Sundre Petroleum Operators Group (SPOG) Alternative Fugitive Emissions Management Pilot Program Performance Report

Submitted by:
Tracey McCrimmon, Sundre Petroleum Operators Group

March 31, 2023

Table of Contents

Figures & Tables

Executive Summary

The 2-year pilot alternative Fugitive Emissions Management Program (alt-FEMP) for the Sundre Petroleum Operators Group (SPOG) successfully utilized alternative technologies to cost-effectively locate and mitigate 737,036.55 m^3 of fugitive emissions. This equates to a 14.4% reduction from a baseline (no LDAR) scenario, according to Arolytics' most recent modelling. With this, the participating operators were able to make positive contributions regarding emissions reductions while reducing costs relative to implementing a default FEMP in Alberta.

Area-based LDAR programs are not without challenges. Most participating operators needed to manage two methane programs: SPOG's alt-FEMP as well as a default FEMP prescribed by Alberta Energy Regulator (AER) Directive 060 for the remainder of their Alberta assets. In general, tracking leak repairs in a timely fashion proved difficult. This could be mitigated by deploying just one leak-detection company for the SPOG area. As well, the program administrator's role could incorporate compliance assurance to increase awareness, success, and operator responsibilities amongst participating operators.

Background

Funded by the Alberta provincial government in 2020, the SPOG Methane Emission Management Program (MEMP) involves the systematic evaluation of alternative methane detection and quantification technologies relative to conventional technologies currently prescribed in regulation. A primary objective of the MEMP was to develop and receive regulatory approval for an area-based alt-FEMP for producers operating in the Sundre region of Alberta, where SPOG exists. The program was designed to involve multiple companies, lead to the wide-spread deployment of innovative emissions detection technologies across the province, and mitigate emissions similarly to or better than traditional (OGI-based) leak detection and repair (LDAR) methods at a reduced cost. In 2021, SPOG was granted approval from the AER to conduct a 2-year pilot alt-FEMP from January 2021 – December 2022.

Introduction

SPOG is a grassroots not-for-profit society that responds to the interests and concerns of the residents, landowners, and industry operators in the Sundre region. In this region, 32 producers own and operate 505 upstream oil and gas facilities located on 398 sites (according to 2020 data). The pilot alt-FEMP included 12 SPOG producers, listed below in Table 1, who each signed an AMEP Pilot Participation Agreement.

Table 1. Companies participating in SPOG's alt-FEMP.

Company Name
ALTAGAS LTD. (AltaGas)
BONAVISTA ENERGY CORP. (Bonavista)
CERTUS OIL AND GAS INC. (Certus)
ENERCHEM INTERNATIONAL INC. (Enerchem)
LOYAL ENERGY (CANADA) OPERATING LTD. (Loyal)
HARVEST OPERATIONS CORP. (Harvest)
INSIGNIA ENERGY LTD. (Insignia)
KEYERA ENERGY LTD. (Keyera)
PIERIDAE ENERGY LTD. (Pieridae)
PLAINS MIDSTREAM CANADA ULC (Plains)
TAQA NORTH LTD. (TAQA)
WHITECAP RESOURCES INC. (Whitecap)

The participating producers account for the majority of sites in the SPOG region, collectively operating 399 facilities across 363 legal subdivisions during the pilot period. Notably, there were numerous acquisitions and mergers that took place in the SPOG region during the pilot period, including participating producers Sitka Exploration Ltd. (Sitka) and Timberrock Energy Corp. (Timberrock) being acquired by Certus and Whitecap, respectively. With this, all information in this report pertaining to Sitka or Certus will be attributed solely to Certus, while all information in this report pertaining to Timberrock or Whitecap will be attributed solely to Whitecap. Whitecap also acquired NAL Resources Ltd. (NAL), a participating producer who also signed an AMEP agreement, prior to the program's start, and the acquired assets were added to the alt-FEMP program under Whitecap's ownership. The alt-FEMP's results reflect all changes resulting from the mentioned acquisitions.

Beginning in 2020, truck-based and aerial-based emissions detection technologies have been piloted throughout the SPOG region. Releases of methane were detected and quantified, and a comprehensive collection of methane release data as well as a source equipment inventory were created. Over 1,580 individual methane measurements were collected using a combination of alternative and default (i.e., OGI, high-flow sampler, etc.) technologies. These proactive measurements enabled SPOG to quantify baseline methane emissions, become familiar with available alternative technologies including how to implement them, and collect data to support emissions modelling as well as a pilot alt-FEMP application.

A third-party analytics company, Arolytics, was contracted by SPOG to conduct methane emissions modelling and provide alt-FEMP application support in 2020 and 2021, as well as alt-FEMP performance evaluation/report writing in 2022 and 2023. A proprietary methane emissions and repair simulation model was used to estimate methane emissions reductions that result from implementing numerous different LDAR programs and assess each program's technical, economic, and regulatory compliance viability at scale. Nearly 200 LDAR programs were modelled to determine an optimal program for SPOG, considering cost abatement opportunities and emissions reductions in the context of the MEMP. The model incorporated attributes of oil and gas production infrastructure in the Sundre area, company-specific information regarding methane leaks and repair practices, and historical SPOG MEMP data collected in 2020 from OGI, aerial, and truck-based technologies.

The selected alternative program involved deploying one Bridger aerial-based survey and one ExACT truck-based survey annually over the course of the 2-year pilot program. These surveys captured both vented and fugitive emissions at the site level, occurred more than 3 months apart and Bridger specifically was deployed in snow-free months. Following each Bridger or ExACT campaign, each producer's sites were ranked according to site-level emissions to determine their highest emitting sites. Then, a predetermined percentage of these sites were followed-up with using OGI technology for leak localization and repair. The selected program had the following follow-up thresholds:

- Screening campaign 1 (Q2, 2021): 40% follow-up,
- Screening campaign 2 (Q4, 2021): 25% follow-up,
- Screening campaign 3 (Q2, 2022): 20% follow-up, and
- Screening campaign 4 (Q4, 2022): 15% follow-up.

Follow-up thresholds operated on a per-company basis, meaning all participants were responsible for follow-ups at the same percentage of their respective sites. The OGI follow-up surveys allowed for fugitive emissions to be differentiated from vented emissions so that fugitive sources could be tagged and recorded for repair, while vented emissions were recorded for potential future reduction programs. Once a leak had been localized at a follow-up site, its repair was to abide by AER Directive 60 timelines.

Modelling

Based on modelling efforts from 2020 that were used to build the alt-FEMP application, this program was estimated to achieve emissions reductions of 50.4% from the baseline (no LDAR) scenario and improve emissions reductions compared to the default (OGI-based) scenario by 4.5% from the baseline at a reduced cost over the 2-year pilot period. Re-modelling was conducted in Spring 2022, taking into consideration SPOG's pilot program data collected throughout 2021, and the results indicated that the alt-FEMP would reduce emissions by 56.9% from the adjusted baseline scenario and achieve just 3.5% less emissions reductions than the adjusted default scenario but still at a reduced cost.

While conducting data analyses for this report, it was decided that adjusting the fugitive emissions baseline modelled in 2022 was the best option for evaluating the program's actual performance given the improved accuracy and site representation associated with using updated data from the entire pilot period. Further, rather than modelling another default or alt-FEMP scenario using this newly-adjusted baseline, estimated emissions reductions were calculated by dividing up the baseline emissions based on facility type (annually vs. triannually-surveyed facilities under a default program) and applying 40% and 70% reductions (depending on the facility type) to simulate a generic default program according to the AER. This most recent baseline and its associated emissions reduction estimates were used to evaluate SPOG's alt-FEMP in this report.

To summarize, three fugitive emission baselines along with three different sets of emissions reduction estimates were produced for SPOG's alt-FEMP. The baselines and reduction estimates improved each time, meaning that those produced in 2023 reflect reality the most accurately. The table below outlines the different baselines that were modelled in 2020, 2022 and 2023 to show how they changed and improved over time.

Table 2. Each participant's fugitive emissions baseline modelled in 2020, 2022 and 2023.

Company	Baseline Emissions Modelled in 2020 (m^3)	Baseline Emissions Modelled in 2022 (m^3)	Baseline Emissions Modelled in 2023 (m^3)
ALTAGAS	119,058	497,182	747,598
BONAVISTA	1,661,414	927,073	814,241
CERTUS	1,857,270	704,443	436,119
ENERCHEM	37,080	13,154	10,964
HARVEST	404,773	143,147	105,436
INSIGNIA	235,211	70,575	45,936
KEYERA	42,584	25,142	27,975
LOYAL	1,256,232	452,880	325,455
PIERIDAE	288,605	77,389	185,596
PLAINS*	118,093	28,806	19,900
TAQA	3,201,919	1,486,002	775,614
WHITECAP	3,610,720	3,518,368	1,625,166
Total	**12,832,959**	**7,944,161**	**5,120,000**

*Plains' baselines produced in 2022 and 2023 were built from program data that showed no leaks at their facilities, which resulted in a more representative Day 0 fugitive emissions baseline and fugitive emissions baseline frequency of 1 and 1%, respectively. However, historical LDAR data collected prior to 2021 was used to produce Plains' leak distribution profile in both instances, and so their fugitive emissions baselines for the length of the program likely included a higher number of leaks/fugitive emissions than what actually occurred during the pilot period. In summary, Plains' second and third baselines shown above are more representative of the current reality than the first but may be overestimations that would subsequently overestimate any modelled emissions reductions.

Performance Results

Based on all pilot program data that was collected throughout the 2-year period, SPOG's alt-FEMP program saw actual emissions reductions of 737,036.55 m^3; a reduction of 14.40% from the total fugitive emissions baseline. These experienced emissions reductions equate to 32.76% of the reductions that would result from a generic default scenario where reductions of 40% and 70% from the baseline occur at annually and triannually-surveyed facilities respectively.

Table 3. Each participant's fugitive emissions baseline, estimated emissions reductions from a generic default scenario and emissions reductions achieved through the alt-FEMP.

Company	Fugitive Emissions Baseline (m^3)	Total Estimated Emissions Reductions From a Generic Default Program (m^3)	Achieved Emissions Reductions (m^3)	% of Estimated Reductions Achieved
AltaGas	747,598	451,350.44	169,458.25	37.54
Bonavista	814,241	337,211.82	3,400.85	1.01
Certus	436,119	174,447.74	32,221.81	18.47
Enerchem	10,964	4,385.47	4,795.06	109.34
Harvest	105,436	42,174.24	601.20	1.43
Insignia	45,936	18,374.35	242.35	1.32
Keyera	27,975	11,189.82	51,378.62	459.16
Loyal	325,455	130,182.14	0.00	0.00
Pieridae	185,596	74,238.51	0.00	0.00
Plains*	19,900	12,465.04	0.00	0.00
TAQA	775,614	310,245.74	34,433.78	11.10
Whitecap	1,625,166	683,864.92	440,504.63	64.41
Total:	**5,120,000**	**2,250,130.24**	**737,036.55**	**32.76**

*Plains had 0 detected leaks which explains their absent emissions reductions. With this, their 0% of estimated reductions achieved can likely be explained by an overestimated fugitive emissions baseline and subsequently overestimated emissions reductions expected from a generic default program (described below Table 2).

To summarize, 2,250,130.24 m^3 of fugitive emissions were estimated to be reduced by the program, but only 737,036.55 m^3 or 32.76% of estimated reductions were achieved. The received records/data revealed many non-repaired leaks, and so considerably more reductions could have been achieved if more leak repairs were performed. Additionally, some unachieved reductions may have resulted from the OGI follow-ups potentially not detecting (and tagging for repair) some of the larger leaks that were detected by Bridger, due to the OGI technology's detection limits. Given that data from the first Bridger screening was used to build the baselines, any large leaks that were missed by OGI follow-ups but detected by Bridger (as a single emission rate combining leaks and/or vents) would result in fewer confirmed leaks and presumably fewer repaired leaks than what was possible, which limits one's ability to achieve the estimated emissions reductions (which are relative to the baselines).

Conclusion

This report serves to evaluate and discuss the performance of SPOG's completed 2-year pilot program and will help guide decisions surrounding SPOG's LDAR efforts going forward. It includes all necessary components as outlined by the AER.

Section 1: General Alternative Program Details

a) Submitter contact information and identification of all participants:

Sundre Petroleum Operators Group (SPOG):

- Tracey McCrimmon, Executive Director, SPOG
  tracey.mccrimmon@spog.ab.ca

- Wayne Heikkinen, Treasurer, SPOG
  heikkiw@preparefirstem.onmicrosoft.com

- Wayne Hillier, Vice President, Modern West Advisory Inc.
  whillier@modernwestadvisory.com

Company Name
ALTAGAS LTD. (AltaGas)
BONAVISTA ENERGY CORP. (Bonavista)
CERTUS OIL AND GAS INC. (Certus)
ENERCHEM INTERNATIONAL INC. (Enerchem)
LOYAL ENERGY (CANADA) OPERATING LTD. (Loyal)
HARVEST OPERATIONS CORP. (Harvest)
INSIGNIA ENERGY LTD. (Insignia)
KEYERA ENERGY LTD. (Keyera)
PIERIDAE ENERGY LTD. (Pieridae)
PLAINS MIDSTREAM CANADA ULC (Plains)
TAQA NORTH LTD. (TAQA)
WHITECAP RESOURCES INC. (Whitecap)

Measurement Service Providers:

- Bridger Photonics (Bridger): Kerry Neal, Accounts Manager
  Kerry.Neal@bridgerphotonics.com

- ExACT Truck-Based Technology: Jennifer Bailie, Emissions Monitoring Coordinator
  jennifer.baillie@geoverra.com

- OGI Services – OGI service providers were contracted individually by each SPOG participant

Emissions Modeling and Program Data Support:

- Arolytics: Matthew Rygus, Emissions Analyst
  matthew.rygus@arolytics.com

b) Proposal type:

SPOG applied for a 2-year, 'area-based' pilot alt-FEMP that was undertaken from January 2021 to December 2022.

c) Area of program coverage:

For the purposes of their alt-FEMP, SPOG had 399 facilities across 363 sites during the pilot period that qualified under Directive 60.

No Control Region was established for SPOG's alt-FEMP.

