BONAVISTA ENERGY CORPORATION

Alt-FEMP Pilot Performance Report

May 1st, 2021 – December 31st, 2022

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1. Executive Summary

Bonavista Energy Corporation (Bonavista) contracted Arolytics to conduct methane emissions equivalency modeling for three geographical areas in Alberta in which Bonavista owns and operates upstream oil and gas infrastructure. Throughout Alberta, Bonavista operates 894 active facilities located on 694 different sites. The AER issued Bonavista regulatory approval for an Alternative Fugitive Emissions Management Program (Alt-FEMP) pilot including the Deep Basin and West Central regions. These two areas contain 784 facilities, and the pilot was issued for two full compliance years (2021 - 2022). As part of the Alt-FEMP approval, Bonavista identified 40 sites that would follow the standard Directive 060 FEMP survey requirements using Optical Gas Imaging (OGI) (referred to in this report as "Default OGI"). This area acted as a Control region for comparison to the performance of the Alt-FEMP. Furthermore, Bonavista's facilities that are part of the SPOG Alt-FEMP pilot are not included in this Alt-FEMP performance report.

The approved Alt-FEMP for each of the three regions involves:

1) Q2 2021: Using aerial Gas Mapping LiDAR technology from Bridger Photonics Inc. (Bridger) to screen facilities for methane emissions, followed by OGI follow-up surveys to localize fugitive emissions occurring at the top 30% of highest emitting sites.

2) Q4 2021: Using GeoVerra's truck mounted methane detection technology called ExACT to screen the facilities for methane emissions, followed by Vertex OGI follow-up surveys at the top 30% of highest emitting sites.

3) Q2 2022: Using the aerial Gas Mapping LiDAR technology from Bridger to screen facilities for methane emissions, followed by OGI follow-up surveys to localize fugitive emissions occurring at the top 20% of highest emitting sites.

Along with 40 identified sites (Control Region) that were surveyed under Directive 060 FEMP requirements using OGI.

Bonavista' two-year Alt-FEMP pilot ended as of Dec 31st, 2022. The Leak Detection and Repair (LDAR) data has since been analyzed to understand the performance of the alt-FEMP relative to the model-estimated emission reduction targets and the control region, and to fulfill the remaining alt-FEMP performance report requirements.

This alt-FEMP performance report summarizes the data collected on the Alt-FEMP screening and follow-up campaigns, and cumulative methane emission reductions achieved through fugitive repairs from the start of the pilot program (May 1st, 2021) until December 31st, 2022. These reductions are compared to the total model-predicted reductions for the full 2-year pilot (from May 1st, 2021 – December 31st, 2022) and between the regions employing the alt-FEMP and the control region.

2. Methods

2.1. Datasets and Inputs

Listed below are the datasets and inputs considered in this report:

- Vertex Resource Group, Ltd. (Vertex) OGI methane detection datasets collected throughout the year 2021 and 2022.
- Bonavista's fugitive emission repair datasets from 2021 to December 31st, 2022.
- Bridger Gas Mapping LiDAR datasets collected in June 2021 in Deep Basin and West Central Regions.
- GeoVerra ExACT datasets collected in October 2021 in Deep Basin and West Central Regions.
- Bridger Gas Mapping LiDAR datasets collected in May 2022 in Deep Basin and West Central Regions.
- All model values referred to in this report come from the most recent round of methane modeling that Arolytics conducted for Bonavista (March 2021), which is the same modeling report that was used to inform the Alt-FEMP application.

2.2. Calculations

2.2.1. Fugitive Methane Reductions

This report contains summaries of the Bridger and GeoVerra data collected in the first and second years of Bonavista's Alt-FEMP, however only OGI and repair data were used to calculate the cumulative fugitive methane reductions. This is because the sources of emissions captured by Bridger's aerial technology and GeoVerra's truck mounted sensors are often unknown (i.e., they could include fugitives, vents, and episodic short-lived emissions associated with operational events).

The AER's Manual 015: Estimating Methane Emissions (2020, p.37, section 4.7.2) suggests reporting leaks located on FEMP surveys as new leaks with a duration lasting from the start of the program to the repair date. Following this, fugitive methane reductions for year one of the pilot were calculated as the total emission volume that would have leaked between the repair date and December 31st, 2021, assuming a constant leak rate.

For clarity, we used the following formula to calculate the total fugitive methane reductions from each repair for year one of the pilot:

*Fugitive Methane Reductions in Year 1 = (December 31st, 2021 – Leak Repair Date) * (Detected emission rate in m^3/day)*

And to project the total fugitive methane reductions from each repair until the end of the two-year pilot, we used the following formula:

*Projected Fugitive Methane Reductions Throughout 2-Year Pilot = (December 31st, 2022 – Leak Repair Date) * (Detected emission rate in m^3/day)*

The fugitive methane reductions for year two of the pilot were calculated as the total emissions volume that would have leaked between the approximate repair date and December 31st, 2022, assuming a constant leak rate.

*Fugitive Methane Reductions in Year 2 = (December 31st, 2022 – Leak Repair Date) * (Detected emission rate in m^3/day)*

We then summed the reductions from all repairs within each Alt-FEMP region to calculate total fugitive methane reductions. For these calculations, all the repaired leaks were assumed to remain repaired. Only leaks repaired after the start of the pilot (May 1st, 2021) were considered.

