the controller operated by the pilot, these must be considered, but can be quickly and easily overcome by repositioning the UAV.

## 6. Success of the alt-FEMP

The alt-FEMP was designed to meet methane emission equivalency to a default FEMP using alternative site screening technologies combined with OGI surveys. The execution of this program had been successfully completed until the last screening campaign was missed by the vendor.

## 7. Nonperforming Program Elements

In 2023, one site was not given permission to fly the drone due to proximity to a prison. This site was moved to undergo ground-based OGI only moving forward. The reporting for 2023 campaigns was also delayed but through conversations with the AER, an allowance was granted to submit by July 31, 2024.

In 2024, the third screening and follow-up of triannual facilities (as per Manual 011) were not completed. The weather limitations of the drone and the proximity to the end of the calendar year contributed to this as cold temperatures and precipitation meant the drone was unable to fly.

## 8. Additional Control Measures

Following 2023 campaigns, the vendor was asked to improve the recording of venting information resulting in a much larger number of detections for 2024.

## 9. Additional Information

N/A

## 10. Key Performance Indicators

- Pine Cliff Energy Ltd. was successful in implementing alternative technologies to conduct LDAR screening, where emissions were detected at 116 of the 329 screened sites.
- In 2023 and 2024, a total of 525.0 m<sup>3</sup>/day of methane fugitives was found to be emitting by screening technologies on 27 detections.
- 15 of the 17 fugitives were repaired in 2024 (88%). Some repairs require shutdowns, may have been currently underway at the time of this report, or have not been updated in tracking systems.
- A comparison of the alt-FEMP and control regions can be found in Table 4.
- On average, leak repairs were completed 56 days after an OGI follow-up under the alt-FEMP. In the Control Region, on average, leak repairs were completed 58 days after an OGI survey.

## Appendix A: Raw Detailed Data

Please refer to the attached excel file of the raw data collected during the screening and follow-up surveys titled “PineCliff 2024 femp-screening-data.xlsx”.

## Appendix B: Screening Data – Site-total Emissions by Campaign

See attached “PineCliff AER-altFEMP-PerformanceReport-Appendix.xlsx”. Note that truck screenings are typically just given as a site-total rate and not individual detections.

## Appendix C: Screening Data – Individual Emissions

See attached “PineCliff AER-altFEMP-PerformanceReport-Appendix.xlsx”. Note that truck screenings are typically just given as a site-total rate and not individual detections.