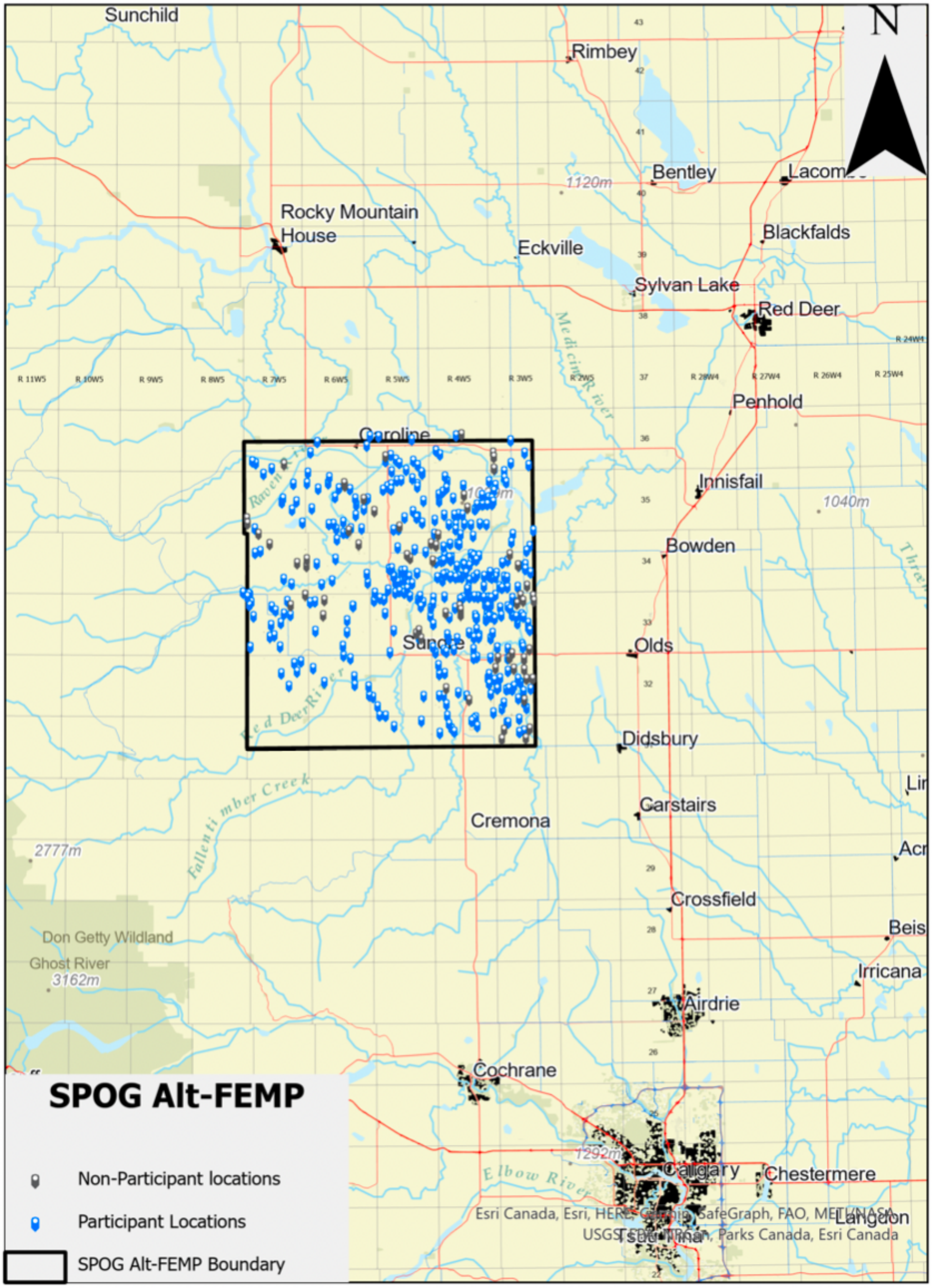


Figure 1. Map displaying SPOG's alt-FEMP sites.

d) List of all facilities and wells included in the program, along with associated facility IDs

Please see Appendix A for a full list of the applicable SPOG facilities. An Excel document containing this information is also attached to this report.

e) Summary of alternative program deployment

The following is a summary of the 2-year (January 2021 – December 2022) alt-FEMP's deployment:

Step 1	**Screen**	Site-level screening was conducted. The selected alternative program deployed 4 screening campaigns over the course of the program: 1) Bridger, Q2 2021, 2) ExACT, Q4 2021, 3) Bridger, Q2 2022, and 4) ExACT, Q4 2022. The screening technologies captured both vented and fugitive emissions. Screening campaigns occurred more than 3 months apart, and Bridger was deployed in snow-free months.
Step 2	**Rank**	Following each screening campaign, each producer's sites were ranked according to site-level emissions to determine their highest emitting sites. A predetermined percentage of these sites were followed-up with using OGI technology for leak localization and repair. The selected program had the following follow-up requirements after each screening event, which applied to every producer: o Screening campaign 1 (Q2, 2021): 40% follow-up, o Screening campaign 2 (Q4, 2021): 25% follow-up, o Screening campaign 3 (Q2, 2022): 20% follow-up, and o Screening campaign 4 (Q4, 2022): 15% follow-up. To clarify, these follow-up requirements operated on a per-company basis, meaning all operators were responsible for follow-ups at the same percentage of their respective sites.
Step 3	**Follow-up**	Follow-up emissions localization occurred on the ground at the emitting sites outlined in Step 2. Here, fugitive emissions were differentiated from vented emissions. Fugitive emissions were then tagged and recorded for repair, while vented emissions were recorded for potential future reduction programs.
Step 4	**Repair**	At the follow-up sites, all fugitive repairs were to be made according to AER Directive 60 timelines once a fugitive leak had been localized.

Based on all pilot program data that was collected throughout the 2-year period, SPOG's alt-FEMP program saw actual emissions reductions of 737,036.55 m^3. Table 4 below outlines the achieved emissions reductions for each participant and in total.

Table 4. Achieved emissions reductions for each participant and in total.

Company	Achieved Emissions Reductions (m^3)
AltaGas	169,458.25
Bonavista	3,400.85
Certus	32,221.81
Enerchem	4,795.06
Harvest	601.20
Insignia	242.35
Keyera	51,378.62
Loyal	0.00
Pieridae	0.00
Plains*	0.00
TAQA	34,433.78
Whitecap	440,504.63
Total:	**737,036.55**

*Plains had 0 detected leaks which explains their absent emissions reductions.

Section 2: Alternative Program's Performance Data

An Excel spreadsheet providing extensive details about every survey/screening is provided alongside this report. Below is a summary of the data provided in the spreadsheet.

a) Provide survey and screening details

Types and Dates of Surveys/Screenings:

Screening #1: Bridger Aerial Screening, May 31 – June 6, 2021
Follow-Up OGI Survey #1: May 5 – October 10, 2021*

*May 5 – June 6 saw earlier than expected OGI surveys conducted by AltaGas and Keyera, while the majority of the program's first round of OGI surveys occurred from June 27 – October 10 as expected.

Screening #2: ExACT Truck Screening, November 9 – 20, 2021
Follow-Up OGI Survey #2: December 6, 2021 – January 14, 2022

Screening #3: Bridger Aerial Screening, May 22 – 27, 2022
Follow-Up OGI Survey #3: June 17 – July 13, 2022

Screening #4: ExACT Truck Screening, September 13 – 27, 2022
Follow-Up OGI Survey #4: October 12 – November 15, 2022

Summary of Screening Data:

Number of sites screened: 372 facilities across 350 legal subdivisions/sites

Number of sites emitting: 370 facilities across 348 legal subdivisions/sites

Number of total emission sources identified: 784 sources of either fugitive or vented emissions were identified at the site level via alternative technologies; 1771 sources of either fugitive or vented emissions were identified at the component level.

Average time between leak (emissions) detection and follow-up survey: 41.66 days

b) Provide follow-up survey details including trends observed for fugitive leaks

Summary of Follow-Up Surveys:

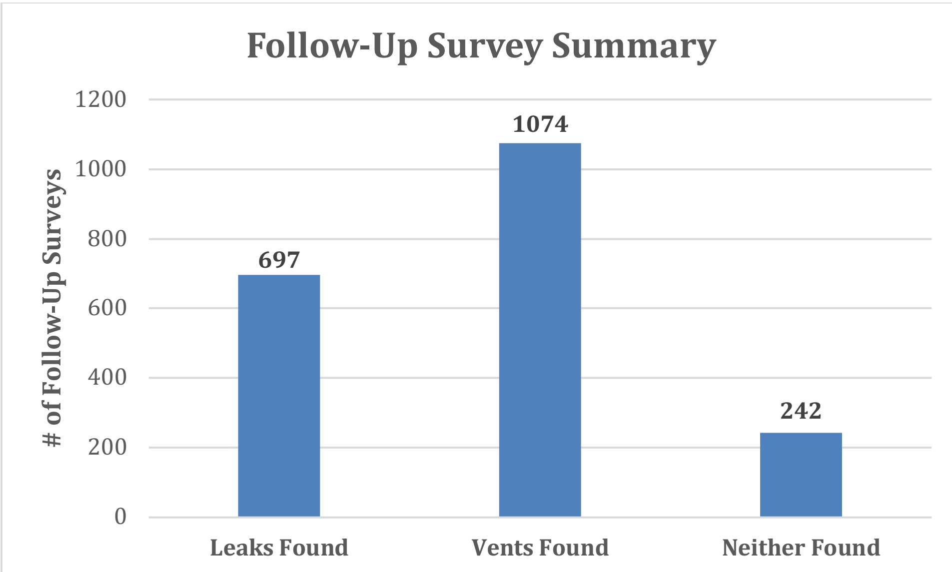


Figure 2. Follow-up survey summary showing the number of surveys with leaks found, vents found and neither found.

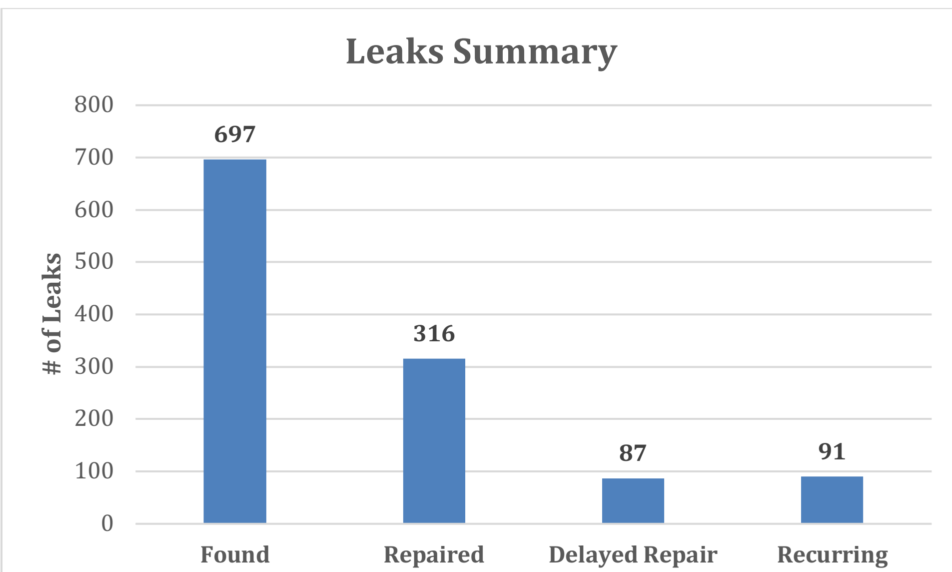


Figure 3. Leaks summary showing the number of leaks found, repaired, having a delayed repair and recurring.

Average time between survey and repair: 47.30 days

<u>Analysis of Fugitive Leak Trends:</u>

Analysis of trends in emitting site types:

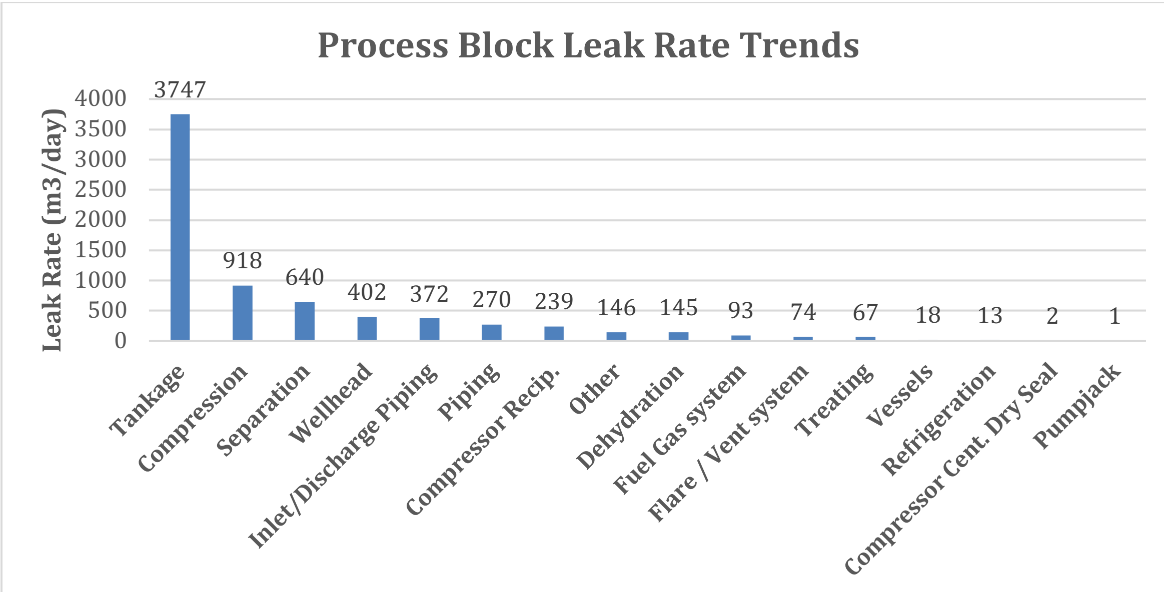


Figure 4. Leak rate trends based on process block type.

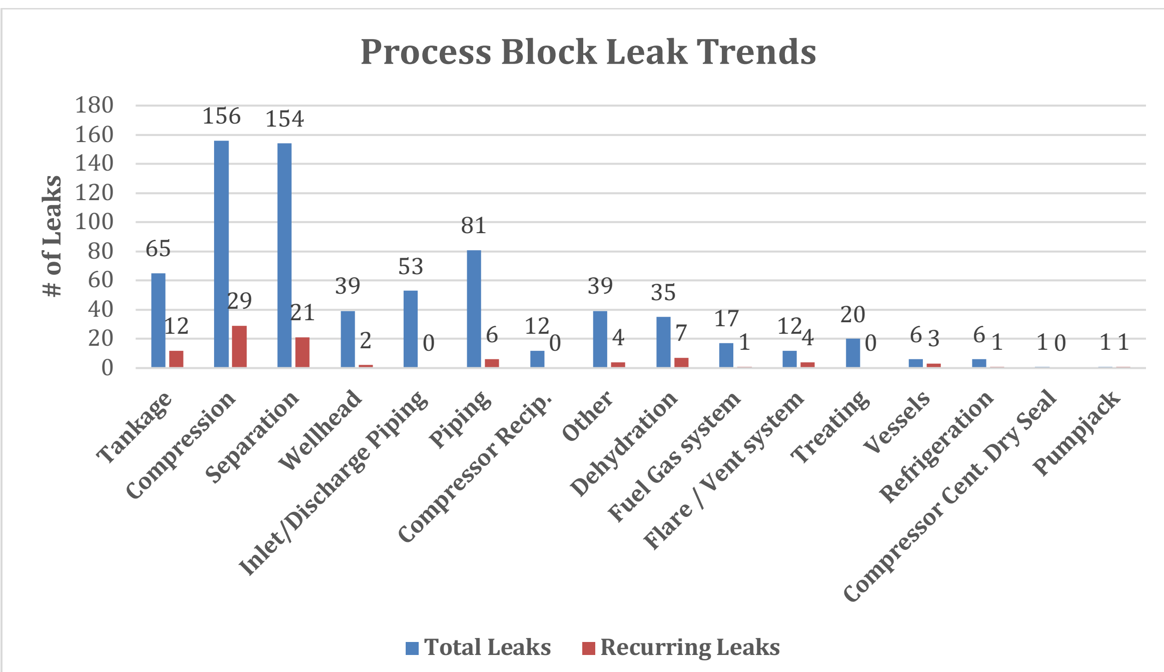


Figure 5. Leak trends based on process block type.

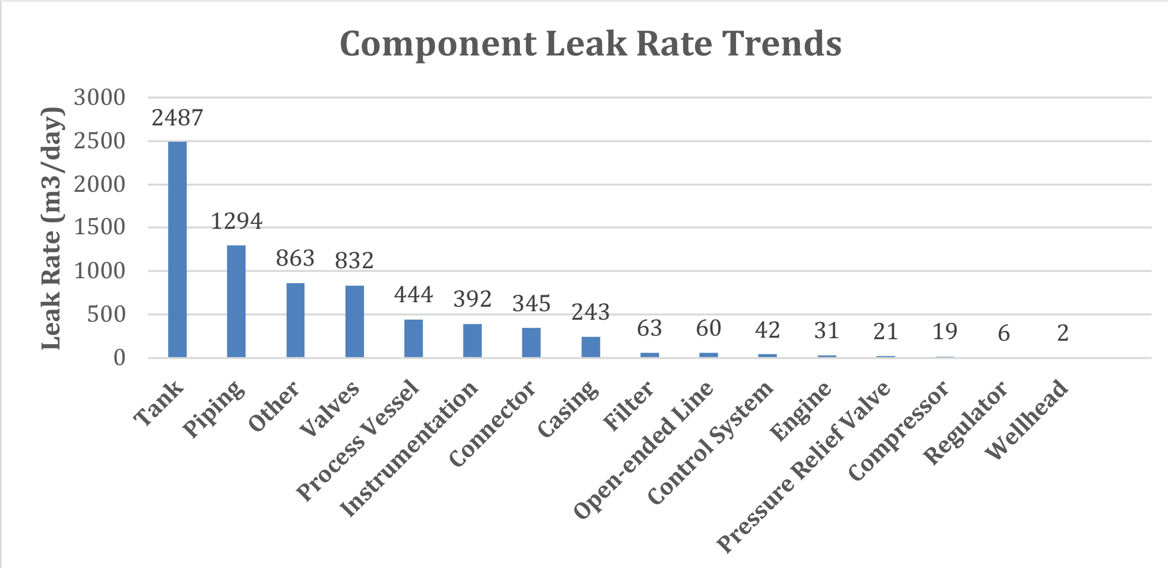


Figure 6. Leak rate trends based on component type.