2.2.2. Model Predicted Alt-FEMP and Default Program Methane Reductions Calculations

The values from the March 2021 model report, which used updated model inputs based on actual Bonavista LDAR data, were used to perform this calculation. These are the same model estimates that were used for comparison in the Year 1 progress report.

To enable a comparison between the performance in the control region and the performance in the alt-FEMP regions – which have different numbers of facilities and different proportions of facility subtypes – the reductions per "facility day" were also calculated. Where "facility days" is the sum of the total number of days that each facility was in the FEMP. This provides an evaluation of the fugitive reductions per facility, per day, that can be compared between regions with different facility counts that may have varied with time throughout the FEMP.

2.3. Assumptions & Considerations

Because there are no unique component/leak identifiers to determine whether repairs stay repaired, all leaks are considered indefinitely repaired after the repair date. This may not be reflective of what occurred but should have a negligible impact on the reduction calculations.

Arolytics' model is a predictive software model of real-world emissions using the best available data to describe the emissions from a client's facilities and/or wellsites over a defined time period. Due to the random nature of leak occurrence, the variability in leak rates, detections, and repairs, and the uncertainty in each of these factors, there is also uncertainty in the emissions predictions of the model, particularly when assessing emissions on an absolute (i.e., m^3) basis. Given the fact that the model reports approximate average emissions applicable to an extensive time period while real-world emissions data is collected over a very brief time period, it is likely there will be a discrepancy between any absolute emissions estimated by the model and real-world emission measurements collected during a FEMP.

Arolytics recommends programs be compared on a relative basis, for example: *the model predicted the alt-FEMP would achieve X% greater total emissions reductions than a default OGI program, and on a per-facility basis the alternative program reduced X% greater emissions compared to the default program in the control region.*

Quantification of the uncertainty associated with model results is challenging as the uncertainty of each individual input must be considered. Where possible, Arolytics considers ranges of inputs such as a probability of detection curve instead of a single minimum detection limit (MDL) for a technology. However, the uncertainty with that input is not provided to us by the service provider. These parameters can also vary significantly both between facilities and with time. This challenge is further exacerbated by modeling a large number of facilities of varying types. Finally, it is likely that the alt-FEMP will not be carried out by the producer in the exact same way it was modeled (i.e., it may take longer to repair fugitives or measurement campaigns might occur at a different time than was modeled), creating a further discrepancy between absolute and modeled estimates.

Plans for future model improvements include continued sensitivity analysis to evaluate the impact of uncertainty and various parameters on model results and to improve understanding of the model parameters. Meanwhile, every program performance evaluation contributes to a better understanding of how the input parameters affect model certainty. In addition, Arolytics is actively researching real-world scenarios to improve model certainty.

3. Screening (Aerial and Truck) Data

3.1. Type of Screening

Two aerial screenings (June 2021, and May 2022) were performed by Bridger Photonics, Inc. (Bridger), and one truck mounted screening (October 2021) was performed by GeoVerra ExACT.

3.2. Dates of Screenings

1) Screening #1: Aerial (Bridger): May 17 – June 03, 2021
2) Screening #2: Truck (Geoverra ExACT): October 28 – November 11, 2021
3) Screening #3: Aerial (Bridger): May 6-16, 2022

3.3. Summary of Screening Results

Below is the summary of results for both technologies (aerial and truck) summed separately.

3.3.1. Bridger Aerial Surveys

Table 1 and Table 2 show the total methane emissions that were detected during the Bridger Gas Mapping LiDAR Survey in June 2021 and May 2022. Also summarized in this table is the number of facilities that were surveyed, and the number of facilities with and without detectable emissions. Facilities where a methane concentration was detected but an emission rate could not be calculated due to environmental conditions are not considered in the sum of emission rates detected on these campaigns. Facilities in the Control Region are covered by the Default OGI program and were not included in the Bridger surveys as a result.

Bridger screening results showed some sites with multiple measurements completed during the same field program. Measurements were averaged to obtain one emission rate for each facility and to calculate the summed emissions (m^3/day) for each assessed region.

Please note that the total emissions presented in Table 1 and Table 2 are expected to include fugitive, vented, and sporadic operations-related emissions. Table 1 and 2 show that on average ~690 unique facilities were visited, however some site locations contain multiple facilities, hence the number of unique facilities surveyed was higher than shown. It was made sure that all the facilities within the alt-FEMP are screened by checking with the service providers and data analysis after each screening is performed.

Table 1: Bridger aerial survey in June 2021.

Region	Total Emissions Detected (m^3/day)	Unique Facilities Screened (n)	Facilities with Detectable Emissions (n)	Facilities Without Detectable Emissions (n)	Total Emission Sources (n)
Deep Basin	20,635	149	52	98	77
West Central	64,434	509	86	423	205
Total for Alt-FEMP Regions	84,799	658	138	520	282

Table 2: Bridger aerial survey in May 2022.