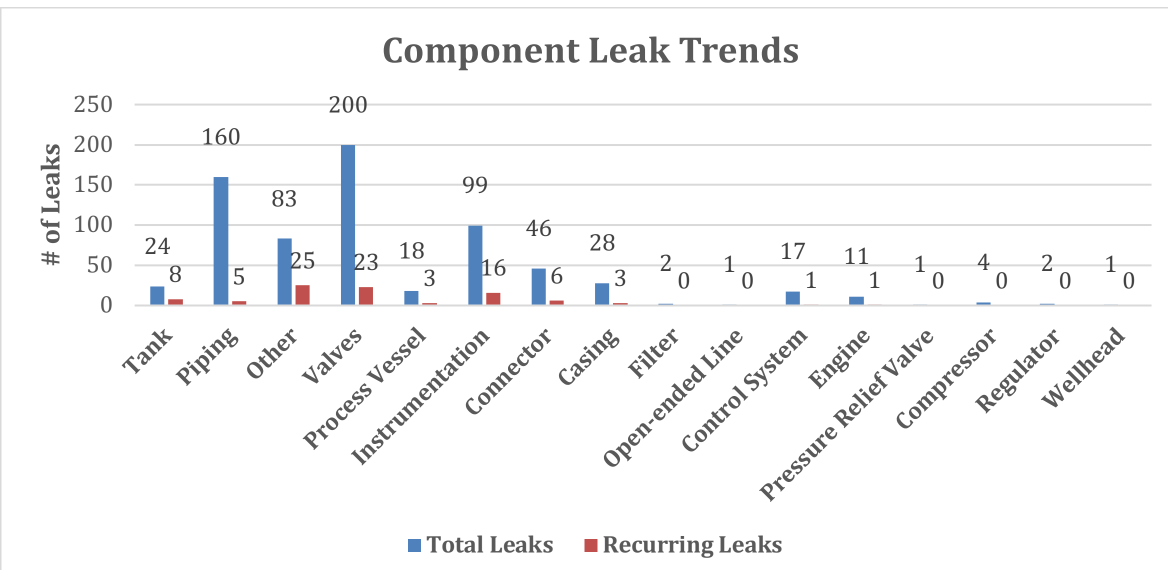


Figure 7. Leak trends based on component type.

c) Summarize the Key Performance Indicators (KPIs) mentioned in the program's application that are not provided elsewhere in this report

Comparing Alternative Technologies: Bridger vs. ExACT

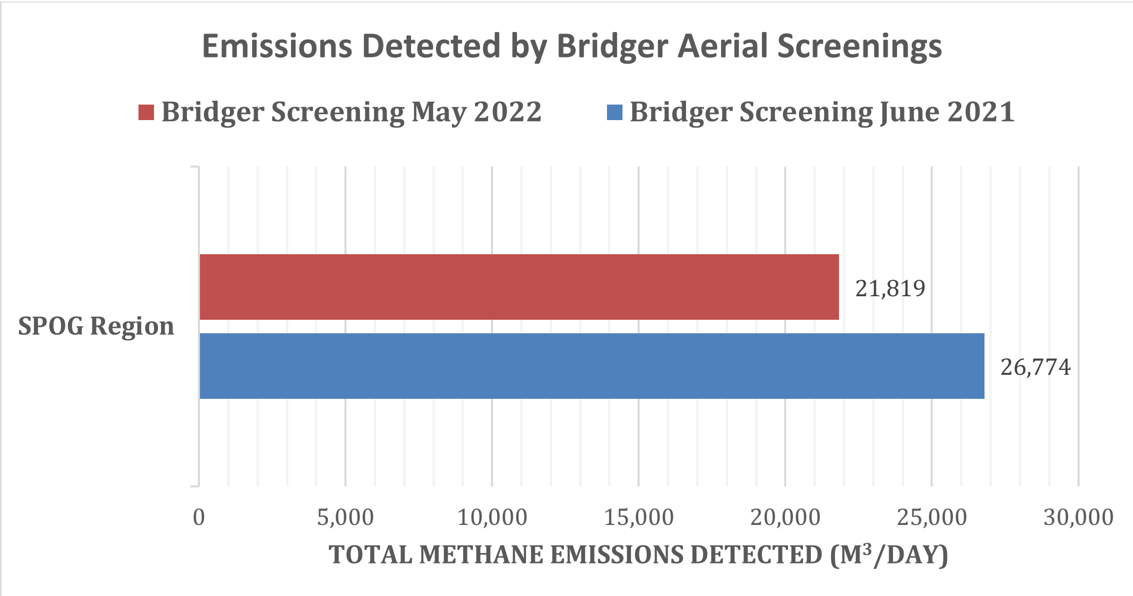


Figure 8. Emissions detected by Bridger aerial screenings.

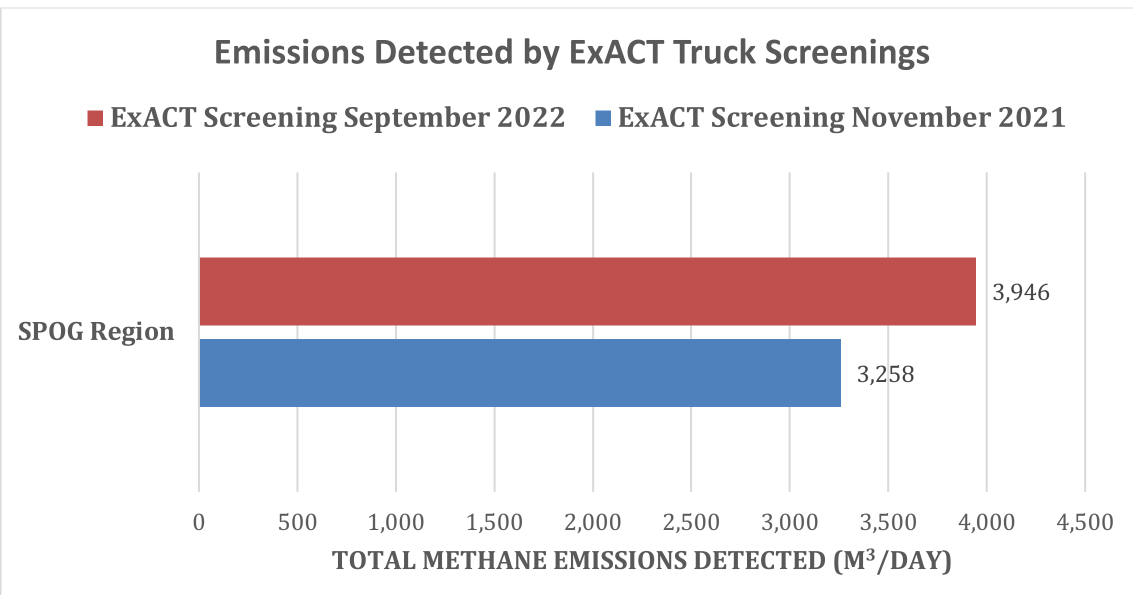


Figure 9. Emissions detected by ExACT truck screenings.

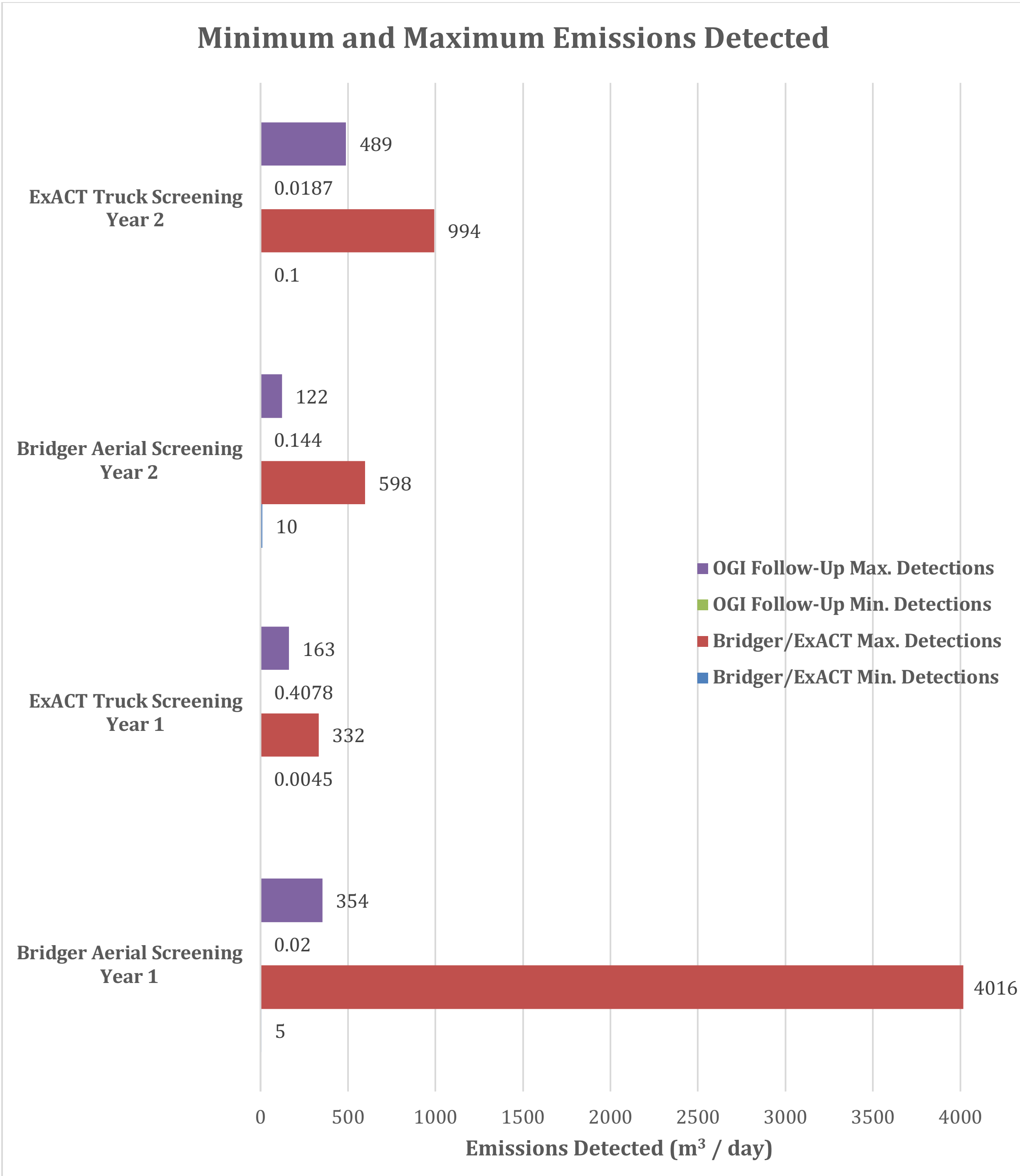


Figure 10. Minimum and maximum emissions detected based on technology type and date.

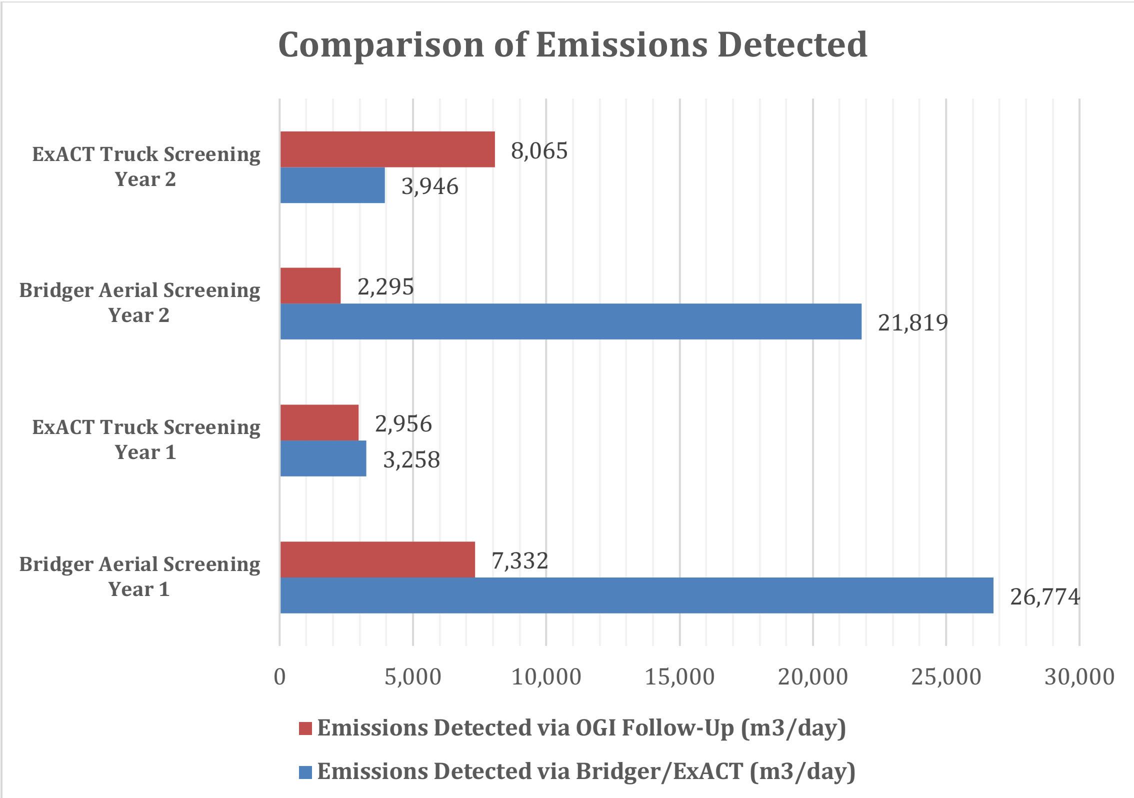


Figure 11. Comparing the emissions detected based on technology type and date.

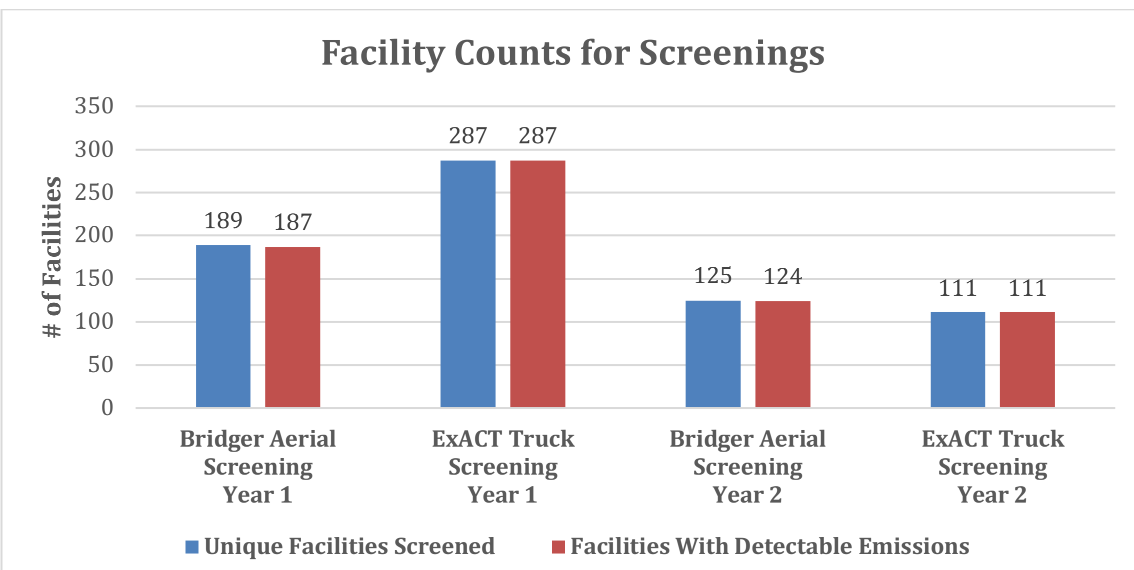


Figure 12. Number of unique facilities that were screened and that had detectable emissions, according to technology type and date.