Region	Total Emissions Detected (m³/day)	Unique Facilities Screened (n)	Facilities with Detectable Emissions (n)	Facilities Without Detectable Emissions (n)	Total Emission Sources (n)
Deep Basin	13,532	105	43	62	81
West Central	41,710	585	122	463	154
Total for Alt-FEMP Regions	55,242	690	165	525	265

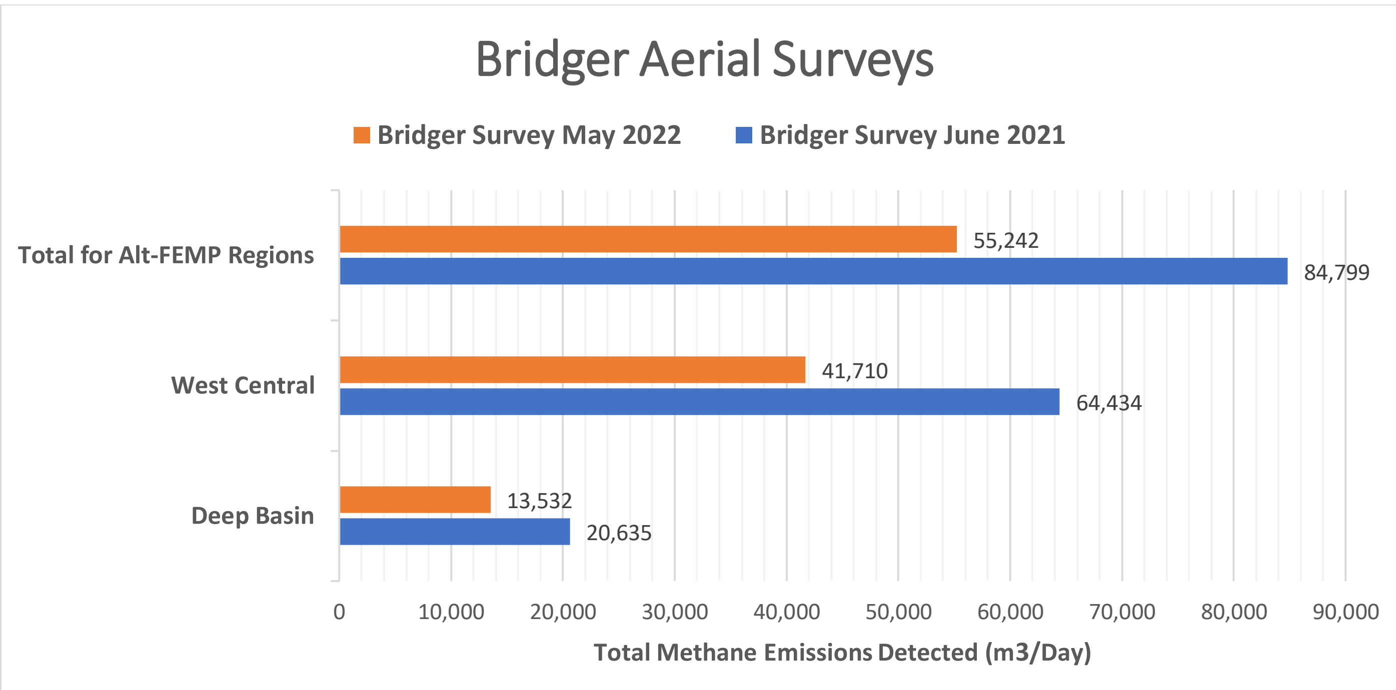

Figure 1: Comparison of total methane emissions detected in year 1 and year 2 of Alt-FEMP pilot by Bridger.

Figure 1 shows that Bridger detected 34 % less total emissions in Year 2 as compared to Year 1.

Table 3: OGI follow-up for Bridger aerial survey in June 2021 and May 2022.

Pilot Year	Percentage of Sites followed up %	Total Methane Emissions Detected after OGI Follow-up (m³/day) for Alt-FMEP Regions	Percentage of Screening Emissions Detected on Follow-Up Campaign (%)
Year 1 – 2021	21 %	1571	2%
Year 2 – 2022	20 %	545	1%

Table 3 summarizes the total emissions detected by the OGI follow-up survey after the Bridger Aerial survey in June 2021 and May 2022. For Year 1 (2021) the follow-up survey was meant to occur at the top 30% of the highest emitting sites, however Bridger only detected emissions at 21% of the surveyed facilities. Thus, all facilities with detectable emissions were tasked to be followed-up. For Year 2 (2022) the follow-up survey was meant to occur at the top 20% of the highest emitting sites, Bridger was able to detect the emissions at 22 % of the surveyed facilities. Thus, facilities within the top 20% of the highest emitting sites were tasked to be followed-up.

3.3.2. Truck Mounted Surveys

As part of year one of Bonavista's Alt-FEMP, a truck mounted survey was conducted by GeoVerra using ExACT technology in October 2021. Table 4 shows the total methane emissions that were detected during the survey. Also summarized in this table is the number of facilities that were surveyed, the number of facilities with detectable emissions, and the number of facilities without detectable emissions. Facilities where a methane concentration was detected but an emission rate could not be calculated due to environmental conditions are not considered in the sum of emission rates detected during these campaigns.

Table 4: GeoVerra ExACT survey in October in 2021.

Region	Total Emissions Detected (m^3/day)	Unique Facilities Screened (n)	Facilities with Detectable Emissions (n)	Facilities With No Detectable Emissions (n)
Deep Basin	1468	185	123	62
West Central	4895	593	393	201
Total for Alt-FEMP Regions	6362	778	515	263

Table 5 summarizes the total emissions detected by the OGI follow-up survey after the GeoVerra ExACT survey in October 2021. The follow-up survey targeted the top 30% of the highest emitting sites from the screening campaign.

Table 5: OGI follow-up for GeoVerra ExACT survey in October 2021.

Region	Total Methane Emissions Detected after OGI Follow-up (m^3/day)	Percentage of Screening Emissions Detected on Follow-Up Campaign (%)
Deep Basin	1179	80%
West Central	1425	29%
Total for Alt-FEMP Regions	2604	41%

3.3.3. Bridger Aerial Screening vs GeoVerra ExACT Truck Screening

Figure 2 shows that although aerial screening was able to detect significantly more emissions as compared to ExACT truck-based screenings, the follow-up OGI campaigns after the aerial screening detected less fugitive methane per facility visited than the follow-up after the ExACT truck-based screening. This suggests that the truck surveys were more effective at prioritizing sites with methane fugitive leaks than the aerial screening method. Also, it's worth noting that the truck found many more facilities to be leaking than Bridger, but those added to a lower emission rate overall than the what Bridger detected.

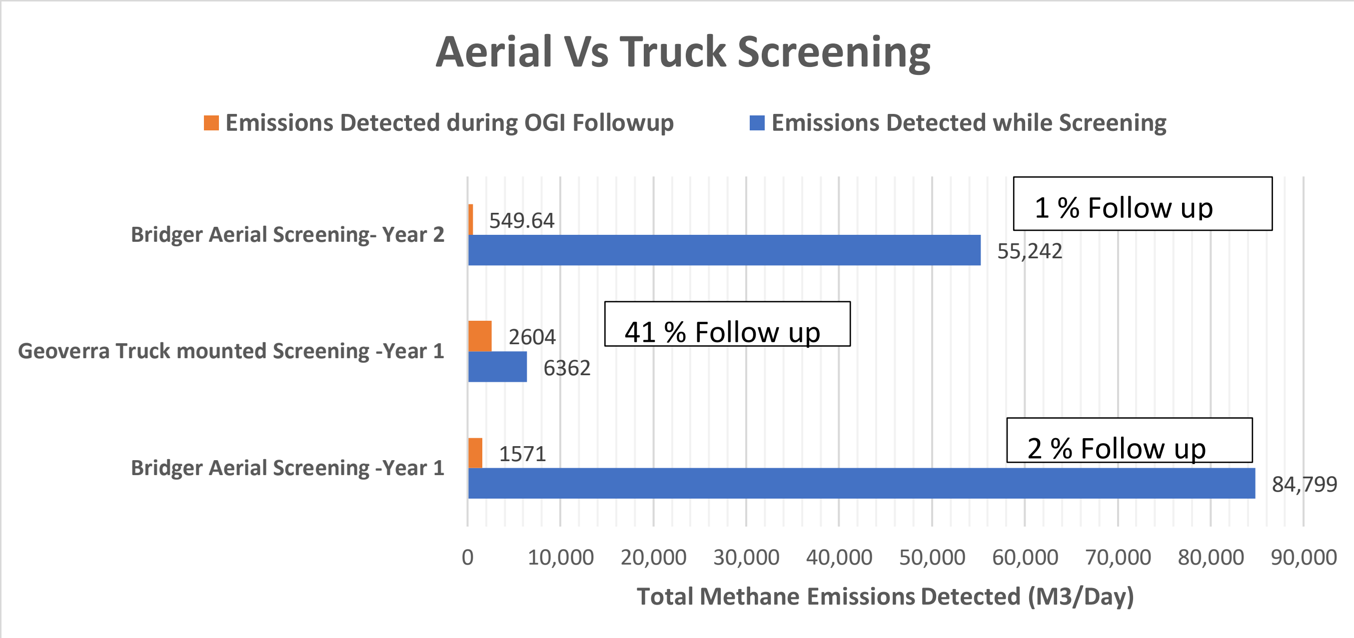

Figure 2: Comparison of total emission detected in year 1 and year 2 of Alt-FEMP pilot by aerial and truck screening campaigns.

3.3.1. Summary of follow up Surveys and Fugitive Repair

Table 6 shows the summary of follow up surveys performed after each screening campaign showing the number of leaks and vents detected and the average time the OGI service provider (Vertex) took to complete the follow-up campaigns once the screening campaigns were completed.

Table 6: Summary of follow-up survey results and leak throughout the alt-FEMP.

Screening Campaign Followed-Up	Number of Surveys with Leaks (n)	Number of Surveys with Vents (n)	Number of Surveys without Leaks or Vents (n)	Average Time from Screening to Follow up OGI Survey (days)
Bridger, June 2021	192	79	160	87
GeoVerra, October 2021	183	303	75	57
Bridger, May 2022	208	359	135	59
Total, Avg	**583**	**741**	**370**	**68**

Table 7 shows the leak detection and repair timeline statistics. The minimum time between leak detection and repair was 0 days, and the maximum was 182 days. Please note that some of the leaks that took more than 30 days to repair were documentation issues which skew the numbers shown in Table 7 below. The number of days to repair leaks also varied due to accessibility issues, parts/service availability, and repair delays to align with planned shutdown schedules.