Analysis of characteristics of the top portion of emitting sites:

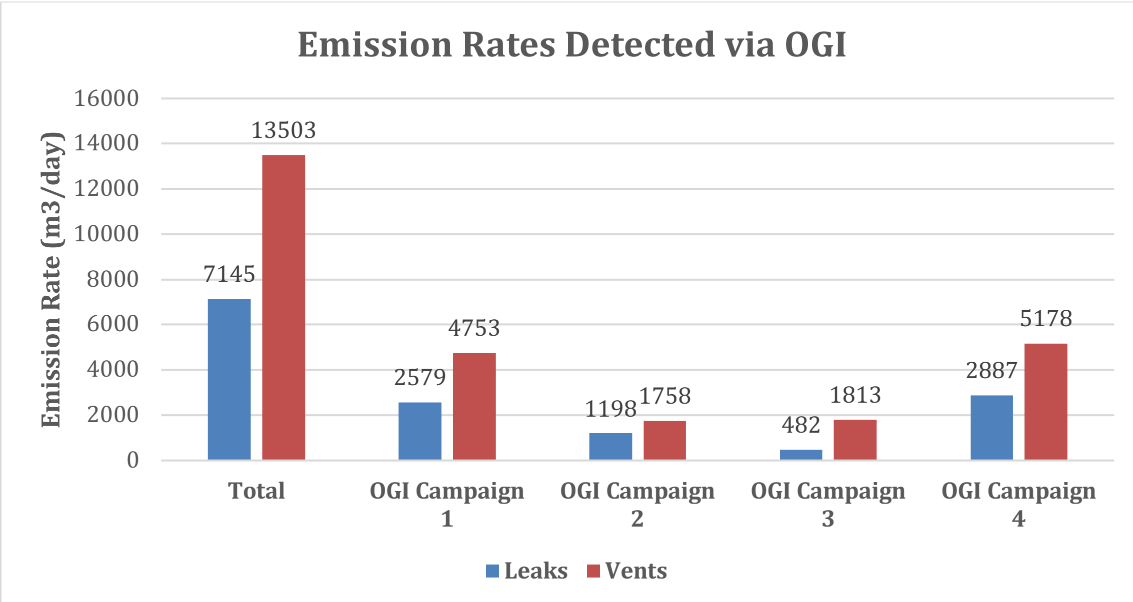


Figure 13. Emission rates detected during OGI campaigns classified as either leaks or vents.

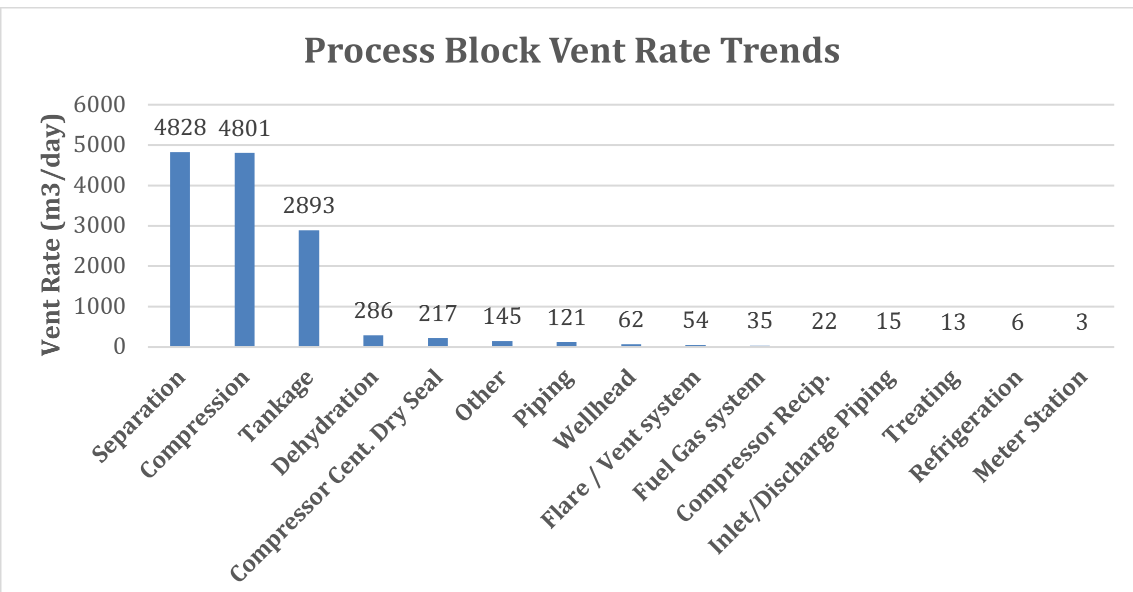


Figure 14. Vent rate trends based on process block type.

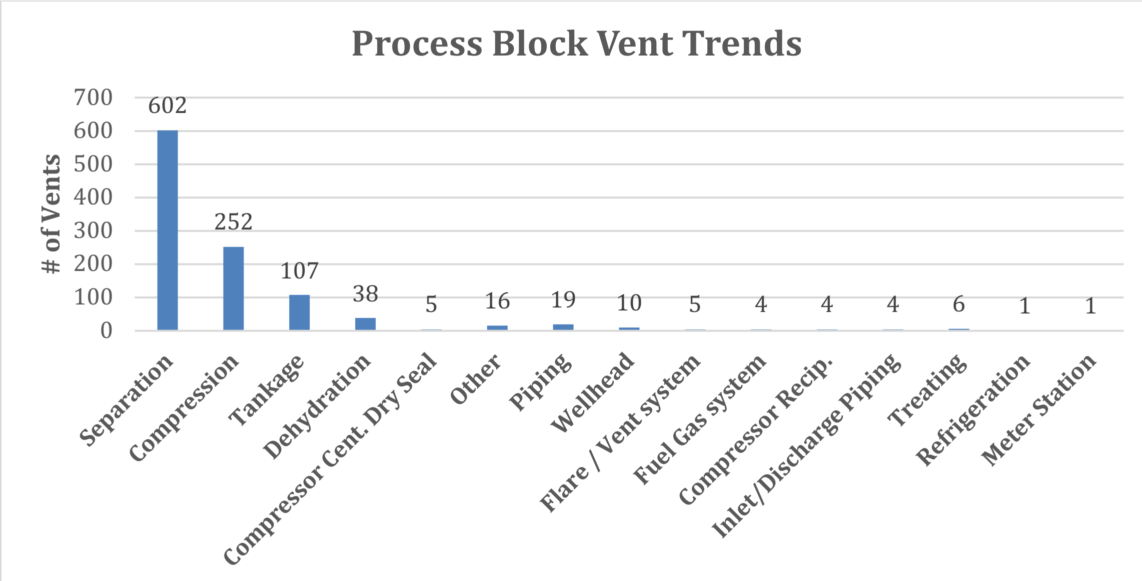


Figure 15. Vent trends based on process block type.

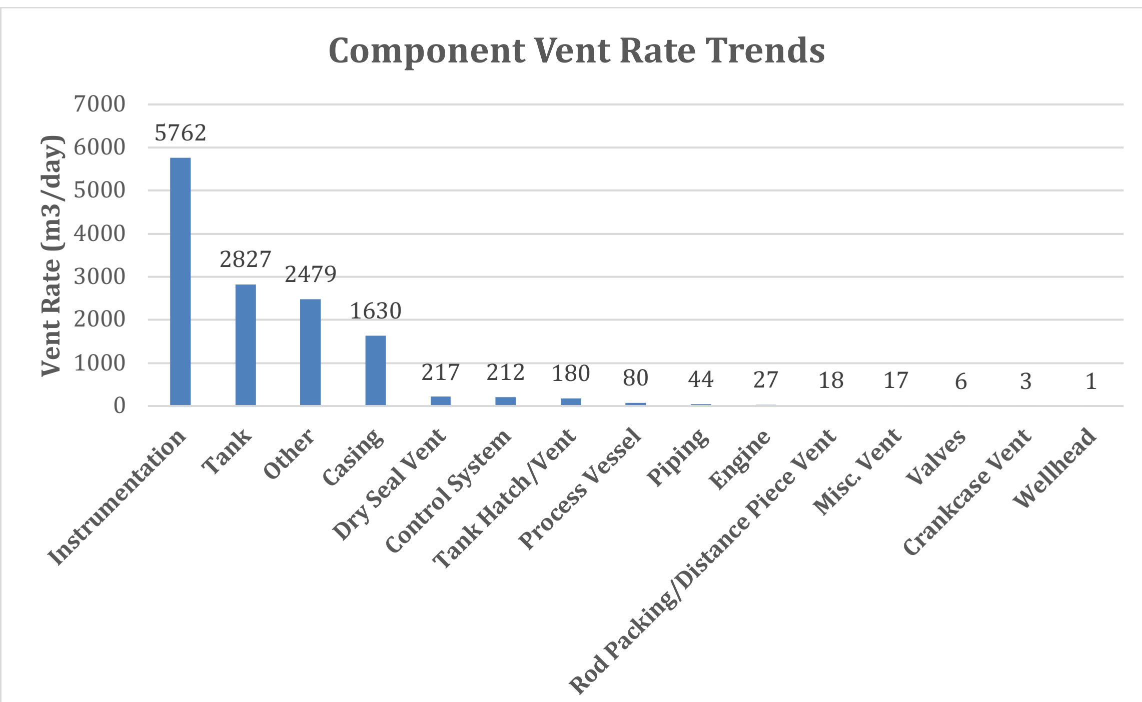


Figure 16. Vent rate trends based on component type.

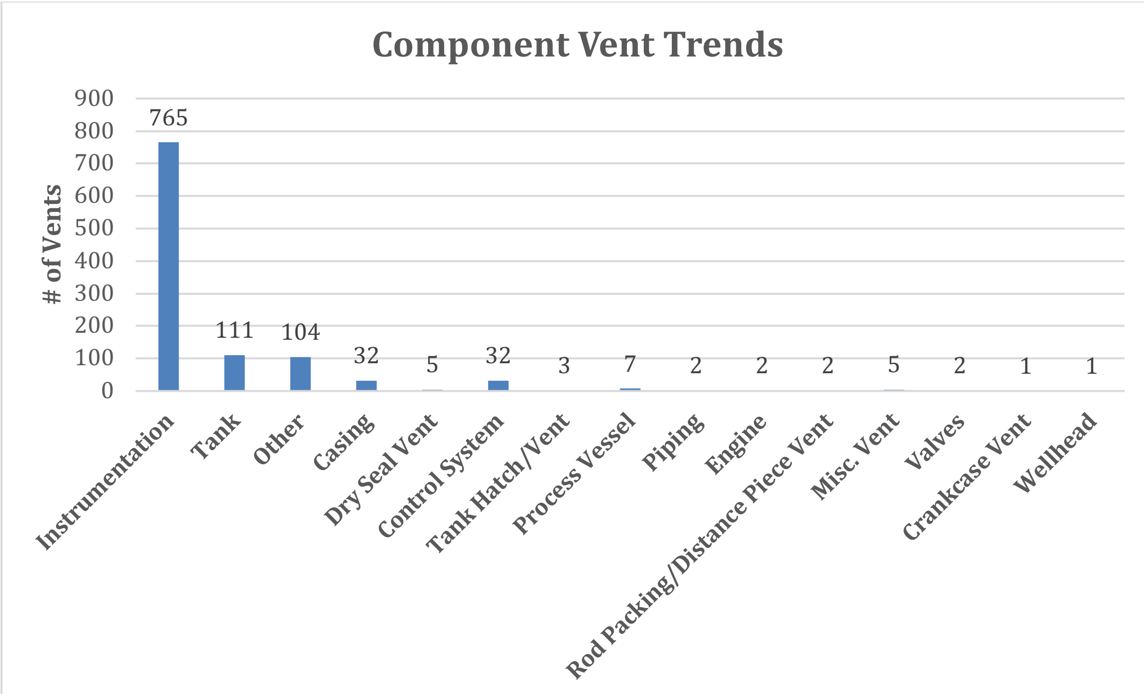


Figure 17. Vent trends based on component type.

Section 3: Fugitive Emissions Reduction Assessment

a) Compare the actual reductions in fugitive emissions with those that were modeled

Section 3.1: Actual & Modelled Emissions Reductions

Actual emission reductions:

The emissions reductions achieved by repairing a single leak was calculated by taking the difference in days between the program end date (December 31, 2022) and that leak's documented repair date, then multiplying the difference in days by the leak's detected emission rate. This was performed for every repaired leak and then emissions reductions were summed to produce reduction totals for each participant. These emissions reduction totals for each participant as well as every participant combined are displayed below.

Company	Emissions Reduced (m^3)
AltaGas	169,458.25
Bonavista	3,400.85
Certus	6872.02
Enerchem	4,795.06
Harvest	601.20
Insignia	242.35
Keyera	51,378.62
Loyal	0.00
Pieridae	0.00
Plains*	0.00
TAQA	34,433.78
Whitecap	440,504.63
Total:	**737,036.55**

*Plains had 0 detected leaks which explains their absent emissions reductions.

Modeled emission reductions:

Each participant's fugitive emissions baseline was adjusted (from those produced in 2022) using updated data from the entire pilot period, producing baselines that more accurately reflect reality. Then, estimated emissions reductions were calculated by dividing up the baseline emissions based on facility type (annually vs. triannually-surveyed facilities under a default program) and applying 40% and 70% reductions (depending on the facility type) to simulate a generic default program according to the AER. These emissions reduction estimates resembling a generic default program were deemed sufficient for evaluating actual emissions reductions in lieu of a Control Region and are displayed below.

Table 5. Estimated emissions reductions for each participant resulting from a generic default program.

Company	Estimated Emissions Reductions From a Generic Default Program for Annually-Surveyed Facilities (m^3)	Estimated Emissions Reductions From a Generic Default Program for Triannually-Surveyed Facilities (m^3)	Total Estimated Emissions Reductions From a Generic Default Program (m^3)
ALTAGAS	95,957.61	355,392.83	451,350
BONAVISTA	310,342.49	26,869.33	337,212
CERTUS	174,447.74	N/A	174,448
ENERCHEM	4,385.47	N/A	4,385
HARVEST	42,174.24	N/A	42,174
INSIGNIA	18,374.35	N/A	18,374
KEYERA	11,189.82	N/A	11,190
LOYAL	130,182.14	N/A	130,182
PIERIDAE	74,238.51	N/A	74,239
PLAINS*	1,953.11	10,511.93	12,465
TAQA	310,245.74	N/A	310,246
WHITECAP	605,001.78	78,863.15	683,864.92
Total	**1,778,493.00**	**471,637.24**	**2,250,130**

*Plains' estimated emissions reductions shown above are likely overestimated, as explained below Table 2.

Section 3.2: Analysis of Emissions Reductions

Section 3.2.1: Context

Based on modelling efforts from 2020 that were used to build the alt-FEMP application, this program was estimated to achieve emissions reductions of 50.4% from the baseline (no LDAR) scenario and improve emissions reductions compared to the default (OGI-based) scenario by 4.5% from the baseline at a reduced cost over the 2-year pilot period. Re-modelling was conducted in Spring 2022, taking into consideration SPOG's pilot program data collected throughout 2021 to produce baselines and emissions reductions that better reflect reality, and the results indicated that the alt-FEMP would reduce emissions by 56.9% from the adjusted baseline scenario and achieve just 3.5% less emissions reductions than the adjusted default scenario but still at a reduced cost.

While conducting data analyses for this report, it was decided that adjusting the fugitive emissions baseline modelled in 2022 was the best option for evaluating the program's actual performance given the improved accuracy and site representation associated with using updated data from the entire pilot period. Further, rather than modelling another default or alt-FEMP scenario using this newly-adjusted baseline, estimated emissions reductions were calculated by dividing up the baseline emissions based on facility type (annually vs. triannually-surveyed facilities under a default program) and applying 40% and 70% reductions (depending on the facility type) to simulate a generic default program according to the AER. This most recent baseline and its associated emissions reduction estimates were used to evaluate SPOG's alt-FEMP in this report.

To summarize, three fugitive emission baselines along with three different sets of emissions reduction estimates were produced for SPOG's alt-FEMP. The baselines and reduction estimates improved each time, meaning that those produced in 2023 reflect reality the most accurately. The different baselines that were modelled in 2020, 2022 and 2023 are displayed below.

Company	Baseline Emissions Modelled in 2020 (m^3)	Baseline Emissions Modelled in 2022 (m^3)	Baseline Emissions Modelled in 2023 (m^3)
ALTAGAS	119,058	497,182	747,598
BONAVISTA	1,661,414	927,073	814,241
CERTUS	1,857,270	704,443	436,119
ENERCHEM	37,080	13,154	10,964
HARVEST	404,773	143,147	105,436
INSIGNIA	235,211	70,575	45,936
KEYERA	42,584	25,142	27,975
LOYAL	1,256,232	452,880	325,455
PIERIDAE	288,605	77,389	185,596
PLAINS*	118,093	28,806	19,900
TAQA	3,201,919	1,486,002	775,614
WHITECAP	3,610,720	3,518,368	1,625,166
Total	**12,832,959**	**7,944,161**	**5,120,000**

*Plains' baselines produced in 2022 and 2023 were built from program data that showed no leaks at their facilities, which resulted in a more representative Day 0 fugitive emissions baseline and fugitive emissions baseline frequency of 1 and 1%, respectively. However, historical LDAR data collected prior to 2021 was used to produce Plains' leak distribution profile in both instances, and so their fugitive emissions baselines for the length of the program likely included a higher number of leaks/fugitive emissions than what actually occurred during the pilot period. In summary, Plains' second and third baselines shown above are more representative of the current reality than the first but may be overestimations that would subsequently overestimate any modelled emissions reductions.