Table 7: Leak detection and Repair timeline statistics throughout the alt-FEMP.

Region	**Mean Days from Leak Detection to Repair (n)**	**Median Days from Leak Detection to Repair (n)**	**Min Days from Leak Detection to Repair (n)**	**Max Days from Leak Detection to Repair (n)**
Deep Basin	35	30	0	127
West Central	35	30	1	182
Averages for Alt-FEMP Regions	**35**	**30**	**0.5**	**155**
Control	21	17	2	91

Discussions with Vertex – the follow up OGI provider – revealed that the OGI follow up reports and data that they provide to Bonavista do not track leaks and repairs in a way that allows identification of recurring leaks. Vertex is currently investigating whether it is possible to determine the number of recurring leaks using identifiers that are currently only used in the background of their data management system.

4. Emission Reductions Summary

4.1. Year 1 Fugitive Reductions

Table 8 shows the total fugitive methane reductions according to OGI leak detection data collected by Vertex as well as repair datasets maintained by Bonavista. Please refer to the section titled Methodology for more information about how these values were calculated.

Table 8: Total fugitive methane mitigated in year 1.

Region	Total Fugitive Methane Reduced in Year 1 (m^3)	Total Fugitive Methane Reduced by End of Year 2 (Based on Repairs To-Date Only) (m^3)
Deep Basin	35,292	217,129
West Central	61,235	273,135
Total for Alt-FEMP Regions	96,527	490,263
Control Region	20,455	63,760

4.2. Year 2 Fugitive Reductions

Table 9 shows the total fugitive methane reductions according to OGI leak detection data collected by Vertex during year 2 as well as repair datasets To-Date maintained by Bonavista. Please refer to the section titled Calculations for more information about how these values were calculated.

Table 9: Total fugitive methane mitigated in year 2.

Region	Total Fugitive Methane Estimated to be Reduced in Year 2 (m^3)	Total Fugitive Methane Reduced by End of Pilot (Based on Repairs To-Date Year 1 + Repairs To-Date Year 2) (m^3)
Total for Alt-FEMP Regions	139,073	627,497
Control Region	24,460	88,220

Table 9.1: Emission Reductions per facility day for both regions.

Region	No. Of Facilities (n)	Emission Reductions Achieved by End of Year 2 (m^3)	Emissions Reduction per Facility Day (m^3/facility day)
Control Region	40	88,220	3.021
Alt-FEMP Region	779	627,497	1.109

5. Comparison to Modeled Emissions Estimates

5.1. Control Region Comparison to Modelled Emissions Estimates

Table 10 shows a) the AroFEMP model-estimated fugitive emission reductions that would be achieved by the Control Region throughout the two-year pilot timeframe, b) the total real fugitive methane reductions achieved in the control region throughout year one of the pilot (until December 31st 2021), and c) the total real fugitive methane reductions achieved at the end of the two-year pilot (until December 31st 2022) for the control region.

Table 10: Pilot FEMP Control Region fugitive emission reduction progress compared to AroFEMP model estimates.

Program (Control Region)	AroFEMP Modeled Methane Emissions for Full Two-Year Pilot (m^3)	Real Emission Reductions Achieved in Year 1 (m^3)	Real Emission Reductions Achieved by Full 2 Year Pilot (m^3)	Percentage of Model Predicted Reductions Achieved by Actual Pilot Alt-FEMP Repairs to Date (%)
Default (OGI)	517,008	20,455	88,220	17 %

The model estimated that over two years the default FEMP in the Control region would achieve approximately 517 e^3m^3 absolute methane reductions. By the end of the pilot, Bonavista's Control Region had achieved 63,760 m3 of reductions from repairs completed in the first year and 24,460 m^3 of reductions from repairs completed in the second year. Thus, Bonavista's Control region achieved approximately 17 % of the model-estimated reductions relative to the baseline (no LDAR) scenario.

5.2. Alt-FEMP Comparison to Modeled Emissions Estimates

Table 11 shows a) the AroFEMP model-estimated fugitive emission reductions that would be achieved by the alt-FEMP throughout the two-year pilot, b) the total real fugitive methane reductions throughout year one of the alt-FEMP pilot (until December 31st 2021), and c) the total real fugitive methane reductions achieved at end of the two-year pilot (until December 31st 2022).

Table 11: Alt-FEMP fugitive emission reduction progress compared to AroFEMP model estimates.

Program (Alt-FEMP Regions)	AroFEMP Modeled Methane Emissions for Full Two-Year Pilot (m^3)	Modeled Emission Reductions for Full Two-Year Pilot (Compared to Baseline) (m^3)	Emission Reductions Achieved by Year 1 Repairs (Reductions Earned in Year 1 (m^3) + Reductions Earned in Year 2) (m^3)	Emission Reductions Achieved by Year 2 Repairs (m^3)	Emission Reductions for Full 2 Year Alt-FEMP	Percentage of Model Predicted Reductions Achieved by Actual Pilot Alt-FEMP Repairs to Date (%)
Baseline (No LDAR)	16,072,306	-	-	-		-
Default (OGI)	9,431,572	6,640,734	-	-		-
Alt-FEMP	9,661,459	6,411,847	96,527 (year 1 only) 490,263 (year 1 and 2)	139,073	629,336	10 %

The model estimated that the two-year alt-FEMP (including both the Deep Basin and West Central regions) would achieve roughly 6,411 e^3m^3 absolute methane reductions relative to the baseline (no LDAR) scenario. By the end of the pilot, Bonavista's alt-FEMP had achieved 490 e3m3 from repairs in its first year and 139 e3m3 from repairs in its second year. Adding the reductions from year one repairs and year two repairs shows that Bonavista's alt-FEMP achieved 10% of the model-estimated reductions."

Overall, the real performance relative to the model predicted performance was similar for both the control region (17%) and the alt-FEMP regions (10%). Both programs resulted in less emission reductions than the model predicted on an absolute basis. Further analysis was performed to understand the discrepancy between the model estimated reductions and the actual reductions achieved in the pilot alt-FEMP. This analysis is presented in the following section.

5.3. Understanding the Discrepancy between the Model Estimated Reductions and Actual Reductions

To better understand the discrepancy between the model estimated reductions and actual reductions, the leak distribution that was used in the AroFEMP model was compared to the OGI measurements that were collected throughout the Control and alt-FEMP regions in 2021 and in 2022 (Figure 3). Table 12 shows the statistics from each of these distributions for direct comparison.

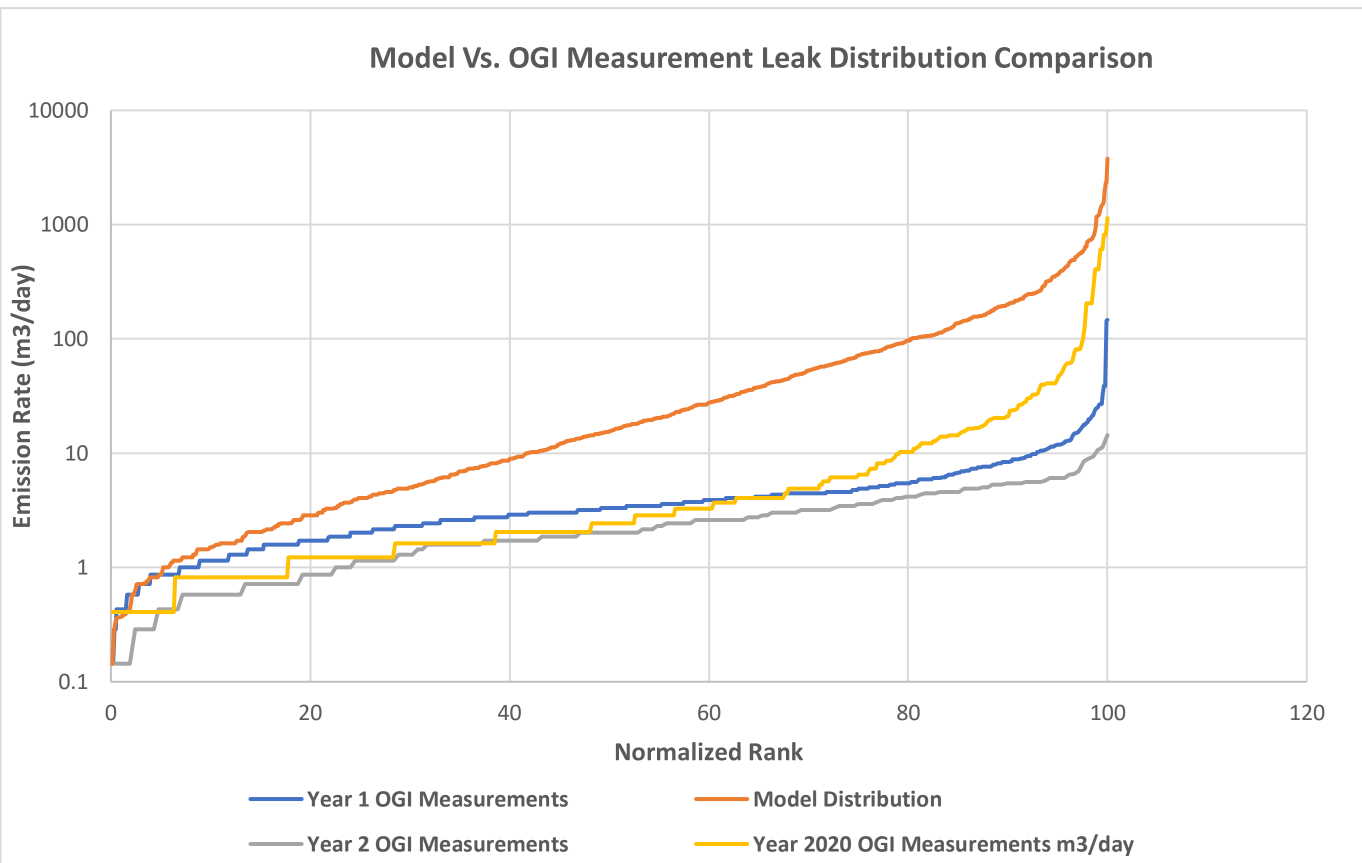

Figure 3: Comparison between the leak distribution used for AroFEMP modeling and the distribution of OGI fugitive emission measurements collected throughout the two years of the alt-FEMP pilot.