The total estimated emissions reductions shown in Table 5 amount to a 43.95% reduction from the baseline emissions modelled in 2023. Compared to all previous modelling, the total baseline emissions, the total estimated emissions reductions, and the percent reduction from the modelled baseline are all smaller in value.

Achieved emissions reductions for each participant were divided up to reveal the reductions achieved by each participant on a facility-type basis. This allowed for the achieved emissions reductions to be compared with the estimated reductions displayed in Table 5.

Table 6. Achieved emissions reductions for each participant on a facility-type basis and in total.

Company	Emissions Reduced at Annually-Surveyed Facilities (m^3)	Emissions Reduced at Triannually-Surveyed Facilities (m^3)	Total Emissions Reduced (m^3)
ALTAGAS	169,458.25	0.00	169,458.25
BONAVISTA	1,422.43	1,978.42	3,400.85
CERTUS	32,221.81	N/A	32,221.81
ENERCHEM	4,795.06	N/A	4,795.06
HARVEST	601.20	N/A	601.20
INSIGNIA	242.35	N/A	242.35
KEYERA	51,378.62	N/A	51,378.62
LOYAL	0.00	N/A	0.00
PIERIDAE	0.00	N/A	0.00
PLAINS*	0.00	0.00	0.00
TAQA	34,433.78	N/A	34,433.78
WHITECAP	440,504.63	0.00	440,504.63
Total	**735,058.13**	**1,978.42**	**737,036.55**

*Plains had 0 detected leaks which explains their absent emissions reductions.

Taking Tables 5 and 6 together, the percent of estimated emissions reductions that were achieved are as follows:

Table 7. Percent of estimated emissions reductions achieved by each participant.

Company	% of Estimated Reductions Achieved for Annually-Surveyed Facilities	% of Estimated Reductions Achieved for Triannually-Surveyed Facilities	Total % of Estimated Reductions Achieved
ALTAGAS	176.60	0.00	37.54
BONAVISTA	0.46	7.36	1.01
CERTUS	18.47	N/A	18.47
ENERCHEM	109.34	N/A	109.34
HARVEST	1.43	N/A	1.43
INSIGNIA	1.32	N/A	1.32
KEYERA	459.16	N/A	459.16
LOYAL	0.00	N/A	0.00
PIERIDAE	0.00	N/A	0.00
PLAINS*	0.00	0.00	0.00
TAQA	11.10	N/A	11.10
WHITECAP	72.81	0.00	64.41
Total	**41.33**	**0.42**	**32.76**

*Given that Plains had 0 detected leaks, their 0% of estimated reductions achieved can likely be explained by an overestimated fugitive emissions baseline and subsequently overestimated emissions reductions expected from a generic default program (described below Table 2).

It is important to note that fugitive emission baselines as well as estimated or modelled emissions reductions never reflect reality perfectly; they may be higher or lower than reality even if all input parameters are as accurate and comprehensive as possible. With this, any outlined discrepancy between achieved and estimated emissions reductions does not state with absolute certainty that the full or partial extent of that discrepancy reflects a participant's shortcomings regarding emissions reductions. In summary, a comparison of achieved vs. estimated emissions reductions can offer insights, but the estimated reductions are not perfect reflections of reality.

Section 3.2.2: Analysis of Discrepancies – Participants with 0% of Estimated Reductions Achieved

3 companies repaired 0 leaks throughout the program, Loyal, Pieridae and Plains. Excluding Plains, who (as previously mentioned) had no detected leaks to repair, the performance of these companies reduced the program's overall effectiveness/success. Loyal's four OGI campaigns revealed 8 leaks (with 2 being repeat leaks), and 4 of the 8 leaks had emission rates > 50 m^3 / day. Pieridae's four OGI campaigns revealed 41 leaks (with 2 being repeat leaks), with just 1 leak showing an emission rate > 10 m^3 / day (~78 m^3 / day). The discovered leaks from Loyal and Pieridae had a combined emission

rate of 579.35 m^3 / day, which is approximately 8% of the total emission rate from every discovered leak for the entire program. Notably, none of the leaks mentioned in this paragraph had their repairs officially delayed.

Taking together the estimated emissions reductions for Loyal (130,182.14 m^3) and the emissions reductions that would have been realized if they had repaired every discovered leak (78,026.46 m^3, assuming every leak was repaired 30 days after its discovery), a large extent of Loyal's emissions reductions discrepancy could be explained by their lack of leak repairing. However, this would've only resulted in approximately 60% of their estimated emissions reductions being achieved. The remaining discrepancy may be partially or fully attributed to the OGI follow-ups potentially not detecting (and tagging for repair) some of the larger leaks that were detected by Bridger, due to the OGI technology's detection limits. Given that data from the first Bridger screening was used to build the baselines, any large leaks that were missed by OGI follow-ups but detected by Bridger (as a single emission rate combining leaks and/or vents) would result in fewer confirmed leaks and presumably fewer repaired leaks than what was possible, which limits one's ability to achieve the estimated emissions reductions (which are relative to the baselines). As an example, Bridger's first screening of a particular site revealed an emission rate of 1,455 m^3 / day with 337.77 m^3 / day estimated to be from fugitive emissions (based on site-specific fugitive to vent ratios), while the site's first OGI campaign detected just 183.48 m^3 / day of emissions with only 81.55 m^3 / day being fugitive emissions.

Taking together the estimated emissions reductions for Pieridae (74,238.51 m^3) and the emissions reductions that would have been realized if they had repaired every discovered leak (72,335.33 m^3, assuming every leak was repaired 30 days after its discovery), it is sensible to argue that Pieridae's emissions reductions discrepancy can be entirely explained by their lack of leak repairing.

Plains had only one screening that detected emissions (the first ExACT screening which revealed an emission rate of < 1 m^3 / day at one site), which did not provoke any follow-up surveys. Given that Plains had 0 confirmed leaks, their emissions reductions "discrepancy" can be primarily attributed to an overestimation of emissions reductions produced from their modelling. To reiterate the explanation provided below Table 2, Plains' baseline was built from recent data that showed no leaks at any of their facilities, which resulted in a more representative Day 0 fugitive emissions baseline and fugitive emissions baseline frequency of 1 and 1%, respectively. However, historical LDAR data collected prior to 2021 was still used to produce Plains' leak distribution profile, and so their fugitive emissions baseline for the length of the program likely reflects a higher number of leaks/fugitive emissions than what actually occurred during the pilot period. This overestimated 2-year fugitive emissions baseline would subsequently overestimate the emissions reductions expected from a generic default program.

Section 3.2.3: Analysis of Discrepancies – Participants with 1-20% of Estimated Reductions Achieved

5 companies including Bonavista, Certus, Harvest, Insignia and TAQA only repaired a small fraction of their total discovered leaks (70 out of 250), which amounts to approximately 25% of the total emission rate from their discovered leaks. Out of the 180 non-repaired leaks, 14 had repairs that were officially

delayed in June, July, or December 2021 (7 by Bonavista, 6 by Harvest and 1 by TAQA). The majority of the non-repaired leaks (119 out of 180), which corresponds to 531.31 m^3 / day or approximately 70% of the non-mitigated fugitive emission rate from these 5 companies combined, are attributed to Bonavista.

Taking together the estimated emissions reductions for Bonavista (337,211.82 m^3) and the combination of their achieved emissions reductions with the emissions reductions that would have been realized if they had repaired every discovered, non-delayed for repair leak (assuming every non-repaired leak was repaired 30 days after its discovery) (137,706.41 m^3), a large extent of Bonavista's emissions reductions discrepancy could be explained by their lack of leak repairing. However, this would've only resulted in approximately 41% of their estimated emissions reductions being achieved, and also repairing the leaks that had delayed repairs would likely not increase this by much. The remaining discrepancy may be partially or fully attributed to the OGI follow-ups potentially not detecting (and tagging for repair) some of the larger leaks that were detected by Bridger, due to the OGI technology's detection limits. Given that data from the first Bridger screening was used to build the baselines, any large leaks that were missed by OGI follow-ups but detected by Bridger (as a single emission rate combining leaks and/or vents) would result in fewer confirmed leaks and presumably fewer repaired leaks than what was possible, which limits one's ability to achieve the estimated emissions reductions (which are relative to the baselines). As an example, Bridger's first screening of thirteen sites revealed a total emission rate of 1,952 m^3 / day with 1003.14 m^3 / day estimated to be from fugitive emissions (based on site-specific fugitive to vent ratios), while the sites' first OGI campaign detected just 1000.66 m^3 / day of emissions with only 218.40 m^3 / day being fugitive emissions.

Taking together the estimated emissions reductions for Certus, (174,447.74 m^3) and the combination of their achieved emissions reductions with the emissions reductions that would have been realized if they had repaired every discovered leak (assuming every non-repaired leak was repaired 30 days after its discovery) (32,610.41 m^3; repairing the non-repaired leaks results in little additional emissions reductions), only a small extent of Certus' emissions reductions discrepancy could be explained by their lack of leak repairing. The remaining discrepancy may be partially or fully attributed to the OGI follow-ups potentially not detecting (and tagging for repair) some of the larger leaks that were detected by Bridger, due to the OGI technology's detection limits. Given that data from the first Bridger screening was used to build the baselines, any large leaks that were missed by OGI follow-ups but detected by Bridger (as a single emission rate combining leaks and/or vents) would result in fewer confirmed leaks and presumably fewer repaired leaks than what was possible, which limits one's ability to achieve the estimated emissions reductions (which are relative to the baselines). As an example, Bridger's first screening of eleven sites revealed a total emission rate of 1,852 m^3 / day with 294 m^3 / day estimated to be from fugitive emissions (based on site-specific fugitive to vent ratios), while the sites' first OGI campaign detected just 567.62 m^3 / day of emissions with only 55.47 m^3 / day being fugitive emissions. The remaining discrepancy after repairing all non-repaired leaks may also be attributed to the fact that numerous Sitka facilities that were originally participating in the program and used for modelling purposes were no longer participating after Certus' acquisition of Sitka. It is difficult to expand on this with absolute certainty, but it is possible that modelling facilities/infrastructure that ended up not being surveyed for the program resulted in higher estimated emissions reductions than reality would normally replicate.

Taking together the estimated emissions reductions for Harvest (42,174.24 m^3) and the combination of their achieved emissions reductions with the emissions reductions that would have been realized if they had repaired every discovered, non-delayed for repair leak (assuming every non-repaired leak was repaired 30 days after its discovery) (4,801.89 m^3), only a small extent of Harvest's emissions reductions discrepancy could be explained by their lack of leak repairing (this remains likely even if the leaks with delayed repairs were also repaired). The remaining discrepancy may be partially or fully attributed to the OGI follow-ups potentially not detecting (and tagging for repair) some of the larger leaks that were detected by Bridger, due to the OGI technology's detection limits. Given that data from the first Bridger screening was used to build the baselines, any large leaks that were missed by OGI follow-ups but detected by Bridger (as a single emission rate combining leaks and/or vents) would result in fewer confirmed leaks and presumably fewer repaired leaks than what was possible, which limits one's ability to achieve the estimated emissions reductions (which are relative to the baselines). As an example, Bridger's first screening of seven sites revealed a total emission rate of 619 m^3 / day with 233.16 m^3 / day estimated to be from fugitive emissions (based on site-specific fugitive to vent ratios), while the sites' first OGI campaign detected just 175.80 m^3 / day of emissions with only 20.70 m^3 / day being fugitive emissions.

Taking together the estimated emissions reductions for Insignia (18,374.35 m^3) and the combination of their achieved emissions reductions with the emissions reductions that would have been realized if they had repaired every discovered leak (assuming every non-repaired leak was repaired 30 days after its discovery) (3,855.40 m^3), only a small extent of Insignia's emissions reductions discrepancy could be explained by their lack of leak repairing. The remaining discrepancy may be partially or fully attributed to the OGI follow-ups potentially not detecting (and tagging for repair) some of the larger leaks that were detected by Bridger, due to the OGI technology's detection limits. Given that data from the first Bridger screening was used to build the baselines, any large leaks that were missed by OGI follow-ups but detected by Bridger (as a single emission rate combining leaks and/or vents) would result in fewer confirmed leaks and presumably fewer repaired leaks than what was possible, which limits one's ability to achieve the estimated emissions reductions (which are relative to the baselines). As an example, Bridger's first screening of three sites revealed a total emission rate of 260 m^3 / day with 64.89 m^3 / day estimated to be from fugitive emissions (based on site-specific fugitive to vent ratios), while the sites' first OGI campaign detected just 67.56 m^3 / day of emissions with only 4.68 m^3 / day being fugitive emissions.

Taking together the estimated emissions reductions for TAQA (310,245.74 m^3) and the combination of their achieved emissions reductions with the emissions reductions that would have been realized if they had repaired every discovered, non-delayed for repair leak (assuming every non-repaired leak was repaired 30 days after its discovery) (85,150.65 m^3), only a small extent of TAQA's emissions reductions discrepancy could be explained by their lack of leak repairing (this remains likely even if the one leak with a delayed repair was also repaired). The remaining discrepancy may be partially or fully attributed to the OGI follow-ups potentially not detecting (and tagging for repair) some of the larger leaks that were detected by Bridger, due to the OGI technology's detection limits. Given that data from the first Bridger screening was used to build the baselines, any large leaks that were missed by OGI follow-ups but detected by Bridger (as a single emission rate combining leaks and/or vents) would result in fewer confirmed leaks and presumably fewer repaired leaks than what was possible, which limits one's ability to achieve the estimated emissions reductions (which are relative to the baselines). As an example, Bridger's first screening of twenty-two sites revealed a total emission rate of 4,179 m^3 / day with 1351.29 m^3 / day estimated to be from fugitive emissions (based on site-specific fugitive to vent ratios), while the sites' first OGI campaign detected just 1743.30 m^3 / day of emissions with only 104.78 m^3 / day being fugitive emissions. Notably, TAQA shares a site/LSD with Enerchem and it is possible that Bridger's screening included emissions from Enerchem's infrastructure located on the same site. This would make TAQA's fugitive emissions baseline higher and thus produce higher estimated emissions reductions.

Section 3.2.4: Analysis of Discrepancies – Participants with 21-70% of Estimated Reductions Achieved

AltaGas seemingly performed well in terms of their annually-surveyed facilities, but their 1 triannually-surveyed facility, which accounts for most of their fugitive emissions baseline and subsequently most of their estimated emission reductions, saw no actual emissions reductions. However, given that only 4 leaks with a combined emission rate of 18.34 m^3 / day were discovered at this facility during the pilot period, the modelling may have overestimated the fugitive emissions and subsequently the reductions associated with this facility, and so AltaGas' emissions reductions discrepancy may have little to do with not repairing leaks at this facility. This is deemed likely given that the Bridger data used to build AltaGas' baseline detected emissions from a single annually-surveyed facility but not the triannually-surveyed facility, and baselines specific to triannually-surveyed facilities were produced from a fraction of the total baseline value rather than only using screening data from triannually-surveyed facilities. Thus, triannually-surveyed facilities that saw no emissions from the first Bridger screening would still have fugitive emissions baselines and subsequently estimated emissions reductions that reflect a higher number of leaks/fugitive emissions than what was revealed by the first Bridger screening (and the first OGI follow-up campaign). This would explain AltaGas' scenario where their triannually-surveyed facility saw significantly less leaks than modelled and therefore significantly less emissions reductions than estimated, which affects the perception of their overall performance.

Taking together the estimated emissions reductions for AltaGas (451,350.44 m^3) and the combination of their achieved emissions reductions with the emissions reductions that would have been realized if they had repaired every discovered, non-delayed for repair leak (assuming every non-repaired leak was repaired 30 days after its discovery) (252,512.39 m^3 or approximately 56% of the estimated emissions reductions), only a small extent of AltaGas' emissions reductions discrepancy could be explained by their lack of leak repairing across all facilities. If one were to also consider the repair of all leaks with officially delayed repairs, assuming each leak was repaired 100 days after its discovery, an additional 59,484.14 m^3 / day of fugitive emissions would have been mitigated, making it so that approximately 69% of the estimated emissions reductions would have been achieved. As mentioned above, the remaining discrepancy may be partially or fully attributed to the potentially overestimated fugitive emissions baseline and estimated emissions reductions for the triannually-surveyed facility.