Table 12: Distribution statistics for the leak distribution used for AroFEMP modeling and the distribution of OGI fugitive emission measurements collected in year one and two of the alt-FEMP pilot.

Distribution	**Mean m^3/day**	**Median m^3/day**	**Min m^3/day**	**Max m^3/day**
Model Distribution	85.01	15.54	0.14	3780.78
Year 2020 OGI Measurements	18.31	2.48	0.408	1141.78
Year 2021 OGI Measurements (Year 1)	4.70	3.32	0.14	146.95
Year 2022 OGI Measurements (Year 2)	2.64	2.016	0.14	14.44

Due to the lack of company specific data in 2021, the leak distribution used in AroFEMP modeling included a combination of Bonavista fugitive emission data from 2020 as well as a generic leak distribution dataset from Alberta upstream oil and gas to make the dataset statistically acceptable. As can be seen in Figure 3 and Table 12, the distributions from year one and two OGI measurements contain much smaller leaks than the distribution used in the model or observed in 2020. As a result, it is likely that the AroFEMP model simulated and repaired larger leaks than were realistically present during the pilot alt-FEMP, thereby over-estimating the fugitive reductions that could be achieved by Bonavista's alt-FEMP and default program. It is likely that the larger leaks discovered during the 2020 FEMP were repaired and did not re-occur, leaving only smaller leaks to be discovered and repaired during the pilot alt-FEMP and leading to lesser fugitive emission reductions.

Table 13: Emission reduction progress during different years.

Year	Emission Reductions Achieved by Repairs in Indicated Year, During Indicated Year (m^3)	Emission Reductions Achieved by Repairs in Indicated Year, from Indicated Year Start to End of Year 2022 (m^3)	Ranking of Emission Reductions Achieved
2020 (Jan 1 – Dec 31)	849,239	3,535,633	1
2021 (May 1 – Dec 31)	96,527	490,263	2
2022 (Jan 1 – Dec 31)	139,073	139,073	3

Furthermore, in 2020 Bonavista employed a default FEMP in accordance with D 060 before the implementation of the pilot alt-FEMP in 2021-2022, where 573 leaks at 207 facilities were found and repaired. The leaks ranged between 0.408 m^3/day and 1141 m^3/day, summing up to 10,477 m^3/day in total. The emission reductions achieved by the default FEMP in 2020 were 849,239 m^3. Figure 3, Table 12 and Table 13 provide evidence that the majority of large leaks in Bonavista's infrastructure were detected and repaired in 2020, leaving only smaller fugitive leaks to be detected during the alt-FEMP.

This analysis suggests that Bonavista's leak distribution initially consisted of more frequent large leaks which were preferentially and successfully repaired through implementation of FEMPs, thereby successively decreasing the size of leaks in Bonavista's leak distribution. While the emissions reductions achieved during the pilot alt-FEMP were lower than those predicted by the modelling, the steady decrease in the leak sizes in Bonavista's leak distribution suggests that Bonavista is successfully decreasing its fugitive emissions each year.

In addition, while the pilot alt-FEMP only achieved 10% of the model predicted fugitive emission reductions, it achieved 37% of the reductions per facility day that the control region achieved. As the leak distribution in the control region should be affected by the FEMP activities in a similar way to the leak distribution in the alt-FEMP region, this should be a more accurate measure of the performance of the alt-FEMP.

6. Technology Limitation

6.1. Weather Effects:

It is well understood that Bridger's GML technology cannot currently detect and measure methane emissions if there is snow on the ground. As the screenings were conducted in the months of May and June with no snow, this limitation did not cause any disruptions to the screenings or interfere with the screening data collected by Bridger. The weather had no impact on the GeoVerra ExACT screening.

6.2. Measurements:

It was observed that Bridger detected significantly more total emissions rate than the truck-based ExACT screenings. We believe this is because a) the aerial surveys captured fugitive, vented, and episodic operations-related emissions, and b) the aerial surveys capture cumulative emissions from sources at all heights above ground level whereas ExACT is more likely to only capture emissions from sources near ground-level.

6.3. Detection Limits:

Bridger's GML: The smallest detection of methane emissions had a rate of 19 m^3/day (June 2021). Given this technology's minimum detection limit (MDL) of 106 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. Further results from the pilot alt-FEMP suggest that Bridger's screenings are also effective at revealing leaks below the MDL of 106 m^3/day. In the pilot alt-FEMP 44% of the leaks that were identified during follow up at the sites flagged by Bridger were below 106 m^3/day, demonstrating that the Bridger screenings led to the discovery of many leaks below the accepted MDL. The leaks below Bridger's MDL only accounted for 21% of the total emission rates discovered throughout the alt-FEMP. This demonstrates that the use of Bridger aerial screening technology still led to the discovery of many leaks below the stated MDL of 106 m^3/day. Therefore, Bridger is very well suited to identifying the leaks with the greatest impact on overall fugitive emissions while still being effective at revealing smaller leaks with a lesser but significant impact on overall fugitive emissions.

GeoVerra's ExACT: The smallest detection of methane emissions had a rate of 0.00785 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 slightly higher, and it could therefore be argued that GeoVerra's ExACT performed as expected.

OGI's FLIR G320: The smallest detection of methane emissions had a rate of 0.14 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.