Whitecap repaired the majority of their leaks (117 out of 156), which corresponds to 3,055.34 m^3 / day or approximately 69% of the total emission rate from their discovered leaks. 6 of the non-repaired leaks had their repairs officially delayed in July 2021.

Taking together the estimated emissions reductions for Whitecap (683,864.92 m^3) and the combination of their achieved emissions reductions with the emissions reductions that would have been realized if they had repaired every discovered, non-delayed for repair leak (assuming every non-repaired leak was repaired 30 days after its discovery) (624,711.88 m^3), it is sensible to argue that Whitecaps' emissions reductions discrepancy could be largely explained by their lack of leak repairing. This is especially true if Whitecap had also repaired the leaks that had their repairs delayed.

Section 3.2.5: Analysis of Discrepancies – Participants with 71-100+% of Estimated Reductions Achieved

2 companies performed better than expected in terms of emissions reductions: Enerchem and Keyera. Their combined emission rate from discovered leaks amounted to 116.02 m^3 / day, or approximately 2% of the total emission rate from all leaks, and the leaks that make up approximately 93% of this emission rate were repaired. All of the remaining leaks to be repaired are attributed to Keyera, with one being a repeat leak.

Taking together the estimated emissions reductions for Enerchem (4,385.47 m^3) and their achieved emissions reductions (since they repaired all discovered leaks) (4,795.06 m^3), one could argue that little to no discrepancy exists.

Taking together the estimated emissions reductions for Keyera (11,189.82 m^3) and the combination of their achieved emissions reductions with the emissions reductions that would have been realized if they had repaired every discovered leak (assuming every non-repaired leak was repaired 30 days after its discovery) (55,264.10 m^3), Keyera seemingly exceeded expectations. It is possible that Keyera's modelling underestimated their baseline emissions and subsequently their estimated emissions reductions. Notably, just one of Keyera's repaired leaks accounted for 11,005.43 m^3 or approximately 21% of their achieved emissions reductions, and such a scenario may have been missed in the modelling.

Section 3.2.6: Analysis of Discrepancies – Summary

In summary, 2,250,130.24 m^3 of fugitive emissions were estimated to be reduced by the program, but only 737,036.55 m^3 or 32.76% of estimated reductions were actually achieved. The received records/data revealed many non-repaired leaks, and so considerably more reductions could have been achieved if more leak repairs were performed. Combining the total achieved emissions reductions with those that would have resulted from repairing every currently non-repaired leak (assuming every leak was repaired 30 days after its discovery and excluding the leaks with officially delayed repairs; 614,131.62 m^3), we would get a total of 1,351,168.17 m^3 of fugitive emissions that were or could have been mitigated, which represents approximately 60% of the estimated emissions reductions. If one were to also consider the repair of all leaks with officially delayed repairs, assuming each leak was repaired 100 days after its discovery, an additional 169,131.07 m^3 / day of fugitive emissions would have been mitigated, making it so that approximately 68% of the estimated emissions reductions would have been achieved. Some unachieved reductions may have resulted from the OGI follow-ups potentially not detecting (and tagging for repair) some of the larger leaks that were detected by Bridger, due to the OGI technology's detection limits. Given that data from the first Bridger screening was used to build the baselines, any large leaks that were missed by OGI follow-ups but detected by Bridger (as a single emission rate combining leaks and/or vents) would result in fewer confirmed leaks and presumably fewer repaired leaks than what was possible, which limits one's ability to achieve the estimated emissions reductions (which are relative to the baselines). Finally, any remaining discrepancy may be partially or fully attributed to potentially overestimated fugitive emissions baselines as well as estimated emissions reductions for a participant, as discussed in Section 3.2.4.

Section 4: Pilot Program Review

a) Provide details on experienced technology limitations

Weather Effects:

Smoky conditions occurred in the SPOG area during a small segment of the pilot period, but these conditions had no perceived impact on the alt-FEMP's implementation. Aerial screenings were deployed without impact during this time, showcasing the technology's flexibility.

Aerial screenings only occurred when there was no snow on the ground to avoid any potential effects from this weather condition.

Measurements:

No technology limitations pertaining to the actual measuring of emissions were experienced during the pilot period, besides the already known limitations to do with each technology's measurement capabilities. As mentioned above, aerial screenings were only conducted during snow-free periods to ensure accurate measurements.

Detection Limits:

Bridger's GML: The smallest detection of methane emissions had a rate of 5 m^3 / day (June 2021). Given this technology's minimum detection limit (MDL) of 72 m^3 / day (with a 95% probability of detection) that was used for all previous modelling, the experienced technology limitation was considerably lower, and it could therefore be argued that Bridger's GML performed better than expected.

ExACT Truck-Based Technology: The smallest detection of methane emissions had a rate of 0.0045 m^3 / day (November 2021). Given its MDL of 0.0071 m^3 / day (with an 89% probability of detection) that was used for all previous modelling, the experienced technology limitation was lower, and it could therefore be argued that ExACT performed better than expected.

OGI's FLIR G320: The smallest detection of methane emissions had a rate of 0.0187 m^3 / day (October 2022). Given its MDL of 0.708 m^3 / day (with a 40% probability of detection) that was used for all previous modelling, the experienced technology limitation was considerably lower, and it could therefore be argued that OGI's FLIR G320 performed better than expected.

b) Provide details on any additional control measures that were outlined in the alt-FEMP application

No changes were made to the pilot program regarding voluntary vent reductions. This decision was made upon review of the pilot's Year 1 results, which indicated that the program was still meeting expectations and therefore there was no perceived need to implement voluntary vent reductions.

With that said, one SPOG producer did implement solutions to successfully reduce their own tank emissions.

Regarding the trial of other alternative technologies, an additional truck-based technology as well as a stationary monitor from EoSense were trialed in the SPOG region during the pilot period. The observed performance of EoSense's technologies (primarily the mobile technology) indicated that they deserve further consideration for their use in the SPOG region. This is due to the technologies being extremely cost-efficient and being able to detect emissions while providing records of location, time, and emissions readings. Using these technologies while avoiding having additional vehicles on the roads is something to consider in future trials.

Field operators performed regular audio, visual, and olfactory testing while on-site, and took necessary corrective and reporting actions if an abnormality is detected.

c) Provide details on any nonperforming program elements

alt-FEMP program elements that did not meet expectations:

The number of facilities and sites considered as part of the program changed over the course of the 2-year program, although it is difficult to quantify the precise change from beginning to end using the provided datasets. Using the data provided, it appears as though an unknown number of facilities across 338 sites were participating in the beginning, and 399 facilities across 363 sites participated in the end. Further, the number of producers decreased by 1 after NAL was acquired by Whitecap, and circumstances also changed when Sitka was acquired by Certus and 28 of their 45 participating facilities were acquired by three different participating producers (Certus (26), TAQA (1) and Whitecap (1)) and continued to be part of the program (the remaining 17 facilities were presumably dropped from the program; 14 of these facilities participated in data collection for the first and second screenings as well as the first OGI follow-up campaign).

Two of the participating producers (AltaGas and Keyera) performed their first OGI campaign prior to their first Bridger aerial screening, completing the OGI campaign weeks before the remaining producers started theirs. It is understood that this first OGI campaign conducted by AltaGas and Keyera was a full-scale OGI campaign rather than one conducted at only a percentage of the top emitting sites, as the two producers believed they were still implementing a default FEMP rather than an alt-FEMP, and so it is reasonable to believe that this circumstance did not negatively impact the performance of the alt-FEMP.

The first truck-based screening (or the second overall screening) was delayed for technology maintenance purposes, which pushed back the screening's dates beyond predicted times. This truck-based screening was still performed successfully, though.

Numerous program elements that did not meet expectations had to do with operator or OGI service provider responsibilities and are provided below:

- In general, numerous repairs were not made after a leak was detected. In some cases, comments were provided to give context (e.g., "Further Investigation Required").
- There were instances where no leak tags were assigned to fugitive emission sources or where no repair information was provided on placed leak tags. The repairs for the leaks in question were still performed but were delayed by multiple months.
- In many instances, a repair was delayed for a particular reason (e.g., shutdown required or specialized equipment required) and a proposed repair date was often assigned to it, but a repair never occurred.
- Numerous repairs were made after more than 30 days since a leak's discovery. Sometimes this was due to a stated reason (e.g., no leak tag placed at the source or a PLC failure at a connecting site), but there were many instances where no comment/reason was provided.

Changes made to the technology or work practices during the alt-FEMP program in response to nonperforming elements or to optimize the program:

No changes were made in response to nonperforming elements or to optimize the program.

d) Describe the overall success of the alt-FEMP including any additional performance analyses considered for the program's evaluation

Regarding SPOG's alt-FEMP, all 12 participating producers successfully utilized alternative technologies combined with OGI follow-up surveys to cost-effectively locate, quantify, and mitigate fugitive emissions. In other words, the participating operators were able to make positive contributions regarding emissions reductions while reducing costs relative to implementing a default FEMP in Alberta. Further, all alternative technologies arguably performed as expected or better based on their published minimum detection limits. However, the degree to which each participating producer followed through with their leak repairs varied significantly (with some producers performing much better than others in terms of emissions reductions across their respective facilities/sites), and in general, most participating producers could have done better to repair their detected leaks. Essentially, the alt-FEMP could have been more successful based on improved operator-level decisions rather than adjusting the design or characteristics of the alt-FEMP itself.

Speaking further on the performance of the alternative technologies, emissions detected by Bridger went down over time, however 64 fewer sites were screened the second time. 176 fewer sites were screened for the second ExACT screening compared to the first, but the second screening detected more emissions. Overall, Bridger detected more emissions than ExACT, but Bridger was also able to detect the highest of all detected emission rates while ExACT was able to detect the smallest, suggesting that Bridger is more suitable for detecting large emission sources while ExACT is more suitable for detecting small emission sources (relative to each other).

Considering OGI technology as well, it was able to detect the smallest emission sources compared to the two alternative technologies but was far from detecting the highest emission sources. Notably, the total emissions detected by OGI technology was less than the total emissions detected by alternative technologies for each of the first three screenings/campaigns, and this difference was considerable with regards to the Bridger screenings. This was expected given that OGI follow-ups only occur at a top percent of the highest-emitting sites, however the especially large differences between emissions detected by Bridger vs. OGI in both instances may suggest that other factors were at play, such as: the OGI technology potentially not detecting some of the larger leaks detected by Bridger, rare events that involved venting high levels of emissions around the time of Bridger screening events, the exclusion of select high-emitting sites from OGI follow-ups, or the natural halting of select leaks and/or vents prior to the OGI follow-ups. This finding is particularly interesting given that the follow-up threshold decreased from 40% to 20% between Bridger screenings, but the differences in emissions detected by Bridger vs. OGI were similar (~19,500 m^3 / day). For the fourth screening/campaign, OGI technology detected considerably more emissions than the ExACT screening, which is especially interesting given that this screening's follow-up threshold was the lowest of all at 15%. This may suggest that ExACT underestimated site-level emissions, or more likely that high-emitting vents and/or leaks appeared after the ExACT screening in this instance. Overall, the combined use of alternative and OGI technologies successfully and cost-effectively detected fugitive emissions at the majority of sites, although the amount of detected fugitive emissions did not decrease over time across all four screenings/campaigns. This can likely be explained by the lack of repairs made during the pilot period as well as the relatively high number of emission sources detected during the time period of the fourth screening/campaign.

An important element of any FEMP is data tracking/organization. On the topic of the success of SPOG's alt-FEMP, it should be noted that this program element was seemingly more difficult to execute efficiently for SPOG. With company/asset acquisitions taking place, some sites/LSDs containing facilities for multiple companies, and certain companies facing confusion about the program's start date/implementation, the tracking and organizing of FEMP data required additional attention. In particular, tracking leak repairs in a timely fashion proved difficult. This could be mitigated by deploying just one leak-detection company for the SPOG area.

Speaking to emissions reductions, 737,036.55 m^3 of SPOG's fugitive emissions were mitigated through the alt-FEMP, which equates to a 14.4% reduction from the baseline (no LDAR) scenario modelled in 2023. This only accounts for 32.76% of the estimated emissions reductions, though, and as mentioned, the alt-FEMP would have proven to be considerably more successful in terms of emissions reductions if the majority of participants had performed more leak repairs given the information available to them.

Overall, the success of SPOG's alt-FEMP varied by company, and the difficulties associated with a regional-level, multi-producer LDAR program may have had something to do with the results. Most participating operators needed to manage two methane programs: SPOG's alt-FEMP as well as a default FEMP prescribed by Alberta Energy Regulator (AER) Directive 060 for the remainder of their Alberta assets. As a potential pathway for improving program success, the program administrator's role could incorporate compliance assurance to increase awareness, success, and operator responsibilities amongst participating operators.

Appendix A: Facility List

Company	Facility ID	Site / LSD	Subtype Code	D60 Survey Frequency	Former Sitka Facility?
ALTAGAS LTD.	ABGP0001060	09-27-031-04W5	405	Annual	
ALTAGAS LTD.	ABGS0152661	10-34-033-04W5	621	Triannual	
ALTAGAS LTD.	ABIF0146461	05-12-032-05W5	507	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0055070	11-33-034-04W5	361	Annual	
BONAVISTA ENERGY CORPORATION	ABCS0004774	03-16-034-04W5	621	Triannual	
BONAVISTA ENERGY CORPORATION	ABGP0001118	11-17-034-03W5	401	Triannual	
BONAVISTA ENERGY CORPORATION	ABGP0001231	13-05-034-03W5	401	Triannual	
BONAVISTA ENERGY CORPORATION	BEC GARR 7-12-34-4	07-12-034-04W5	311	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0121702	12-29-031-03W5	321	Annual	
BONAVISTA ENERGY CORPORATION	ABCS0004446	10-26-032-07W5	601	Annual	
BONAVISTA ENERGY CORPORATION	ABCS0004444	11-22-032-07W5	601	Annual	
BONAVISTA ENERGY CORPORATION	ABBT4050001	13-05-036-04W5	361	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0121563	09-28-034-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT1940019	01-11-035-06W5	361	Annual	
BONAVISTA ENERGY CORPORATION	ABGS0126912	08-01-034-06W5	361	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0100319	06-03-034-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0119066	13-11-034-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0113868	13-11-034-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABCS0117153	01-11-035-06W5	361	Annual	
BONAVISTA ENERGY CORPORATION	ABBT4050059	13-05-034-03W5	322	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0062364	10-19-031-04W5	361	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0110212	16-21-031-03W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0104357	01-01-034-07W5	311	Annual	
BONAVISTA ENERGY CORPORATION	ABBT7850007	13-18-034-07W5	311	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0124595	12-22-035-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0100752	01-14-034-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0113449	04-17-034-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0141899	15-32-034-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0121565	14-15-034-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0078202	10-33-035-07W5	321	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0128793	01-18-034-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0095944	08-13-034-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0099673	03-18-034-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0118428	12-20-035-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT4480018	10-03-034-04W5	361	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0139229	14-34-033-04W5	311	Annual	
BONAVISTA ENERGY CORPORATION	ABBT4050186	16-02-035-05W5	311	Annual	
BONAVISTA ENERGY CORPORATION	ABBT1940018	11-23-034-05W5	361	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0100555	02-11-033-04W5	311	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0123481	16-31-033-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0098496	10-03-034-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	F40238	16-28-033-04W5	321	Annual	
BONAVISTA ENERGY CORPORATION	ABBT4050285	14-21-034-03W5	311	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0099513	08-02-034-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABIF0007998	10-02-034-06W5	507	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0104483	04-24-034-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0114378	04-04-035-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABCS0021594	12-34-032-07W5	361	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0088290	04-23-033-04W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABCS0023569	10-07-034-04W5	361	Annual	
BONAVISTA ENERGY CORPORATION	ABBT4480001	10-10-033-04W5	361	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0124629	13-35-032-04W5	311	Annual	
BONAVISTA ENERGY CORPORATION	ABBT4480075	06-16-033-03W5	361	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0112286	09-17-034-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0095010	05-13-035-07W5	311	Annual	
BONAVISTA ENERGY CORPORATION	ABGS0079546	03-20-034-04W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0131093	04-09-034-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0099579	06-13-034-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0094967	13-01-034-06W5	351	Annual	

BONAVISTA ENERGY CORPORATION	ABBT0100536	11-21-031-03W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0133799	06-24-034-05W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0118431	14-04-036-05W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0122730	14-28-035-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0121564	01-15-034-06W5	351	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0099578	15-01-034-06W5	311	Annual	
BONAVISTA ENERGY CORPORATION	ABGS0002374	03-20-034-04W5	621	Annual	
BONAVISTA ENERGY CORPORATION	ABGS0156831	03-16-034-04W5	621	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0159547	15-34-033-04W5	321	Annual	
BONAVISTA ENERGY CORPORATION	ABBT0087354	04-25-033-04W5	351	Annual	
CERTUS OIL AND GAS INC.	ABBT0099255	06-08-034-04W5	351	Annual	Yes
CERTUS OIL AND GAS INC.	ABBT0098226	01-29-034-04W5	351	Annual	Yes
CERTUS OIL AND GAS INC.	F48182	16-12-036-06W5	351	Annual	Yes
CERTUS OIL AND GAS INC.	ABBT0084530	15-16-036-04W5	351	Annual	Yes
CERTUS OIL AND GAS INC.	ABBT0147631	12-17-036-05W5	351	Annual	Yes
CERTUS OIL AND GAS INC.	ABBT0044912	07-07-036-04W5	351	Annual	Yes
CERTUS OIL AND GAS INC.	ABBT0146777	05-10-034-05W5	351	Annual	Yes
CERTUS OIL AND GAS INC.	ABBT0144355	09-17-034-04W5	351	Annual	Yes
CERTUS OIL AND GAS INC.	F52131	04-23-034-04W5	321	Annual	
CERTUS OIL AND GAS INC.	ABBT0144724	09-18-034-04W5	351	Annual	Yes
CERTUS OIL AND GAS INC.	ABBT0150845	03-09-034-05W5	351	Annual	Yes
CERTUS OIL AND GAS INC.	ABIF0007463	10-04-034-05W5	501	Annual	Yes
CERTUS OIL AND GAS INC.	ABBT0086581	03-09-034-05W5	351	Annual	Yes
CERTUS OIL AND GAS INC.	ABBT0150862	01-10-034-05W5	351	Annual	Yes
CERTUS OIL AND GAS INC.	F4780	05-02-034-05W5	321	Annual	Yes
CERTUS OIL AND GAS INC.	ABBT0048110	06-04-034-05W5	351	Annual	Yes
CERTUS OIL AND GAS INC.	ABBT0137760	12-18-035-05W5	351	Annual	Yes
CERTUS OIL AND GAS INC.	ABBT0077342	13-09-034-05W5	351	Annual	Yes
CERTUS OIL AND GAS INC.	ABBT0095778	14-18-036-05W5	351	Annual	Yes
CERTUS OIL AND GAS INC.	ABBT0147739	16-02-035-05W5	311	Annual	Yes
CERTUS OIL AND GAS INC.	ABBT0128216	16-20-035-05W5	351	Annual	Yes
CERTUS OIL AND GAS INC.	F4552	09-33-033-05W5	321	Annual	
CERTUS OIL AND GAS INC.	ABBT0138088	16-17-034-04W5	351	Annual	Yes
CERTUS OIL AND GAS INC.	ABBT0100448	09-33-034-05W5	311	Annual	Yes
CERTUS OIL AND GAS INC.	ABBT0093074	05-10-034-05W5	351	Annual	Yes
CERTUS OIL AND GAS INC.	ABBT0087350	13-03-034-05W5	351	Annual	Yes
CERTUS OIL AND GAS INC.	ABBT1940098	11-10-034-05W5	351	Annual	Yes
CERTUS OIL AND GAS INC.	ABBT8820011	07-04-034-05W5	321	Annual	Yes
ENERCHEM INTERNATIONAL INC.	ABTM0143398	03-26-033-06W5	671	Annual	
HARVEST OPERATIONS CORP.	ABGS0115365	06-31-035-03W5	621	Annual	
HARVEST OPERATIONS CORP.	ABBT0123591	12-18-035-03W5	311	Annual	
HARVEST OPERATIONS CORP.	ABBT0116775	11-11-035-04W5	311	Annual	
HARVEST OPERATIONS CORP.	ABBT0125333	13-35-034-06W5	362	Annual	
HARVEST OPERATIONS CORP.	ABBT0059885	10-02-035-06W5	351	Annual	
HARVEST OPERATIONS CORP.	F29258	06-36-034-06W5	351	Annual	
HARVEST OPERATIONS CORP.	ABBT0062420	14-24-034-06W5	351	Annual	
HARVEST OPERATIONS CORP.	F28636	16-23-034-06W5	351	Annual	
HARVEST OPERATIONS CORP.	ABBT0100693	06-32-035-03W5	311	Annual	
HARVEST OPERATIONS CORP.	ABBT0114485	15-11-035-04W5	311	Annual	
HARVEST OPERATIONS CORP.	ABBT0064207	03-29-035-03W5	351	Annual	
HARVEST OPERATIONS CORP.	ABBT0111795	03-13-035-04W5	311	Annual	
HARVEST OPERATIONS CORP.	ABBT0096452	11-30-035-03W5	351	Annual	
HARVEST OPERATIONS CORP.	ABBT0110681	07-32-035-03W5	311	Annual	
HARVEST OPERATIONS CORP.	ABBT0095433	11-29-035-03W5	351	Annual	
INSIGNIA ENERGY LTD.	ABBT0128264	06-20-033-06W5	351	Annual	
INSIGNIA ENERGY LTD.	ABBT0117780	07-36-033-07W5	351	Annual	
INSIGNIA ENERGY LTD.	ABBT0120486	15-29-033-06W5	351	Annual	
INSIGNIA ENERGY LTD.	ABBT0105922	16-13-034-07W5	351	Annual	
INSIGNIA ENERGY LTD.	ABBT0110285	08-14-034-07W5	351	Annual	
INSIGNIA ENERGY LTD.	ABBT0121155	01-13-034-07W5	351	Annual	
INSIGNIA ENERGY LTD.	ABBT0110286	01-13-034-07W5	351	Annual	

KEYERA ENERGY LTD.	ABCS0005161	03-36-035-05W5	621	Annual	
KEYERA ENERGY LTD.	ABGS0003899	03-36-035-05W5	621	Annual	
LOYAL ENERGY (CANADA) OPERATING LT	ABBT4480002	07-12-032-04W5	321	Annual	
LOYAL ENERGY (CANADA) OPERATING LT	ABBT4480004	09-04-032-03W5	362	Annual	
LOYAL ENERGY (CANADA) OPERATING LT	F44770	09-06-032-03W5	321	Annual	
LOYAL ENERGY (CANADA) OPERATING LT	F4293	12-32-031-04W5	321	Annual	
LOYAL ENERGY (CANADA) OPERATING LT	F44749	01-06-032-03W5	321	Annual	
LOYAL ENERGY (CANADA) OPERATING LT	F4273	07-20-031-03W5	501	Annual	
LOYAL ENERGY (CANADA) OPERATING LT	F45449	04-35-032-04W5	321	Annual	
LOYAL ENERGY (CANADA) OPERATING LT	F46166	03-17-032-03W5	321	Annual	
LOYAL ENERGY (CANADA) OPERATING LT	F4420	05-08-032-04W5	321	Annual	
LOYAL ENERGY (CANADA) OPERATING LT	ABCS0040216	10-16-032-03W5	601	Annual	
LOYAL ENERGY (CANADA) OPERATING LT	ABCS0026533	06-10-032-04W5	601	Annual	
LOYAL ENERGY (CANADA) OPERATING LT	F44754	03-33-031-03W5	321	Annual	
LOYAL ENERGY (CANADA) OPERATING LT	ABBT0076692	06-18-034-04W5	351	Annual	
PIERIDAE ENERGY LIMITED	SHANTZ Sulphur Loading	04-35-031-04W5	N/A	Annual	
PIERIDAE ENERGY LIMITED	ABGP0001662	12-35-034-06W5	405	Annual	
PIERIDAE ENERGY LIMITED	ABCS0028712	12-18-034-04W5	601	Annual	
PIERIDAE ENERGY LIMITED	ABCS0027874	16-33-034-05W5	601	Annual	
PIERIDAE ENERGY LIMITED	ABCS0142371	06-20-033-04W5	601	Annual	
PIERIDAE ENERGY LIMITED	ABBT0137852	03-16-034-03W5	351	Annual	
PIERIDAE ENERGY LIMITED	ABIF0008551	03-30-034-04W5	507	Annual	
PLAINS MIDSTREAM CANADA ULC	ABI03644001	04-35-031-04W5	401	Triannual	
SITKA EXPLORATION LTD.	ABBT0155464	16-05-034-04W5	351	Annual	
SITKA EXPLORATION LTD.	ABBT0129983	06-34-033-05W5	311	Annual	
SITKA EXPLORATION LTD.	ABBT0098868	11-30-033-05W5	351	Annual	
SITKA EXPLORATION LTD.	ABBT0060614	02-04-035-04W5	351	Annual	
SITKA EXPLORATION LTD.	ABBT0127356	15-01-033-04W5	321	Annual	
SITKA EXPLORATION LTD.	F42893	12-10-034-05W5	321	Annual	
SITKA EXPLORATION LTD.	F4551	15-27-033-05W5	321	Annual	
SITKA EXPLORATION LTD.	F4555	01-35-033-05W5	321	Annual	
SITKA EXPLORATION LTD.	ABBT0092707	08-03-034-05W5	351	Annual	
SITKA EXPLORATION LTD.	ABCS0020577	09-04-034-05W5	621	Annual	
SITKA EXPLORATION LTD.	SITKA EXPL CAROL 9-9-34-5	09-09-034-05W5	N/A	Annual	
SITKA EXPLORATION LTD.	ABBT0104865	08-12-033-04W5	351	Annual	
SITKA EXPLORATION LTD.	F4554	01-34-033-05W5	321	Annual	
SITKA EXPLORATION LTD.	ABBT0154203	04-23-034-04W5	311	Annual	
TAQA NORTH LTD.	ABBT0078695	06-31-033-05W5	351	Annual	
TAQA NORTH LTD.	ABGP0001437	03-26-033-06W5	403	Annual	
TAQA NORTH LTD.	F34033	10-17-032-06W5	311	Annual	
TAQA NORTH LTD.	ABCS0004445	12-25-032-07W5	601	Annual	
TAQA NORTH LTD.	PWEI RICINUS 4-27-32-7	04-27-032-07W5	311	Annual	
TAQA NORTH LTD.	F30141	04-03-033-07W5	311	Annual	
TAQA NORTH LTD.	ABCS0004559	03-06-033-07W5	601	Annual	
TAQA NORTH LTD.	F32853	07-17-033-07W5	311	Annual	
TAQA NORTH LTD.	ABBT0141877	05-23-033-07W5	351	Annual	
TAQA NORTH LTD.	ABBT0141876	09-27-033-07W5	351	Annual	
TAQA NORTH LTD.	ABI26862001	06-31-033-07W5	N/A	Annual	
TAQA NORTH LTD.	ABBT0067285	02-19-033-07W5	321	Annual	
TAQA NORTH LTD.	ABBT0133459	11-30-033-07W5	351	Annual	
TAQA NORTH LTD.	PWEI CAROLINE 6-35-33-6	06-35-033-06W5	311	Annual	
TAQA NORTH LTD.	ABBT1940002	10-13-035-06W5	321	Annual	
TAQA NORTH LTD.	ABBT0075540	11-23-035-06W5	351	Annual	
TAQA NORTH LTD.	ABBT1940014	04-28-035-06W5	321	Annual	
TAQA NORTH LTD.	ABBT1940020	16-16-035-06W5	321	Annual	
TAQA NORTH LTD.	ABBT1940001	07-03-035-06W5	311	Annual	
TAQA NORTH LTD.	ABBT1940008	10-33-034-06W5	311	Annual	
TAQA NORTH LTD.	PWEI CAROLINE 16-33-34-6	16-33-034-06W5	311	Annual	
TAQA NORTH LTD.	PWEI CAROLINE 6-34-34-6	06-34-034-06W5	311	Annual	
TAQA NORTH LTD.	ABBT1940005	12-36-034-06W5	361	Annual	
TAQA NORTH LTD.	ABBT0141879	12-30-033-06W5	351	Annual	