7. Success of the Alt-FEMP

Bonavista successfully utilized the alternative technologies combined with OGI follow-up surveys to cost-effectively detect and quantify methane emissions. During this Alt-FEMP, numerous learnings were gathered that will be utilised to design Bonavista's next Alt-FEMP.

Both alternative technologies performed as expected or better based on their published minimum detection limits. Aerial screenings conducted by Bridger's Gas Mapping LiDAR detected significantly more total emissions than the truck-based GeoVerra ExACT screenings. Bonavista believes this is because a) the aerial surveys captured fugitive, vented, and episodic operations-related emissions, and b) the aerial surveys capture cumulative emissions from sources at all heights above ground level, whereas GeoVerra ExACT is more likely to only capture emissions from sources near ground-level. As Bridger's technology detected considerably more emissions than the GeoVerra screening, this may suggest that GeoVerra ExACT underestimated site-level emissions, or more likely that high-emitting vents and/or leaks appeared before and after the GeoVerra ExACT screening in this instance. Furthermore, it was observed that Bridger detected 34% less total emissions in Year 2 as compared to Year 1 indicating that the magnitude of leaks in Bonavista's leak distribution is decreasing with each year of alt-FEMP implementation (large leaks are being repaired and are not reoccurring).

The Bridger aerial screening required fewer OGI follow-ups than the ExACT truck-based screening because leaks were only detected at 21% of sites during the first screening campaign whereas leaks were detected at 30% of sites during the truck screening. For Year 1 (June 2021), the follow-up was meant to survey the top 30% of the highest emitting sites identified by Bridger, however, Bridger only detected emissions at 21% of the screened facilities. Thus, all facilities with detectable emissions were tasked to be followed-up. The follow-up OGI campaigns after the aerial screening detected less fugitive methane per facility visited than the follow-up after the ExACT truck-based screening. This suggests that truck surveys were more effective at prioritizing sites with fugitive methane leaks than the aerial screening method. Furthermore, if the follow up campaign after the first aerial screening included 30% of sites instead of only including sites with detected emissions (21%), the OGI follow up campaign would have been able to detect more leaks due to the additional site surveys (9% more sites).

The OGI technology 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 the OGI technology were less than the total emissions detected by alternative technologies for each of the three screenings/campaigns. This difference was considerably larger for the Bridger screenings than for the truck screening. 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. These factors may include 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. Overall, the combined use of alternative and OGI technologies successfully and cost-effectively detected fugitive emissions at the majority of sites.

Based on leak repairs made to-date, the pilot alt-FEMP achieved 10% (629,336 m^3) of the model-estimated fugitive emission reductions while the control region achieved 17% of the model-estimated fugitive emission reductions. However, as the leak distribution used in the modeling was found to contain leaks that were much larger than any of the leaks that were discovered throughout the pilot alt-FEMP, the model likely overpredicted the fugitive emission reductions that could be achieved by both the alt-FEMP and the default FEMP. This issue artificially contributes to the actual fugitive reductions appearing lower than the model-estimated reductions; however, the extent of their contribution is unknown. It can only be concluded that, in reality, the pilot alt-FEMP achieved more than 10% of the predicted fugitive reductions, but not how much more.

Due to these confounding factors, it is more appropriate to gauge the performance of the alt-FEMP by comparing it to the performance of the control region as the control region is also affected by these factors and should be affected to a similar extent. Evaluation of the reductions per facility day in Table 9.1 revealed that the alt-FEMP achieved 37% of the reductions per facility day that were achieved by the control region employing the default FEMP. This suggests that the alt-FEMP achieved approximately 37% of the fugitive reductions that would have been achieved by implementation of the default FEMP in the alt-FEMP region. While this still falls below the target of equivalent fugitive reductions, it is considerably better performance than the 10% suggested by the model results.

It was found that the leak distribution used in the AroFEMP model contained larger leaks than were actually observed by OGI in the Alt-FEMP and Control regions throughout 2021 and 2022. The model distribution was informed by 2020 LDAR data and a generic Alberta OGI dataset, and it appears that most large leaks were addressed during the 2020 LDAR campaign and have not recurred. This means that the leak distribution used for modeling may have resulted in the fugitive reductions being overestimated for both the alt-FEMP and control regions. In conclusion, the leaks observed throughout 2021 -2022 are much smaller than the leaks observed in 2020. Bonavista will use the updated leak distribution datasets collected during the pilot program to generate more accurate emission reduction targets for the alt-FEMP full scale program.

Overall, Bonavista was successfully able to implement the designed Alt-FEMP. The magnitude of the leaks in Bonavista’s leak distribution appeared to decrease each year as a result of more large leaks being repaired and not recurring. This suggests that Bonavista’s fugitive emissions decreased throughout the alt-FEMP implementation. Going forward Bonavista will utilize the key learnings to update their full-scale alt-FEMP design.

8. Non-Performing Program Elements

For Year 1 (June 2021) the follow-up survey was meant to occur at the top 30% of the highest emitting sites for Bridger, however Bridger only detected emissions at 21% of the surveyed facilities. All facilities with detectable emissions were tasked to be followed-up. Hence, it is safe to say if the follow-up OGI campaigns after the first aerial screening were done on 30 % there is a high chance more leaks could have detected contributing towards more reductions.