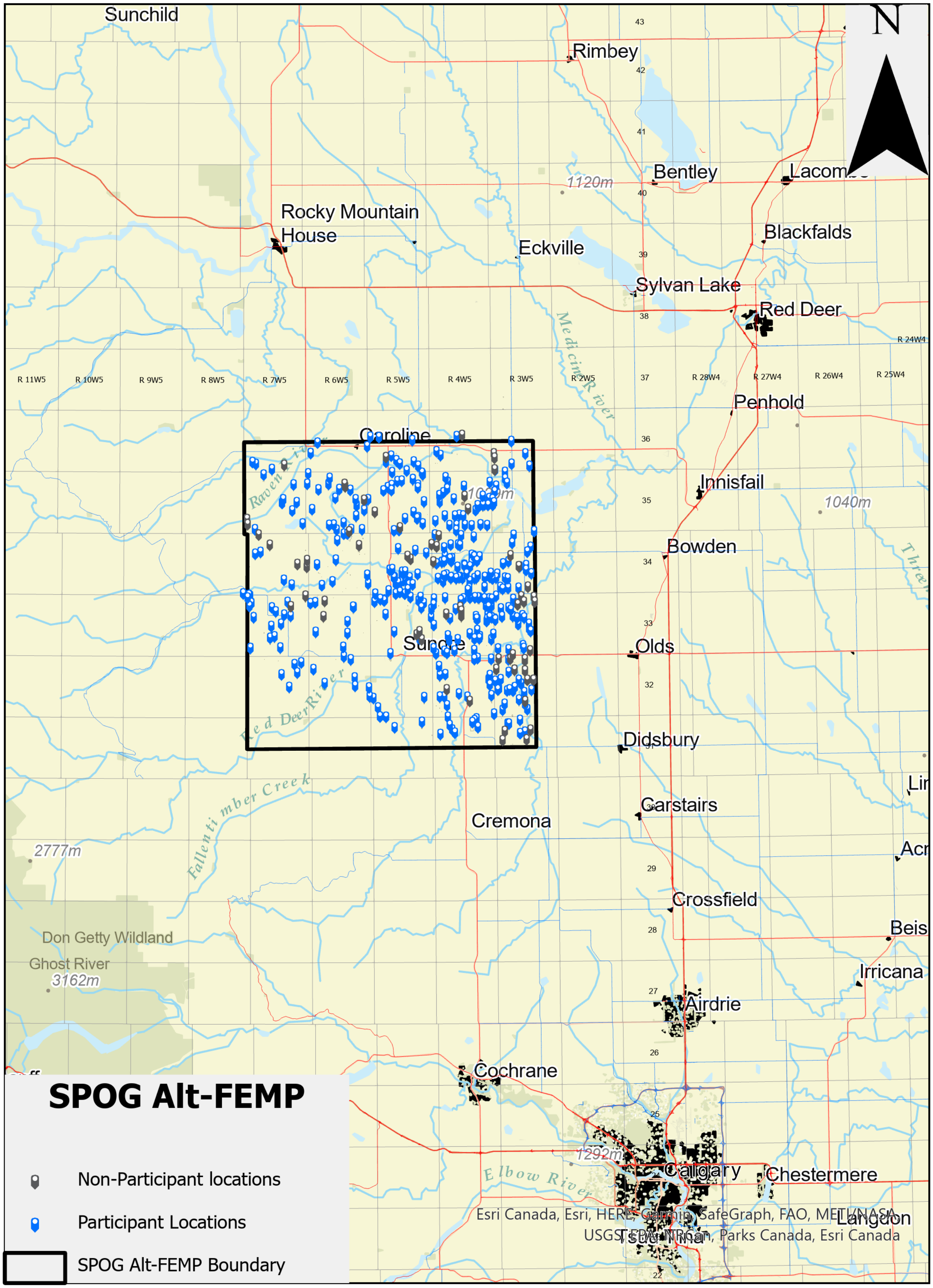
TAQA NORTH LTD.	F5174	01-26-035-07W5	321	Annual	
TAQA NORTH LTD.	ABBT1940027	01-32-035-07W5	321	Annual	
TAQA NORTH LTD.	ABGS0003130	01-32-035-07W5	321	Annual	
TAQA NORTH LTD.	ABWI100042703207W500	04-27-032-07W5	N/A	Annual	
TAQA NORTH LTD.	ABBT0080887	06-11-035-05W5	351	Annual	
TAQA NORTH LTD.	ABWI100063503306W500	06-35-033-06W5	N/A	Annual	
TAQA NORTH LTD.	ABBT0133720	15-03-035-05W5	351	Annual	
TAQA NORTH LTD.	F32673	11-15-033-07W5	311	Annual	
TAQA NORTH LTD.	ABGS0117187	12-36-034-06W5	361	Annual	
TAQA NORTH LTD.	ABBT7850006	06-31-033-07W5	321	Annual	
TAQA NORTH LTD.	ABWI100082703307W500	09-27-033-07W5	N/A	Annual	
TAQA NORTH LTD.	ABBT0067287	04-09-033-07W5	321	Annual	
TAQA NORTH LTD.	ABCS0004561	07-09-033-07W5	621	Annual	
TAQA NORTH LTD.	ABBT0150843	15-03-034-07W5	351	Annual	
TAQA NORTH LTD.	ABBT0141882	03-28-033-07W5	351	Annual	
TAQA NORTH LTD.	ABBT0141878	07-22-033-07W5	351	Annual	
TAQA NORTH LTD.	ABBT0141883	16-21-033-07W5	351	Annual	
TAQA NORTH LTD.	PC RICINUS 6-30-33-7	06-30-033-07W5	311	Annual	
TAQA NORTH LTD.	ABBT0149339	06-16-033-07W5	351	Annual	
TAQA NORTH LTD.	ABBT0065239	04-31-033-07W5	351	Annual	
TAQA NORTH LTD.	ABBT0127262	11-20-034-07W5	361	Annual	
TAQA NORTH LTD.	ABBT0050888	10-11-035-07W5	351	Annual	
TAQA NORTH LTD.	ABBT1940038	10-12-035-06W5	321	Annual	
TAQA NORTH LTD.	ABBT0075535	07-15-035-07W5	361	Annual	
TAQA NORTH LTD.	ABBT0112190	06-27-034-06W5	311	Annual	
TAQA NORTH LTD.	ABBT0086245	08-05-036-05W5	351	Annual	
TAQA NORTH LTD.	F5680	04-05-036-07W5	321	Annual	
TAQA NORTH LTD.	ABBT0150842	08-24-034-07W5	351	Annual	
TAQA NORTH LTD.	ABBT1940035	08-34-034-06W5	311	Annual	
TAQA NORTH LTD.	ABBT0140018	08-06-036-07W5	311	Annual	
TAQA NORTH LTD.	PWEI RICINUS 7-33-32-6	07-33-032-06W5	311	Annual	
TAQA NORTH LTD.	PC 7-36 RICINUS 7-36-32-7	07-36-032-07W5	311	Annual	
TAQA NORTH LTD.	F40215	04-35-032-06W5	311	Annual	
TAQA NORTH LTD.	ABBT0147961	09-14-035-06W5	351	Annual	Yes
TAQA NORTH LTD.	ABBT0141880	10-30-033-06W5	351	Annual	
TAQA NORTH LTD.	ABBT0078713	11-04-034-06W5	351	Annual	
TAQA NORTH LTD.	ABBT0112293	07-12-034-06W5	351	Annual	
TAQA NORTH LTD.	ABBT0080184	06-09-034-06W5	601	Annual	
TAQA NORTH LTD.	F32854	16-23-032-07W5	311	Annual	
TAQA NORTH LTD.	ABBT0120668	06-03-033-06W5	311	Annual	
TAQA NORTH LTD.	ABBT0126855	05-31-033-07W5	361	Annual	
TAQA NORTH LTD.	ABBT0044779	02-04-035-06W5	311	Annual	
TAQA NORTH LTD.	ABBT0080528	06-02-034-07W5	351	Annual	
TAQA NORTH LTD.	ABBT0078715	06-05-034-06W5	351	Annual	
TAQA NORTH LTD.	F5172	04-30-035-06W5	321	Annual	
TAQA NORTH LTD.	ABBT0160346	16-30-033-05W5	351	Annual	
TAQA NORTH LTD.	ABBT0154286	15-21-034-05W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0041564	06-28-034-03W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0053650	08-34-034-03W5	321	Annual	
WHITECAP RESOURCES INC.	ABBT0060704	06-15-033-03W5	361	Annual	
WHITECAP RESOURCES INC.	ABBT0061501	06-36-035-05W5	361	Annual	
WHITECAP RESOURCES INC.	ABBT0064209	14-22-035-04W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0066492	03-07-036-06W5	361	Annual	
WHITECAP RESOURCES INC.	ABBT0068330	07-10-034-03W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0075236	10-13-035-04W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0075925	06-24-033-04W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0078330	01-24-033-05W5	321	Annual	
WHITECAP RESOURCES INC.	ABBT0079190	06-20-033-05W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0080098	06-13-035-05W5	361	Annual	
WHITECAP RESOURCES INC.	ABBT0080917	16-15-033-06W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0083378	07-06-032-05W5	322	Annual	

WHITECAP RESOURCES INC.	ABBT0084875	10-10-033-06W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0086564	10-07-036-03W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0086938	11-26-035-05W5	361	Annual	
WHITECAP RESOURCES INC.	ABBT0088131	08-29-035-04W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0090062	10-20-035-04W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0091638	06-20-035-04W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0095493	15-29-035-04W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0095813	11-16-035-04W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0096288	08-18-034-06W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0096665	10-20-035-05W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0100051	11-21-035-05W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0100058	14-29-033-05W5	351	Annual	Yes
WHITECAP RESOURCES INC.	ABBT0104758	03-31-034-04W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0106183	16-06-035-04W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0111661	15-34-035-03W5	322	Annual	
WHITECAP RESOURCES INC.	ABBT0111727	14-19-035-03W5	N/A	Annual	
WHITECAP RESOURCES INC.	ABBT0113523	01-19-035-04W5	321	Annual	
WHITECAP RESOURCES INC.	ABBT0116336	08-15-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	ABBT0118546	01-04-033-03W5	321	Annual	
WHITECAP RESOURCES INC.	ABBT0120068	16-31-034-07W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0120679	03-03-035-04W5	321	Annual	
WHITECAP RESOURCES INC.	ABBT0124463	03-18-032-03W5	321	Annual	
WHITECAP RESOURCES INC.	ABBT0124628	04-28-034-04W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0125855	16-08-036-03W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0128086	16-32-033-05W5	361	Annual	
WHITECAP RESOURCES INC.	ABBT0128841	14-29-032-03W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0130776	10-06-035-04W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0131976	02-04-035-04W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0132071	16-26-031-05W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0133927	14-10-033-03W5	321	Annual	
WHITECAP RESOURCES INC.	ABBT0135226	10-10-033-03W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0136662	15-22-034-03W5	321	Annual	
WHITECAP RESOURCES INC.	ABBT0138278	03-28-035-05W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0138856	07-01-035-07W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0139841	12-25-033-05W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0147291	01-22-034-04W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0148718	15-24-033-04W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0148773	06-33-035-05W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0151705	01-15-034-04W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0152888	13-27-033-04W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0152989	15-19-033-03W5	361	Annual	
WHITECAP RESOURCES INC.	ABBT0153123	06-33-033-05W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0153126	02-35-033-04W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0153945	14-02-034-04W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0154266	12-05-034-04W5	361	Annual	
WHITECAP RESOURCES INC.	ABBT0155279	13-27-033-04W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0155540	15-06-034-04W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0156054	14-29-033-05W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0156234	16-04-034-04W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT0157629	02-09-034-04W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0158491	14-04-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	ABBT0158494	16-21-033-04W5	361	Annual	
WHITECAP RESOURCES INC.	ABBT0158495	16-04-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	ABBT0158505	13-18-033-03W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0158982	05-30-033-07W5	351	Annual	
WHITECAP RESOURCES INC.	ABBT0160058	16-25-033-04W5	321	Annual	
WHITECAP RESOURCES INC.	ABBT1940112	07-08-033-04W5	321	Annual	
WHITECAP RESOURCES INC.	ABBT4050003	02-21-033-03W5	321	Annual	
WHITECAP RESOURCES INC.	ABBT4050023	06-13-035-04W5	321	Annual	
WHITECAP RESOURCES INC.	ABBT4050035	01-27-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	ABBT4050037	03-03-035-04W5	321	Annual	

WHITECAP RESOURCES INC.	ABBT4050047	04-15-034-03W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT4050118	06-19-035-03W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT4050253	06-14-036-05W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT4050280	08-29-034-03W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT4480008	11-20-032-03W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT4480023	14-32-032-03W5	311	Annual	
WHITECAP RESOURCES INC.	ABBT4480073	08-04-033-03W5	311	Annual	
WHITECAP RESOURCES INC.	ABCS0023728	03-03-035-04W5	321	Annual	
WHITECAP RESOURCES INC.	ABCS0028727	05-30-033-07W5	351	Annual	
WHITECAP RESOURCES INC.	ABCS0032141	06-15-033-03W5	601	Triannual	
WHITECAP RESOURCES INC.	ABCS0032312	16-17-034-04W5	601	Triannual	
WHITECAP RESOURCES INC.	ABCS0040503	14-04-033-04W5	621	Triannual	
WHITECAP RESOURCES INC.	ABGS0102987	02-03-034-04W5	621	Triannual	
WHITECAP RESOURCES INC.	ABGS0112112	08-15-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	ABGS0116372	14-04-033-04W5	621	Triannual	
WHITECAP RESOURCES INC.	F20902	06-02-036-05W5	321	Annual	
WHITECAP RESOURCES INC.	F21098	04-03-036-05W5	321	Annual	
WHITECAP RESOURCES INC.	F32715	06-07-032-05W5	321	Annual	
WHITECAP RESOURCES INC.	F32973	08-13-032-06W5	321	Annual	
WHITECAP RESOURCES INC.	F34064	06-32-031-05W5	321	Annual	
WHITECAP RESOURCES INC.	F34066	06-28-031-05W5	321	Annual	
WHITECAP RESOURCES INC.	F36382	08-12-032-06W5	321	Annual	
WHITECAP RESOURCES INC.	F37014	04-08-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	F38083	01-19-035-04W5	321	Annual	
WHITECAP RESOURCES INC.	F40538	06-10-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	F40944	03-11-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	F41545	02-09-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	F42257	12-10-034-03W5	321	Annual	
WHITECAP RESOURCES INC.	F42779	02-28-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	F42830	01-05-036-03W5	321	Annual	
WHITECAP RESOURCES INC.	F42938	04-02-035-04W5	321	Annual	
WHITECAP RESOURCES INC.	F42976	13-20-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	F43118	13-25-033-04W5	321	Annual	
WHITECAP RESOURCES INC.	F43210	02-14-035-04W5	321	Annual	
WHITECAP RESOURCES INC.	F43213	04-13-035-04W5	321	Annual	
WHITECAP RESOURCES INC.	F43217	04-18-035-03W5	321	Annual	
WHITECAP RESOURCES INC.	F43261	04-12-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	F43274	02-13-035-04W5	321	Annual	
WHITECAP RESOURCES INC.	F43510	03-10-035-04W5	321	Annual	
WHITECAP RESOURCES INC.	F43565	04-15-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	F43613	02-12-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	F43623	02-23-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	F4438	11-32-032-04W5	321	Annual	
WHITECAP RESOURCES INC.	F44473	02-15-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	F44487	02-06-034-03W5	321	Annual	
WHITECAP RESOURCES INC.	F44547	13-26-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	F44646	16-29-033-03W5	321	Annual	
WHITECAP RESOURCES INC.	F44671	03-29-033-03W5	321	Annual	
WHITECAP RESOURCES INC.	F45094	04-35-033-04W5	321	Annual	
WHITECAP RESOURCES INC.	F4519	16-31-033-03W5	321	Annual	
WHITECAP RESOURCES INC.	F45545	14-05-034-03W5	321	Annual	
WHITECAP RESOURCES INC.	F45585	14-32-033-03W5	321	Annual	
WHITECAP RESOURCES INC.	F45955	13-08-032-03W5	321	Annual	
WHITECAP RESOURCES INC.	F45957	14-14-033-04W5	321	Annual	
WHITECAP RESOURCES INC.	F46049	14-33-033-03W5	321	Annual	
WHITECAP RESOURCES INC.	F46184	08-18-034-03W5	321	Annual	
WHITECAP RESOURCES INC.	F46290	03-35-033-04W5	321	Annual	
WHITECAP RESOURCES INC.	F46316	15-25-033-04W5	321	Annual	
WHITECAP RESOURCES INC.	F46370	02-16-034-03W5	321	Annual	
WHITECAP RESOURCES INC.	F46385	05-28-033-03W5	321	Annual	
WHITECAP RESOURCES INC.	F46562	04-11-033-04W5	321	Annual	

WHITECAP RESOURCES INC.	F46574	01-24-033-04W5	321	Annual	
WHITECAP RESOURCES INC.	F46577	14-13-033-04W5	321	Annual	
WHITECAP RESOURCES INC.	F47081	04-21-033-03W5	321	Annual	
WHITECAP RESOURCES INC.	F47184	14-21-033-04W5	321	Annual	
WHITECAP RESOURCES INC.	F47243	03-08-035-04W5	321	Annual	
WHITECAP RESOURCES INC.	F47272	04-31-033-03W5	321	Annual	
WHITECAP RESOURCES INC.	F47321	03-09-035-04W5	321	Annual	
WHITECAP RESOURCES INC.	F47419	13-30-033-04W5	321	Annual	
WHITECAP RESOURCES INC.	F4751	06-22-034-03W5	321	Annual	
WHITECAP RESOURCES INC.	F47516	16-24-033-05W5	321	Annual	
WHITECAP RESOURCES INC.	F47571	07-12-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	F4761	16-01-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	F4772	11-14-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	F47781	13-02-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	F4779	01-33-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	F48290	01-08-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	F48596	13-13-035-04W5	321	Annual	
WHITECAP RESOURCES INC.	F48603	03-10-036-03W5	321	Annual	
WHITECAP RESOURCES INC.	F51035	16-21-033-04W5	311	Annual	
WHITECAP RESOURCES INC.	F51037	04-01-034-04W5	321	Annual	
WHITECAP RESOURCES INC.	F51067	14-11-033-04W5	321	Annual	
WHITECAP RESOURCES INC.	F5137	05-18-035-03W5	321	Annual	
WHITECAP RESOURCES INC.	F5141	01-09-035-04W5	321	Annual	
WHITECAP RESOURCES INC.	F5151	16-23-035-05W5	321	Annual	
WHITECAP RESOURCES INC.	F5160	16-35-035-05W5	321	Annual	
WHITECAP RESOURCES INC.	F51872	14-29-033-05W5	311	Annual	
WHITECAP RESOURCES INC.	F51893	16-04-034-04W5	311	Annual	
WHITECAP RESOURCES INC.	F52014	02-09-034-04W5	311	Annual	
WHITECAP RESOURCES INC.	F5667	08-04-036-05W5	321	Annual	
WHITECAP RESOURCES INC.	NAL CAROL 6-1-35-5	06-01-035-05W5	N/A	Annual	
WHITECAP RESOURCES INC.	NAL HARM-ELK 7-25-31-5	01-25-031-05W5	N/A	Annual	
WHITECAP RESOURCES INC.	NAL HZ CAROL 5-15-34-4	01-15-034-04W5	N/A	Annual	
WHITECAP RESOURCES INC.	TIMBERROCK HZ GARR 3-29-	04-32-033-04W5	N/A	Annual	
WHITECAP RESOURCES INC.	WHITECAP GARR 3-6-35-3	02-18-035-03W5	N/A	Annual	
WHITECAP RESOURCES INC.	WHITECAP GARR 6-19-34-3_	06-19-034-03W5	N/A	Annual	

Appendix B: Facility Location Map



N
Sunchild
Rimbey
Bentley
Lacombe
Rocky Mountain House
Eckville
Blackfalds
Sylvan Lake
Red Deer
1120m
R 11W5
R 10W5
R 9W5
R 8W5
R 7W5
R 6W5
R 5W5
R 4W5
R 3W5
R 2W5
R 28W4
R 27W4
R 26W4
R 25W4
R 24W4
Medicine River
Penhold
Caroline
Raven River
Innisfail
1040m
Bowden
Olds
Sundre
Red Deer River
Didsbury
Carstairs
Cremona
Fallentimber Creek
2777m
Crossfield
Don Getty Wildland
Ghost River
3162m
Airdrie
Irricana
Cochrane
1292m
Calgary
Chestermere
Elbow River
Langdon
Esri Canada, Esri, HERE, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NRCan, Parks Canada, Esri Canada
SPOG Alt-FEMP
Non-Participant locations
Participant Locations
SPOG Alt-FEMP Boundary